

References

- A, G., Wahr, J. & Zhong, S., 2013. Computations of the viscoelastic response of a 3-D compressible Earth to surface loading: an application to Glacial Isostatic Adjustment in Antarctica and Canada, *Geophys. J. Int.*, **192**(2), 557–572, doi: 10.1093/gji/ggs030.
- Abdalati, W., Krabill, W., Frederick, E., Manizade, S., Martin, C., Sonntag, J., Swift, R., Thomas, R., Yungel, J. & Koerner, R., 2004. Elevation changes of ice caps in the Canadian Arctic Archipelago, *J. Geophys. Res.*, **109**, F04007, doi: 10.1029/2003JF000045.
- Abdelmoula, A., Moakher, M. & Philippe, B., 2015. A Slepian framework for the inverse problem of equivalent gravitational potential generated by discrete point masses, *Inverse Problems in Science and Engineering*, **23**(2), 331–350, doi: 10.1080/17415977.2014.906412.
- Abdulhameed, S., Ratschbacher, L., Jonckheere, R., Gałała, Ł., Enkelmann, E., Käßner, A., Kars, M. A. C., Szulc, A., Kufner, S.-K., Schurr, B., Ringenbach, J.-C., Nakapelyukh, M., Khan, J., Gadoev, M. & Oimahmadov, I., 2020. Tajik basin and southwestern Tian Shan, northwestern India-Asia collision zone: 2. Timing of basin inversion, Tian Shan mountain building, and relation to Pamir-plateau advance and deep India-Asia indentation, *Tectonics*, **39**(5), e2019TC005873, doi: 10.1029/2019TC005873.
- Abelson, J., 2007. The birth of oxygen, *Bull. Amer. Acad.*, **LX**(3), 26–31.
- Abercrombie, R., 2005. The start of something big?, *Nature*, **438**, 171–173.
- Abers, G. A. & Roecker, S. W., 1991. Deep structure of an arc-continent collision: Earthquake relocation and inversion for upper mantle *P* and *S* wave velocities beneath Papua New Guinea, *J. Geophys. Res.*, **96**(B4), 6379–6401.
- Abraham, J. P., Baringer, M., Bindoff, N. L., Boyer, T., Cheng, L. J., Church, J. A., Conroy, J. L., Domingues, C. M., Fasullo, J. T., Gilson, J., Goni, G., Good, S. A., Gorman, J. M., Gouretski, V., Ishii, M., Johnson, G. C., Kizu, S., Lyman, J. M., Macdonald, A. M., Minkowycz, W. J., Moffitt, S. E., Palmer, M. D., Piola, A. R., Reseghetti, F., Schuckmann, K., Trenberth, K. E., Velicogna, I. & Willis, J. K., 2013. A review of global ocean temperature observations: Implications for ocean heat content estimates and climate change, *Rev. Geophys.*, **51**(3), 450–483, doi: 10.1002/rog.20022.
- Abramowitz, M. & Stegun, I. A., 1965. *Handbook of Mathematical Functions*, Dover, New York.
- Abreu, L. D. & Pereira, J. M., 2015. Measures of localization and quantitative Nyquist densities, *Appl. Comput. Harmon. Anal.*, **38**(3), 524–534, doi: 10.1016/j.acha.2014.08.002.
- Abubakar, A., Habashy, T. M., Lin, Y. & Li, M., 2012. A model-compression scheme for nonlinear electromagnetic inversions, *Geophysics*, **5**, E379–E389, doi: 10.1190/GEO2011–0494.1.
- Ackerley, N., 2012, Estimating the spectra of small events for the purpose of evaluating microseismic detection thresholds, in *GeoConvention 2012: Vision*, pp. 1–10, Canad. Soc. Petrol. Geol.

- Acuña, M. H., Connerney, J. E. P., Wasilewski, P., Lin, R. P., Anderson, K. A., Carlson, C. W., McFadden, J., Curtis, D. W., Mitchell, D., Reme, H., Mazelle, C., Sauvaud, J. A., d’Uston, C., Cros, A., Medale, J. L., Bauer, S. J., Cloutier, P., Mayhew, M., Winterhalter, D. & Ness, N. F., 1998. Magnetic field and plasma observations at Mars: Initial results of the Mars Global Surveyor mission, *Science*, **279**(5357), 1676–1680, doi: 10.1126/science.279.5357.1676.
- Acuña, M. H., Connerney, J. E. P., Ness, N. F., Lin, R. P., Mitchell, D., Carlson, C. W., McFadden, J., Anderson, K. A., Rème, H., Mazelle, C., Vignes, D., Wasilewski, P. & Cloutier, P., 1999. Global distribution of crustal magnetization discovered by the Mars Global Surveyor MAG/ER experiment, *Science*, **284**(5415), 790–793, doi: 10.1126/science.284.5415.790.
- Acuña, M. H., Connerney, J. E. P., Wasilewski, P., Lin, R. P., Mitchell, D., Anderson, K. A., Carlson, C. W., McFadden, J., Rème, H., Mazelle, C., Vignes, D., Bauer, S. J., Cloutier, P. & Ness, N. F., 2001. Magnetic field of Mars: Summary of results from the aerobraking and mapping orbits, *J. Geophys. Res.*, **106**(E10), 23403–23417, doi: 10.1029/2000JE001404.
- Ádám, A., 1976. Quantitative connections between regional heat flow the depth of conductive layers in the Earth’s crust and upper mantle., *Acta Geodaet., Geophys. et Montanist. Acad. Sci. Hung.*, **11**(3–4), 503–509.
- Adam, C. & Bonneville, A., 2005. Extent of the South Pacific Superswell, *J. Geophys. Res.*, **110**(B9), B09408, doi: 10.1029/2004JB003465.
- Adam, C., Vidal, V. & Bonneville, A., 2005, doi: 10.1029/2004GC000814. MiFil: A method to characterize seafloor swells with application to the south central Pacific, *Geochem. Geophys. Geosys.*, **6**(1).
- Adam, C., Yoshida, M., Suetsugu, D., Fukao, Y. & Cadio, C., 2014. Geodynamic modeling of the South Pacific superswell, *Phys. Earth Planet. Inter.*, **229**, 24–39, doi: 10.1016/j.pepi.2013.12.014.
- Adam, D., 2002. Gravity measurement: Amazing grace, *Nature*, **416**, 10–11.
- Afanasiev, M., Peter, D., Sager, K., Simutè, S., Ermert, L., Krischer, L. & Fichtner, A., 2016. Foundations for a multiscale collaborative global earth model, *Geophys. J. Int.*, **204**(1), 39–58, doi: 10.1093/gji/ggv439.
- Afanasiev, M., Boehm, C., van Driel, M., Krischer, L., Rietmann, M., May, D. A., Knepley, M. G. & Fichtner, A., 2019. Modular and flexible spectral-element waveform modelling in two and three dimensions, *Geophys. J. Int.*, **216**(3), 1675–1692, doi: 10.1093/gji/ggy469.
- Agius, M. R., Rychert, C. A., Harmon, N. & Laske, G., 2017. Mapping the mantle transition zone beneath Hawaii from Ps receiver functions: Evidence for a hot plume and cold mantle downwellings, *Earth Planet. Sci. Lett.*, **474**, 226–236, doi: 10.1016/j.epsl.2017.06.033.
- Agius, M. R., Rychert, C. A., Harmon, N., Tharimena, S. & Kendall, J.-M., 2021. A thin mantle transition zone beneath the equatorial Mid-Atlantic Ridge, *Nature*, **589**(7843), 562–566, doi: 10.1038/s41586-020-03139-x.

- Agnew, D., 2015, Earth tides, in *Treatise on Geophysics*, edited by T. Spohn, vol. 10, pp. 151–178, doi: 10.1016/B978-0-444-53802-4.00058-0, Elsevier, Amsterdam, Neth., 2nd edn.
- Agnew, D. C., 1986. Strainmeters and tiltmeters, *Rev. Geophys.*, **24**(3), 579–624.
- Aguilar, L., Walton, G. & Wieman, C., 2014. Psychological insights for improved physics teaching, *Physics Today*, **67**(5), 43–49, doi: 10.1063/PT.3.2383.
- Aharonson, O., Zuber, M. T., Neumann, G. A. & Head, J. W., 1998. Mars: Northern hemisphere slopes and slope distributions, *Geophys. Res. Lett.*, **25**(24), 4413–4416.
- Aharonson, O., Zuber, M. T. & Rothman, D. H., 2001. Statistics of Mars’ topography from the Mars Orbiter Laser Altimeter: Slopes, correlations, and physical models, *J. Geophys. Res.*, **106**(E10), 23723–23735, doi: 10.1029/1998GL900057.
- Aharonson, O., Zuber, M. T., Rothman, D. H., Schorghofer, N. & Whipple, K. X., 2001. Drainage basins and channel incision on Mars, *Proc. Natl. Acad. Sci.*, **99**(4), 1780–1783.
- Aharonson, O., Zuber, M. T. & Solomon, S. C., 2004. Crustal remanence in an internally magnetized non-uniform shell: a possible source for Mercury’s magnetic field?, *Earth Planet. Sci. Lett.*, **218**(3), 261–268, doi: 10.1016/S0012-821X(03)00682-4.
- Ahmed, A., Sharma, M. L. & Sharma, A., 2007. Wavelet based automatic phase picking algorithm for 3-component broadband seismological data, *J. Seismol. Earthq. Eng.*, **9**(1–2), 15–24.
- Aich, M., 2007, CMB temperature and polarization anisotropies on an incomplete sky, Graduate school project, Inter-University Centre for Astronomy and Astrophysics.
- Akaike, H., 1964. Statistical measurement of frequency response function, *Ann. Inst. Statist. Math.*, **3**, 5–17.
- Akaike, H., 1969. Power spectrum estimation through autoregressive model fitting, *Ann. Inst. Statist. Math.*, **21**(1), 407–419.
- Akaike, H., 1998, Information theory and an extension of the maximum likelihood principle, in *Selected Papers of Hirotugu Akaike*, edited by E. Parzen, K. Tanabe, & G. Kitagawa, pp. 199–213, doi: 10.1007/978-1-4612-1694-0_15, Springer, New York.
- Akçelik, V., Biros, G. & Ghattas, O., 2002, Parallel multiscale Gauss-Newton-Krylov methods for inverse wave propagation, in *Proc. Conf. Supercomputing*, p. doi: 10.1109/SC.2002.10002, ACM/IEEE.
- Akçelik, V., Bielak, J., Biros, G., Epanomeritakis, I., Fernández, A., Ghattas, O., Kim, E. J., López, J., O’Hallaron, D., Tu, T. & Urbanic, J., 2003, High resolution forward and inverse earthquake modeling on terascale computers, in *Proc. Conf. Supercomputing*, pp. 52, doi: 10.1109/SC.2003.10056, ACM/IEEE.
- Aki, K., 1957. Space and time spectra of stationary stochastic waves, with special reference to microtremors, *Bull. Earthquake Res. Inst.*, **35**, 415–456.

- Aki, K., 1967. Scaling law of seismic spectrum, *J. Geophys. Res.*, **72**(4), 1217–1231.
- Aki, K. & Lee, W. H. K., 1976. Determination of three-dimensional velocity anomalies under a seismic array using 1st-P arrival times from local earthquakes. 1. A homogeneous initial model, *J. Geophys. Res.*, **81**(23), 4381–4399, doi: 10.1029/JB081i023p04381.
- Aki, K. & Richards, P. G., 1980. *Quantitative Seismology*, Freeman, San Francisco, Calif., 1st edn.
- Aki, K. & Richards, P. G., 2002. *Quantitative Seismology*, University Science, Sausalito, Calif., 2nd edn.
- Aki, K., Christoffersson, A. & Husebye, E. S., 1977. Determination of the three-dimensional seismic structure of the lithosphere, *J. Geophys. Res.*, **82**(2), 277–296.
- Al-Dajani, A., Alkhalifah, T. & Morgan, F. D., 1999. Reflection moveout inversion in azimuthally anisotropic media: accuracy, limitations and acquisition, *Geophys. Prospect.*, **47**, 735–756.
- Albee, A. L., Palluconi, F. D. & Arvidson, R., 1998. Mars Global Surveyor mission: Overview and status, *Science*, **279**(5357), 1671–1672, doi: 10.1126/science.279.5357.1671.
- Albee, A. L., Arvidson, R. E., Palluconi, F. & Thorpe, T., 2001. Overview of the Mars Global Surveyor mission, *J. Geophys. Res.*, **106**(E10), 23291–23316, doi: 10.1029/2000JE001306.
- Albertella, A. & Rummel, R., 2009. On the spectral consistency of the altimetric ocean and geoid surface: a one-dimensional example, *J. Geod.*, **83**(9), 805–815, doi: 10.1007/s00190-008-0299-5.
- Albertella, A. & Sacerdote, F., 2001. Using Slepian functions for local geodetic computations, *Boll. Geod. Sc. Aff.*, **60**(1), 1–14.
- Albertella, A., Sansò, F. & Sneeuw, N., 1999. Band-limited functions on a bounded spherical domain: the Slepian problem on the sphere, *J. Geod.*, **73**, 436–447.
- Albertella, A., Savcenko, R., Bosch, W. & Rummel, R., 2008, Dynamic Ocean Topography — The Geodetic Approach, Tech. Rep. 27, Institut für Astronomische und Physikalische Geodäsie, Forschungseinrichtung Satellitengeodäsie, München.
- Aldrich, J., 1997. R. a. Fisher and the making of maximum-likelihood 1912–1922, *Stat. Sci.*, **12**(3), 162–176.
- Alkhalifah, T., 2016. Full-model wavenumber inversion: An emphasis on the appropriate wavenumber continuation, *Geophysics*, **81**(3), R89–R98, doi: 10.1190/geo2015-0537.1.
- Alkhalifah, T. & Choi, Y., 2012. Taming waveform inversion non-linearity through phase unwrapping of the model and objective functions, *Geophys. J. Int.*, **191**(3), 1171–1178, doi: 10.1111/j.1365-246X.2012.05699.x.
- Allaire, G. & Kaber, S. M., 2008. *Numerical Linear Algebra*, Springer.

- Allen, R. M. & Kanamori, H., 2003. The potential for earthquake early warning in Southern California, *Science*, **300**, 786–789, doi: 10.1126/science.1080912.
- Allen, R. V., 1978. Automatic earthquake recognition and timing from single traces, *B. Seismol. Soc. Am.*, **68**(5), 1521–1532.
- Allen, R. V., 1982. Automatic phase pickers: Their present use and future prospects, *B. Seismol. Soc. Am.*, **72**(6), S225–S242.
- Alley, R. B., Marotzke, J., Nordhaus, W. D., Overpeck, J. T., Peteet, D. M., Jr., R. A. P., Pierrehumbert, R. T., Rhines, P. B., Stocker, T. F. & andn J. M. Wallace, L. D. T., 2003. Abrupt climate change, *Science*, **299**(5615), 2005–2010, doi: 10.1126/science.1081056.
- Alley, R. B., Clark, P. U., Huybrechts, P. & Joughin, I., 2005. Ice-sheet and sea-level changes, *Science*, **310**(5747), 456–460, doi: 10.1126/science.1114613.
- Alsina, D., Snieder, R. & Maupin, V., 1993. A test of the great-circle approximation in the analysis of surface-waves, *Geophys. Res. Lett.*, **20**(10), 915–918.
- Amado, R. D., Stricker-Bauer, K. & Sparrow, D. A., 1985. Semiclassical methods and the summation of the scattering partial wave series, *Phys. Rev. C*, **32**(1), 329–332.
- Amatya, A. Y., 2021, *Receiver Function Analysis of the Mantle Transition Zone Beneath Cape Verde*, A. B. Thesis, Princeton University.
- Amirbekyan, A., 2007, *The application of reproducing kernel based spline approximation to seismic surface and body wave tomography: Theoretical aspects and numerical results*, Ph.D. thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern, <http://kluedo.ub.uni-kl.de/volltexte/2007/2103/>.
- Amirbekyan, A. & Michel, V., 2007. Splines on the 3-dimensional ball and their application to seismic body wave tomography, *Schriften zur Funktionalanalysis und Geomathematik*, **33**.
- Amirbekyan, A. & Michel, V., 2008. Splines on the 3-dimensional ball and their application to seismic body wave tomography, *Inv. Probl.*, **24**, 015022, doi: 10.1088/0266–5611/24/1/015022.
- Amirbekyan, A., Michel, V. & Simons, F. J., 2005. The applicability of harmonic spherical splines to seismic surface wave tomography, *Geophys. Res. Abstr.*, **7**, 04740.
- Amirbekyan, A., Michel, V. & Simons, F. J., 2008. Parameterizing surface-wave tomographic models with harmonic spherical splines, *Geophys. J. Int.*, **174**(2), 617–628, doi: 10.1111/j.1365–246X.2008.03809.x.
- Amit, H., Christensen, U. R. & Langlais, B., 2011. The influence of degree-1 mantle heterogeneity on the past dynamo of Mars, *Phys. Earth Planet. Inter.*, **189**, 63–79, doi: 10.1016/j.pepi.2011.07.008.
- Ammann, M. W., Brodholt, J. P., Wookey, J. & Dobson, D. P., 2010. First-principles constraints on diffusion in lower-mantle minerals and a weak D” layer, *Nature*, **465**(7297), 462–465.

- Ammon, C. J., 1991. The isolation of receiver effects from teleseismic *P* waveforms, *B. Seismol. Soc. Am.*, **81**(6), 2504–2510.
- Ammon, C. J., Ji, C., Thio, H.-K., Robinson, D., Ni, S., Hjörleifsdóttir, V., Kanamori, H., Lay, T., Das, S., Helmberger, D., Ichinose, G., Polet, J. & Wald, D., 2004. Rupture process of the 2004 Sumatra-Andaman earthquake, *Science*, **308**(5725), 1133–1139, doi: 10.1126/science.1112260.
- Amos, D. E., 1986. Algorithm 644: A portable package for Bessel functions of a complex argument and nonnegative order, *ACM T. Math. Software*, **12**(3), 265–273.
- An, Y., Gu, Y. J. & Sacchi, M. D., 2007. Imaging mantle discontinuities using least squares Radon transform, *J. Geophys. Res.*, **112**, B10303, doi: 10.1029/2007JB005009.
- Anant, K. S. & Dowla, F. U., 1997. Wavelet transform methods for phase identification in three-component seismograms, *B. Seismol. Soc. Am.*, **87**(6), 1598–1612.
- Anderes, E. B. & Stein, M. L., 2008. Estimating deformations of isotropic Gaussian random fields on the plane, *Ann. Stat.*, **36**(2), 719–741.
- Anderson, D. L., 1961. Elastic wave propagation in layered anisotropic media, *J. Geophys. Res.*, **66**, 2953–2963.
- Anderson, D. L., 2000. The statistics of Helium isotopes along the global spreading ridge system and the Central Limit Theorem, *Geophys. Res. Lett.*, **27**(16), 2401–2404.
- Anderson, D. L., 2000. The thermal state of the upper mantle; no role for mantle plumes, *Geophys. Res. Lett.*, **27**(22), 3623–3626.
- Anderson, D. L., 2001. Top-down tectonics?, *Science*, **293**, 2016–2018.
- Anderson, D. L., 2001. A statistical test of the two reservoir model for Helium isotopes, *Earth Planet. Sci. Lett.*, **193**, 77–82.
- Anderson, D. L. & Bass, J. D., 1984. Mineralogy and composition of the upper mantle, *Geophys. Res. Lett.*, **11**, 637–640.
- Anderson, D. L. & Dziewoński, A. M., 1982. Upper mantle anisotropy: Evidence from free oscillations, *Geophys. J. R. Astron. Soc.*, **69**, 383–404.
- Anderson, D. L. & Hart, R. S., 1978. *Q* of the Earth, *J. Geophys. Res.*, **83**(B12), 5869–5880.
- Anderson, D. L., Duennebier, F. K., Latham, G. V., Toksöz, M. N., Kovach, R. L., Knight, T. C. D., Lazarewicz, A. R., Miller, W. F., Nakamura, Y. & Sutton, G., 1976. The Viking Seismic Experiment, *Science*, **194**, 1318–1321.
- Anderson, D. L., Kanamori, H., Hart, R. S. & Liu, H.-P., 1977. The Earth as a seismic absorption band, *Science*, **196**, 1104–1106.
- Anderson, E., Bai, Z., Bischof, C., Blackford, S., Demmel, J., Dongarra, J., Croz, J. D., A. Greenbaum, Hammarling, S., McKenney, A. & Sorensen, D., 2000. *LAPACK Users' Guide*, Society for Industrial and Applied Mathematics, 3rd edn.

- Anderson, F. S. & Smrekar, S. E., 2001. Global admittance estimates of elastic and crustal thickness of Venus: Preliminary results from top and bottom loading models, *32nd Lunar Planetary Science Conference*, p. 2182.
- Anderson, F. S. & Smrekar, S. E., 2005. Global mapping of crustal and lithospheric thickness of Venus, *J. Geophys. Res.*, **111**, E08006, doi: 10.1029/2004JE002395.
- Anderson, O. L., 1999. A thermal balancing act, *Science*, **283**, 1652–1653.
- Anderson, W. L., 1979. Computer Program: Numerical integration of related Hankel transforms of orders 0 and 1 by adaptive digital filtering, *Geophysics*, **44**(7), 1287–1305.
- Andrews, J. & Deuss, A., 2008. Detailed nature of the 660 km region of the mantle from global receiver function data, *J. Geophys. Res.*, **113**(B6), B06304 doi: 10.1029/2007JB005111.
- Andrews-Hanna, J. C., Zuber, M. T. & Banerdt, W. B., 2008. The Borealis basin and the origin of the martian crustal dichotomy, *Nature*, **453**, 1212–1215, doi: 10.1038/nature07011.
- Angrisano, A., Gaglione, S. & Gioia, C., 2013. Performance assessment of GPS/GLONASS single point positioning in an urban environment, *Acta Geod. Geophys.*, **48**, 149–161, doi: 10.1007/s40328-012-0010-4.
- Ansorge, J. & Mueller, S., 1973. The *P*-wave structure of the uppermost mantle in Europe based on long-range explosion observations, *Zeitschrift für Geophysik*, **39**, 385–394.
- Anthony, R. E., Ringler, A. T., Wilson, D. C. & Wolin, E., 2019. Do low-cost seismographs perform well enough for your network? An overview of laboratory tests and field observations of the OSOP Raspberry Shake 4D, *Seismol. Res. Lett.*, **90**(1), 219–228, doi: 10.1785/0220180251.
- Antoine, J.-P. & Vandergheynst, P., 1998. Wavelets on the *n*-sphere and related manifolds, *J. Math. Phys.*, **39**(8), 3987–4008.
- Antoine, J.-P. & Vandergheynst, P., 1999. Wavelets on the 2-sphere: A group-theoretical approach, *Appl. Comput. Harmon. Anal.*, **7**, 262–291.
- Antoine, J.-P., Demanet, L., Jacques, L. & Vandergheynst, P., 2002. Wavelets on the sphere: implementation and approximations, *Appl. Comput. Harmon. Anal.*, **13**, 177–200.
- Antoni, M., Keller, W. & Weigelt, M., 2008. Regionale Schwerefeldmodellierung durch regionale Schwerefeldmodellierung durch Slepian- und radiale Basisfunktionen, *Zeitschrift für Geodäsie, Geoinformation und Landmanagement*, **133**, 120–129.
- Appel, W., 2007. *Mathematics for Physics and Physicists*, Princeton Univ. Press, Princeton, N.J.
- Appourchaux, T., Gizon, L. & Rabello-Soares, M.-C., 1998. The art of fitting p-mode spectra. I. Maximum likelihood estimation, *Astron. Astroph. Suppl. Ser.*, **132**, 107–119.
- Appourchaux, T., Rabello-Soares, M.-C. & Gizon, L., 1998. The art of fitting p-mode spectra. II. Leakage and noise covariance matrices, *Astron. Astroph. Suppl. Ser.*, **132**, 121–132.

- Aravkin, A. Y. & van Leeuwen, T., 2012. Estimating nuisance parameters in inverse problems, *Inv. Probl.*, **28**(11), 115016, doi: 10.1088/0266-5611/28/11/115016.
- Arendt, A., Bolch, T., Cogley, J. G., Gardner, A., Hagen, J.-O., Hock, R., Kaser, G., Pfeffer, W. T., Moholdt, G., Paul, F., Radić, V., Andreassen, L., Bajracharya, S., Barrand, N. E., Beedle, M., Berthier, E., Bhambri, R., Bliss, A., Brown, I., Burgess, D., Burgess, E., Cawkwell, F., Chinn, T., Copland, L., Davies, B., de Angelis, H., Dolgova, E., Filbert, K., Forester, R. R., Fountain, A., Frey, H., Giffen, B., Glasser, N., Gurney, S., Hagg, W., Hall, D., Haritashya, U. K., Hartmann, G., Helm, C., Herreid, S., Howat, I. M., Kapustin, G., Khromova, T., Kienholz, C., König, M., Kohler, J., Kriegel, D., Kutuzov, S., Lavrentiev, I., Le Bris, R., Lund, J., Manley, W., Mayer, C., Miles, E., Li, X., Menounos, B., Mercer, A., Mölg, N., Mool, P., Nosenko, G., Negrete, A., Nuth, C., Pettersson, R., Racoviteanu, A., Ranzi, R., Rastner, P., Rau, F., Raup, B., Rich, J., Rott, H., Schneider, C., Seliverstov, Y., Sharp, M., Sigurðsson, O., Stokes, C., Wheate, R., Winsvold, S., Wolken, G., Wyatt, F. & Zheltyhina, N., 2013, Randolph Glacier Inventory — A Dataset of Global Glacier Outlines: Version 3.2, Tech. rep., National Snow and Ice Data Center, Boulder, Colo.
- Arendt, A. A., 2011. Assessing the status of Alaska's glaciers, *Science*, **332**(6033), 1044–1045, doi: 10.1126/science.1204400.
- Arendt, A. A., Luthcke, S. B., Gardner, A. S., O'Neel, S., Hill, D., Moholdt, G. & Abdalati, W., 2013. Analysis of a GRACE global mascon solution for Gulf of Alaska glaciers, *J. Glaciol.*, **59**(217), 913–924, doi: 10.3189/2013JoG12J197.
- Argos, 1984. *Location and data collection satellite system user's guide*, Service Argos, Toulouse, France.
- Argos, 1987. *Location and data collection satellite system*, Service Argos, Toulouse, France.
- Argus, D. F. & Gordon, R. G., 1991. No-net-rotation model of current plate velocities incorporating plate motion model Nuvel-1, *Geophys. Res. Lett.*, **18**(11), 2039–2042.
- Arkani-Hamed, J., 2001. A 50-degree spherical harmonic model of the magnetic field of Mars, *J. Geophys. Res.*, **106**(E10), 23197–23208, doi: 10.1029/2000JE001365.
- Arkani-Hamed, J., 2001. Paleomagnetic pole positions and pole reversals of Mars, *Geophys. Res. Lett.*, **28**(17), 3409–3412, doi: 10.1029/2001GL012928.
- Arkani-Hamed, J., 2002. An improved 50-degree spherical harmonic model of the magnetic field of Mars derived from both high-altitude and low-altitude data, *J. Geophys. Res.*, **107**(E10), 5083, doi: 10.1029/2001JE001835.
- Arkani-Hamed, J., 2004. A coherent model of the crustal magnetic field of Mars, *J. Geophys. Res.*, **109**, E09005, doi: 10.1029/2004JE002265.
- Arkani-Hamed, J. & Boutin, D., 2004. Paleomagnetic poles of Mars: Revisited, *J. Geophys. Res.*, **109**, E03011, doi: 10.1029/2003JE002229.

- Arkani-Hamed, J. & Boutin, D., 2012. Is the primordial crust of Mars magnetized?, *Icarus*, **221**, 192–207, doi: 10.1016/j.icarus.2012.07.030.
- Arkani-Hamed, J. & Strangway, D. W., 1986. Band-limited global scalar magnetic anomaly map of the Earth derived from Magsat data, *J. Geophys. Res.*, **91**(B8), 8193–8203.
- Aronson, E., Delap, J., Edwards, F., Maxam, S., Minter, M. & Valenti, D., 2021, Diversity, equity, inclusion annual report 2020–2021, Tech. rep., Princeton University.
- Aronszajn, N., 1950. Theory of reproducing kernels, *Trans. Am. Math. Soc.*, **68**(3), 337–404.
- Artemieva, I., 2011. *The lithosphere: An interdisciplinary approach*, Cambridge Univ. Press.
- Artemieva, I. M., 2009. The continental lithosphere: Reconciling thermal, seismic, and petrologic data, *Lithos*, **109**(1–3), 23–46.
- Artemieva, I. M. & Mooney, W. D., 2001. Thermal thickness and evolution of Precambrian lithosphere: A global study, *J. Geophys. Res.*, **106**(B8), 16387–16414.
- Artyushkov, E. V., 1984. On the origin of the seismic anisotropy of the lithosphere, *Geophys. J. R. Astron. Soc.*, **76**, 173–178.
- Asch, G., 2009, Seismic systems, in *New Manual of Seismological Observatory Practice 2 (NMSOP-2)*, edited by P. Bormann, chap. 6, pp. 1–20, doi: 10.2312/GFZ.NMSOP_r1_ch6, Deutsches GeoForschungsZentrum, IASPEI, Potsdam, Germany.
- Aschwanden, C., 2015. Science isn't broken, <http://fivethirtyeight.com/features/science-isnt-broken/>, **Aug 19 2015** (accessed Sep 14 2015).
- Ash, E., 2018, *Characterizing the seismic noise spectrum of the Princeton University Seismometer*, Junior Paper, Princeton University.
- Ashby, N., 2002. Relativity and the Global Positioning System, *Physics Today*, **55**(5), 41–47.
- Askan, A., Akcelik, V., Bielak, J. & Ghattas, O., 2007. Full waveform inversion for seismic velocity and anelastic losses in heterogeneous structures, *B. Seismol. Soc. Am.*, **97**(6), 1990–2008, doi: 10.1785/0120070079.
- Askan, A., Akcelik, V., Bielak, J. & Ghattas, O., 2010. Parameter sensitivity analysis of a nonlinear least-squares optimization-based anelastic full waveform inversion method, *CR Mécanique*, **338**(7–8), 364–376, doi: 10.1016/j.crme.2010.07.002.
- Aspinall, A., Gaffney, C. & Schmidt, A., 2008. *Magnetometry for Archaeologists*, vol. 2, AltaMira Press, Plymouth, UK.
- Aster, R., Beaudoin, B., Hole, J., Fouch, M., Fowler, J. & James, D., 2005. IRIS seismology program marks 20 years of discovery, *Eos Trans. AGU*, **86**(17), 171–172.
- Aster, R. C., Borchers, B. & Thurber, C. H., 2005. *Parameter Estimation and Inverse Problems*, vol. 90 of **International Geophysics Series**, Elsevier Academic Press, San Diego, Calif.

- Aster, R. C., Borchers, B. & Thurber, C. H., 2013. *Parameter Estimation and Inverse Problems*, Elsevier Academic Press, San Diego, Calif.
- Astiz, L., Earle, P. S. & Shearer, P. M., 1996. Global stacking of broadband seismograms, *Seismol. Res. Lett.*, **67**(4), 8–18.
- Atkinson, G., Bakun, B., Bodin, P., Boore, D., Camer, C., Frankel, A., Gasperini, P., Gomborg, J., Hanks, T., Hermann, B., Hough, S., Johnston, A., Kenner, S., Langston, C., Linker, M., Mayne, P., Petersen, M., Powell, C., Prescott, W., Schweig, E., Segall, P., Stein, S., Stuart, B., Tuttle, M. & VanArsdale, R., 2000. Reassessing the New Madrid seismic zone, *Eos Trans. AGU*, **81**(35), 397 & 402–403.
- Atlas, R., Hoffman, R. N., Bloom, S. C., Jusem, J. C. & Ardizzone, J., 1996. A multiyear global surface wind velocity dataset using SSM/I wind observations, *B. Am. Meteorol. Soc.*, **77**(5), 869–882.
- Audet, P., 2011. Directional wavelet analysis on the sphere: Application to gravity and topography of the terrestrial planets, *J. Geophys. Res.*, **116**, E01003, doi: 10.1029/2010JE003710.
- Audet, P., 2014. Toward mapping the effective elastic thickness of planetary lithospheres from a spherical wavelet analysis of gravity and topography, *Phys. Earth Planet. Inter.*, **226**, 48–82, doi: 10.1016/j.pepi.2013.09.01.
- Audet, P. & Bürgmann, R., 2011. Dominant role of tectonic inheritance in supercontinent cycles, *Nature Geosci.*, **4**(3), 184–187, doi: 10.1038/ngeo1080.
- Audet, P. & Mareschal, J.-C., 2004. Anisotropy of the flexural response of the lithosphere in the Canadian Shield, *Geophys. Res. Lett.*, **31**, L20601, doi: 10.1029/2004GL021080.
- Audet, P. & Mareschal, J.-C., 2004. Variations in elastic thickness in the Canadian Shield, *Earth Planet. Sci. Lett.*, **226**, 17–31.
- Audet, P. & Mareschal, J.-C., 2007. Wavelet analysis of the coherence between Bouguer gravity and topography: application to the elastic thickness anisotropy in the Canadian Shield, *Geophys. J. Int.*, **168**, 287–298, doi: 10.1111/j.1365–246X.2006.03231.x.
- Austin, J., 2003. Interdisciplinarity and tenure, *Science*, p. 2003/01/10.
- Averbuch, A., Coifman, R. R., Donoho, D. L., Elad, M. & Israeli, M., 2006. Fast and accurate Polar Fourier transform, *Appl. Comput. Harmon. Anal.*, **21**, 145–167, doi: 10.1016/j.acha.2005.11.003.
- Axler, S., Bourdon, P. & Ramey, W., 2001. *Harmonic function theory*, Springer, New York, 2nd edn.
- Babacan, A. E., Gelisli, K. & Ersoy, H., 2014. Seismic tomography and surface wave analysis based methodologies on evaluation of geotechnical properties of volcanic rocks: A case study, *J. Earth Sci.*, **25**(2), 348–356.

- Babcock, J. M., Kirkendall, B. A. & Orcutt, J. A., 1994. Relationships between ocean bottom noise and the environment, *B. Seismol. Soc. Am.*, **84**(6), 1991–2007.
- Babcock, J. M., Simons, F. J. & Nolet, G., 2004. An autonomous mid-column float designed to detect earthquakes, *Eos Trans. AGU*, **85**(47), Fall Meet. Suppl., Abstract OS43B–0545.
- Babuška, V. & Cara, M., 1991. *Seismic Anisotropy in the Earth*, vol. 10 of **Modern Approaches in Geophysics**, Kluwer, Boston, Mass.
- Babuška, V., Montagner, J.-P., Plomerová, J. & Girardin, N., 1998. Age-dependent large-scale fabric of the mantle lithosphere as derived from surface-wave velocity anisotropy, *Pure Appl. Geophys.*, **151**, 257–280.
- Bachmann, E. & Tromp, J., 2020. Source encoding for viscoacoustic ultrasound computed tomography, *J. Acoust. Soc. Am.*, **147**(5), 3221–3235, doi: 10.1121/10.0001191.
- Backus, G., 1986. Poloidal and toroidal fields in geomagnetic field modeling, *Rev. Geophys.*, **24**(1), 75–109, doi: 10.1029/RG024i001p00075.
- Backus, G. E., 1962. Long-wave elastic anisotropy produced by horizontal layering, *J. Geophys. Res.*, **67**(11), 4427–4440.
- Backus, G. E., 1964. Geographical interpretation of measurements of average phase velocities of surface waves over great circular and great semi-circular paths, *B. Seismol. Soc. Am.*, **54**, 571–610.
- Backus, G. E., 1965. Possible forms of seismic anisotropy of the uppermost mantle under oceans, *J. Geophys. Res.*, **70**(14), 3429–3439.
- Backus, G. E., 1970. A geometrical picture of anisotropic elastic tensors, *Rev. Geophys. Space Phys.*, **8**(3), 633–671.
- Backus, G. E., 1970. Inference from inadequate and inaccurate data, I, *Proc. Natl. Acad. Sc.*, **65**(1), 1–7.
- Backus, G. E., 1970. Inference from inadequate and inaccurate data, II, *Proc. Natl. Acad. Sc.*, **65**(2), 281–287.
- Backus, G. E., 1970. Inference from inadequate and inaccurate data, III, *Proc. Natl. Acad. Sc.*, **67**(1), 282–289.
- Backus, G. E., 1975. Gross thermodynamics of heat engines in deep interior of Earth, *Proc. Natl. Acad. Sc.*, **72**, 1555–1558.
- Backus, G. E. & Gilbert, F., 1968. The resolving power of gross Earth data, *Geophys. J. R. Astron. Soc.*, **16**(2), 169–205.
- Backus, G. E. & Gilbert, F., 1970. Uniqueness in the inversion of inaccurate gross Earth data, *Phil. Trans. R. Soc. London, Ser. A*, **266**, 123–192.

- Backus, G. E., Parker, R. L. & Constable, C. G., 1996. *Foundations of Geomagnetism*, Cambridge Univ. Press, Cambridge, UK.
- Baer, M. & Kradolfer, U., 1987. An automatic phase picker for local and teleseismic events, *B. Seismol. Soc. Am.*, **77**(4), 1437–1445.
- Bagheri, A., Pistone, E. & Rizzo, P., 2014. Guided ultrasonic wave imaging for immersed plates based on wavelet transform and probabilistic analysis, *Res. Nondestr. Eval.*, **25**(2), 63–81, doi: 10.1080/09349847.2013.837212.
- Bahr, K. & Simpson, F., 2002. Electrical anisotropy below slow- and fast-moving plates: Paleoflow in the upper mantle?, *Science*, **295**, 1270–1272.
- Baig, A. M., Dahlen, F. A. & Hung, S.-H., 2003. Traveltimes of waves in three-dimensional random media, *Geophys. J. Int.*, **153**(2), 467–482, doi: 10.1046/j.1365-246X.2003.01905.x.
- Bailey, J. M., Phinney, R. A., Slater, T. F. & Steinberg, D. J., 2002. Implementing a formative evaluation plan for the Princeton Earth Physics Project, *Amer. Astron. Soc. 199th meeting, Washington DC*, p. 22.11.
- Baillard, C., Crawford, W. C., Ballu, V., Hibert, C. & Mangeney, A., 2014. An automatic kurtosis-based *P*- and *S*-phase picker designed for local seismic networks, *B. Seismol. Soc. Am.*, **104**(1), 394–409, doi: 10.1785/0120120347.
- Baisch, S. & Bokelmann, G. H. R., 1999. Spectral analysis with incomplete time series: An example from seismology, *Comput. Geosci.*, **25**, 739–750.
- Balachandar, S., Yuen, D. A. & Reuteler, D., 1993. Viscous and adiabatic heating effects in three-dimensional compressible convection at infinite Prandtl number, *Phys. Fluids A*, **5**(11), 2938–2945.
- Balay, S., Abhyankar, S., Adams, M., Brown, J., Brune, P., Buschelman, K., Dalcin, L., Dener, A., Eijkhout, V., Gropp, W., Karpeyev, D., Kaushik, D., Knepley, M., May, D., McInnes, L. C., Mills, R., Munson, T., Rupp, K., Sanan, P., Smith, B., Zampini, S. & Zhang, H., 2019, PETSc Users Manual. Revision 3.11, Tech. rep., Argonne National Laboratory, Chicago, Ill.
- Balfour, N. J., Salmon, M. & Sambridge, M., 2014. The Australian Seismometers in Schools Network: Education, outreach, research, and monitoring, *Seismol. Res. Lett.*, **85**(5), 1063–1068, doi: 10.1785/0220140025.
- Ballani, L., Engels, J. & Grafarend, E., 1993. Global base functions for the mass density in the interior of a massive body (Earth), *Manuscr. Geod.*, **18**(2), 99–114.
- Balmino, G., 1993. The spectra of the topography of the Earth, Venus and Mars, *Geophys. Res. Lett.*, **20**(11), 1063–1066.
- Bamber, J., 2012. Shrinking glaciers under scrutiny, *Nature*, **482**(7386), 482–483, doi: 10.1038/nature10948.

- Bamber, J. L. & Riva, R., 2010. The sea level fingerprint of recent ice mass fluxes, *The Cryosphere*, **4**, 621–627, doi: 10.5194/tc-4-621-2010.
- Banerdt, W. B., Smrekar, S. E., Banfield, D., Giardini, D., Golombek, M., Johnson, C. L., Lognonné, P., Spiga, A., Spohn, T., Perrin, C., Stähler, S. C., Antonangeli, D., Asmar, S., Beghein, C., Bowles, N., Bozdağ, E., Chi, P., Christensen, U., Clinton, J., Collins, G. S., Daubar, I., Dehant, V., Drilleau, M., Fillingim, M., Folkner, W., Garcia, R. F., Garvin, J., Grant, J., Grott, M., Grygorczuk, J., Hudson, T., **J. C. E. Irving**, Kargl, G., Kawamura, T., Kedar, S., King, S., Knapmeyer-Endrun, B., Knapmeyer, M., Lemmon, M., Lorenz, R., Maki, J. N., Margerin, L., McLennan, S. M., Michaut, C., Mimoun, D., Mittelholz, A., Mocquet, A., Morgan, P., Mueller, N. T., Murdoch, N., Nagihara, S., Newman, C., Nimmo, F., Panning, M., Pike, W. T., Plesa, A.-C., Rodriguez, S., Rodriguez-Manfredi, J. A., Russell, C. T., Schmerr, N., Siegler, M., Stanley, S., Stutzmann, E., Teanby, N., Tromp, J., van Driel, M., Warner, N., Weber, R. & Wieczorek, M., 2020. Initial results from the InSight mission on Mars, *Nature Geosci.*, **13**(3), 183–189, doi: 10.1038/s41561-020-0544-y.
- Bangerth, W. & Heister, T., 2014. Quo vadis, scientific software?, *SIAM News*, **47**(1), 7–8.
- Bank, C.-G., Bostock, M. G., Ellis, R. & Cassidy, J., 2000. A reconnaissance teleseismic study of the upper mantle and transition zone beneath the Archean Slave craton in NW Canada, *Tectonophysics*, **319**(3), 151–166.
- Banks, R. J., Parker, R. L. & Huestis, S. P., 1977. Isostatic compensation on a continental scale: local versus regional mechanisms, *Geophys. J. R. Astron. Soc.*, **51**, 431–452.
- Banks, R. J., Francis, S. C. & Hipkin, R. G., 2001. Effects of loads in the upper crust on estimates of the elastic thickness of the lithosphere, *Geophys. J. Int.*, **145**(1), 291–299.
- Bannister, S. C., Ruud, B. & Husebye, E. S., 1991. Tomographic estimates of sub-Moho seismic velocities in Fennoscandia and structural implications, *Tectonophysics*, **189**, 37–53.
- Barakat, R. & Parshall, E., 1996. Numerical evaluation of the zero-order Hankel transform using Filon quadrature philosophy, *Appl. Math. Lett.*, **9**(5), 21–26, doi: 10.1016/0893-9659(96)00067-5.
- Barakat, R. & Parshall, E., 1998. Evaluation of first-order Hankel transform using Filon quadrature philosophy, *Appl. Math. Lett.*, **11**(1), 127–131, doi: 10.1016/S0893-9659(97)00145-6.
- Barakat, R. & Sandler, B. H., 2000. Filon trapezoidal schemes for Hankel transforms of orders zero and one, *Comput. Math. Appl.*, **40**(8–9), 1037–1041, doi: 10.1016/S0898-1221(00)85014-2.
- Baraniuk, R. G., Coates, M. & Steeghs, P., 2000. Hybrid linear/quadratic time-frequency attributes, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, vol. 2, pp. 681–684, IEEE.
- Baraniuk, R. G., Coates, M. & Steeghs, P., 2001. Hybrid linear/quadratic time-frequency attributes, *IEEE T. Signal Process.*, **49**(4), 760–766.

- Barletta, V. R., Sørensen, L. S. & Forsberg, R., 2011. Scatter of mass changes estimates at basin scale for Greenland and Antarctica, *The Cryosphere*, **7**, 1411–1432, doi: 10.5194/tc-7-1411-2013.
- Barnes, A. E., 1992. The calculation of instantaneous frequency and instantaneous bandwidth, *Geophysics*, **57**(11), 1520–1524.
- Barnes, C. & Turok, N., 1997. Cosmic texture from a broken global SU(3) symmetry, *Phys. Rev. D*, **56**(4), 1989–2001.
- Barnes, C. R., Best, M. M. R., Johnson, F. R., Pautet, L. & Pirenne, B., 2013. Challenges, benefits, and opportunities in installing and operating cabled ocean observatories: Perspectives from NEPTUNE Canada, *IEEE J. Ocean. Eng.*, **38**(1), 144–157, doi: 10.1109/JOE.2012.2212751.
- Barnes, N., 2010. Publish your computer code: it is good enough, *Nature*, **467**, 753, doi: 10.1038/467753a.
- Barnett, T. P., Adam, J. C. & Lettenmaier, D. P., 2005. Potential impacts of a warming climate on water availability in snow-dominated regions, *Nature*, **438**(7066), 303–309, doi: 10.1038/nature04141.
- Barruol, G. & Hoffman, R., 1999. Upper mantle anisotropy beneath the GEOSCOPE stations, *J. Geophys. Res.*, **104**(B5), 10757–10773.
- Barruol, G., Helffrich, G. & Vauchez, A., 1997. Shear wave splitting around the northern Atlantic: Frozen Pangaean lithospheric anisotropy?, *Tectonophysics*, **279**, 135–148.
- Barruol, G., Souriau, A., Vauchez, A., Diaz, J., Gallart, J., Tubia, J. & Cuevas, J., 1998. Lithospheric anisotropy beneath the Pyrenees from shear wave splitting, *J. Geophys. Res.*, **103**(B12), 30039–30053.
- Barth, N. & Wunsch, C., 1990. Oceanographic experiment design by simulated annealing, *J. Phys. Oceanog.*, **20**, 1249–1263.
- Bass, J. D. & Anderson, D. L., 1984. Composition of the upper mantle: Geophysical tests of two petrological models, *Geophys. Res. Lett.*, **11**(3), 237–240.
- Bastien, S., Grilli, A. R., Grilli, S. T., Jr, R. S. & Spaulding, M. L., 2008, Small buoy for energy harvesting — Final report prepared for Phase I ONR SBIR N07-144, Tech. rep., Department of Ocean Engineering, University of Rhode Island, Narragansett, RI.
- Bastien, S., Jr, R. S., Grilli, S. T., Grilli, A. R. & Spaulding, M. L., 2008, Ocean energy extraction for sensor applications, ONR STTR Topic N08-T021, no. n08a-021-0386, Tech. rep., University of Rhode Island, Narragansett, RI.
- Bates, A., Khalid, Z. & Kennedy, R., 2017. Efficient computation of Slepian functions for arbitrary regions on the sphere, *IEEE T. Signal Process.*, **65**(16), 4379–4393, doi: 10.1109/TSP.2017.2712122.

- Bates, A. P., Khalid, Z. & Kennedy, R. A., 2017. Slepian spatial-spectral concentration problem on the sphere: Analytical formulation for limited colatitude–longitude spatial region, *IEEE T. Signal Process.*, **65**(6), 1527–1537, doi: 10.1109/TSP.2016.2646668.
- Bauer, E. & Staabs, C., 1998. Statistical properties of global significant wave heights and their use for validation, *J. Geophys. Res.*, **103**(C1), 1153–1166.
- Bauer, F. & Gutting, M., 2011. Spherical fast multiscale approximation by locally compact orthogonal wavelets, *Intern. J. Geomath.*, **2**(1), 69–85, doi: 10.1007/s13137–011–0015–0.
- Bauer, F., Mathé, P. & Pereverzev, S., 2007. Local solutions to inverse problems in geodesy, *J. Geod.*, **81**(1), 39–51.
- Baur, O. & Sneeuw, N., 2011. Assessing Greenland ice mass loss by means of point-mass modeling: a viable methodology, *J. Geod.*, **85**(9), 607–615, doi: 10.1007/s00190–011–0463–1.
- Baur, O., Kuhn, M. & Featherstone, W. E., 2009. GRACE-derived ice-mass variations over Greenland by accounting for leakage effects, *J. Geophys. Res.*, **114**, B06407, doi: 10.1029/2008JB006239.
- Bawa, K. S., Koh, L. P., Lee, T. M., Liu, J., Ramakrishnan, P. S., Yu, D. W., Zhang, Y. & Raven, P. H., 2010. China, India, and the environment, *Science*, **327**(5972), 1457–1459, doi: 10.1126/science.1185164.
- Bayram, M. & Baraniuk, R., 2001, Multiple window time-varying spectrum estimation, in *Non-linear and nonstationary signal processing*, edited by W. J. Fitzgerald, R. L. Smith, A. T. Walden, & P. C. Young, chap. 10, pp. 292–316, Cambridge Univ. Press, Cambridge, UK.
- Bayram, M. & Baraniuk, R. G., 1996, Multiple window time-frequency analysis, in *Proc. IEEE-SP International Symposium on Time-Frequency and Time-Scale Analysis*, pp. 173–176, IEEE.
- BBC News, Accessed 11/28/2007. Climate scepticism: The top 10, http://news.bbc.co.uk/2/hi/in_depth/629/629/7074601.stm.
- Bear, L. K. & Pavlis, G., 1997. Estimation of slowness vectors and their uncertainties using multi-wavelet seismic array processing, *B. Seismol. Soc. Am.*, **87**(4), 755–769.
- Bear, L. K. & Pavlis, G., 1999. Multi-channel estimation of time residuals from broadband seismic data using multi-wavelets, *B. Seismol. Soc. Am.*, **89**(3), 681–692.
- Bear, L. K., Pavlis, G. & Bokelmann, G. H. R., 1999. Multi-wavelet analysis of three-component seismic arrays: Application to measure effective anisotropy at pinon flats, California, *B. Seismol. Soc. Am.*, **89**(3), 693–705.
- Beaty, K. S., Schmitt, D. R. & Sacchi, M., 2002. Simulated annealing inversion of multimode Rayleigh wave dispersion curves for geological structure, *Geophys. J. Int.*, **151**(2), 622–631, doi: 10.1046/j.1365–246X.2002.01809.x.

- Beauduin, R., Montagner, J. P. & Karczewski, J. F., 1996. Time evolution of broadband seismic noise during the French pilot experiment OFM/SISMOBS, *Geophys. Res. Lett.*, **23**(21), 2995–2998, doi: 10.1029/96GL02880.
- Beaulieu, C., Seidou, O., Ouarda, T. B. M. J., Zhang, X., Boulet, G. & Yagouti, A., 2008. Inter-comparison of homogenization techniques for precipitation data, *Water Resources Res.*, **44**(2), W02425, doi: 10.1029/2006WR005615.
- Beaulieu, C., Chen, J. & Sarmiento, J. L., 2012. Change-point analysis as a tool to detect abrupt climate variations, *PTRSL-A*, **370**, 1228–1249, doi: 10.1098/rsta.2011.0383.
- Beaumont, C., 1979. Rheological zonation of the lithosphere during flexure, *Tectonophysics*, **59**(1–4), 347–365.
- Bécel, A., Laigle, M., Diaz, J., Montagner, J.-P. & Hirn, A., 2011. Earth's free oscillations recorded by free-fall OBS ocean-bottom seismometers at the Lesser Antilles subduction zone], *Geophys. Res. Lett.*, **38**(24), L24305, doi: 10.1029/2011GL049533.
- Bechtel, T. D., 1989, *Mechanisms of isostatic compensation in East Africa and North America*, Ph.D. thesis, Brown Univ., Providence, R. I.
- Bechtel, T. D., Forsyth, D. W. & Swain, C. J., 1987. Mechanisms of isostatic compensation in the vicinity of the East African Rift, Kenya, *Geophys. J. R. Astron. Soc.*, **90**(2), 445–465, doi: 10.1111/j.1365-246X.1987.tb00734.x.
- Bechtel, T. D., Forsyth, D. W., Sharpton, V. L. & Grieve, R. A. F., 1990. Variations in effective elastic thickness of the North-American lithosphere, *Nature*, **343**(6259), 636–638.
- Beck, A. & Teboulle, M., 2009. A Fast Iterative Shrinkage-Thresholding Algorithm for linear inverse problems, *SIAM J. Imag. Sci.*, **2**(1), 183–202, doi: 10.1137/080716542.
- Becker, J. J. & Sandwell, D. T., 2008. Global estimates of seafloor slope from single-beam ship soundings, *J. Geophys. Res.*, **113**, C05028, doi: 10.1029/2006JC003879.
- Becker, J. J., Sandwell, D. T., Smith, W. H. F., Braud, J., Binder, B., Depner, J., Fabre, D., Factor, J., Ingalls, S., Kim, S.-H., Ladner, R., Marks, K., Nelson, S., Pharaoh, A., Trimmer, R., Rosenberg, J. V., Wallace, G. & Weatherall, P., 2009. Global bathymetry and elevation data at 30 arc seconds resolution: SRTM30_PLUS, *Mar. Geod.*, **32**(4), 355–371, doi: 10.1080/01490410903297766.
- Becker, T. W. & Boschi, L., 2002. A comparison of tomographic and geodynamic mantle models, *Geochem. Geophys. Geosys.*, **3**(1), 1003, doi: 10.1029/2001GC000168.
- Becker, T. W., Kellogg, J. B., Ekström, G. & O'Connell, R. J., 2003. Comparison of azimuthal seismic anisotropy from surface waves and finite-strain from global mantle-circulation models, *Geophys. J. Int.*, **155**(2), 696–714, doi: 10.1046/j.1365-246X.2003.02085.x.
- Becker, T. W., Chevrot, S., Schulte-Pelkum, V. & Blackman, D. K., 2006. Statistical properties of seismic anisotropy predicted by upper mantle geodynamic models, *J. Geophys. Res.*, **111**(B10), B08309, doi: 10.1029/2005JB004095.

- Becker, T. W., Browaeys, J. T. & Jordan, T. H., 2007. Stochastic analysis of shear-wave splitting length scales, *Earth Planet. Sci. Lett.*, **259**(3–4), 526–540, doi: 10.1016/j.epsl.2007.05.010.
- Becker, T. W., Ekström, G., Boschi, L. & Woodhouse, J. H., 2008. Length scales, patterns and origin of azimuthal seismic anisotropy in the upper mantle as mapped by Rayleigh waves, *Geophys. J. Int.*, **171**, 451–462, doi: 10.1111/j.1365–246X.2007.03536.x.
- Bedle, H. & van der Lee, S., 2009. *S* velocity variations beneath North America, *J. Geophys. Res.*, **114**(B7), B07308, doi: 10.1029/2008JB005949.
- Beggan, C. D., Whaler, K. A., Saarimäki, J. & Simons, F. J., 2012. Spectral and spatial decomposition of crustal and core magnetic field models using Slepian functions, *Geophys. Res. Abstr.*, **14**, 1174.
- Beggan, C. D., Saarimäki, J., Whaler, K. A. & Simons, F. J., 2013. Spectral and spatial decomposition of lithospheric magnetic field models using spherical Slepian functions, *Geophys. J. Int.*, **193**(1), 136–148, doi: 10.1093/gji/ggs122.
- Behn, M. D. & Lin, J., 2000. Segmentation in gravity and magnetic anomalies along the U.S. East Coast passive margin: Implications for incipient structure of the oceanic lithosphere, *J. Geophys. Res.*, **105**(B11), 25769–25790.
- Belardinelli, M. E., Cocco, M., Coutant, O. & Cotton, F., 1999. Redistribution of dynamic stress during coseismic ruptures: Evidence for fault interaction and earthquake triggering, *J. Geophys. Res.*, **104**(B7), 14925–14945.
- Bell, B., Percival, D. B. & Walden, A. T., 1993. Calculating Thomson’s spectral multitapers by inverse iteration, *J. Comp. Graph. Stat.*, **2**(1), 119–130.
- Bell, R. E., 2008. The unquiet ice, *Sc. Am.*, pp. 60–67.
- Belleguic, V., Lognonné, P. & Wieczorek, M., 2005. Constraints on the Martian lithosphere from gravity and topography data, *J. Geophys. Res.*, **110**, E11005, doi: 10.1029/2005JE002437.
- Ben-Hadj-Ali, H., Operto, S. & Virieux, J., 2011. An efficient frequency-domain full waveform inversion method using simultaneous encoded sources, *Geophysics*, **76**(4), R109–R124, doi: 10.1190/1.3581357.
- Bendat, J. S., 1978. Statistical errors in measurement of coherence functions and input/output quantities, *J. Sound Vibration*, **59**, 405–421.
- Bendat, J. S. & Piersol, A. G., 1986. *Measurement and Analysis of Random Data*, John Wiley, New York, 2nd edn.
- Bendat, J. S. & Piersol, A. G., 1993. *Engineering Applications of Correlation and Spectral Analysis*, John Wiley, New York, 2nd edn.
- Bendat, J. S. & Piersol, A. G., 2000. *Random Data: Analysis and Measurement Procedures*, John Wiley, New York, 3rd edn.

- Bennett, C. L., Banday, A. J., Górski, K. M., Hinshaw, G., Jackson, P., Keegstra, P., Kogut, A., Smoot, G. F., Wilkinson, D. T. & Wright, E. L., 1996. Four-year *cobe* DMR cosmic microwave background observations: Maps and basic results, *Astroph. J.*, **464**(1), L1–L4.
- Benoit, M. H., Long, M. D. & King, S. D., 2013. Anomalously thin transition zone and apparently isotropic upper mantle beneath Bermuda: Evidence for upwelling, *Geochem. Geophys. Geosys.*, **14**(10), 4282–4291, doi: 10.1002/ggge.20277.
- Bensen, G. D., Ritzwoller, M. H., Barmin, M. P., Levshin, A. L., Lin, F., Moschetti, M. P., Shapiro, N. M. & Yang, Y., 2007. Processing seismic ambient noise data to obtain reliable broad-band surface wave dispersion measurements, *Geophys. J. Int.*, **169**(3), 1239–1260, doi: 10.1111/j.1365–246X.2007.03374.x.
- Bent, A. L., Cassidy, J., Prépetit, C., Lamontagne, M. & Ulysse, S., 2018. Real-time seismic monitoring in Haiti and some applications, *Seismol. Res. Lett.*, **89**(2A), 407–415, doi: 10.1785/0220170176.
- Bentham, H. L. M. & Rost, S., 2014. Scattering beneath Western Pacific subduction zones: evidence for oceanic crust in the mid-mantle, *Geophys. J. Int.*, **197**(3), 1627–1641, doi: 10.1093/gji/ggu043.
- Berber, M. M., Ustun, A. & Yetkin, M., 2017. Static and kinematic PPP using online services: a case study in Florida, *J. Spat. Sci.*, **62**(2), 337–352, doi: 10.1080/14498596.2017.1292964.
- Bercovici, D. & Karato, S., 2003. Whole-mantle convection and the transition-zone water filter, *Nature*, **425**, 39–44.
- Bercovici, D., Ricard, Y. & Richards, M. A., 2000. The relation between mantle dynamics and plate tectonics: A primer, in *The History and Dynamics of Global Plate Motions*, edited by M. A. Richards, R. G. Gordon, & R. D. van der Hilst, vol. 121 of **Geophysical Monograph**, pp. 5–46, Amer. Geophys. Union, Washington, D. C.
- Berger, J., Laske, G., Babcock, J. & Orcutt, J., 2016. An ocean-bottom seismic observatory with near real-time telemetry, *Earth Space Sci.*, **3**, 68–77, doi: 10.1002/2015EA000137.
- Bergeron, S., Yuen, D. & Vincent, A., 2000. Looking at the inside of the Earth with 3-d wavelets: A pair of new glasses for geoscientists, *Visual Geosciences*, **5**(3), 1–14, doi: 10.1007/s10069–000–0003–2.
- Bergeron, S. Y., Vincent, A. P., Yuen, D. A., Tranchant, B. J. S. & Tchong, C., 1999. Viewing seismic velocity anomalies with 3-D continuous Gaussian wavelets, *Geophys. Res. Lett.*, **26**(15), 2311–2314.
- Bergeron, S. Y., Yuen, D. A. & Vincent, A. P., 2000. Capabilities of 3-D wavelet transforms to detect plume-like structures from seismic tomography, *Geophys. Res. Lett.*, **27**(20), 3433–3436.
- Berkel, P. & Michel, V., 2010. On mathematical aspects of a combined inversion of gravity and normal mode variations by a spline method, *Math. Geosci.*, **42**(7), 795–816, doi: 10.1007/s11004–010–9297–2.

- Berner, R. A., 1995. Chemical weathering and its effect on atmospheric CO_2 and climate, *Reviews Mineralogy*, **31**, 565–583.
- Berryman, J. G., 1990. Stable iterative reconstruction algorithm for nonlinear traveltime tomography, *Inv. Probl.*, **6**, 21–42.
- Berryman, J. G., 1991. Convexity properties of inverse problems with variational constraints, *J. Franklin Inst.*, **328**, 1–13.
- Bertero, M., de Mol, C. & Pike, E. R., 1985. Linear inverse problems with discrete data. I. General formulation and singular system analysis, *Inv. Probl.*, **1**, 301–330, doi: 10.1088/0266–5611/1/4/004.
- Bertero, M., de Mol, C. & Pike, E. R., 1985. Linear inverse problems with discrete data. II. Stability and regularisation, *Inv. Probl.*, **1**, 301–330, doi: 10.1088/0266–5611/1/4/004.
- Berthier, E., Scambos, T. A. & Shuman, C. A., 2012. Mass loss of Larsen B tributary glaciers (Antarctic Peninsula) unabated since 2002, *Geophys. Res. Lett.*, **39**(13), L13501, doi: 10.1029/2012GL051755.
- Bertiger, W., Bar-Sever, Y., Dorsey, A., Haines, B., Harvey, N., Hemberger, D., Heflin, M., Lu, W., Miller, M., Moore, A. W., Murphy, D., Ries, P., Romans, L., Sibois, A., Sibthorpe, A., Szilagyi, B., Vallisneri, M. & Willis, P., 2020. GipsyX/RTGx, a new tool set for space geodetic operations and research, *Adv. Space Res.*, **66**(2), 469–489, doi: 10.1016/j.asr.2020.04.015.
- Bettadpur, S., 2007, Gravity Recovery And Climate Experiment Level-2 gravity field product user handbook, Tech. rep., Center for Space Research at The University of Texas at Austin.
- Bettadpur, S. & the CSR Level-2 Team, 2012. Insights into the Earth system mass variability from CSR-RL05 GRACE gravity fields, *Geophys. Res. Abstr.*, **14**, 6409, url: http://www.csr.utexas.edu/grace/RL05_details.html.
- Betts, P. G., Giles, D., Lister, G. S. & Frick, L. R., 2002. Evolution of the Australian lithosphere, *Aust. J. Earth Sci.*, **49**, 661–695.
- Beuthe, M., 2008. Thin elastic shells with variable thickness for lithospheric flexure of one-plate planets, *Geophys. J. Int.*, **172**, 817–841, doi: 10.1111/j.1365–246X.2007.03671.x.
- Beveridge, A. K., 2016, *Measuring the changing mass of glaciers on the Tibetan Plateau using time-variable gravity from the GRACE mission*, A. b., Princeton University.
- Beveridge, A. K., Harig, C. & Simons, F. J., 2018. The changing mass of glaciers on the Tibetan Plateau, 2002–2016, using time-variable gravity from the GRACE satellite mission, *J. Geod. Sci.*, **8**, 83–97, doi: 10.1515/jogs–2018–0010.
- Bevington, P. R. & Robinson, D. K., 1992. *Data Reduction and Error Analysis for the Physical Sciences*, McGraw-Hill, New York, 2nd edn.

- Bevis, M., Wahr, J., Khan, S. A., Madsen, F. B., Brown, A., Willis, M., Kendrick, E., Knudsen, P., Box, J. E., van Dam, T., II, D. C., Johns, B., Nylén, T., Abbott, R., White, S., Miner, J., Forsberg, R., Zhou, H., Wang, J., Wilson, T., Bromwich, D. & Francis, O., 2012. Bedrock displacements in Greenland manifest ice mass variations, climate cycles and climate change, *Proc. Natl. Acad. Sci.*, **109**(30), 11944–11948, doi: 10.1073/pnas.1204664109.
- Bevis, M., Harig, C., Khan, S. A., Brown, A., Simons, F. J., Willis, M., Fettweis, X., van den Broeke, M. R., Madsen, F. B., Kendrick, E. C., II, D. J. C., van Dam, T., Knudsen, P. & Nylén, T., 2019. Accelerating changes in ice mass within Greenland, and the ice sheet's sensitivity to atmospheric forcing, *Proc. Natl. Acad. Sci.*, **116**(6), 1934–1939, doi: 10.1073/pnas.1806562116.
- Beydoun, W. B. & Keho, T. H., 1987. The paraxial ray method, *Geophysics*, **52**(12), 1639–1653, doi: 10.1190/1.1442281.
- Beylkin, G., 1992. On the representation of operators in bases of compactly supported wavelets, *SIAM J. Numer. Anal.*, **6**(6), 1715–1740.
- Beylkin, G. & Monzón, L., 2002. On generalized Gaussian quadratures for exponentials and their applications, *Appl. Comput. Harmon. Anal.*, **12**, 332–372, doi: 10.1006/acha.2002.0380.
- Beylkin, G. & Sandberg, K., 2005. Wave propagation using bases for bandlimited functions, *Wave Motion*, **41**(3), 263–291.
- Beyreuther, M., Barsch, R., Krischer, L., Megies, T., Behr, Y., & Wassermann, J., 2010. ObsPy: A Python toolbox for seismology, *Seismol. Res. Lett.*, **81**(3), 530–533, doi: 10.1785/gssrl.81.3.530.
- Bigot-Cormier, F. & Berenguer, J.-L., 2017. How students can experience science and become researchers: Tracking MERMAID floats in the ocean, *Seismol. Res. Lett.*, **88**(2A), 416–420, doi: 10.1785/0220160121.
- Bijwaard, H. & Spakman, W., 1999. Tomographic evidence for a narrow whole mantle plume below Iceland, *Earth Planet. Sci. Lett.*, **166**(3–4), 121–126, doi: 10.1016/S0012-821X(99)00004-7.
- Bijwaard, H. & Spakman, W., 2000. Non-linear global *P*-wave tomography by iterated linearized inversion, *Geophys. J. Int.*, **141**, 71–82.
- Bijwaard, H., Spakman, W. & Engdahl, E. R., 1998. Closing the gap between regional and global travel time tomography, *Geophys. J. Int.*, **103**(B12), 30055–30078.
- Billen, M. I. & Gurnis, M., 2005. Constraints on subducting plate strength within the Kermadec trench, *J. Geophys. Res.*, **110**(B5), B05407, doi: 10.1029/2004JB003308.
- Bina, C. R., 1991. Mantle discontinuities, *Rev. Geophys.*, **Supplement**(29), 783–793.
- Bina, C. R., 1998. A note on latent heat release from disequilibrium phase transformations and deep seismogenesis, *Earth Planets Space*, **50**, 1029–1034.
- Bina, C. R., 1998. Free energy minimization by simulated annealing with applications to lithospheric slabs and mantle plumes, *Pure Appl. Geophys.*, **151**, 605–618.

- Bina, C. R. & Helffrich, G. R., 1994. Phase transition Clapeyron slopes and transition zone seismic discontinuity topography, *J. Geophys. Res.*, **99**(B8), 15853–15860, doi: 10.1029/94JB00462.
- Bintanja, R., van Oldenborgh, G. J., Drijfhout, S. S., Wouters, B. & Katsman, C. A., 2013. Important role for ocean warming and increased ice-shelf melt in Antarctic sea-ice expansion, *Nature Geosci.*, **6**(5), 376–379, doi: 10.1038/ngeo1767.
- Bird, P., 1988. Formation of the Rocky Mountains, Western United States — A continuum computer-model, *Science*, **239**(4847), 1501–1507.
- Bird, P., 1989. New finite-element techniques for modeling deformation histories of continents with stratified temperature-dependent rheology, *J. Geophys. Res.*, **94**(B4), 3967–3990.
- Bird, P. & Piper, K., 1980. Plane-stress finite-element models of tectonic flow in Southern California, *Phys. Earth Planet. Inter.*, **21**, 158–175.
- Birkelund, Y., Hanssen, A. & Powers, E. J., 2003. Multitaper estimators of polyspectra, *Signal Process.*, **83**(2003), 545–559.
- Birkelund, Y., Hanssen, A. & Powers, E. J., 2003. On the estimation of nonlinear Volterra models in offshore engineering, *Int. J. Offshore Polar Eng.*, **13**(1), 12–20.
- Björck & Elfving, T., 1979. Accelerated projection methods for computing pseudoinverse solutions of systems of linear equations, *BIT Numerical Mathematics*, **19**(2), 143–165.
- Blackman, D. K. & Forsyth, D. W., 1991. Isostatic compensation of tectonic features of the Mid-Atlantic Ridge: 25–27deg30'S, *J. Geophys. Res.*, **96**(B7), 11741–11758.
- Blackman, D. K., Cann, J. R., Janssen, B. & Smith, D. K., 1998. Origin of extensional core complexes: Evidence from the Mid-Atlantic Ridge at Atlantis Fracture Zone, *J. Geophys. Res.*, **103**(B9), 21315–21333.
- Blais, J. A. R. & Provins, D. A., 2002. Spherical harmonic analysis and synthesis for global multiresolution applications, *J. Geod.*, **76**(29–35).
- Blakely, R. J., 1995. *Potential Theory in Gravity and Magnetic Applications*, Cambridge Univ. Press, New York.
- Blakely, R. J. & McKee, E. H., 1985. Subsurface structural features of the Saline Range and adjacent regions of eastern California as interpreted from isostatic residual gravity anomalies, *Geology*, **13**, 781–785.
- Blanchon, P., Eisenhauer, A., Fietzke, J. & Liebetrau, V., 2009. Rapid sea-level rise and reef back-stepping at the close of the last interglacial highstand, *Nature*, **458**(7240), 881–884, doi: 10.1038/nature07933.
- Blanco, M. A., Flórez, M. & Bermejo, M., 1997. Evaluation of the rotation matrices in the basis of real spherical harmonics, *J. Mol. Struct. (Theochem)*, **419**, 19–27.

- Blewitt, G., 1989. Carrier phase ambiguity resolution for the Global Positioning System applied to geodetic baselines up to 2000 km, *J. Geophys. Res.*, **94**(B8), 10187–10203, doi: 10.1029/JB094iB08p10187.
- Blewitt, G., 1990. An automatic editing algorithm for GPS data, *Geophys. Res. Lett.*, **17**(3), 199–202, doi: 10.1029/GL017i003p00199.
- Bloxham, J. & Gubbins, D., 1985. The secular variation of Earth’s magnetic field, *Nature*, **317**, 777–781, doi: 10.1038/317777a0.
- Bluhm, R. & Kostelecký, V. A., 1994. Atomic supersymmetry, Rydberg wave packets, and radial squeezed states, *Phys. Rev. A*, **49**(6), 4628–4640.
- Bluhm, R., Kostelecký, V. A. & Tudose, B., 1995. Elliptical squeezed states and Rydberg wave packets, *Phys. Rev. A*, **52**(3), 2234–2244, doi: 10.1103/PhysRevA.52.2234.
- Blumensath, T. & Davies, M. E., 2008. Iterative thresholding for sparse approximations, *J. Fourier Anal. Appl.*, **14**(5), 629–654, doi: 10.1007/s00041-008-9035-z.
- Blumensath, T. & Davies, M. E., 2009. Iterative hard thresholding for compressed sensing, *Appl. Comput. Harmon. Anal.*, **27**(3), 265–274.
- Boashash, B., 1992. Estimating and interpreting the instantaneous frequency of a signal—Part 1: Fundamentals, *Proc. IEEE*, **80**(4), 520–538.
- Bodin, T. & Sambridge, M., 2009. Seismic tomography with the reversible jump algorithm, *Geophys. J. Int.*, **178**(3), 1411–1436, doi: 10.1111/j.1365-246X.2009.04226.x.
- Bodin, T., Sambridge, M. & Gallagher, K., 2009. A self-parametrizing partition model approach to tomographic inverse problems, *Inv. Probl.*, **25**, 055009, doi: 10.1088/0266-5611/25/5/055009.
- Boening, C., Lebsock, M., Landerer, F. & Stephens, G., 2012. Snowfall-driven mass change on the East Antarctic ice sheet, *Geophys. Res. Lett.*, **39**, L21501, doi: 10.1029/2012GL053316.
- Bogiatzis, P. & Ishii, M., 2015. Continuous wavelet decomposition algorithms for automatic detection of compressional- and shear-wave arrival times, *B. Seismol. Soc. Am.*, **105**(3), 1628–1641, doi: 10.1785/0120140267.
- Bogiatzis, P., Ishii, M. & Davis, T. A., 2019. The Dulmage–Mendelsohn permutation in seismic tomography, *Geophys. J. Int.*, **218**(2), 1157–1173, doi: 10.1093/gji/ggz216.
- Böhme, M., 2002, *A fast algorithm for filtering and wavelet decomposition on the sphere*, Master’s thesis, Institut für Mathematik, Medizinische Universität zu Lübeck.
- Böhme, M. & Potts, D., 2003. A fast algorithm for filtering and wavelet decomposition on the sphere, *Electron. Trans. Numer. Anal.*, **16**, 70–93.
- Böhme, M. & Potts, D., 2003, A fast algorithm for spherical filtering on arbitrary grids, in *Wavelets: Applications in Signal and Image Processing*, edited by M. A. Unser, A. Aldroubi, & A. F. Laine, vol. 5207, SPIE.

- Bohnenstiehl, D. R., Tolstoy, M., Dziak, R. P., Fox, C. G. & Smith, D. K., 2002. Aftershock sequences in the mid-ocean ridge environment: an analysis using hydroacoustic data, *Tectonophysics*, **354**, 49–70, doi: 10.1016/S0040-1951(02)00289-5.
- Bokelmann, G. H. R., 2002. Convection-driven motion of the North American craton: Evidence from *P*-wave anisotropy, *Geophys. J. Int.*, **148**, 278–287.
- Bokelmann, G. H. R. & Silver, P., 2000. Mantle variation within the Canadian Shield: Travel times from the portable broadband Archean-Proterozoic transect 1989, *J. Geophys. Res.*, **105**(B1), 579–605.
- Bokelmann, G. H. R. & Silver, P. G., 2002. Shear stress at the base of shield lithosphere, *Geophys. Res. Lett.*, **29**(23), 2091, doi: 10.1029/2002GL015925.
- Bölling, K. & Grafarend, E. W., 2005. Ellipsoidal spectral properties of the Earth’s gravitational potential and its first and second derivatives, *J. Geod.*, **79**(6–7), 300–330, doi: 10.1007/s00190-005-0465-y.
- Bolotnikov, V. & Rodman, L., 2004. Remarks on interpolation in reproducing kernel Hilbert spaces, *Houston J. Math.*, **30**(2), 559–576.
- Bond, J. R., Crittenden, R., Davis, R. L., Efstathiou, G. & Steinhardt, P. J., 1994. Measuring cosmological parameters with cosmic microwave background experiments, *Phys. Rev. Lett.*, **72**, 13–16.
- Bond, J. R., Jaffe, A. H. & Knox, L., 1998. Estimating the power spectrum of the cosmic microwave background, *Phys. Rev. D*, **57**(4), 2117–2137.
- Bond, J. R., Jaffe, A. H. & Knox, L., 2000. Radical compression of cosmic microwave background data, *Astroph. J.*, **533**, 19–37.
- Bondár, I. & Storchak, D., 2011. Improved location procedures at the International Seismological Centre, *Geophys. J. Int.*, **186**(3), 1220–1244 doi: 10.1111/j.1365-246X.2011.05107.x.
- Bonin, J. & Chambers, D., 2013. Uncertainty estimates of a GRACE inversion modelling technique over Greenland using a simulation, *Geophys. J. Int.*, **194**(1), 212–229, doi: 10.1093/gji/ggt091.
- Bonnieux, S., Mosser, S., Blay-Fornarino, M., Hello, Y. & Nolet, G., 2019, Model driven programming of autonomous floats for multidisciplinary monitoring of the oceans, in *OCEANS 2019-Marseille*, pp. 1–10, doi: 10.1109/OCEANSE.2019.8867453, IEEE.
- Bonnieux, S., Cazau, D., Mosser, S., Blay-Fornarino, M., Hello, Y. & Nolet, G., 2020. MeLa: A programming language for a new multidisciplinary oceanographic float, *Sensors*, **20**(21), 6081, doi: 10.3390/s20216081.
- Bookhagen, B., Thiede, R. C. & Strecker, M. R., 2005. Late quaternary intensified monsoon phases control landscape evolution in the northwest Himalaya, *Geology*, **33**(2), 149–152, doi: 10.1130/G20982.

- Borcea, L., Papanicolaou, G. & Vasquez, F. G., 2008. Edge illumination and imaging of extended reflectors, *SIAM J. Imag. Sci.*, **1**(1), 75–114, doi: 10.1137/07069290X.
- Borisov, D., Singh, S. C. & Fuji, N., 2015. An efficient method of 3-D elastic full waveform inversion using a finite-difference injection method for time-lapse imaging, *Geophys. J. Int.*, **202**(3), 1908–1922, doi: 10.1093/gji/ggv268.
- Borisov, D., Modrak, R., Rusmanugroho, H., Yuan, Y. O., Gao, F., Simons, F. J. & Tromp, J., 2016, Spectral-element based 3D elastic full waveform inversion of surface waves in the presence of complex topography using an envelope-based misfit function, in *SEG Tech. Prog. Expanded Abstracts*, pp. 1211–1215, doi: 10.1190/segam2016–13843759.1, Soc. Explor. Geophys., Denver, Col.
- Borisov, D., Modrak, R., Gao, F. & Tromp, J., 2018. 3D elastic full-waveform inversion of surface waves in the presence of irregular topography using an envelope-based misfit function, *Geophysics*, **83**(1), R1–R11, doi: 10.1190/geo2017–0081.1.
- Borisov, D., Gao, F., Williamson, P., Simons, F. J. & Tromp, J., 2019, Robust surface-wave full-waveform inversion, in *SEG Tech. Prog. Expanded Abstracts*, pp. 5005–5009, doi: 10.1190/segam2019–3215047.1, Soc. Explor. Geophys., Denver, Col.
- Borisov, D., Gao, F., Williamson, P. & Tromp, J., 2020. Application of 2D full-waveform inversion on exploration land data, *Geophysics*, **85**(2), R75–R86, doi: 10.1190/geo2019–0082.1.
- Bormann, P., ed., 2002. *New Manual of Seismological Observatory Practice*, GeoForschungsZentrum, Potsdam, Germany.
- Bormann, P., ed., 2012. *New Manual of Seismological Observatory Practice 2 (NMSOP-2)*, Deutsches GeoForschungsZentrum, IASPEI, Potsdam, Germany.
- Born, A. & Nisancioglu, K. H., 2012. Melting of Northern greenland during the last interglaciation, *The Cryosphere*, **6**(6), 1239–1250, doi: 10.5194/tc-6-1239-2012.
- Bosch, W., 2000. On the computation of derivatives of Legendre functions, *Phys. Chem. Earth (A)*, **25**(9–11), 655–659.
- Boschi, E., Ekström, G. & Morelli, A., eds., 1996, *Seismic Modelling of Earth Structure*, Bologna, Italy, Editrice Compositori.
- Boschi, L., 2006. Global multiresolution models of surface wave propagation: comparing equivalently regularized Born and ray theoretical solutions, *Geophys. J. Int.*, **167**(1), 238–252, doi: 10.1111/j.1365–246X.2006.03084.x.
- Boschi, L. & Dziewoński, A. M., 1999. High- and low-resolution images of the Earth’s mantle. Implications of different approaches to tomographic modeling, *J. Geophys. Res.*, **104**(B11), 25567–25594.
- Boschi, L. & Dziewoński, A. M., 2000. Whole Earth tomography from delay times of *P*, *PcP*, and *PKP* phases: Lateral heterogeneities in the outer core or radial anisotropy in the mantle?, *J. Geophys. Res.*, **105**(B6), 13675–13696.

- Boschi, L. & Ekström, G., 2002. New images of the Earth's upper mantle from measurements of surface wave phase velocity anomalies, *J. Geophys. Res.*, **107**(B4), 2059, doi: 10.1029/2000JB000059.
- Boschi, L. & Woodhouse, J. H., 2006. Surface wave ray tracing and azimuthal anisotropy: a generalized spherical harmonic approach, *Geophys. J. Int.*, **164**, 569–578, doi: 10.1111/j.1365–246X.2006.02870.x.
- Boschi, L., Ekström, G. & Kustowski, B., 2004. Multiple resolution surface wave tomography: the Mediterranean basin, *Geophys. J. Int.*, **157**, 293–304, doi: 10.1111/j.1365–246X.2004.02194.x.
- Boschi, L., Becker, T. W., Soldati, G. & Dziewoński, A. M., 2006. On the relevance of Born theory in global seismic tomography, *Geophys. Res. Lett.*, **33**, L06302, doi: 10.1029/2005GL025063.
- Böse, M. & Heaton, T. H., 2010. Probabilistic prediction of rupture length, slip and seismic ground motions for an ongoing rupture: implications for early warning for large earthquakes, *Geophys. J. Int.*, **183**(2), 1014–1030, doi: 10.1111/j.1365–246X.2010.04774.x.
- Bostock, M., 1999. Seismic imaging of lithospheric discontinuities and continental evolution, *Lithos*, **48**(1–4), 1–16.
- Bostock, M. G., 1997. Anisotropic upper-mantle stratigraphy and architecture of the Slave craton, *Nature*, **390**, 392–395.
- Bostock, M. G., 1998. Mantle stratigraphy and evolution of the Slave province, *J. Geophys. Res.*, **103**(B9), 21183–21200.
- Bostock, M. G., Hyndman, R. D., Rondenay, S. & Peacock, S. M., 2002. An inverted continental Moho and serpentinization of the forearc mantle, *Nature*, **417**, 536–538.
- Botev, Z. I., Grotowski, J. F. & Kroese, D. P., 2010. Kernel density estimation via diffusion, *Ann. Stat.*, **38**(5), 2916–2957, doi: 10.1214/10-AOS799.
- Bouman, J., Fuchs, M., Ivins, E., van der Wal, W., Schrama, E., Visser, P. & Horwath, M., 2014. Antarctic outlet glacier mass change resolved at basin scale from satellite gravity gradiometry, *Geophys. Res. Lett.*, **41**(16), 5919–5926, doi: 10.1002/2014GL060637.
- Boutin, C., 2008. For geoscientist Simons, Earth's deepest secrets may come from the sea, *Princeton Weekly Bulletin*, p. 03/10/2008.
- Boutin, D. & Arkani-Hamed, J., 2006. Pole wandering of Mars: Evidence from paleomagnetic poles, *Icarus*, **181**, 12–25, doi: 10.1016/j.icarus.2005.10.025.
- Bouwkamp, C. J., 1947. On spheroidal wave functions of order zero, *J. Math. Phys.*, **26**, 79–92.
- Bowin, C., 2000. Mass anomaly structure of the Earth, *Rev. Geophys.*, **38**(3), 355–387.
- Bowman, J. R. & Kennett, B. L. N., 1991. Propagation of L_g waves in the North Australian craton — Influence of crustal velocity-gradients, *B. Seismol. Soc. Am.*, **81**(2), 592–610.

- Bowring, S. A. & Housh, T., 1995. The Earth's early evolution, *Science*, **269**, 1535–1540.
- Bowring, S. A., Grotzinger, J. P., Isachsen, C. E., Knoll, A. H., Pelechaty, S. M. & Kolosov, P., 1993. Calibrating rates of Early cambrian evolution, *Science*, **261**, 1293–1298.
- Boyce, A. & Cottaar, S., 2021. Insights into deep mantle thermochemical contributions to African magmatism from converted seismic phases, *Geochem. Geophys. Geosys.*, **22**(3), e2020GC009478, doi: 10.1029/2020GC009478.
- Boyd, F. R., 1989. Compositional distinction between oceanic and cratonic lithosphere, *Earth Planet. Sci. Lett.*, **96**, 15–26.
- Boyd, F. R. & Gurney, J. J., 1986. Diamonds and the African lithosphere, *Science*, **232**, 472–477.
- Boyd, F. R., Gurney, J. J. & Richardson, S. H., 1985. Evidence for a 150–200-km thick Archaean lithosphere from diamond inclusion thermobarometry, *Nature*, **315**, 387–389.
- Boyd, J. P., 2001. *Chebyshev and Fourier spectral methods*, Dover, New York.
- Boyd, J. P., 2003. Approximation of an analytic function on a finite real interval by a bandlimited function and conjectures on properties of prolate spheroidal functions, *Appl. Comput. Harmon. Anal.*, **15**(2), 168–176.
- Boyd, J. P., 2004. Prolate spheroidal wavefunctions as an alternative to Chebyshev and Legendre polynomials for spectral element and pseudospectral algorithms, *J. Comput. Phys.*, **199**(2), 688–716.
- Bozdağ, E. & Trampert, J., 2008. On crustal corrections in surface wave tomography, *Geophys. J. Int.*, **172**(3), 1066–1082, doi: 10.1111/j.1365-246X.2007.03690.x.
- Bozdağ, E. & Trampert, J., 2010. Assessment of tomographic mantle models using spectral element seismograms, *Geophys. J. Int.*, **180**(3), 1187–1199, doi: 10.1111/j.1365-246X.2009.04468.x.
- Bozdağ, E., Trampert, J. & Tromp, J., 2011. Misfit functions for full waveform inversion based on instantaneous phase and envelope measurements, *Geophys. J. Int.*, **185**(2), 845–870, doi: 10.1111/j.1365-246X.2011.04970.x.
- Bozdağ, E., Peter, D., Lefebvre, M., Komatitsch, D., Tromp, J., Hill, J., Podhorszki, N. & Pugmire, D., 2016. Global adjoint tomography: first-generation model, *Geophys. J. Int.*, **207**(3), 1739–1766, doi: 10.1093/gji/ggw356.
- Bracewell, R. N., 1986. *The Fourier Transform and its Applications*, McGraw-Hill Series In Electrical Engineering. Circuits And Systems, McGraw-Hill, New York, 2nd edn.
- Bradley, R. S., Vuille, M., Diaz, H. F. & Vergara, W., 2006. Threats to water supplies in the tropical Andes, *Science*, **312**(5781), 1755–1756, doi: 10.1126/science.1128087.
- Bradner, H., 1964. Seismic measurements on the ocean bottom, *Science*, **146**(3641), 208–216, doi: 10.1126/science.146.3641.208.

- Bradner, H. & Brune, J. N., 1974. Use of sonobuoys in determining hypocenters of aftershocks of February 21, 1973 Pt. Mugu earthquake, *B. Seismol. Soc. Am.*, **64**(1), 99–101.
- Bradner, H., de Jerphanion, L. G. & Langlois, R., 1970. Ocean microseism measurements with a neutral buoyancy free-floating midwater seismometer, *B. Seismol. Soc. Am.*, **60**, 1139–1150.
- Brain, D. A., Bagenal, F., Acuña, M. H. & Connerney, J. E. P., 2003. Martian magnetic morphology: Contributions from the solar wind and crust, *J. Geophys. Res.*, **108**(A12), 424, doi: 10.1029/2002JA009482.
- Brander, O. & DeFacio, B., 1986. A generalisation of Slepian's solution for the singular value decomposition of filtered Fourier transforms, *Inv. Probl.*, **2**, L9–L14.
- Braun, J. & Sambridge, M., 1995. A numerical method for solving partial differential equations on highly irregular evolving grids, *Nature*, **376**, 655–660.
- Braun, J., Dooley, J. C., Goleby, B., van der Hilst, R. D. & Klootwijk, C., eds., 1998. *Structure and Evolution of the Australian Continent*, vol. 26 of **Geodyn. Ser.**, Amer. Geophys. Union, Washington, D. C.
- Braun, J., Chéry, J., Poliakov, A., Mainprice, D., Vauchez, A., Tommasi, A. & Daignières, M., 1999. A simple parameterization of strain localization in the ductile regime due to grain size reduction: A case study for olivine, *J. Geophys. Res.*, **104**(B11), 25167–25181.
- Braun, J., Simon-Labric, T., Murray, K. E. & Reiners, P. W., 2014. Topographic relief driven by variations in surface rock density, *Nature Geosci.*, **7**, 534–540, doi: 10.1038/NGEO2171.
- Brems, D., Degryse, P., Hasendoncks, F., Gimeno, D., Silvestri, A., Vassilieva, E., Luypaers, S. & Honings, J., 2012. Western mediterranean sand deposits as a raw material for Roman glass production, *J Archaeol. Sci.*, **39**, 2897–2907, doi: 10.1016/j.jas.2012.03.009.
- Brennan, M. C., Fischer, R. A. & **J. C. E. Irving**, 2020. Core formation and geophysical properties of Mars, *Earth Planet. Sci. Lett.*, **530**, 115923, doi: 10.1016/j.epsl.2019.115923.
- Brevdo, E., 2011, *Efficient representations of signals in nonlinear signal processing with applications to inverse problems*, Ph.D. thesis, Princeton University.
- Brillinger, D. R., 1975. *Time Series, Data Analysis and Theory*, Holt, Rhinehart & Winston, New York.
- Brillinger, D. R., 1981. *Time Series: Data Analysis and Theory*, Holden Day, San Francisco.
- Broecker, W. S., 1985. *How to build a habitable planet*, Eldigio Press, Palisades, New York.
- Broecker, W. S. & Stocker, T. F., 2006. The Holocene CO₂ rise: Anthropogenic or natural?, *Eos Trans. AGU*, **87**(3), 27.
- Broerse, T., Riva, R. & Vermeersen, B., 2014. Ocean contribution to seismic gravity changes: the sea level equation for seismic perturbations revisited, *Geophys. J. Int.*, **199**, 1094–1109, doi: 10.1093/gji/ggu315.

- Bromirski, P. D., Cayan, D. R. & Flick, R. E., 2005. Wave spectral energy variability in the northeast Pacific, *J. Geophys. Res.*, **110**, C3005, doi: 10.1029/2004JC002398.
- Bromwich, D. H. & Nicolas, J. P., 2010. Ice-sheet uncertainty, *Nature Geosci.*, **3**, 596–597, doi:10.1038/ngeo946.
- Bromwich, D. H., Nicolas, J. P., Monaghan, A. J., Lazzara, M. A., Keller, L. M., Weidner, G. A. & Wilson, A. B., 2013. Central West Antarctica among the most rapidly warming regions on Earth, *Nature Geosci.*, **6**, 139–145, doi: 10.1038/ngeo1671.
- Bronez, T. P., 1988. Spectral estimation of irregularly sampled multidimensional processes by generalized prolate spheroidal sequences, *IEEE T. Acoust. Speech Signal Process.*, **36**(12), 1862–1873.
- Bronez, T. P., 1992. On the performance advantage of multitaper spectral analysis, *IEEE T. Signal Process.*, **40**(12), 2941–2946.
- Brossier, R., Operto, S. & Virieux, J., 2009. Seismic imaging of complex onshore structures by 2D elastic frequency-domain full-waveform inversion, *Geophysics*, **74**(6), WCC105–WCC118, doi: 10.1190/1.3215771.
- Brown, C. D., 2001. Thermal controls on flexure of underthrust continental lithosphere, *Geophys. J. Int.*, **146**, 813–826.
- Brown, C. D. & Phillips, R. J., 2000. Crust-mantle decoupling by flexure of continental lithosphere, *J. Geophys. Res.*, **105**(B6), 13221–13237.
- Brown, D., Ceranna, L., Prior, M., Mialle, P. & Bras, R. J. L., 2014. The IDC seismic, hydroacoustic and infrasound global low and high noise models, *Pure Appl. Geophys.*, **171**(3), 361–375, doi: 10.1007/s00024-012-0573-6.
- Brown, J. M. & Shankland, T. J., 1981. Thermodynamic parameters in the Earth as determined from seismic profiles, *Geophys. J. R. Astron. Soc.*, **66**, 579–596.
- Brown, J. R. & Slawinski, M. A., 2017. *On Foundations of Seismology: Bringing Idealizations Down to Earth*, World Scientific, Singapore.
- Bruckstein, A. M., Donoho, D. L. & Elad, M., 2009. From sparse solutions of systems of equations to sparse modeling of signals and images, *SIAM Rev.*, **51**(1), 34–81, doi: 10.1137/060657704.
- Bruhn, D., Groebner, N. & Kohlstedt, D. L., 2000. An interconnected network of core-forming melts produced by shear deformation, *Nature*, **403**, 883–886.
- Bruinsma, S., Lemoine, J.-M., Biancale, R. & Valès, N., 2010. CNES/GRGS 10-day gravity field models (release 2) and their evaluation, *Adv. Space Res.*, **45**(4), 587–601, doi: 10.1016/j.asr.2009.10.012.
- Brune, J. & Dorman, J., 1963. Seismic waves and earth structure in the Canadian shield, *B. Seismol. Soc. Am.*, **53**(1), 167–210.

- Brune, J. N., 1962. Attenuation of dispersed wave trains, *B. Seismol. Soc. Am.*, **52**, 109–112.
- Brune, J. N., 1964. Travel times, body waves, and normal modes of the Earth, *B. Seismol. Soc. Am.*, **54**(6), 2099–2128.
- Brune, J. N., 1970. Tectonic stress and the spectra of seismic shear waves from earthquakes, *J. Geophys. Res.*, **75**(26), 4997–5009.
- Brune, J. N. & Allen, C. R., 1967. A micro-earthquake survey of the San Andreas fault system in southern California, *B. Seismol. Soc. Am.*, **57**, 277–296.
- Bruneton, M., 2002. Non-linear surface wave phase velocity inversion based on ray theory, *GJI*, **151**, 583–596.
- Brussaard, P. J. & Tolhoek, H. A., 1957. Classical limits of Clebsch-Gordan coefficients, Racah coefficients and $D_{mn}^l(\phi, \theta, \psi)$ -functions, *Physica*, **23**(10), 955–971.
- Buffett, B. A., 2002. Estimates of heat flow in the deep mantle based on the power requirements for the geodynamo, *Geophys. Res. Lett.*, **29**(12), 10.1029/2001GL014649.
- Bui-Thanh, T. & Girolami, M., 2014. Solving large-scale PDE-constrained Bayesian inverse problems with Riemann manifold Hamiltonian Monte carlo, *Inv. Probl.*, **30**(11), 114014, doi: 10.1088/0266–5611/30/11/114014.
- Bui-Thanh, T., Ghattas, O., Martin, J. & Stadler, G., 2014. A computational framework for infinite-dimensional Bayesian inverse problems, Part I: The linearized case, with application to global seismic inversion, *SIAM J. Sci. Comput.*, **35**(6), A2494–A2523, doi: 10.1137/12089586X.
- Buil, C., 1991. *CCD Astronomy*, Willmann-Bell, Richmond, VA.
- Bukchin, B. G. & Levshin, A. L., 1980. Propagation of Love waves across a vertical discontinuity, *Wave Motion*, **2**, 293–302.
- Buland, R. & Chapman, C. H., 1983. The computation of seismic travel times, *B. Seismol. Soc. Am.*, **73**(5), 1271–1302.
- Buland, R. & Gilbert, F., 1984. Computation of free oscillations of the Earth, *J. Comput. Phys.*, **54**(1), 95–114.
- Bull, A. L., McNamara, A. K. & Ritsema, J., 2009. Synthetic tomography of plume clusters and thermochemical piles, *Earth Planet. Sci. Lett.*, **278**(3–4), 152–162.
- Bullen, K. E. & Bolt, B. A., 1985. *An Introduction to the Theory of Seismology*, Cambridge Univ. Press, Cambridge, UK, 4th edn.
- Bullen, K. E. & Haddon, R. A. W., 1967. Earth models based on compressibility theory, *Phys. Earth Planet. Inter.*, **1**, 1–13.
- Bunge, H.-P., 2013. Paleo-structure of the Earth’s mantle: Derivation from fluid dynamic inverse theory, *SIAM News*, **46**(10), 1 & 8.

- Bunge, H.-P., Ricard, Y. & Matas, J., 2001. Non-adiabaticity in mantle convection, *Geophys. Res. Lett.*, **28**(5), 879–882.
- Bunge, H.-P., Richards, M. A. & Baumgardner, J. R., 2002. Mantle-circulation models with sequential data assimilation: Inferring present-day mantle structure from plate-motion histories, *Phil. Trans. R. Soc. London, Ser. A*, **360**(2545–2567, doi: 10.1098/rsta.2002.1080).
- Bunge, H.-P., Hagelberg, C. R. & Travis, B. J., 2003. Mantle circulation models with variational data assimilation: Inferring past mantle flow and structure from plate motion histories and seismic tomography, *Geophys. J. Int.*, **152**(2), 280–301, doi: 10.1046/j.1365–246X.2003.01823.x.
- Bunks, C., Saleck, F. M., Zaleski, S. & Chavent, G., 1995. Multiscale seismic waveform inversion, *Geophysics*, **60**(5), 1457–1473, doi: 10.1190/1.1443880.
- Bunn, E. F., 2002. Detectability of microwave background polarization, *Phys. Rev. D*, **65**, 043003.
- Burdick, S. & Lekić, V., 2017. Velocity variations and uncertainty from transdimensional *P*-wave tomography of North America, *Geophys. J. Int.*, **209**(2), 1337–1351, doi: 10.1093/gji/ggx091.
- Burdick, S., van der Hilst, R. D., Vernon, F. L., Martynov, V., Cox, T., Eakins, J., Karasu, G. H., Tylell, J., Astiz, L. & Pavlis, G. L., 2010. Model update January 2010: Upper mantle heterogeneity beneath North America from traveltimes tomography with global and USArray Transportable Array data, *Seismol. Res. Lett.*, **81**(5), 689–693, doi: 10.1785/gssrl.81.5.689.
- Burdick, S., van der Hilst, R. D., Vernon, F. L., Martynov, V., Cox, T., Eakins, J., Karasu, G. H., Tylell, J., Astiz, L. & Pavlis, G. L., 2014. Model update January 2013: Upper mantle heterogeneity beneath North America from travel-time tomography with global and USArray Transportable Array data, *Seismol. Res. Lett.*, **85**(1), 77–81, doi: 10.1785/0220130098.
- Burg, J. P., 1975, *Maximum Entropy Spectral Analysis*, Ph.D. thesis, Stanford Univ., Stanford, Calif.
- Bürgmann, R. & Chadwell, D., 2014. Seafloor geodesy, *Annu. Rev. Earth Planet. Sc.*, **42**, 509–534, doi: 10.1146/annurev-earth-060313-054953.
- Burke, K. & Kind, W. S. F., 1978. Were Archean continental geothermal gradients much steeper than those of today?, *Nature*, **272**, 240–241.
- Burky, A., Irving, J. C. E. & Simons, F. J., 2018. Unraveling the origin of the Bermuda Rise using receiver functions: Insights from mantle discontinuity structure, *Presented at 2018 Cooperative Institute for Dynamic Earth Research Meeting, Santa Barbara, CA, 18 July*.
- Burky, A., Irving, J. C. E. & Simons, F. J., 2021. Mantle transition zone receiver functions for Bermuda: Automation, quality control, and interpretation, *J. Geophys. Res.*, **126**(3), e2020JB020177, doi: 10.1029/2020JB020177.
- Burky, A., Irving, J. C. E. & Simons, F. J., 2021. Instrument response removal and the 2020 M_{Lg} 3.1 Marlboro, New Jersey, earthquake, *Seismol. Res. Lett.*, **92**(6), 3865–3872, doi: 10.1785/0220210118.

- Burky, A. L., 2018, *Unraveling the origin of the Bermuda Rise using receiver functions: Insights from mantle discontinuity structure*, Generals paper, Princeton University.
- Burky, A. L., Irving, J. C. E. & Simons, F. J., 2017. Unraveling the origin of the Bermuda Rise using receiver functions: Insights from mantle discontinuity structure, *Presented at 2017 Fall Meeting, AGU, New Orleans, LA, 11–15 Dec*, abstract DI13A-0284.
- Burnham, K. P. & Anderson, D. R., 2002. *Model selection and multimodel inference: A practical information-theoretic approach*, Springer, New York, 2nd edn.
- Burov, E. B., 2010. The equivalent elastic thickness (T_e), seismicity and the long-term rheology of continental lithosphere: Time to burn-out “crème brûlée”? Insights from large-scale geodynamic modeling, *Tectonophysics*, **484**(1), 4–26, doi: 10.1016/j.tecto.2009.06.013.
- Burov, E. B. & Diament, M., 1995. The effective elastic thickness (T_e) of continental lithosphere: What does it really mean?, *J. Geophys. Res.*, **100**(B3), 3905–3927.
- Burov, E. B. & Watts, A. B., 2006. The long-term strength of continental lithosphere: ‘jelly sandwich’ or ‘crème brûlée’?, *GSA Today*, **16**(1), 10.1130/1052–5173(2006)016<4:tlstSOc>2.0.cO;2.
- Burov, E. B., Jaupart, C. & Mareschal, J.-C., 1998. Large-scale crustal heterogeneities and lithospheric strength in cratons, *Earth Planet. Sci. Lett.*, **164**(1–2), 205–219.
- Butler, R., 1977. A source of bias in multiple ScS differential times determined by waveform correlation, *Geophys. Res. Lett.*, **4**(12), 593–595, doi: 10.1029/GL004i012p00593.
- Butler, R., 2003. The Hawaii-2 Observatory: Observation of nanoearthquakes, *Seismol. Res. Lett.*, **74**(3), 290–297, doi: 10.1785/gssrl.74.3.290.
- Butler, R. & Lomnitz, C., 2002. Coupled seismoacoustic modes on the seafloor, *Geophys. Res. Lett.*, **29**(10), 1418, doi: 10.1029/2002GL014722.
- Butler, R., Chave, A. D., K., F., Duennebie, Yoerger, D. R., Petitt, R., Harris, D., Wooding, F. B., Bowen, A. D., Bailey, J., Hildebrand, J. J. E. H. J. A. & Dodeman, A. H., 2000. Hawaii-2 observatory pioneers opportunities for remote instrumentation in ocean studies, *Eos Trans. AGU*, **81**(15), 157–168, doi: 10.1029/00EO00105.
- Butler, R. F., 1992. *Paleomagnetism: Magnetic Domains to Geologic Terranes*, Blackwell, Oxford, UK.
- Byerly, P., 1940. Seismicity of the northern Pacific Coast of the United States, *Geol. Soc. Amer. Bull.*, **51**(1–4), 255–260.
- Byerly, W. E., 1893. *An Elementary Treatise on Fourier’s Series and Spherical, Cylindrical, and Ellipsoidal Harmonics*, Ginn & Co., Boston, Mass.
- Cadio, C. & Korenaga, J., 2014. Resolving the fine-scale density structure of shallow oceanic mantle by Bayesian inversion of localized geoid anomalies, *J. Geophys. Res.*, **119**, 3627–3645, doi: 10.1002/2013JB010840.

- Cadio, C., Ballmer, M. D., Panet, I., Diament, M. & Ribe, N., 2012. New constraints on the origin of the Hawaiian swell from wavelet analysis of the geoid to topography ratio, *Earth Planet. Sci. Lett.*, **359–360**, 40–54, doi: 10.1016/j.epsl.2012.10.006.
- Cadzow, J. A., 1979. An extrapolation procedure for band-limited signals, *IEEE-AS*, **27**(1), 4–12, doi: 10.1109/TASSP.1979.1163187.
- Cain, J. C., Wang, Z., Schmitz, D. R. & Meyer, J., 1989. The geomagnetic spectrum for 1980 and core-crustal separation, *Geophys. J. Int.*, **7**, 443–447.
- Cain, J. C., Ferguson, B. B. & Mozzoni, D., 2003. An $n=90$ internal potential function of the Martian crustal magnetic field, *J. Geophys. Res.*, **108**(E2), 5008, doi: 10.1029/2000JE001487.
- Çakrak, F. & Loughlin, P. J., 2001. Multiwindow time-varying spectrum with instantaneous bandwidth and frequency constraints, *IEEE T. Signal Process.*, **49**(8), 1656–1666.
- Çakrak, F. & Loughlin, P. J., 2001. Multiple window time-varying spectral analysis, *IEEE T. Signal Process.*, **49**(2), 448–453.
- Calais, E., Boisson, D., Symithe, S., Momplaisir, R., Prépetit, C., Ulysse, S., Etienne, G. P., Courboux, F., Deschamps, A., Monfret, T., Ampuero, J.-P., de Lépinay, B. M., Clouard, V., Bossu, R., Fallou, L. & Bertrand, E., 2019. Monitoring Haiti’s quakes with Raspberry Shake, *Eos Trans. AGU*, **100**(11), 17–21.
- Caldeira, K., Jain, A. K. & Hoffert, M. I., 2003. Climate sensitivity uncertainty and the need for energy without CO₂ emission, *Science*, **299**(5615), 2052–2054, doi: 10.1126/science.1078938.
- Calderbank, R., Daubechies, I., Sweldens, W. & Yeo, B.-L., 1997, Lossless image compression using integer to integer wavelet transforms, in *International Conference on Image Processing (ICIP)*, Vol. I, pp. 596–599, IEEE Press.
- Calderbank, R., Daubechies, I., Sweldens, W. & Yeo, B.-L., 1998. Wavelet transforms that map integers to integers, *Appl. Comput. Harmon. Anal.*, **5**(3), 332–369, doi: 10.1006/acha.1997.0238.
- Calmant, S. & Cazenave, A., 1987. Anomalous elastic thickness of the ocean lithosphere in the South Central Pacific, *Nature*, **328**(6127), 236–238.
- Cambiotti, G. & Sabadini, R., 2012. A source model for the great 2011 tohoku earthquake (mw= 9.1) from inversion of GRACE gravity data, *Earth Planet. Sci. Lett.*, **335**, 72–79, doi: 10.1016/j.epsl.2012.05.002.
- Cambiotti, G. & Sabadini, R., 2013. Gravitational seismology retrieving Centroid-Moment-Tensor solution of the 2011 Tohoku earthquake, *J. Geophys. Res.*.
- Cambiotti, G., Bordon, A., Sabadini, R. & Colli, L., 2011. GRACE gravity data help constraining seismic models of the 2004 Sumatran earthquake, *J. Geophys. Res.*, **116**, B10403, doi: 10.1029/2010JB007848.
- Cammarano, F., Goes, S., Vacher, P. & Giardini, D., 2003. Inferring upper mantle temperatures from seismic velocities, *Phys. Earth Planet. Inter.*, **138**, 97–222.

- Cammarano, F., Goes, S., Deuss, A. & Giardini, D., 2005. Is a pyrolitic adiabatic mantle compatible with seismic data?, *Earth Planet. Sci. Lett.*, **232**(3–4), 227–243, doi: 10.1016/j.epsl.2005.01.03.
- Cammarano, F., Lekić, V., Manga, M., Panning, M. & Romanowicz, B., 2006. Long-period seismology on Europa: 1. Physically consistent interior models, *J. Geophys. Res.*, **111**(E12), E12009, doi: 10.1029/2006JE002710.
- Campbell, W. H., Barton, C. E., Chamalaun, F. H. & Welsh, W., 1998. Quiet-day ionospheric currents and their application to upper mantle conductivity in Australia, *Earth Planets Space*, **50**, 347–360, doi: 10.1186/BF03352121.
- Campillo, M. & Paul, A., 2003. Long-range correlations in the diffuse seismic coda, *Science*, **299**(5606), 547–549.
- Campillo, M., Margerin, L. & Shapiro, N., 1999, Seismic wave diffusion in the earth lithosphere, in *Diffuse Waves in Complex Media*, edited by J.-P. Fouque, vol. 531 of **NATO ASI Series C: Mathematical and Physical Sciences**, pp. 383–404, Kluwer, Boston, Mass.
- Candela, T., Renard, F., Klinger, Y., Mair, K., Schmittbuhl, J. & Brodsky, E. E., 2012. Roughness of fault surfaces over nine decades of length scales, *J. Geophys. Res.*, **117**, B08409, doi: 10.1029/2011JB009041, 2012.
- Candès, E. & Romberg, J., 2005, Practical signal recovery from random projections, Tech. rep., California Institute of Technology, Pasadena, Calif.
- Candès, E. J., Demanet, L., Donoho, D. L. & Ying, L., 2005. Fast discrete curvelet transforms, *Multisc. Model. Simul.*, **5**, 861–899.
- Candès, E. J., Romberg, J. K. & Tao, T., 2006. Stable signal recovery from incomplete and inaccurate measurements, *Comm. Pure Appl. Math.*, **59**(8), 1207–1223.
- Canil, D., 2004. Mildly incompatible elements in peridotites and the origins of mantle lithosphere, *Lithos*, **77**(1), 375–393, doi: 10.1016/j.lithos.2004.04.014.
- Cao, J., Brossier, R. & Metivier, L., 2021, 3D fluid-solid coupled full-waveform inversion for ocean-bottom seismic data, in *First International Meeting for Applied Geoscience & Energy Expanded Abstracts*, pp. 832–836, doi: 10.1190/segam2021–3583300.1, Denver, Col.
- Cao, Q., van der Hilst, R. D., de Hoop, M. V. & Shim, S.-H., 2011. Seismic imaging of transition zone discontinuities suggests hot mantle West of Hawaii, *Science*, **332**, 1068–1071, doi: 10.1126/science.1202731.
- Capdeville, Y., 2005. An efficient Born normal mode method to compute sensitivity kernels and synthetic seismograms in the Earth, *Geophys. J. Int.*, **163**, 639–646, doi: 10.1111/j.1365–246X.2005.02765.x.
- Capdeville, Y. & Cance, P., 2015. Residual homogenization for elastic wave propagation in complex media, *Geophys. J. Int.*, **200**(2), 984–997, doi: 10.1093/gji/ggu452.

- Capdeville, Y., Chaljub, E. & Montagner, J.-P., 2003. Coupling the spectral element method with a modal solution for elastic wave propagation in global earth models, *Geophys. J. Int.*, **152**(1), 34–67, doi: 10.1046/j.1365–246X.2003.01808.x.
- Capdeville, Y., Gung, Y. & Romanowicz, B., 2005. Towards global earth tomography using the spectral element method: a technique based on source stacking, *Geophys. J. Int.*, **162**(2), 541–554, doi: 10.1111/j.1365–246X.2005.02689.x.
- Capdeville, Y., Guillot, L. & Marigo, J.-J., 2010. 1-D non-periodic homogenization for the seismic wave equation, *Geophys. J. Int.*, **181**(2), 897–910, doi: 10.1111/j.1365–246X.2010.04529.x.
- Capdeville, Y., Guillot, L. & Marigo, J.-J., 2010. 2-D non-periodic homogenization to up-scale elastic media for *P*–*SV* waves, *Geophys. J. Int.*, **182**(2), 903–922, doi: 10.1111/j.1365–246X.2010.04636.x.
- Caplan-Auerbach, J., Fox, C. & Duennebier, F. K., 2001. Hydroacoustic detection of submarine landslides on Kilauea volcano, *Geophys. Res. Lett.*, **28**(9), 1811–1813, doi: 10.1029/2000GL012545.
- Capon, J., 1969. High-resolution frequency-wavenumber spectrum analysis, *Proc. IEEE*, **57**(8), 1408–1418.
- Capon, J., 1970. Applications of detection and estimation theory to large array seismology, *Proc. IEEE*, **58**(5), 760–770.
- Cara, M., 1979. Lateral variations of *s*-velocity in the upper mantle from higher Rayleigh modes, *Geophys. J. R. Astron. Soc.*, **57**, 649–670.
- Cara, M. & L  v  que, J.-J., 1987. Waveform inversion using secondary observables, *Geophys. Res. Lett.*, **14**(10), 1046–1049.
- Cara, M. & L  v  que, J.-J., 1988. Anisotropy of the asthenosphere: The higher mode data of the Pacific revisited, *Geophys. Res. Lett.*, **15**(3), 205–208.
- Cara, M., L  v  que, J.-J. & Maupin, V., 1984. Density-versus-depth models from multimode surface waves, *Geophys. Res. Lett.*, **11**(7), 633–636.
- Carath  odory, C., 1937. On Dirichlet’s problem, *Am. J. Math.*, **59**(4), 709–731.
- Carpenter, E. W., Marshall, P. D. & Douglas, A., 1967. The amplitude-distance curve for short period teleseismic *P*-waves, *Geophys. J. R. Astron. Soc.*, **13**, 61–70.
- Carpentier, S. & Roy-Chowdhury, K., 2007. Underestimation of scale lengths in stochastic fields and their seismic response: a quantification exercise, *Geophys. J. Int.*, **169**(2), 547–562.
- Carpentier, S. F. A. & Roy-Chowdhury, K., 2009. Conservation of lateral stochastic structure of a medium in its simulated seismic response, *J. Geophys. Res.*, **114**(B10), B10314, doi: 10.1029/2008JB006123.

- Carpentier, S. F. A., Roy-Chowdhury, K., Stephenson, R. A. & Stovba, S., 2009. Delineating tectonic units beneath the Donbas Fold Belt using scale lengths estimated from DOBRE 2000/2001 deep reflection data, *J. Geophys. Res.*, **114**(B10), B10315, doi: 10.1029/2008JB006124.
- Carruthers, P. & Nieto, M. M., 1968. Phase and angle variables in quantum mechanics, *Rev. Mod. Phys.*, **40**(2), 411–440.
- Carter, G. C., 1987. Coherence and time-delay estimation, *Proc. IEEE*, **75**, 236–255.
- Carter, G. C., Knapp, C. H. & Nuttal, A. H., 1973. Statistics of the estimate of the magnitude-coherence function, *IEEE T. Audio Electroacoust.*, **AU21**, 388–389.
- Case, J., 2013. Foxes, hedgehogs, and the art of prediction (book review), *SIAM News*, **46**(3).
- Castle, J. C. & van der Hilst, R. D., 2000. The core-mantle boundary under the Gulf of Alaska: No ULVZ for shear waves, *Earth Planet. Sci. Lett.*, **176**, 311–321.
- Cazenave, A., Souriau, A. & Dominh, K., 1989. Global coupling of Earth surface topography with hotspots, geoid and mantle heterogeneities, *Nature*, **340**, 54–57.
- Cazenave, A., Parsons, B. & Calcagno, P., 1995. Geoid lineations of 1000 km wavelength over the Central Pacific, *Geophys. Res. Lett.*, **22**(2), 97–100.
- Chadwell, C. D. & Sweeney, A. D., 2010. Acoustic ray-trace equations for seafloor geodesy, *Marine Geodesy*, **33**(2-3), 164–186, doi: 10.1080/01490419.2010.492283.
- Chakraborty, A. & Okaya, D., 1995. Frequency-time decomposition of seismic data using wavelet-based methods, *Geophysics*, **60**(6), 1906–1916, doi: 10.1190/1.1443922.
- Chambat, F. & Ricard, Y., 2005. Empirical 3-D basis for the internal density of a planet, *Geophys. J. Int.*, **162**(1), 32–35, doi: 10.1111/j.1365-246X.2005.02650.x.
- Chambat, F. & Valette, B., 2001. Mean radius, mass, and inertia for reference Earth models, *Phys. Earth Planet. Inter.*, **124**(3–4), 237–253.
- Chamberlain, K. R., Patel, S. C., Frost, B. R. & Snyder, G. L., 1993. Thick-skinned deformation of the Archean Wyoming province during Proterozoic arc-continent collision, *Geology*, **21**, 995–998.
- Chamberlin, T. C., 1890. The method of multiple working hypotheses, *Science*, **15**(366), 92–96.
- Chambers, D. P., 2009. Calculating trends from GRACE in the presence of large changes in continental ice storage and ocean mass, *Geophys. J. Int.*, **176**, 415–419, doi: 10.1111/j.1365-246X.2008.04012.x.
- Chambers, D. P., Wahr, J. M. & Nerem, R. S., 2004. Preliminary observations of global ocean mass with GRACE, *Geophys. Res. Lett.*, **31**, L13310, doi: 10.1029/2004GL020461.
- Chambodut, A., Panet, I., Manda, M., Diament, M., Holschneider, M. & Jamet, O., 2005. Wavelet frames: an alternative to spherical harmonic representation of potential fields, *Geophys. J. Int.*, **163**(3), 875–899.

- Chambolle, A. & Lions, P.-L., 1997. Image recovery via total variation minimization and related problems, *Numer. Math.*, **76**(2), 167–188.
- Chamoli, A., Rani, V. S., Srivastava, K., Srinagesh, D. & Dimri, V. P., 2010. Wavelet analysis of the seismograms for tsunami warning, *Nonlin. Proc. Geophys.*, **17**, 569–574, doi: 10.5194/npg-17-569-2010.
- Chamoli, A., Lowry, A. R. & Jeppson, T. N., 2014. Implications of transient deformation in the northern basin and range, western united states, *J. Geophys. Res.*, **119**, 4393–4413, doi: 10.1002/2013JB010605.
- Champagnac, J.-D., Valla, P. G. & Herman, F., 2014. Late-Cenozoic relief evolution under evolving climate: A review, *Tectonophysics*, **614**, 44–65.
- Chan, G. & Wood, A. T. A., 1999. Simulation of stationary Gaussian vector fields, *Stat. Comput.*, **9**(4), 265–268, doi: 10.1023/A:1008903804954.
- Chang, W.-F. & McMechan, G. A., 1986. Reverse-time migration of offset vertical seismic profiling data using the excitation-time imaging condition, *Geophysics*, **51**(1), 67–84, doi: 10.1190/1.1442041.
- Channell, J. E. T. & Lehman, B., 1997. The last two geomagnetic polarity reversals recorded in high-deposition-rate sediment drifts, *Nature*, **389**, 712–715.
- Chao, B. F., 2005. On inversion for mass distribution from global (time-variable) gravity field, *J. Geodyn.*, **39**, 223–230, doi: 10.1016/j.jog.2004.11.001.
- Chao, B. F. & Au, A. Y., 1991. Temporal variation of the Earth's low-degree zonal gravitational field caused by atmospheric mass redistribution: 1980–1988, *J. Geophys. Res.*, **96**(B4), 6569–6575.
- Chao, B. F. & Gross, R. S., 1987. Changes in the Earth's rotation and low-degree gravitational field induced by earthquakes, *Geophys. J. Int.*, **91**, 569–596, doi: 10.1111/j.1365-246X.1987.tb01659.x.
- Chao, B. F. & Gross, R. S., 1995. Changes Earth's rotational energy induced by earthquakes, *Geophys. J. Int.*, **122**(3), 776–783.
- Chao, B. F., O'Connor, W. P., Chang, A. T. C., Hall, D. K. & Foster, J. L., 1987. Snow load effect on the earth's rotation and gravitational field, 1979–1985, *J. Geophys. Res.*, **92**(B9), 9415–9422.
- Chao, B. F., Gross, R. S. & Dong, D.-N., 1995. Changes in global gravitational energy induced by earthquakes, *Geophys. J. Int.*, **122**(3), 784–789.
- Chapman, C. H., 1978. A new method for computing synthetic seismograms, *Geophys. J. R. Astron. Soc.*, **54**, 481–518.
- Chapman, D. S., 1993, Thermal gradients in the continental crust, in *The nature of the lower continental crust*, edited by J. B. Dawson, D. A. Carswell, J. Hall, & K. H. Wedepohl, no. 24 in Geol. Soc. Spec. Pub., pp. 63–70, Geol. Soc., London, UK.

- Charl  ty, J., Nolet, G., Sigloch, K., Voronin, S., Loris, I., Simons, F. J., Daubechies, I. & Judd, S., 2010. Wavelet regularization per nullspace shuttle, *Abstract S31A-2053 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13–17 Dec.*.
- Charl  ty, J., Nolet, G., Voronin, S., Loris, I., Simons, F. J., Daubechies, I. & Sigloch, K., 2012. Inversion with a sparsity constraint: Application to mantle tomography, *Geophys. Res. Abstr.*, **14**, 5551.
- Charl  ty, J., Voronin, S., Nolet, G., Loris, I., Simons, F. J., Sigloch, K. & Daubechies, I. C., 2013. Global seismic tomography with sparsity constraints: Comparison with smoothing and damping regularization, *J. Geophys. Res.*, **118**(9), 4887–4899, doi: 10.1002/jgrb.50326.
- Chase, C. G. & Sprowl, D. R., 1983. The modern geoid and ancient plate boundaries, *Earth Planet. Sci. Lett.*, **62**, 314–320.
- Chase, C. G., Sussman, A. J. & Coblentz, D. D., 2009. Curved Andes: Geoid, forebulge, and flexure, *Lithosphere*, **1**(6), 358.
- Chave, A. D., Thomson, D. J. & Ander, M. E., 1987. On the robust estimation of power spectra, coherences, and transfer functions, *J. Geophys. Res.*, **92**(B1), 633–648, doi: 10.1029/JB092iB01p00633.
- Chen, C. W., Miller, D. E., Djikpesse, H. A., Haldorsen, J. B. U. & Rondenay, S., 2010. Array-conditioned deconvolution of multiple-component teleseismic recordings, *Geophys. J. Int.*, **182**(2), 967–976, doi: 10.1111/j.1365–246X.2010.04646.x.
- Chen, G. C. & Hodgkiss, W. S., 1993. VLF source localization with a freely drifting acoustic sensor array, *IEEE J. Ocean. Eng.*, **18**(3), 209–223.
- Chen, J. L. & Wilson, C. R., 2008. Low degree gravity changes from GRACE, Earth rotation, geophysical models, and satellite laser ranging, *J. Geophys. Res.*, **266**, B06402, doi: 10.1029/2007JB005397.
- Chen, J. L., Tapley, B. D. & Wilson, C. R., 2006. Alaskan mountain glacial melting observed by satellite gravimetry, *Earth Planet. Sci. Lett.*, **248**, 368–378, doi: 10.1016/j.epsl.2006.05.039.
- Chen, J. L., Wilson, C. R. & Seo, K.-W., 2006. Optimized smoothing of Gravity Recovery and Climate Experiment (GRACE) time-variable gravity observations, *J. Geophys. Res.*, **111**, B06408, doi: 10.1029/2005JB004064.
- Chen, J. L., Wilson, C. R. & Tapley, B. D., 2006. Satellite gravity measurements confirm accelerated melting of Greenland ice sheet, *Science*, **313**, 1958–1960.
- Chen, J. L., Wilson, C. R., Tapley, B. D. & Grand, S., 2007. GRACE detects coseismic and post-seismic deformation from the sumatra-andaman earthquake, *Geophys. Res. Lett.*, **34**, L13302.
- Chen, J. L., Wilson, C. R., Tapley, B. D., Blankenship, D. & Young, D., 2008. Antarctic regional ice loss rates from GRACE, *Earth Planet. Sci. Lett.*, **266**, 140–148, doi: 10.1016/j.epsl.2007.10.057.

- Chen, J. L., Wilson, C. R., Blankenship, D. & Tapley, B. D., 2009. Accelerated Antarctic ice loss from satellite gravity measurements, *Nature Geosci.*, **2**, 859–862, doi: 10.1038/ngeo694.
- Chen, J. L., Wilson, C. R. & Tapley, B. D., 2011. Interannual variability of Greenland ice losses from satellite gravimetry, *J. Geophys. Res.*, **116**(B7), B07406, doi: 10.1029/2010JB007789.
- Chen, P., Jordan, T. H. & Zhao, L., 2007. Full three-dimensional tomography: a comparison between the scattering-integral and adjoint-wavefield methods, *Geophys. J. Int.*, **170**(1), 175–181, doi: 10.1111/j.1365–246X.2007.03429.x.
- Chen, Q. Y., Gottlieb, D. & Hesthaven, J. S., 2005. Spectral methods based on prolate spheroidal wave functions for hyperbolic PDEs, *Wave Motion*, **43**(5), 1912–1933.
- Chen, W.-P. & Brudzinski, M. R., 2001. Evidence for a large-scale remnant of subducted lithosphere beneath Fiji, *Science*, **292**, 2475–2479.
- Chen, W.-P. & Özalaybey, S., 1998. Correlation between seismic anisotropy and Bouguer anomalies in Tibet and its implications for lithospheric structures, *Geophys. J. Int.*, **135**, 93–101.
- Chen, Y., 2018. Automatic microseismic event picking via unsupervised machine learning, *Geophys. J. Int.*, **212**, 88–102, doi: 10.1093/gji/ggx420.
- Chen, Y., Hill, J., Lei, W., Lefebvre, M., Tromp, J., Bozdağ, E. & Komatitsch, D., 2017, Automated time-window selection based on machine learning for full-waveform inversion, in *SEG Tech. Prog. Expanded Abstracts*, pp. 1604–1609, doi: 10.1190/segam2017–17734162.1, Soc. Explor. Geophys., Houston, Tex.
- Chenet, H., Lognonné, P., Wieczorek, M. & Mizutani, H., 2006. Lateral variations of lunar crustal thickness from the Apollo seismic data set, *Earth Planet. Sci. Lett.*, **243**, 1–14.
- Cheng, H., Rokhlin, V. & Yarvin, N., 1999. Nonlinear optimization, quadrature, and interpolation, *SIAM J. Optim.*, **9**(4), 901–923.
- Cheng, M. & Tapley, B. D., 2004. Variations in the Earth’s oblateness during the past 28 years, *J. Geophys. Res.*, **109**(B9), B09402, doi: 10.1029/2004JB003028.
- Cheng, M., Tapley, B. D. & Ries, J. C., 2013. Deceleration in the Earth’s oblateness, *J. Geophys. Res.*, **118**, 740–747, doi: 10.1002/jgrb.50058.
- Chevrot, S., 2000. Multichannel analysis of shear wave splitting, *J. Geophys. Res.*, **105**(B9), 21579–21590.
- Chevrot, S. & Girardin, N., 2000. On the detection and identification of converted and reflected phases from receiver functions, *Geophys. J. Int.*, **141**(3), 801–808, doi: 10.1046/j.1365–246x.2000.00139.x.
- Chevrot, S. & van der Hilst, R. D., 2000. The Poisson’s ratio of the Australian crust: Geological and geophysical implications, *Earth Planet. Sci. Lett.*, **183**, 121–132, doi: 10.1016/S0012–821X(00)00264–8.

- Chevrot, S. & Zhao, L., 2007. Multiscale finite-frequency Rayleigh wave tomography of the Kaapvaal craton, *Geophys. J. Int.*, **169**(1), 201–215, doi: 10.1111/j.1365–246X.2006.03289.x.
- Chevrot, S., Montagner, J.-P. & Snieder, R. K., 1998. The spectrum of tomographic Earth models, *Geophys. J. Int.*, **133**, 783–788.
- Chevrot, S., Montagner, J.-P. & Snieder, R. K., 1998. Corrigendum: The spectrum of tomographic earth models, *Geophys. J. Int.*, **135**, 311.
- Chevrot, S., Vinnik, L. & Montagner, J.-P., 1999. Global scale analysis of mantle *Pds* phases, *J. Geophys. Res.*, **104**(B9), 20203–20219, doi: 10.1029/1999JB900087.
- Chevrot, S., Martin, R. & Komatitsch, D., 2012. Optimized discrete wavelet transforms in the cubed sphere with the lifting scheme — implications for global finite-frequency tomography, *Geophys. J. Int.*, **191**(3), 1391–1402, doi: 10.1111/j.1365–246X.2012.05686.x.
- Chiao, L.-Y. & Kuo, B.-Y., 2001. Multiscale seismic tomography, *Geophys. J. Int.*, **145**, 517–527, doi: 10.1046/j.0956–540x.2001.01403.x.
- Chiao, L. Y. & Liang, W. T., 2003. Multiresolution parameterization for geophysical inverse problems, *Geophysics*, **68**(1), 199–209, doi: 10.1190/1.1543207.
- Chiao, L.-Y., Lin, J.-R. & Gung, Y.-C., 2006. Crustal magnetization equivalent source model of Mars constructed from a hierarchical multiresolution inversion of the Mars Global Surveyor data, *J. Geophys. Res.*, **111**, E12010, doi: 10.1029/2006JE002725.
- Childs, W. A. P., 1997. The Iron Age kingdom of Marion, *B. Am. Sch. Oriental Re.*, **308**, 37–48.
- Childs, W. A. P., 2008. Polis Chrysochous: Princeton University’s excavations of Ancient Marion and Arsinoe, *Near Eastern Archaeology*, **71**(1–2), 64–75.
- Choi, C. H., Ivanic, J., Gordon, M. S. & Ruedenberg, K., 1999. Rapid and stable determination of rotation matrices between spherical harmonics by direct recursion, *J. Chem. Phys.*, **111**(19), 8825–8831.
- Choi, Y. & Alkhalifah, T., 2012. Application of multi-source waveform inversion to marine streamer data using the global correlation norm, *Geophys. Prospect.*, **60**, 748–758, doi: 10.1111/j.1365–2478.2012.01079.x.
- Choi, Y. & Alkhalifah, T., 2013. Frequency-domain waveform inversion using the phase derivative, *Geophys. J. Int.*, **195**(3), 1904–1916, doi: 10.1093/gji/ggt351.
- Chong, J., Ni, S., Chu, R. & Somerville, P., 2016. Joint inversion of body-wave receiver function and Rayleigh-wave ellipticity, *B. Seismol. Soc. Am.*, **106**(2), 537–551, doi: 10.1785/0120150075.
- Chouet, B. A., 1996. Long-period volcano seismicity: its source and use in eruption forecasting, *Nature*, **380**, 309–316.

- Christakos, G., 1992. *Random Field Models in Earth Sciences*, Academic Press, San Diego, Calif., 2nd edn.
- Christensen, N., Meyer, R., Knox, L. & Luey, B., 2001. Bayesian methods for cosmological parameter estimation from cosmic microwave background measurements, *Class. Quantum Grav.*, **18**, 2677–2688.
- Christensen, U., Olson, P. & Glatzmaier, G. A., 1998. A dynamo model interpretation of geomagnetic field structures, *Geophys. Res. Lett.*, **25**(10), 1565–1568.
- Christensen, U. R., 1987. Some geodynamical effects of anisotropic viscosity, *Geophys. J. R. Astron. Soc.*, **91**(3), 711–736, doi: 10.1111/j.1365–246X.1987.tb01666.x.
- Christensen, U. R. & Yuen, D. A., 1989. Time-dependent convection with non-Newtonian viscosity, *J. Geophys. Res.*, **94**(B1), 814–820, doi: 10.1029/JB094iB01p00814.
- Chung, M. K., 2005, Model building in two-sphere via gauss-weierstrass kernel smoothing and its application to cortical analysis, Part I, Tech. Rep. 1115, University of Wisconsin, Madison, Wisc.
- Chung, M. K., Dalton, K. M., Shen, L., Evans, A. C. & Davidson, R. J., 2007. Weighted Fourier series representation and its application to quantifying the amount of gray matter, *IEEE T. Med. Imag.*, **26**(4), 566–581, doi: 10.1109/TMI.2007.892519.
- Chung, M. K., Dalton, K. M., Shen, L., Evans, A. C. & Davidson, R. J., 2007. Weighted Fourier series representation and its application to quantifying the amount of gray matter, *IEEE T. Med. Imag.*.
- Chung, M. K., Dalton, K. M. & Davidson, R. J., 2008. Tensor-based cortical surface morphometry via weighted spherical harmonic representation, *IEEE T. Med. Imag.*, **27**(8), 1143–1151, doi: 10.1109/TMI.2008.918338.
- Chung, M. K., Dalton, K. M., Evans, A. C. & Davidson, R. J., 2008. Tensor-based cortical surface morphometry via weighted spherical harmonic representation, *IEEE T. Med. Imag.*, **27**(8), 1143–1151, doi: 10.1109/TMI.2008.918338.
- Chung, S.-L., Lo, C.-H., Lee, T.-Y., Zhang, Y., Xie, Y., Li, X., Wang, K.-L. & Wang, P.-L., 1998. Diachronous uplift of the Tibetan plateau starting 40 Myr ago, *Nature*, **394**(769–773).
- Ciardelli, C., Bozdağ, E., Peter, D. & van der Lee, S., 2022. SphGLLTools: A toolbox for visualization of large seismic model files based on 3D spectral-element meshes, *Comput. Geosci.*, **159**, 105007, doi: 10.1016/j.cageo.2021.105007.
- Cichowicz, A. & Green, R. W. E., 1989. Changes in the early part of the seismic coda due to localized scatterers: The estimation of Q in a stope environment, *Pure Appl. Geophys.*, **129**(3–4), 497–511.
- Cichowicz, A. & Green, R. W. E., 1992. Tomographic study of upper-mantle structure of the South-African continent, using wave-form inversion, *Phys. Earth Planet. Inter.*, **72**(3–4), 276–285.

- Citron, R. I. & Zhong, S., 2012. Constraints on the formation of the Martian crustal dichotomy from remnant crustal magnetism, *Phys. Earth Planet. Inter.*, **212–213**, 55–63, doi: 10.1016/j.pepi.2012.09.008.
- Claerbout, J., 1998. Multidimensional recursive filters via a helix, *Geophysics*, **63**(5), 1532–1541.
- Claerbout, J. F., 1971. Toward a unified theory of reflector mapping, *Geophysics*, **36**(3), 467–481, doi: 10.1190/1.1440185.
- Claerbout, J. F., 1992. *Earth Soundings Analysis: Processing Versus Inversion*, Blackwell, Cambridge, Mass.
- Claerbout, J. F. & Fomel, S., 2014. *Geophysical Image Estimation by Example*, lulu.com.
- Clark, A. M., 1999. Deep sea observatories, *Mar. Tech. Soc. J.*, **33**(4), 41–48, doi: 10.4031/MTSJ.33.4.5.
- Clark, M. K., Maheo, G., Saleeby, J. & Farley, K. A., 2005. The non-equilibrium landscape of the southern Sierra Nevada, California, *GSA Today*, **15**(9), doi: 10.1130/1052–5173(2005)015<4:TNELOT>2.0.CO;2.
- Clark, P. U., Archer, D., Pollard, D., Blum, J. D., Rial, J. A., Brovkin, V., Mix, A. C., Pisias, N. G. & Roy, M., 2006. The middle pleistocene transition: characteristics, mechanisms, and implications for long-term changes in atmospheric pCO₂, *Quat. Sci. Rev.*, **25**(23–24), 3150–3184, doi: 10.1016/j.quascirev.2006.07.008.
- Clay, C. S. & Medwin, H., 1977. *Acoustical oceanography: Principles and applications*, Wiley-Interscience.
- Clayton, R. W. & Comer, R. P., 1983. A tomographic analysis of mantle heterogeneities from body wave travel time data, *Eos Trans. AGU*, **64**, 776.
- Cleary, J. R. & Simpson, D. W., 1971. Seismotectonics of the Australian continent, *Nature*, **230**.
- Cleary, J. R., Simpson, D. W. & Muirhead, K. J., 1972. Variations in Australian upper mantle structure, from observations of the Cannikin explosion, *Nature*, **236**, 111–112.
- Cleary, J. R., Ingate, S. F., King, D. & Wang, C., 1982. Upper mantle modelling using long-period SH body-wave trains, *Phys. Earth Planet. Inter.*, **30**, 36–48.
- Clitheroe, G. & van der Hilst, R. D., 1998, Complex anisotropy in the Australian lithosphere from shear-wave splitting in broad-band *sks*-records, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klootwijk, vol. 26 of **Geodyn. Ser.**, pp. 73–78, Amer. Geophys. Union, Washington, D. C.
- Clitheroe, G., Guðmundsson, Ó. & Kennett, B. L. N., 2000. The crustal thickness of Australia, *J. Geophys. Res.*, **105**, 13697–13713.
- Clitheroe, G., Guðmundsson, Ó. & Kennett, B. L. N., 2000. Sedimentary and upper crustal structure of Australia from receiver functions, *Aust. J. Earth Sci.*, **47**, 209–216.

- Cloetingh, S., Burov, E. & Poliakov, A., 1999. Lithosphere folding: Primary response to compression? (from central Asia to Paris basin, *Tectonics*, **18**(6), 1064–1083.
- Cloetingh, S. A. P. L., Wortel, M. J. R. & Vlaar, N. J., 1983. State of stress at passive margins and initiation of subduction zones, *Amer. Soc. Petrol. Geol. Mem.*, **34**, 717–723.
- Clowes, R. M., Zelt, C. A., Amor, J. R. & Ellis, R. M., 1995. Lithospheric structure in the southern Canadian Cordillera from a network of seismic refraction lines, *Canadian Journal of Earth Sciences*, **32**(10), 1485–1513.
- Coblentz, D. D. & Richardson, R. M., 1995. Statistical trends in the intraplate stress field, *J. Geophys. Res.*, **100**(B10), 20245–20255.
- Coblentz, D. D., Sandiford, M., Richardson, R. M., Zhou, S. & Hillis, R., 1995. The origins of the intraplate stress field in continental Australia, *Earth Planet. Sci. Lett.*, **133**, 299–309.
- Coblentz, D. D., Zhou, S., Hillis, R. R., Richardson, R. M. & Sandiford, M., 1998. Topography, boundary forces, and the Indo-Australian intraplate stress field, *J. Geophys. Res.*, **103**(B1), 919–931.
- Cochran, E. S., Lawrence, J. F., Christensen, C. & Jakka, R. S., 2009. The Quake-Catcher Network: Citizen science expanding seismic horizons, *Seismol. Res. Lett.*, **80**(1), 26–30, doi: 10.1785/gssrl.80.1.26.
- Cochran, J. R., 1979. An analysis of isostasy in the world's oceans, 2, Midocean ridge crests, *J. Geophys. Res.*, **84**(B9), 4713–4729.
- Cogley, J. G., Hock, R., Rasmussen, L. A., Arendt, A. A., Bauder, A., Braithwaite, R. J., Jansson, P., Kaser, G., Möller, M., Nicholson, L. & Zemp, M., 2011, Glossary of glacier mass balance and related terms, IHP-VII Technical Documents in Hydrology, No. 86 IACS Contribution No. 2, UNESCO-IHP.
- Cogo de Sa, N., Ussami, N. & Molina, E. C., 1993. Gravity map of Brazil; 1. Representation of free-air and Bouguer anomalies, *J. Geophys. Res.*, **98**(B2), 2187–2197.
- Cohen, A., Daubechies, I. & Feauveau, J., 1992. Biorthogonal bases of compactly supported wavelets, *Comm. Pure Appl. Math.*, **45**, 485–560, doi: 10.1002/cpa.3160450502.
- Cohen, A., Daubechies, I. & Vial, P., 1993. Wavelets on the interval and fast wavelet transforms, *Appl. Comput. Harmon. Anal.*, **1**, 54–81, doi: 10.1006/acha.1993.1005.
- Cohen, F. S., Fan, Z. & Patel, M. A., 1991. Classification of rotated and scaled textured images using Gaussian Markov random field models, *IEEE Trans. Pattern Anal. Machine Intell.*, **13**, 192–202, doi: 10.1109/34.67648.
- Cohen, L., 1989. Time-frequency distributions — A review, *Proc. IEEE*, **77**(7), 941–981.
- Cohen, R. E., 1987. Elasticity and equation of state of MgSiO₃ perovskite, *Geophys. Res. Lett.*, **14**(14), 1053–1056.

- Coifman, R. R. & Lafon, S., 2006. Geometric harmonics: A novel tool for multiscale out-of-sample extension of empirical functions, *Appl. Comput. Harmon. Anal.*, **21**, 31–52, doi: 10.1016/j.acha.2005.07.005.
- Collerson, K. D., Hapugoda, S., Kamber, B. S. & Williams, Q., 2000. Rocks from the mantle transition zone: Majorite-bearing xenoliths from Malaita, Southwest Pacific, *Science*, **288**, 1215–1223.
- Collette, B. J., Slootweg, A. P., Verhoef, J. & Roest, W. R., 1984. Geophysical investigations of the floor of the Atlantic Ocean between 10° and 38°N (kroonvlag-project), *Proc. K. Ned. Akad. Wet.*, **87**, 1–76.
- Collins, J. A., Vernon, F. L., Orcutt, J. A., Stephen, R. A., Peal, K. R., Wooding, F. B., Spiess, F. N. & Hildebrand, J. A., 2001. Broadband seismology in the oceans: Lessons from the Ocean Seismic Network Pilot Experiment, *Geophys. Res. Lett.*, **28**(1), 49–52, doi: 10.1029/2000GL011638.
- Coltice, N., Albarède, F. & Gillet, P., 2000. ^{40}K – ^{40}Ar constraints on recycling continental crust into the mantle, *Science*, **288**, 845–847.
- Coltice, N., Ferrachat, S. & Ricard, Y., 2000. Box modeling the chemical evolution of geophysical systems: case study of the Earth's mantle, *Geophys. Res. Lett.*, **27**(11), 1579–1582.
- Colzani, L., 1986. Regularity of spherical means and localization of spherical harmonic expansions, *J. Aust. Math. Soc. Ser. A*, **41**, 287–297.
- Combes, J. M., Grossmann, A. & Tchamitchian, P., eds., 1990. *Wavelets: Time-Frequency Methods and Phase Space*, Proc. Int. Conf., Marseille, France, Dec. 14–18, 1987, Springer, 2nd edn.
- Condie, K. C., 2001. *Mantle Plumes and Their Record in Earth History*, Cambridge Univ. Press, Cambridge, UK.
- Condie, K. C. & Kröner, A., 2008. When did plate tectonics begin? Evidence from the geologic record, *Geol. Soc. Am. Spec. Paper*, **440**, 281–294, doi: 10.1130/2008.2440(14).
- Coney, P. J., Edwards, A., Hine, R., Morrison, F. & Windrim, D., 1990. The regional tectonics of the Tasman orogenic system, eastern Australia, *J. Struct. Geol.*, **12**(5), 519–543.
- Connerney, J. E. P., 2015, Planetary magnetism, in *Treatise on Geophysics*, edited by T. Spohn, vol. 10, pp. 195–237, doi: 10.1016/B978-0-444-53802-4.00171-8, Elsevier, Amsterdam, Neth., 2nd edn.
- Connerney, J. E. P., Acuña, M. H., Wasilewski, P. J., Ness, N. F., Rème, H., Mazelle, C., Vignes, D., Lin, R. P., Mitchell, D. L. & Cloutier, P. A., 1999. Magnetic lineations in the ancient crust of Mars, *Science*, **284**(5415), 794–798.
- Connerney, J. E. P., Acuña, M. H., Wasilewski, P. J., Kletetschka, G., Ness, N. F., Rème, H., Lin, R. P. & Mitchell, D. L., 2001. The global magnetic field of Mars and implications for crustal evolution, *Geophys. Res. Lett.*, **28**(21), 4051–4048, doi: 10.1029/2001GL013619.

- Connerney, J. E. P., Acuña, M. H., Ness, N. F., Kletetschka, G., Mitchell, D. L., Lin, R. P. & Rème, H., 2005. Tectonic implications of Mars crustal magnetism, *Proc. Natl. Acad. Sc.*, **102**(42), 14970–14975, doi: 10.1073/pnas.0507469102.
- Conrad, C. P., 2000. Convective instability of thickening mantle lithosphere, *Geophys. J. Int.*, **143**(1), 52–70.
- Conrad, C. P. & Hager, B. H., 1995. The elastic response of the earth to interannual variations in Antarctic precipitation, *GRL*, **22**(23), 3183–3186.
- Conrad, C. P. & Hager, B. H., 1997. Spatial variations in the rate of sea level rise caused by the present-day melting of glaciers and ice sheets, *Geophys. Res. Lett.*, **24**(12), 1503–1506.
- Conrad, C. P. & Hager, B. H., 1999. Effects of plate bending and fault strength at subduction zones on plate dynamics, *J. Geophys. Res.*, **104**(B8), 17551–17571.
- Conrad, C. P. & Hager, B. H., 1999. The thermal evolution of an Earth with strong subduction zones, *Geophys. Res. Lett.*, **26**(19), 3041–3044.
- Conrad, C. P. & Hager, B. H., 2001. Mantle convection with strong subduction zones, *Geophys. J. Int.*, **144**, 271–288.
- Conrad, C. P. & Molnar, P., 1997. The growth of Rayleigh-Taylor-type instabilities in the lithosphere for various rheological and density structures, *Geophys. J. Int.*, **129**(1), 95–112, doi: j.1365–246X.1997.tb00939.x.
- Conrad, C. P. & Molnar, P., 1999. Convective instability of a boundary layer with temperature- and strain-rate-dependent viscosity in terms of “available buoyancy”, *Geophys. J. Int.*, **139**, 51–68.
- Conrad, C. P., Steinberger, B. & Torsvik, T. H., 2013. Stability of active mantle upwelling revealed by net characteristics of plate tectonics, *Nature*, **498**(7455), 479–482, doi: 10.1038/nature12203.
- Constable, C. G., 1992. Link between geomagnetic reversal paths and secular variation of the field over the past 5 Myr, *Nature*, **358**, 230–232, doi: 10.1038/358230a0.
- Constable, C. G. & Parker, R. L., 1988. Smoothing, splines and smoothing splines; their application in geomagnetism, *J. Comput. Phys.*, **78**, 493–508.
- Constable, S. C., Parker, R. L. & Constable, C. G., 1987. Occam’s inversion: A practical algorithm for generating smooth models from electromagnetic sounding data, *Geophysics*, **52**(3), 289–300.
- Convers, J. A. & Newman, A. V., 2011. Global evaluation of large earthquake energy from 1997 through mid-2010, *J. Geophys. Res.*, **116**, B08304, doi: 10.1029/2010JB007928.
- Convertito, V. & Herrero, A., 2004. Influence of focal mechanism in probabilistic seismic hazard analysis, *B. Seismol. Soc. Am.*, **94**(6), 2124–2136, doi: 10.1785/0120040036.
- Conyers, L. B., 1997. *Ground-Penetrating Radar for Archaeology*, AltaMira Press, Plymouth, UK.

- Cook, C. P., van de Flierdt, T., Williams, T., Hemming, S. R., Iwai, M., Kobayashi, M., Jimenez-Espejo, F. J., Escutia, C., González, J. J., Khim, B.-K., McKay, R. M., Passchier, S., Bohaty, S. M., Riesselman, C. R., Tauxe, L., Sugisaki, S., Galindo, A. L., Patterson, M. O., Sangiorgi, F., Pierce, E. L., Brinkhuis, H. & Expedition 318 Scientists, I., 2013. Dynamic behaviour of the East Antarctic ice sheet during Pliocene warmth, *Nature Geosci.*, **6**, 765–769, doi: 10.1038/ngeo1889.
- Cook, E. R., Anchukaitis, K. J., Buckley, B. M., D’Arrigo, R. D., Jacoby, G. C. & Wright, W. E., 2010. Asian monsoon failure and megadrought during the last millennium, *Science*, **328**, 486–489.
- Cooley, J. W. & Tukey, J. W., 1965. An algorithm for the machine calculation of complex Fourier series, *Math. Comput.*, **19**(90), 297–301.
- Cordero, E. & Tabacco, A., 2004, Localization operators via time-frequency analysis, in *Advances in Pseudo-Differential Operators*, edited by R. Ashino, P. Boggiatto, & M.-W. Wong, vol. 155 of **Operator Theory: Advances and Applications**, Birkhäuser.
- Cotaras, F. D., Fraser, I. A. & Merklinger, H. M., 1988. Near-surface ocean ambient noise measurements at very low-frequencies, *J. Acoust. Soc. Am.*, **83**(4), 1345–1359.
- Cottaar, S. & Lekić, V., 2016. Morphology of seismically slow lower-mantle structures, *Geophys. J. Int.*, **207**(2), 1122–1136, doi: 10.1093/gji/ggw324.
- Cottaar, S. & Romanowicz, B., 2012. An unusually large ULVZ at the base of the mantle near Hawaii, *Earth Planet. Sci. Lett.*, **355–356**, 213–222, doi: 10.1016/j.epsl.2012.09.005.
- Counil, J. L., Cohen, Y. & Achache, J., 1991. The global continent-ocean magnetization contrast, *Earth Planet. Sci. Lett.*, **103**(1-4), 354–364, doi: 10.1016/s0012-821X(91)90172-E.
- Courant, R. & Hilbert, D., 1953. *Methods of Mathematical Physics*, Interscience, New York.
- Courant, R., Friedrichs, K. & Lewy, H., 1967. On the partial difference equations of mathematical physics, *IBM J. Res. Dev.*, **11**(2), 215–234, doi: 10.1147/rd.112.0215.
- Courtier, A. M., Bagley, B. & Revenaugh, J., 2007. Whole mantle discontinuity structure beneath Hawaii, *Geophys. Res. Lett.*, **34**(17), L17304, doi: 10.1029/2007GL031006.
- Courtillot, V. & Besse, J., 1987. Magnetic field reversals, polar wander, and core-mantle coupling, *Science*, **237**(4819), 1140–1147, doi: 10.1126/science.237.4819.1140.
- Courtillot, V. & Mouël, J. L. L., 1984. Geomagnetic secular variation impulses, *Nature*, **311**, 709–716.
- Courtillot, V., Davaille, A., Besse, J. & Stock, J., 2003. Three distinct types of hotspots in the Earth’s mantle, *Earth Planet. Sci. Lett.*, **205**(3–4), 295–308, doi: 10.1016/S0012-821X(02)01048-8.

- Cowles, T., Delaney, J., Orcutt, J. & Weller, R., 2010. The Ocean Observatories Initiative: Sustained ocean observing across a range of spatial scales, *Mar. Technol. Soc. J.*, **44**(6), 54–64, doi: 10.4031/MTSJ.44.6.21.
- Cox, C. M. & Chao, B. F., 1998. Detection of a large-scale mass redistribution in the terrestrial system since 1998, *Science*, **297**, 831–833, doi: 10.1126/science.1072188.
- Cox, C. S. & Jacobs, D. C., 1989. Cartesian diver observations of double frequency pressure-fluctuations in the upper levels of the ocean, *Geophys. Res. Lett.*, **16**(8), 807–810.
- Cox, D. R. & Hinkley, D. V., 1974. *Theoretical Statistics*, Chapman and Hall, London, UK.
- Craigmile, P. F., 2003. Simulating a class of stationary Gaussian processes using the Davies–Harte algorithm, with application to long memory processes, *J. Time Ser. Anal.*, **24**(5), 505–511, doi: 10.1111/1467-9892.00318.
- Cramér, H., 1942. On harmonic analysis in certain functional spaces, *Arkiv Mat. Astr. Fysik*, **28B**, 1–7.
- Cramér, H. & Leadbetter, M. R., 1967. *Stationary and Related Stochastic Processes*, John Wiley, New York.
- Crampin, S., 1984. An introduction to wave propagation in anisotropic media, *Geophys. J. R. Astron. Soc.*, **76**, 17–28.
- Crampin, S., 1989. Suggestions for a consistent terminology for seismic anisotropy, *Geophys. Prospect.*, **37**, 753–770.
- Crampin, S., McGonigle, R. & Bamford, D., 1980. Estimating crack parameters from observations of *P*-wave velocity anisotropy, *Geophysics*, **45**(3), 345–360.
- Craven, P. & Wahba, G., 1979. Smoothing noisy data with spline functions: Estimating the correct degree of smoothing by the method of Generalized Cross-Validation, *Numer. Math.*, **31**, 377–403.
- Creager, K. C., 1992. Anisotropy of the inner core from differential travel times of the phases *pkp* and *pkikp*, *Nature*, **356**, 309–314.
- Creager, K. C., 1997. Inner core rotation rate from small-scale heterogeneity and time-varying travel times, *Science*, **278**, 1284–1288.
- Cressey, D., 2008. The next land rush, *Nature*, **451**, 12–15.
- Crice, D., 2005. MASW, the wave of the future — editorial, *J. Environ. Eng. Geophys.*, **10**(2), 77–79.
- Crider, D. H., 2004. The influence of crustal magnetism on the solar wind interaction with Mars: recent observations, *Adv. Space Res.*, **33**, 152–160, doi: 10.1016/j.asr.2003.04.013.

- Cristini, P. & Komatitsch, D., 2012. Some illustrative examples of the use of a spectral-element method in ocean acoustics, *J. Acoust. Soc. Am.*, **131**(3), EL229–EL235, doi: 10.1121/1.3682459.
- Cronin, T., 2012. Rapid sea-level rise, *Quat. Sci. Rev.*, **56**, 11–30, doi: 10.1016/j.quascirev.2012.08.021.
- Crosby, A. G., 2007. An assessment of the accuracy of admittance and coherence estimates using synthetic data, *Geophys. J. Int.*, **171**(1), 25–54.
- Crosson, R. S., 1976. Crustal structure modeling of earthquake data: 1. Simultaneous least squares estimation of hypocenter and velocity parameters, *J. Geophys. Res.*, **81**(17), 3036–3046, doi: 10.1029/JB081i017p03036.
- Crosson, R. S., 1976. Crustal structure modeling of earthquake data: 2. Velocity structure of the Puget Sound Region, Washington, *J. Geophys. Res.*, **81**(17), 3047–3054, doi: 10.1029/JB081i017p03047.
- Crotwell, H. P. & Owens, T. J., 2005. Automated receiver function processing, *Seismol. Res. Lett.*, **76**(6), 702.
- Crotwell, H. P., Owens, T. J. & Ritsema, J., 1999. The TauP Toolkit: Flexible seismic travel-time and ray-path utilities, *Seismol. Res. Lett.*, **70**(2), 154–160, doi: 10.1785/gssrl.70.2.154.
- Crough, S. T. & Jurdy, D. M., 1980. Subducted lithosphere, hotspots, and the geoid, *Earth Planet. Sci. Lett.*, **48**(1), 15–22.
- Crowley, J. W., Mitrovica, J. X., Bailey, R. C., Tamisiea, M. E. & Davis, J. L., 2006. Land water storage within the Congo Basin inferred from GRACE satellite gravity data, *Geophys. Res. Lett.*, **33**, L19402, doi: 10.1029/2006GL027070.
- Crowley, J. W., Katz, R. F., Huybers, P., Langmuir, C. H. & Park, S.-H., 2015. Glacial cycles drive variations in the production of oceanic crust, *Science*, **347**(6227), 1237–1240, doi: 10.1126/science.1261508.
- Cuellar, C., 2021. Students monitor campus noise in seismic silence, *Eos*, **101**, doi: 10.1029/2020EO152734.
- Cull, J. P., 1991, Heat flow and regional geophysics in Australia, in *Terrestrial Heat Flow and the Lithosphere Structure*, edited by V. Cermak & L. Rybach, pp. 486–500, Springer, New York.
- Cull, J. P. & Denham, D., 1979. Regional variations in Australian heat flow, *BMR J. Aust. Geol. Geophys.*, **4**, 1–13.
- Cummins, P. R., Geller, R. J., Hatori, T. & Takeuchi, N., 1994. DSM complete synthetic seismograms: SH, spherically symmetric, case, *Geophys. Res. Lett.*, **21**(7), 533–536.
- Cummins, P. R., Geller, R. J. & Takeuchi, N., 1994. DSM complete synthetic seismograms: P-SV, spherically symmetric, case, *Geophys. Res. Lett.*, **21**(15), 1663–1666, doi: 10.1029/94GL01281.

- Curtis, A., 2004. Theory of model-based geophysical survey and experimental design, *The Leading Edge*, **23**(10), 997–1004, doi: 10.1190/1.1813346.
- Curtis, A. & Snieder, R., 1997. Reconditioning inverse problems using the genetic algorithm and revised parameterization, *Geophysics*, **62**(4), 1524–1532.
- D’Agostino, N. & McKenzie, D., 1999. Convective support of long-wavelength topography in the Apennines (Italy), *Terra Nova*, **11**, 234–238.
- Dahle, C., Flechtner, F., Gruber, C., König, D., König, R., Michalak, G. & Neumayer, K.-H., 2013, GFZ GRACE Level-2 processing standards document for Level-2 product release 0005, Tech. rep., GeoForschungsZentrum, Potsdam, Germany.
- Dahlen, F. A., 1968. The normal modes of a rotating, elliptical Earth, *Geophys. J. R. Astron. Soc.*, **16**, 329–367.
- Dahlen, F. A., 1969. The normal modes of a rotating, elliptical Earth—II Near-resonance multiplet coupling, *Geophys. J. R. Astron. Soc.*, **18**, 397–436.
- Dahlen, F. A., 1971. The excitation of the Chandler Wobble by earthquakes, *Geophys. J. R. Astron. Soc.*, **25**, 157–206.
- Dahlen, F. A., 1973. A correction to the excitation of the Chandler Wobble by earthquakes, *Geophys. J. R. Astron. Soc.*, **32**, 203–217.
- Dahlen, F. A., 1976. Models of the lateral heterogeneity of the Earth consistent with eigenfrequency splitting data, *Geophys. J. R. Astron. Soc.*, **44**, 77–105.
- Dahlen, F. A., 1976. The passive influence of the oceans upon the rotation of the Earth, *Geophys. J. R. Astron. Soc.*, **46**, 363–406.
- Dahlen, F. A., 1977. The balance of energy in earthquake faulting, *Geophys. J. R. Astron. Soc.*, **48**, 239–261.
- Dahlen, F. A., 1978. Excitation of the normal modes of a rotating earth model by an earthquake fault, *Geophys. J. R. Astron. Soc.*, **54**, 1–9.
- Dahlen, F. A., 1979. Exact and asymptotic synthetic multiplet spectra on an ellipsoidal earth, *Geophys. J. R. Astron. Soc.*, **59**(1), 19–42.
- Dahlen, F. A., 1980. A uniformly valid asymptotic representation of normal mode multiplet spectra on a laterally heterogeneous Earth, *Geophys. J. R. Astron. Soc.*, **62**(2), 225–247.
- Dahlen, F. A., 1982. The effect of data windows on the estimation of free oscillation parameters, *Geophys. J. R. Astron. Soc.*, **69**(2), 537–549.
- Dahlen, F. A., 2004. Resolution limit of traveltimes tomography, *Geophys. J. Int.*, **157**(1), 315–331, doi: 10.1111/j.1365-246X.2004.02214.x.

- Dahlen, F. A., 2005. Finite-frequency sensitivity kernels for boundary topography perturbations, *Geophys. J. Int.*, **162**(2), 525–540, doi: 10.1111/j.1365–246X.2005.02682.x.
- Dahlen, F. A. & Baig, A., 2002. Fréchet kernels for body-wave amplitudes, *Geophys. J. Int.*, **150**, 440–466, doi: 10.1046/j.1365–246X.2002.01718.x.
- Dahlen, F. A. & Simons, F. J., 2008. Spectral estimation on a sphere in geophysics and cosmology, *Geophys. J. Int.*, **174**(3), 774–807, doi: 10.1111/j.1365–246X.2008.03854.x.
- Dahlen, F. A. & Tromp, J., 1998. *Theoretical Global Seismology*, Princeton Univ. Press, Princeton, N.J.
- Dahlen, F. A. & Zhou, Y., 2006. Surface-wave group-delay and attenuation kernels, *Geophys. J. Int.*, **165**(2), 545–554, doi: 10.1111/j.1365–246X.2006.02913.x.
- Dahlen, F. A., Hung, S.-H. & Nolet, G., 2000. Fréchet kernels for finite-frequency traveltimes — I. Theory, *Geophys. J. Int.*, **141**(1), 157–174, doi: 10.1046/j.1365–246X.2000.00070.x.
- Dahlhaus, R., 1983. Spectral analysis with tapered data, *J. Time Ser. Anal.*, **4**(3), 163–175.
- Dahlhaus, R. & Künsch, H., 1987. Edge effects and efficient parameter estimation for stationary random fields, *Biometrika*, **74**(4), 877–882, doi: 10.1093/biomet/74.4.877.
- Dahm, T., Tilmann, F. & Morgan, J. P., 2006. Seismic broadband ocean-bottom data and noise observed with free-fall stations: Experiences from long-term deployments in the North Atlantic and the Tyrrhenian Sea, *B. Seismol. Soc. Am.*, **96**(2), 647–664, doi: 10.1785/0120040064.
- Dai, C., Shum, C. K., Wang, R., Wang, L., Guo, J., Shang, K. & Tapley, B., 2014. Improved constraints on seismic source parameters of the 2011 Tohoku earthquake from GRACE gravity and gravity gradient changes, *Geophys. Res. Lett.*, **41**(6), 1929–1936, doi: 10.1002/2013GL059178.
- Dainty, A. M., Toksöz, M. N., Anderson, K. R., Pines, P. J., Nakamura, Y. & Latham, G., 1974. Seismic scattering and shallow structure of the Moon in Oceanus Procellarum, *The Moon*, **9**, 11–29.
- Dalton, C. A. & Ekström, G., 2006. Global models of surface wave attenuation, *J. Geophys. Res.*, **111**(B5), B05317, doi: 10.1029/2005JB003997.
- Dalton, R., 2002. Oceanography: Voyage of the argonauts, *Nature*, **415**(6875), 954–955, doi: 10.1038/415954a.
- Dalton, R., 2003. Marine seismology: A window on the inner Earth, *Nature*, **421**(6198), 10–12.
- Daly, E., Brown, C., Stark, C. P. & Ebinger, C. J., 2004. Wavelet and multitaper coherence methods for assessing the elastic thickness of the Irish Atlantic margin, *Geophys. J. Int.*, **159**(2), 445–459, doi: 10.1111/j.1365–246X.2004.02427.x.
- Danek, T., Kochetov, M. & Slawinski, M. A., 2013. Uncertainty analysis of effective elasticity tensors using quaternion-based global optimization and Monte-Carlo method, *Quart. J. Mech. Appl. Math.*, **66**(2), 253–272, doi: 10.1093/qjmam/hbt004.

- Danesi, S. & Morelli, A., 2001. Structure of the upper mantle under the Antarctic Plate from surface wave tomography, *Geophys. Res. Lett.*, **28**(23), 4395–4398, doi: 10.1029/2001GL013431.
- Darbyshire, F. A., White, R. S. & Priestley, K. F., 2000. Structure of the crust and uppermost mantle of Iceland from a combined seismic and gravity study, *Earth Planet. Sci. Lett.*, **181**(3), 409–428, doi: 10.1016/S0012-821X(00)00206-5.
- Darragh, R. B., 1985. Mapping of upper mantle structure from differential (PP–P) travel-time residuals, *Phys. Earth Planet. Inter.*, **41**, 6–17, doi: 10.1016/0031-9201(85)90098-6.
- Das, S. & Bode, P., 2008. A large sky simulation of the gravitational lensing of the cosmic microwave background, *Astroph. J.*, **682**, 1–13, doi: 10.1086/589638.
- Das, S., Hajian, A. & Spergel, D. N., 2009. Efficient power spectrum estimation for high resolution CMB maps, *Phys. Rev. D*, **79**(8), 083008.
- Das, S., Hajian, A. & Spergel, D. N., 2010. Slepian functions analysis of CMB data from the Atacama Cosmology Telescope, *manuscript in preparation*.
- Das, S. B., Joughin, I., Behn, M. D., Howat, I. M., King, M. A., Lizarralde, D. & Bhatia, M. P., 2008. Fracture propagation to the base of the Greenland ice sheet during supraglacial lake drainage, *Science*, **320**(5877), 778–781, doi: 10.1126/science.1153360.
- D’Asaro, E. A., 2007. Solar power for autonomous floats, *J. Atmos. Ocean Tech.*, **24**(7), 1309–1314, doi: 10.1175/JTECH2041.1.
- Daubechies, I., 1988. Time-frequency localization operators: A geometric phase space approach, *IEEE T. Inform. Theory*, **34**, 605–612.
- Daubechies, I., 1988. Orthonormal bases of compactly supported wavelets, *Comm. Pure Appl. Math.*, **41**(7), 909–996, doi: 10.1002/cpa.3160410705.
- Daubechies, I., 1990. The wavelet transform, time-frequency localization and signal analysis, *IEEE T. Inform. Theory*, **36**(5), 961–1005.
- Daubechies, I., 1991, The wavelet transform: A method for time-frequency localization, in *Advances in Spectrum Analysis and Array Processing*, edited by S. Haykin, vol. 1, chap. 8, pp. 366–417, Prentice-Hall, Englewood Cliffs, N. J.
- Daubechies, I., 1992. *Ten Lectures on Wavelets*, vol. 61 of **CBMS-NSF Regional Conference Series in Applied Mathematics**, Society for Industrial & Applied Mathematics, Philadelphia, Penn.
- Daubechies, I. & Paul, T., 1988. Time-frequency localisation operators — A geometric phase space approach: II. The use of dilations, *Inv. Probl.*, **4**(3), 661–680.
- Daubechies, I. & Sweldens, W., 1998. Factoring wavelet transforms into lifting steps, *J. Fourier Anal. Appl.*, **4**(3), 247–269, doi: 10.1007/BF02476026.

- Daubechies, I., Defrise, M. & de Mol, C., 2004. An iterative thresholding algorithm for linear inverse problems with a sparsity constraint, *Comm. Pure Appl. Math.*, **57**(11), 1413–1457, doi: 10.1002/cpa.20042.
- Davaille, A., 1999. Simultaneous generation of hotspots and superswells by convection in a heterogeneous planetary mantle, *Nature*, **402**(6763), 756–760, doi: 10.1038/45461.
- Davenport, M. A., Duarte, M. F., Eldar, Y. C. & Kutyniok, G., 2012, Introduction to compressed sensing, in *Compressed Sensing: Theory and Applications*, edited by Y. C. Eldar & G. Kutyniok, chap. 1, pp. 1–64, Cambridge Univ. Press, Cambridge, UK.
- Davidian, M. & Louis, T. A., 2012. Why statistics?, *Science*, **336**, 12.
- Davidson, J. P., Reed, W. E. & Davis, P. M., 2002. *Exploring Earth: An introduction to physical geology*, Pearson Prentice Hall, Upper Saddle River, N. J., 2nd edn.
- Davies, G. F., 1980. Thermal histories of convective Earth models and constraints on radiogenic heat production in the Earth, *J. Geophys. Res.*, **85**(B5), 2517–2530.
- Davies, G. F., 1984. Lagging mantle convection, the geoid and mantle structure, *Earth Planet. Sci. Lett.*, **69**, 187–194.
- Davies, G. F., 1999. *Dynamic Earth: Plates, plumes and mantle convection*, Cambridge Univ. Press, New York.
- Davies, G. F., 2002. Stirring geochemistry in mantle convection models with stiff plates and slabs, *Geochim. Cosmochim. Acta*, **66**(17), 3125–3142.
- Davies, G. F. & Richards, M. A., 1992. Mantle convection, *J. Geol.*, **100**, 151–206, doi: 10.1086/629582.
- Davies, J. H. & Davies, D. R., 2010. Earth’s surface heat flux, *Solid Earth*, **1**, 5–24.
- Davies, J. H., Guðmundsson, O. & Clayton, R. W., 1992. Spectra of mantle shear wave velocity structure, *Geophys. J. Int.*, **108**(3), 865–882, doi: 10.1111/j.1365–246X.1992.tb03476.x.
- Davies, R. B. & Harte, D. S., 1987. Tests for Hurst effect, *Biometrika*, **74**(1), 95–101.
- Davis, P., England, P. & Houseman, G., 1997. Comparison of shear wave splitting and finite strain from the India-Asia collision zone, *J. Geophys. Res.*, **102**(B12), 27511–27522.
- Davis, P. J., 1963. *Interpolation and approximation*, Blaisdell, New York.
- Davis, R. E., 2005. Intermediate-depth circulation of the Indian and South Pacific oceans measured by autonomous floats, *J. Phys. Oceanog.*, **35**(5), 683–707, doi: 10.1175/JPO2702.1.
- Davis, R. E., Webb, D. C., Regier, L. A. & Dufour, J., 1992. The Autonomous Lagrangian Circulation Explorer (ALACE), *J. Atmos. Ocean Tech.*, **9**(3), 264–285.

- Davis, R. E., Sherman, J. T. & Dufour, J., 2001. Profiling ALACEs and other advances in autonomous subsurface floats, *J. Atmos. Ocean Tech.*, **18**(6), 982–993, doi: 10.1175/1520-0426(2001)018<0982:PAAOAI>2.0.CO;2.
- Davison, A. C., 2003. *Statistical Models*, Cambridge Univ. Press, Cambridge, UK.
- Davison, A. C. & Hinkley, D. V., 1997. *Bootstrap Methods and Their Application*, Cambridge Univ. Press, Cambridge, UK.
- de Groot-Hedlin, C. D., 2005. Estimation of the rupture length and velocity of the Great Sumatra earthquake of Dec 26, 2004 using hydroacoustic signals, *Geophys. Res. Lett.*, **32**, L11303, doi: 10.1029/2005GL022695.
- de Groot-Hedlin, C. D., Blackman, D. K. & Jenkins, C. S., 2009. Effects of variability associated with the antarctic circumpolar current on sound propagation in the ocean, *Geophys. J. Int.*, **176**, 478–490, doi: 10.1111/j.1365-246X.2008.04007.x.
- de Hoop, M. V. & van der Hilst, R. D., 2005. On sensitivity kernels for “wave-equation” transmission tomography, *Geophys. J. Int.*, **160**, 621–633.
- de Hoop, M. V., Smith, H., Uhlmann, G. & van der Hilst, R. D., 2009. Seismic imaging with the generalized Radon transform: a curvelet transform perspective, *Inv. Probl.*, **25**(2), 025005, doi: 10.1088/0266-5611/25/2/025005.
- de Hoop, M. V., Qiu, L. & Scherzer, O., 2012. Local analysis of inverse problems: Hölder stability and iterative reconstruction, *Inv. Probl.*, **28**(4), 045001, doi: 10.1088/0266-5611/28/4/045001.
- de Linage, C., Rivera, L., Hinderer, J., Boy, J.-P., Rogister, Y., Lambotte, S. & Biancale, R., 2009. Separation of coseismic and postseismic gravity changes for the 2004 Sumatra-Andaman earthquake from 4.6 years of GRACE observations and modeling of the coseismic change by normal-modes summation, *Geophys. J. Int.*, **176**, 695–714, doi: 10.1111/j.1365-246X.2008.04025.x.
- de Ronde, A. A., Dobson, D. P., Meredith, P. G., Boon, S. A. & Simons, F. J., 2006. Three dimensional location and waveform analysis of micro-seismicity in multi anvil experiments, *Geophys. Res. Abstr.*, **8**, 04747.
- de Santis, A., 1991. Translated origin spherical cap harmonic analysis, *Geophys. J. Int.*, **106**, 253–263.
- de Smet, J. H., van den Berg, A. P. & Vlaar, N. J., 1999. The evolution of continental roots in numerical thermo-chemical mantle convection models including differentiation by partial melting, *Lithos*, **48**(1–4), 153–170.
- de Vicente, G., Cloetingh, S. A. P. L., Muñoz-Martín, A., Olaiz, A., Stich, D., Vegas, R., Galindo-Zaldívar, J. & Fernández-Lozano, J., 2008. Inversion of moment tensor focal mechanisms for active stresses around the microcontinent Iberia: Tectonic implications, *Tectonics*, **27**(1), TC1009, doi: 10.1029/2006TC002093.

- de Villiers, G. D., 2006. Optimal windowing for wideband linear arrays, *IEEE T. Signal Process.*, **54**(7), 2471–2484, doi: 10.1109/TSP.2006.874287.
- de Villiers, G. D., Marchaud, F. B. T. & Pike, E. R., 2001. Generalized Gaussian quadrature applied to an inverse problem in antenna theory, *Inv. Probl.*, **17**, 1163–1179, doi: 10.1088/0266–5611/17/4/339.
- de Villiers, G. D., Marchaud, F. B. T. & Pike, E. R., 2003. Generalized Gaussian quadrature applied to an inverse problem in antenna theory: II. The two-dimensional case with circular symmetry, *Inv. Probl.*, **19**, 755–778, doi: 10.1088/0266–5611/19/3/317.
- de Viron, O., Panet, I., Mikhailov, V., van Camp, M. & Diamant, M., 2008. Retrieving earthquake signature in GRACE gravity solutions, *Geophys. J. Int.*, **174**(1), 14–20, doi: 10.1111/j.1365–246X.2008.03807.x.
- de Viron, O., Dickey, J. O. & Ghil, M., 2013. Global modes of climate variability, *Geophys. Res. Lett.*, **40**(9), 1832–1837, doi: 10.1002/grl.50386.
- de Vos, D., Paulssen, H. & Fichtner, A., 2013. Finite-frequency sensitivity kernels for two-station surface wave measurements, *Geophys. J. Int.*, **194**(2), 1042–1049, doi: 10.1093/gji/ggt144.
- Deal, M., Gharvai, A., McPherson, G. L., Martinez, C. E. & Herman, M. F., 1993. Scaling analysis of exciton annihilations in highly anisotropic crystals, *Chemical Physics*, **174**, 81–92.
- Debayle, E., 1999. SV-wave azimuthal anisotropy in the Australian upper mantle: preliminary results from automated Rayleigh waveform inversion, *Geophys. J. Int.*, **137**(3), 747–754, doi: 10.1046/j.1365–246x.1999.00832.x.
- Debayle, E. & Kennett, B. L. N., 2000. The Australian continental upper mantle: Structure and deformation inferred from surface waves, *J. Geophys. Res.*, **105**(11), 25423–25450.
- Debayle, E. & Kennett, B. L. N., 2000. Anisotropy in the Australasian upper mantle from Love and Rayleigh waveform inversion, *Earth Planet. Sci. Lett.*, **184**, 339–351.
- Debayle, E. & Sambridge, M., 2004. Inversion of massive surface wave data sets: Model construction and resolution assessment, *J. Geophys. Res.*, **109**, B02316, doi: 10.1029/2003JB002652.
- Debayle, E., Lévêque, J.-J. & Cara, M., 2001. Seismic evidence for a deeply rooted low-velocity anomaly in the upper mantle beneath the northeastern Afro/Arabian continent, *Earth Planet. Sci. Lett.*, **193**, 423–436.
- Debayle, E., Kennett, B. L. N. & Priestley, K., 2005. Global azimuthal seismic anisotropy and the unique plate-motion deformation of Australia, *Nature*, **433**(7025), 509–512.
- Dedow, R., Franz, M., Szulc, A., Schneider, J. W., Brückner, J., Ratschbacher, L., Gagała, Ł., Ringenbach, J.-C., Rajabov, N., Gadoev, M. & Oimahmadov, I., 2020. Tajik basin and southwestern Tian Shan, northwestern India-Asia collision zone: 3. Preorogenic to synorogenic retro-foreland basin evolution in the eastern Tajik depression and linkage to the Pamir hinterland, *Tectonics*, **39**(5), e2019TC005874, doi: 10.1029/2019TC005874.

- Deen, M., Wielandt, E., Stutzmann, E., Crawford, W., Barruol, G. & Sigloch, K., 2017. First observation of the Earth's permanent free oscillations on ocean bottom seismometers, *Geophys. Res. Lett.*, **44**(21), 10,988–10,996, doi: 10.1002/2017GL074892.
- Degryse, P. & Schneider, J., 2008. Pliny the Elder and Sr–Nd isotopes: tracing the provenance of raw materials for Roman glass production, *J. Archaeol. Sci.*, **35**(7), 1993–2000, doi: 10.1016/j.jas.2008.01.002.
- Degryse, P., Schneider, J., Lauwers, V., Waelkens, M. & Muchez, P., 2009. Radiogenic isotopes in the provenance determination of raw materials: A case of lead and glass recycling at Sagalassos (SW Turkey), *J. Nordic Archaeol. Sci.*, **16**, 15–23.
- Delsarte, P., Janssen, A. J. E. M. & Vries, L. B., 1985. Discrete prolate spheroidal wave functions and interpolation, *SIAM J. Appl. Math.*, **45**(4), 641–650.
- DeMets, C., Gordon, R. G., Argus, D. F. & Stein, S., 1990. Current plate motions, *Geophys. J. Int.*, **101**, 425–478.
- Demets, C., Gordon, R. G., Argus, D. F. & Stein, S., 1994. Effect of recent revisions to the geomagnetic reversal time-scale on estimates of current plate motions, *Geophys. Res. Lett.*, **21**(20), 2191–2194.
- den Broeke, M. R. V., Bamber, J., Lenaerts, J. & Rignot, E., 2011. Ice sheets and sea level: Thinking outside the box, *Surv. Geophys.*, **32**, 495—505, doi: 10.1007/s10712-011-9137-z.
- Deng, J., Gurnis, M., Kanamori, H. & Hauksson, E., 1998. Viscoelastic flow in the lower crust after the 1992 Landers, California, earthquake, *Science*, **282**, 1689–1692.
- Deng, Z., 2007, Sphärische Slepian-Funktionen, Studienarbeit im Studiengang Geodäsie und Geoinformatik an der Universität Stuttgart, Universität Stuttgart.
- Denison, D. G. T., Holmes, C. C., Mallick, B. K. & Smith, A. F. M., 2002. *Bayesian Methods for Nonlinear Classification and Regression*, John Wiley, New York.
- DePaolo, D. J. & Manga, M., 2003. Deep origin of hotspots — the mantle plume model, *Science*, **300**, 920–921.
- Deschamps, F. & Trampert, J., 2003. Mantle tomography and its relation to temperature and composition, *Phys. Earth Planet. Inter.*, **140**(4), 277–291, doi: 10.1016/j.pepi.2003.09.004.
- Deschamps, F., Snieder, R. & Trampert, J., 2001. The relative density-to-shear velocity scaling in the uppermost mantle, *Phys. Earth Planet. Inter.*, **124**(3–4), 193–211.
- Deslauriers, L., Schelew, E. & Wieman, C., 2011. Improved learning in a large-enrollment physics class, *Science*, **332**(6031), 862, doi: 10.1126/science.1201783.
- Detrick, R. S. & Watts, A. B., 1979. An analysis of isostasy in the world's oceans, 3, Aseismic ridges, *J. Geophys. Res.*, **84**(B7), 3637–3653.

- Deuss, A., 2007, Seismic observations of transition-zone discontinuities beneath hotspot locations, in *Plates, Plumes, and Planetary Processes: Special Paper*, edited by G. R. Foulger & D. M. Jurdy, vol. 430, pp. 121–136, doi: 10.1130/2007.2430(07), Geol. Soc. Am.
- Deuss, A., 2009. Global observations of mantle discontinuities using SS and PP precursors, *Surv. Geophys.*, **30**(4–5), 301–326, doi: 10.1007/s10712-009-9078-y.
- Deuss, A. & Woodhouse, J. H., 2001. Seismic observations of splitting of the mid-transition zone discontinuity in Earth's mantle, *Science*, **294**(5541), 354–357, doi: 10.1126/science.1063524.
- Deuss, A. & Woodhouse, J. H., 2002. A systematic search for mantle discontinuities using SS-precursors, *Geophys. Res. Lett.*, **29**(8), 1249, doi: 10.1029/2002GL014768.
- Deuss, A., Redfern, S. A. T., Chambers, K. & Woodhouse, J. H., 2006. The nature of the 660-kilometer discontinuity in Earth's mantle from global seismic observations of PP-precursors, *Science*, **311**(8), 198–201.
- Dewangan, P., Reddy, R., Raju, K. A. K., Singha, P., Aswini, K. K., Yatheesh, V., Samudrala, K. & Shuhail, M., 2018. Nature of the ambient noise, site response, and orientation of ocean-bottom seismometers (OBSs): Scientific results of a passive seismic experiment in the Andaman Sea, *B. Seismol. Soc. Am.*, **108**(1), 248–259, doi: 10.1785/0120170163.
- Dewar, R., 2001. Faunal extinction in an island society: Pygmy hippopotamus hunters of Cyprus, *American Anthropologist*, **103**(1), 229–230.
- Dewey, J. & Byerly, P., 1969. The early history of seismometry (to 1900), *B. Seismol. Soc. Am.*, **59**(1), 183–227.
- Dey, S. C., Kennett, B. L. N., Bowman, J. R. & Goody, A., 1993. Variations in upper-mantle structure under northern Australia, *Geophys. J. Int.*, **114**, 304–310.
- Dey-Sarkar, S. K. & Chapman, C. H., 1978. A simple method for the computation of body-wave seismograms, *B. Seismol. Soc. Am.*, **68**, 1577–1593.
- Di Achille, G. & Hynek, B. M., 2010. Ancient ocean on Mars supported by global distribution of deltas and valleys, *Nature Geosci.*, **3**, 459–463, doi: 10.1038/ngeo891.
- Diamant, M., 1985. Influence of method of data analysis on admittance computation, *Ann. Geophys.-Germany*, **3**(6), 785–791.
- Dickey, J. O., Bentley, C. R., Bilham, R., Carton, J. A., Eanes, R. J., Herring, T. A., Kaula, W. M., Lagerloef, G. S. E., Rojstaczer, S., Smith, W. H. F., van den Dool, H. M., Wahr, J. M. & Zuber, M. T., 1998. Satellite gravity: Insights into the solid Earth and its fluid envelope, *Eos Trans. AGU*, **79**(20), 237, 242–243.
- Dietrich, C. R. & Newsam, G. N., 1993. A fast and exact method for multidimensional Gaussian stochastic simulations, *Water Resources Res.*, **29**(8), 2861–2870, doi: 10.1029/93WR01070.

- Dietrich, C. R. & Newsam, G. N., 1997. Fast and exact simulation of stationary Gaussian processes through circulant embedding of the covariance matrix, *SIAM J. Sci. Comput.*, **18**(4), 1088–1107, doi: 10.1137/S1064827592240555.
- Dietrich, W. & Wicht, J., 2013. A hemispherical dynamo model: Implications for the martian crustal magnetization, *Phys. Earth Planet. Inter.*, **217**, 10–21, doi: 10.1016/j.pepi.2013.01.001.
- Djebbi, R. & Alkhalifah, T., 2014. Traveltime sensitivity kernels for wave equation tomography using the unwrapped phase, *Geophys. J. Int.*, **197**(2), 975–986, doi: 10.1093/gji/ggu025.
- Dobrin, M. B. & Savit, C. H., 1976. *Introduction to Geophysical Prospecting*, McGraw-Hill, New York, 3rd edn.
- Dobrin, M. B. & Savit, C. H., 1988. *Introduction to Geophysical Prospecting*, McGraw-Hill, New York, 4th edn.
- Dobson, D. C. & Santosa, F., 1996. Recovery of blocky images from noisy and blurred data, *SIAM J. Appl. Math.*, **56**(4), 1181–1198.
- Doglioni, C., Harabaglia, P., Merlini, S., Mongelli, F., a. Peccerillo & Piromallo, C., 1999. Orogens and slabs vs. their direction of subduction, *Earth Sci. Rev.*, **45**, 167–208.
- Dolan, J. F., 2006. Greatness thrust upon them, *Nature*, **444**, 276–278.
- Domenzain, D., Bradford, J. & Mead, J., 2018, Joint inversion of GPR and ER data, in *SEG Tech. Prog. Expanded Abstracts*, pp. 4763–4767, doi: 10.1190/segam2018–2997794.1, Soc. Explor. Geophys., Denver, Col.
- Donoho, D. L., 1995. Nonlinear solution of linear inverse problems by wavelet–vaguelette decomposition, *Appl. Comput. Harmon. Anal.*, **2**(2), 101–126.
- Donoho, D. L., 2006. For most large underdetermined systems of linear equations the minimal ℓ_1 -norm solution is also the sparsest solution, *Comm. Pure Appl. Math.*, **59**(6), 797–829, doi: 10.1002/cpa.20132.
- Donoho, D. L., 2006. Compressed sensing, *IEEE T. Inform. Theory*, **52**(4), 1289–1306, doi: 10.1109/TIT.2006.871582.
- Donoho, D. L. & Johnstone, I. M., 1994. Ideal spatial adaptation by wavelet shrinkage, *Biometrika*, **81**(3), 425–455.
- Donoho, D. L. & Johnstone, I. M., 1995. Adapting to unknown smoothness via wavelet shrinkage, *J. Am. Stat. Assoc.*, **90**(432), 1200–1224.
- Donoho, D. L. & Stark, P. B., 1989. Uncertainty principles and signal recovery, *SIAM J. Appl. Math.*, **49**(3), 906–931.
- Donoho, D. L., Johnstone, I. M., Keryacharian, G. & Picard, D., 1995. Wavelet shrinkage: Asymptopia?, *J. R. Stat. Soc., Ser. B*, **57**(2), 301–369.

- Dooley, J. C., 1977. Implications of Australian seismic and gravity measurements for the structure and composition of the upper mantle, *BMR J. Aust. Geol. Geophys.*, **2**, 1–5.
- Doornbos, D. J., 1976. Characteristics of lower mantle inhomogeneities from scattered waves, *Geophys. J. R. Astron. Soc.*, **44**, 447–470.
- Doornbos, D. J., ed., 1988. *Seismological algorithms: Computational Methods and Computer Programs*, Academic Press, San Diego, Calif.
- Dorman, L. M. & Lewis, B. T. R., 1970. Experimental isostasy, 1, Theory of the determination of the Earth's isostatic response to a concentrated load, *J. Geophys. Res.*, **75**(17), 3357–3365.
- Dorman, L. M. & Lewis, B. T. R., 1972. Experimental isostasy, 3, Inversion of the isostatic Green function and lateral density changes, *J. Geophys. Res.*, **77**(17), 3,068–3,077.
- Doucouré, C. M., de Wit, M. J. & Mushayandebvu, M. F., 1996. Effective elastic thickness of the continental lithosphere in South Africa, *J. Geophys. Res.*, **101**(B5), 11291–11304.
- Dougherty, M. E. & Stephen, R. A., 1991. Seismo/acoustic propagation through rough seafloors, *J. Acoust. Soc. Am.*, **90**(5), 2637–2651, doi: 10.1121/1.402067.
- Dragert, H., Wang, K. & James, T. S., 2001. A silent slip event on the deeper Cascadia subduction interface, *Science*, **292**, 1525–1528.
- Drake, J. B., Worley, P. & D'Azevedo, E., 2008. Algorithm 888: Spherical harmonic transform algorithms, *ACM T. Math. Software*, **35**(3).
- Drake, M. J. & Richter, K., 2002. Determining the composition of the Earth, *Nature*, **416**, 39–44.
- Draper, N. R. & Smith, H., 1981. *Applied Regression Analysis*, John Wiley, New York, 2nd edn.
- Driscoll, J. R. & Healy, D. M., 1994. Computing Fourier transforms and convolutions on the 2-sphere, *Adv. Appl. Math.*, **15**, 202–250.
- Droujinine, A., Plessix, R.-E. & Ernst, F., 2012. Integration of dispersion curve and full waveform inversion techniques for onshore velocity model building — Inner Mongolia Study, *74th EAGE Conference and Exhibition, Extended Abstracts*, pp. doi: 10.3997/2214-4609.20149893.
- Drummond, B., ed., 1991. *The Australian Lithosphere*, Geol. Soc. Aust., Sydney.
- D'Spain, G. L., Hodgkiss, W. S. & Edmonds, G. L., 1991. The simultaneous measurement of infrasonic acoustic particle-velocity and acoustic pressure in the ocean by freely drifting Swallow floats, *IEEE J. Ocean. Eng.*, **16**(2), 195–207.
- D'Spain, G. L., Hodgkiss, W. S. & Edmonds, G. L., 1991. Energetics of the deep ocean's infrasonic sound field, *J. Acoust. Soc. Am.*, **89**(3), 1134–1158.
- Du, M., Kawashima, S., Yonemura, S., Zhang, X. & Chen, S., 2004. Mutual influence between human activities and climate change in the Tibetan Plateau during recent years, *Global and Planetary Change*, **41**(3–4), 241–249, doi: 10.1016/j.gloplacha.2004.01.010.

- Dueker, K., Yuan, H. & Zurek, B., 2001. Thick-structured Proterozoic lithosphere of the Rocky Mountain region, *GSA Today*, **11**(12), 4–9.
- Dueker, K. G. & Sheehan, A. F., 1997. Mantle discontinuity structure from midpoint stacks of converted P to S waves across the Yellowstone hotspot track, *J. Geophys. Res.*, **102**(B4), 8313–8327, doi: 10.1029/96JB03857.
- Duennebier, F. & Sutton, G. H., 1974. Thermal Moonquakes, *J. Geophys. Res.*, **79**, 4351–4364.
- Duennebier, F. K., Becker, N. C., Caplan-Auerbach, J., Clague, D. A., Cowen, J., Cremer, M., Garcia, M., Goff, F., Malahoff, A., McMurtry, G., Midson, B. P., Moyer, C. L., Norman, M., Okubo, P., Resing, J. A., Rhoses, J. M., Rubin, K., Sansone, F. J., Smith, J. R., Spencer, K., Wen, X. & Wheat, C. G., 1997. Researchers rapidly respond to submarine activity at Loihi volcano, Hawaii, *Eos Trans. AGU*, **78**(22), 229–237, doi: 10.1029/97EO00150.
- Duennebier, F. K., Harris, D. W., Jolly, J., Babinec, J., Copson, D. & Stiffel, K., 2002. The Hawaii-2 Observatory seismic system, *IEEE J. Ocean. Eng.*, **27**(2), 212–217, doi: 10.1109/JOE.2002.1002475.
- Duffy, T. S., 2008. Mineralogy at the extremes, *Nature*, **451**(7176), 269–270, doi: 10.1038/nature06584.
- Duffy, T. S. & Anderson, D. L., 1989. Seismic velocities in mantle minerals and the mineralogy of the upper mantle, *J. Geophys. Res.*, **94**(B2), 1895–1912.
- Dufour, H. M., 1977. Fonctions orthogonales dans la sphère: Résolution théorique du problème du potentiel terrestre, *Bull. Géod.*, **51**, 227–237.
- Duliu, O. G., 1999. Computer axial tomography in geosciences: An overview, *Earth Sci. Rev.*, **48**, 265–281.
- Dunlop, D. J. & Arkani-Hamed, J., 2005. Magnetic minerals in the Martian crust, *J. Geophys. Res.*, **110**, E12S04, doi: 10.1029/2005JE002404.
- Dushaw, B. D., 2019. Ocean acoustic tomography in the North Atlantic, *J. Atmos. Ocean Tech.*, **36**(2), 183–202, doi: 10.1175/JTECH-D-18-0082.1.
- Dutton, A., Carlson, A. E., Long, A. J., Milne, G. A., Clark, P. U., DeConto, R., Horton, B. P., Rahmstorf, S. & Raymo, M. E., 2015. Sea-level rise due to polar ice-sheet mass loss during past warm periods, *Science*, **349**(6244), aaa4019–1–aaa4019–9, doi: 10.1126/science.aaa4019.
- Dyment, J. & Arkani-Hamed, J., 1998. Contribution of lithospheric remanent magnetization to satellite magnetic anomalies over the world's oceans, *J. Geophys. Res.*, **103**(B7), 15423–15441, doi: 10.1029/97JB03574.
- Dzhaparidze, K. O. & Yaglom, A. M., 1983, Spectrum parameter estimation in time series analysis, in *Developments in Statistics*, edited by P. Krishnaiah, vol. 4, pp. 1–181, Academic Press, New York.

- Dziak, R. P., Bohnenstiehl, D. R., Matsumoto, H., Fox, C. G., Smith, D. K., Tolstoy, M., Lau, T.-K., Haxel, J. H. & Fowler, M. J., 2004. *P*- and *T*-wave detection thresholds, *Pn* velocity estimate, and detection of lower mantle and core *P*-waves on ocean sound-channel hydrophones at the Mid-Atlantic Ridge, *B. Seismol. Soc. Am.*, **94**(2), 665–677, doi: 10.1785/0120030156.
- Dziewoński, A. & Hales, A. L., 1972, Numerical analysis of dispersed seismic waves, in *Seismology: Surface Waves and Earth Oscillations*, edited by B. A. Bolt, B. Alder, S. Fernbach, & M. Rotenberg, vol. 11 of **Methods In Computational Physics**, pp. 39–84, Academic Press, San Diego, Calif.
- Dziewoński, A. M., 1971. On regional differences in dispersion of mantle Rayleigh waves, *Geophys. J. R. Astron. Soc.*, **22**(3), 289–325.
- Dziewoński, A. M., 1984. Mapping the lower mantle: Determination of lateral heterogeneity in *P* velocity up to degree and order 6, *J. Geophys. Res.*, **89**(B7), 5929–5952.
- Dziewoński, A. M. & Anderson, D. L., 1981. Preliminary Reference Earth Model, *Phys. Earth Planet. Inter.*, **25**, 297–356, doi: 10.1016/0031-9201(81)90046-7.
- Dziewoński, A. M., Block, S. & Landisman, M., 1969. A technique for the analysis of transient seismic signals, *B. Seismol. Soc. Am.*, **59**(1), 427–444.
- Dziewoński, A. M., Hager, B. H. & O’Connell, R. J., 1977. Large-scale heterogeneities in the lower mantle, *J. Geophys. Res.*, **82**(2), 239–255.
- Dziewoński, A. M., Chou, T.-A. & Woodhouse, J. H., 1981. Determination of earthquake source parameters from waveform data for studies of global and regional seismicity, *J. Geophys. Res.*, **86**, 2825–2852.
- Eagar, K. C., Fouch, M. J., James, D. E. & Carlson, R. W., 2011. Crustal structure beneath the High Lava Plains of eastern Oregon and surrounding regions from receiver function analysis, *J. Geophys. Res.*, **116**, B02313, doi: 10.1029/2010JB007795.
- Earle, P. S. & Shearer, P. M., 1994. Characterization of global seismograms using an automatic-picking algorithm, *B. Seismol. Soc. Am.*, **84**(2), 366–376.
- Easley, G., Lim, W. & Labate, D., 2008. Sparse directional image representations using the discrete shearlet transform, *Appl. Comput. Harmon. Anal.*, **25**, 25–46.
- Ebel, J. E. & Kafka, A. L., 2002. A non-Poissonian element in the seismicity of the northeastern United States, *B. Seismol. Soc. Am.*, **92**(5), 2040–2046, doi: 10.1785/0120010211.
- Ebinger, C., 1997. Rifting Archaean lithosphere: the Eyasi-Manyara-Natron rifts, East Africa, *J. Geol. Soc. London*, **154**(6), 947–960.
- Ebinger, C. J., 2005. Continental breakup: The East African perspective, *Astron. Geoph.*, **46**, 2.16–2.21.
- Ebinger, C. J. & Hayward, N. J., 1996. Soft plates and hot spots: Views from Afar, *J. Geophys. Res.*, **101**(B10), 21859–21876.

- Ebinger, C. J., Bechtel, T. D., Forsyth, D. W. & Bowin, C. O., 1989. Effective elastic plate thickness beneath the east African and Afar plateaus and dynamic compensation of the uplifts, *J. Geophys. Res.*, **94**(B3), 2883–2901.
- Ebinger, C. J., Karner, G. D. & Weissel, J. K., 1991. Mechanical strength of extended continental lithosphere: Constraints from the Western Rift system, East Africa, *Tectonics*, **10**(6), 1239–1256.
- Ecoublet, P. E., Singh, S. C., Chapman, C. H. & Jackson, G. M., 2002. Bent-ray traveltimes tomography and migration without ray tracing, *Geophys. J. Int.*, **149**(3), 633–645.
- Eddy, J. A., 1976. The Maunder minimum, *Science*, **192**(4245), 1189–1202.
- Edmonds, A. R., 1996. *Angular Momentum in Quantum Mechanics*, Princeton Univ. Press, Princeton, N.J.
- Efron, B., 1979. Bootstrap methods: Another look at the jackknife, *Ann. Stat.*, **7**(1), 1–26, doi: 10.1214/aos/1176344552.
- Efron, B. & Stein, C., 1981. The jackknife estimate of variance, *Ann. Stat.*, **9**(3), 586–596, doi: 10.1214/aos/1176345462.
- Efron, B. & Tibshirani, R., 1986. Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy, *Stat. Sci.*, **1**(1), 54–75.
- Efron, B. & Tibshirani, R., 1991. Statistical data analysis in the computer age, *Science*, **253**, 390–395.
- Efron, B., Hastie, T., Johnstone, I. & Tibshirani, R., 2004. Least angle regression, *Ann. Stat.*, **32**(2), 407–499, doi: 10.1214/009053604000000067.
- Efstathiou, G., 2004. Myths and truths concerning estimation of power spectra: the case for a hybrid estimator, *Mon. Not. R. Astron. Soc.*, **349**, 603–626.
- Efstathiou, G., Lawrence, C., Tauber, J. & The Planck Science Team, 2005. Planck: *The Scientific Program*, available at <http://www.rssd.esa.int/Planck>.
- Eggers, G. L., 2013, *A regionalized maximum-likelihood estimation of the spatial structure of Venusian Topography*, A. B. Thesis, Princeton University.
- Eggler, D. H., Keen, J. K., Welt, F., Dudas, F. O., Furlong, K. P., McCallum, M. E. & Carlson, R. W., 1988. Tectonomagmatism of the Wyoming Province, *Colorado School of Mines Quart.*, **83**(2), 25–40.
- Eicker, A., Schall, J. & Kusche, J., 2014. Regional gravity modelling from spaceborne data: case studies with GOCE, *Geophys. J. Int.*, **196**, 1431–1440, doi: 10.1093/gji/ggt485.
- Einarsson, I., Hoechner, A., Wang, R. & Kusche, J., 2010. Gravity changes due to the Sumatra-Andaman and Nias earthquakes as detected by the GRACE satellites: a reexamination, *Geophys. J. Int.*, **183**, 733–747, doi: 10.1111/j.1365-246X.2010.04756.x.

- Ekström, G., 2000, Mapping the lithosphere and asthenosphere with surface waves: Lateral structure and anisotropy, in *The History and Dynamics of Global Plate Motions*, edited by M. A. Richards, R. G. Gordon, & R. D. van der Hilst, vol. 121 of **Geophysical Monograph**, pp. 239–255, Amer. Geophys. Union, Washington, D. C.
- Ekström, G. & Dziewoński, A. M., 1998. The unique anisotropy of the Pacific upper mantle, *Nature*, **394**(6689), 168–172.
- Ekström, G., Tromp, J. & Larson, E. W. F., 1997. Measurements and global models of surface wave propagation, *J. Geophys. Res.*, **102**(B4), 8137–8157.
- Ekström, G., Nettles, M. & Dziewonski, A. M., 2012. The global CMT project 2004–2010: Centroid-moment tensors for 13,017 earthquakes, *Phys. Earth Planet. Inter.*, **200–201**, 1–9, doi: 10.1016/j.pepi.2012.04.002.
- Elkins-Tanton, L. T., 2005. Continental magmatism caused by lithospheric delamination, *Geol. Soc. Am. Spec. Paper*, **388**, 449–461.
- Elkins-Tanton, L. T., 2007. Continental magmatism, volatile recycling, and a heterogeneous mantle caused by lithospheric gravitational instabilities, *J. Geophys. Res.*, **112**(B3), B03405, doi: 10.1029/2005JB004072.
- Ellsworth, W. L. & Beroza, G. C., 1995. Seismic evidence for an earthquake nucleation phase, *Science*, **268**(5212), 851–855.
- Enescu, B., Ito, K. & Struzik, Z. R., 2006. Wavelet-based multiscale resolution analysis of real and simulated time-series of earthquakes, *Geophys. J. Int.*, **164**, 63–74, doi: 10.1111/j.1365–246X.2005.02810.x.
- Engdahl, E., van der Hilst, R. D. & Buland, R., 1998. Global teleseismic earthquake relocation with improved travel times and procedures for depth determination, *B. Seismol. Soc. Am.*, **88**(3), 722–743.
- Engelis, T., 1987, Spherical harmonic expansion of the Levitus sea surface topography, Tech. Rep. 385, Department of Geodetic Science and Surveying, The Ohio State University.
- Engl, H. W., 1982. On least-squares collocation for solving linear integral equations of the first kind with noisy right-hand side, *Boll. Geod. Sc. Aff.*, **41**(3), 291–313.
- Engl, H. W., 1983, On the convergence of regularization methods for ill-posed linear operator equations, in *Improperly Posed Problems and Their Numerical Treatment*, edited by G. Hämmerlin & K. H. Hoffmann, vol. 63 of **Int. Ser. Numer. Math**, pp. 81–95, Birkhäuser, Boston.
- Engl, H. W., 1983, Regularization by least-squares collocation, in *Numerical Treatment of Inverse Problems in Differential and Integral Equations*, edited by P. Deufhard & E. Hairer, pp. 345–354, Birkhäuser, Boston.
- Engl, H. W., Hanke, M. & Neubauer, A., 1996. *Regularization of inverse problems*, Kluwer, Dordrecht, Neth.

- England, P. & McKenzie, D. P., 1982. A thin viscous sheet model for continental deformation, *Geophys. J. R. Astron. Soc.*, **70**, 295–321.
- England, P. & Molnar, P., 1997. Active deformation of Asia: From kinematics to dynamics, *Science*, **278**, 647–650.
- England, P. & Wortel, R., 1980. Some consequences of the subduction of young slabs, *Earth Planet. Sci. Lett.*, **47**, 403–415.
- England, P., Molnar, P. & Richter, F., 2007. John Perry's neglected critique of kelvin's age for the Earth: A missed opportunity in geodynamics, *GSA Today*, **17**(1), 4–9, doi: 10.1130/GSAT01701A.1.
- England, P., Molnar, P. & Richter, F., 2007. Kelvin, Perry and the age of the Earth, *Am. Scientist*, **95**(4), 342–349.
- Enning, D. & Garrelfs, J., 2014. Corrosion of iron by sulfate-reducing bacteria: New views of an old problem, *Appl. Env. Microbiol.*, **80**(4), 1226–1236, doi: 10.1128/AEM.02848–13.
- Eom, K. B., 2001. Long-correlation image models for textures with circular and elliptical correlation structures, *IEEE T. Signal Process.*, **10**(7), 1047–1055, doi: 10.1109/83.931099.
- Erb, W. & Mathias, S., 2014. An alternative to Slepian functions on the unit sphere– A space–frequency analysis based on localized spherical polynomials, *Appl. Comput. Harmon. Anal.*, p. doi: 10.1016/j.acha.2014.03.009.
- Escartin, J. & Lin, J., 1998. Tectonic modification of axial crustal structure: Evidence from spectral analyses of residual gravity and bathymetry of the Mid-Atlantic Ridge flanks, *Earth Planet. Sci. Lett.*, **154**, 279–293.
- Eshagh, M., 2008. The effect of polar gaps on the solutions of gradiometric boundary value problems, *Artif. Sat.*, **43**(3), 97–108, doi: 10.2478/v10018–009–0011–x.
- Eshagh, M., 2009. Spatially restricted integrals in gradiometric boundary value problems, *Artif. Sat.*, **44**(4), 131–148, doi: 10.2478/v10018–009–0025–4.
- Eshagh, M., 2009. Comparison of two approaches for considering laterally varying density in topographic effect on satellite gravity gradiometric data, *Acta Geophysica*, pp. 10.2478/s11600–009–0057–y.
- Essenwanger, O., 1964. The cumulative distribution of wind direction frequencies, *Meteorologische Rundschau*, **17**(5), 131–134.
- Essenwanger, O., 1986. *Elements of Statistical Analysis*, no. 1B in World Survey of Climatology, Elsevier, Amsterdam, Neth.
- Estey, L. H. & Douglas, B. J., 1986. Upper mantle anisotropy: A preliminary model, *J. Geophys. Res.*, **91**(B11), 11393–11406.

- Etemadfar, H. & Hossainali, M. M., 2016. Spherical Slepian as a new method for ionospheric modeling in arctic region, *J. Atm. Solar-Terrest. Phys.*, **140**, 10–15, doi: 10.1016/j.jastp.2016.01.003.
- Evans, A. J., Andrews-Hanna, J. C. & Zuber, M. T., 2010. Geophysical limitations on the erosion history within Arabia Terra, *J. Geophys. Res.*, **115**, E05007, doi: 10.1029/2009JE003469.
- Evans, J. R. & Allen, S. S., 1983. A teleseism-specific detection algorithm for single short period traces, *B. Seismol. Soc. Am.*, **73**(4), 1173–1186.
- Ewing, J. & Ewing, M., 1961. A telemetering ocean-bottom seismograph, *J. Geophys. Res.*, **66**(11), 3863–3878, doi: 10.1029/JZ066i011p03863.
- Ewing, J., Leyden, R. & Ewing, M., 1969. Refraction shooting with expendable sonobuoys, *AAPG Bull.*, **53**(1), 174–181.
- Ewing, M. & Press, F., 1959. Determination of crustal structure from phase velocity of Rayleigh waves. Part III: The United States, *The Geological Society of America Bulletin*, **70**, 229–244.
- Ewing, M. & Vine, A., 1938. Deep-sea measurements without wires or cables, *Eos Trans. AGU*, **19**(1), 248–251, doi: 10.1029/TR019i001p00248.
- Ewing, W. M. & Press, F., 1958, Surface waves and guided waves, in *Encyclopedia of Physics*, edited by S. Flügge, vol. 47, pp. 119–139, Springer, Berlin, Germany.
- Ewing, W. M., Jardetzky, W. S. & Press, F., 1957. *Elastic Waves in Layered Media*, Intern. Ser. Earth Sci., McGraw-Hill, New York.
- Fairén, A. G., Ruiz, J. & Anguita, F., 2002. An origin for the linear magnetic anomalies on Mars through accretion of terranes: Implications for dynamo timing, *Icarus*, **160**, 220–223, doi: 10.1006/icar.2002.6942.
- Falkowski, P. G. & Isozaki, Y., 2008. The story of O_2 , *Science*, **322**, doi: 10.1126/science.1162641.
- Falsaperla, S., Wassermann, J. & Scherbaum, F., 2002. Polarization analyses of broadband seismic data recorded on Stromboli Volcano (Italy) from 1996 to 1999, *Geophys. Res. Lett.*, **29**(10), 1391, doi: 10.1029/2001GL014300.
- Famiglietti, J. S., Lo, M., Ho, S. K., Bethune, J., Anderson, K. J., Syed, T. H., Swenson, S. C., de Linage, C. R. & Rodell, M., 2011. Satellites measure recent rates of groundwater depletion in California's Central Valley, *Geophys. Res. Lett.*, **38**, L03403, doi: 10.1029/2010GL046442.
- Fan, J., Hung, H.-N. & Wong, W.-H., 2000. Geometric understanding of likelihood ratio statistics, *J. Am. Stat. Assoc.*, **95**(451), 863–841.
- Fan, J., Zhang, C. & Zhang, J., 2001. Generalized likelihood ratio statistics and Wilks phenomenon, *Ann. Stat.*, **29**(1), 153–193.
- Fang, H. & Zhang, H., 2014. Wavelet-based double-difference seismic tomography with sparsity regularization, *Geophys. J. Int.*, **199**(2), 944–955, doi: 10.1093/gji/ggu305.

- Fang, H., Zhang, H., Yao, H., Allam, A., Zigone, D., Ben-Zion, Y., Thurber, C. & van der Hilst, R. D., 2016. A new algorithm for three-dimensional joint inversion of body wave and surface wave data and its application to the Southern California plate boundary region, *J. Geophys. Res.*, **121**(5), 3557–3569, doi: 10.1002/2015JB012702.
- Farinotti, D., Longuevergne, L., Moholdt, G., Duethmann, D., Mölg, T., Bolch, T., Vorogushyn, S. & Güntner, A., 2015. Substantial glacier mass loss in the Tien Shan over the past 50 years, *Nature Geosci.*, **8**, 716–722, doi: 10.1038/NGEO2513.
- Farquharson, C. G. & Oldenburg, D. W., 1998. Non-linear inversion using general measures of data misfit and model structure, *Geophys. J. Int.*, **134**, 213–227, doi: 10.1046/j.1365–246x.1998.00555.x.
- Farra, V., Stutzmann, E., Gualtieri, L., Schimmel, M. & Arduin, F., 2016. Ray-theoretical modeling of secondary microseism *P* waves, *Geophys. J. Int.*, **206**(3), 1730–1739, doi: 10.1093/gji/ggw242.
- Farrell, W. E. & Clark, J. A., 1976. On postglacial sea level, *Geophys. J. R. Astron. Soc.*, **46**, 647–667.
- Favali, P. & Beranzoli, L., 2006. Seafloor observatory science: a review, *Ann. Geophys.–Italy*, **49**(2–3), 515–567, doi: 10.4401/ag–3132.
- Favier, N. & Chevrot, S., 2003. Sensitivity kernels for shear wave splitting in transverse isotropic media, *Geophys. J. Int.*, **153**(1), 213–228.
- Favier, N., Chevrot, S. & Komatitsch, D., 2004. Near-field influence on shear wave splitting and traveltimes sensitivity kernels, *Geophys. J. Int.*, **156**(3), 467–482, doi: 10.1111/j.1365–246X.2004.02178.x.
- Faÿ, G., Guilloux, F., Betoule, M., Cardoso, J.-F., Delabrouille, J. & Jeune, M. L., 2008. CMB power spectrum estimation using wavelets, *Phys. Rev. D*, **78**, 083013, doi: 10.1103/PhysRevD.78.083013.
- Fearn, D. R., 1998. Hydromagnetic flow in planetary cores, *Rep. Prog. Phys.*, **61**(3), 175–235.
- Fedi, M. & Cascone, L., 2011. Composite continuous wavelet transform of potential fields with different choices of analyzing wavelets, *J. Geophys. Res.*, **116**, B07104, doi: 10.1029/2010JB007882.
- Fedi, M., Florio, G. & Cascone, L., 2012. Multiscale analysis of potential fields by a ridge consistency criterion: the reconstruction of the Bishop basement, *Geophys. J. Int.*, **188**, 103–114, doi: 10.1111/j.1365–246X.2011.05259.x.
- Feller, W., 1968. *An Introduction to Probability Theory and Its Applications*, vol. 1, John Wiley, New York, 2nd edn.
- Feller, W., 1971. *An Introduction to Probability Theory and Its Applications*, vol. 2, John Wiley, New York, 3rd edn.

- Fengler, M. J., Freedden, W. & Michel, V., 2004. The Kaiserslautern multiscale geopotential model SWITCH-03 from orbit perturbations of the satellite CHAMP and its comparison to the models EGM96, UCPH2002_02_0.5, EIGEN-1s and EIGEN-2, *Geophys. J. Int.*, **157**, 499–514.
- Fengler, M. J., Michel, D. & Michel, V., 2006. Harmonic spline-wavelets on the 3-dimensional ball and their application to the reconstruction of the Earth's density distribution from gravitational data at arbitrarily shaped satellite orbits, *Z. Angew. Math. Mech.*, **86**(11), 856–873, doi: 10.1002/zamm.200510277.
- Fengler, M. J., Freedden, W., Kohlhaas, A., Michel, V. & Peters, T., 2007. Wavelet modeling of regional and temporal variations of the earth's gravitational potential observed by GRACE, *J. Geod.*, **81**(1), 5–15, doi: 10.1007/s00190-006-0040-1.
- Ferguson, T. S., 1996. *A Course in Large Sample Theory*, Chapman and Hall/CRC Press, New York.
- Fernández, G., Periaswamy, S. & Sweldens, W., 1996, LIFTPACK: a software package for wavelet transforms using lifting, in *Wavelet Applications in Signal and Image Processing IV*, edited by M. A. Unser, A. Aldroubi, & A. F. Laine, vol. 2825, pp. 396–408, doi: 10.1117/12.255250, SPIE.
- Fernández, N. L., 2002, Polynomial bases on the sphere, in *Advanced problems in constructive approximation*, edited by M. D. Buhmann & D. H. Mache, vol. 142 of **Int. Ser. Numer. Math.**, pp. 39–52, Birkhäuser, Basel.
- Fernández, N. L. & Prestin, J., 2006. Interpolatory band-limited wavelet bases on the sphere, *Constr. Approx.*, **23**, 79–101, doi: 10.1007/s00365-005-0601-1.
- Fernando, B., Leng, K. & Nissen-Meyer, T., 2020. Oceanic high-frequency global seismic wave propagation with realistic bathymetry, *Geophys. J. Int.*, **222**(2), 1178–1194, doi: 10.1093/gji/ggaa248.
- Ferrari, J. A., Perciante, D. & Dubra, A., 1999. Fast Hankel transform of n th order, *JOSA A*, **16**(10), 2581–2582, doi: 10.1364/JOSAA.16.002581.
- Ferrazzini, V. & Aki, K., 1987. Slow waves trapped in a fluid-filled infinite crack: Implications for volcanic tremor, *J. Geophys. Res.*, **92**(B9), 9215–9223.
- Ferrazzini, V., Chouet, B., Fehler, M. & Aki, K., 1990. Quantitative analysis of long-period events recorded during hydrofracture experiments at Fenton Hill, New Mexico, *J. Geophys. Res.*, **95**(B13), 21871–21884.
- Ferreira, A. M. G. & Woodhouse, J. H., 2007. Source, path and receiver effects on seismic surface waves, *Geophys. J. Int.*, **168**, 109–132, doi: 10.1111/j.1365-246X.2006.03092.x.
- Festa, G. & Nielsen, S., 2003. PML absorbing boundaries, *B. Seismol. Soc. Am.*, **93**(2), 891–903, doi: 10.1785/0120020098.

- Fettweis, X., Tedesco, M., van den Broeke, M. & Ettema, J., 2011. Melting trends over the greenland ice sheet (1958–2009) from spaceborne microwave data and regional climate models, *The Cryosphere*, **5**, 359–375, doi: 10.5194/tc-5-359-2011.
- Fialko, Y., Simons, M. & Agnew, D., 2001. The complete (3-D surface displacement field in the epicentral area of the 1999 mw 7.1 Hector Mine earthquake, California, from space geodetic observations, *Geophys. Res. Lett.*, **28**(16), 3063–3066.
- Fichtner, A., 2011. *Full Seismic Waveform Modelling and Inversion*, Springer, Berlin, Germany.
- Fichtner, A. & Simutè, S., 2018. Hamiltonian Monte Carlo inversion of seismic sources in complex media, *J. Geophys. Res.*, **123**(4), 2984–2999, doi: 10.1002/2017JB015249.
- Fichtner, A. & Trampert, J., 2011. Hessian kernels of seismic data functionals based upon adjoint techniques, *Geophys. J. Int.*, **185**(2), 775–798, doi: 10.1111/j.1365-246X.2011.04966.x.
- Fichtner, A. & Trampert, J., 2011. Resolution analysis in full waveform inversion, *Geophys. J. Int.*, **187**(3), 1604–1624, doi: 10.1111/j.1365-246X.2011.05218.x.
- Fichtner, A., Bunge, H.-P. & Igel, H., 2006. The adjoint method in seismology — I. Theory, *Phys. Earth Planet. Inter.*, **157**(1–2), 86–104, doi: 10.1016/j.pepi.2006.03.016.
- Fichtner, A., Bunge, H.-P. & Igel, H., 2006. The adjoint method in seismology — II. Applications: traveltimes and sensitivity functionals, *Phys. Earth Planet. Inter.*, **157**(1–2), 105–123, doi: 10.1016/j.pepi.2006.03.018.
- Fichtner, A., Kennett, B. L. N., Igel, H. & Bunge, H.-P., 2008. Theoretical background for continental-and global-scale full-waveform inversion in the time–frequency domain, *Geophys. J. Int.*, **175**(2), 665–685, doi: 10.1111/j.1365-246X.2008.03923.x.
- Fichtner, A., Kennett, B. L. N., Igel, H. & Bunge, H.-P., 2009. Full seismic waveform tomography for upper-mantle structure in the Australasian region using adjoint methods, *Geophys. J. Int.*, **179**(3), 1703–1725, doi: 10.1111/j.1365-246X.2009.04368.x.
- Fichtner, A., Trampert, J., Cupillard, P., Saygin, E., Taymaz, T., Capdeville, Y. & Villaseñor, A., 2013. Multiscale full waveform inversion, *Geophys. J. Int.*, **194**(1), 534–556, doi: 10.1093/gji/ggt118.
- Field, C. B., Barros, V., Dokken, D. J., March, K. J., Mastrandrea, M. D., Bilir, T. E., Chatterjee, M., Ebi, K. L., Estrada, Y. O., Genova, R. C., Girma, B., Kissel, E. S., Levy, A. N., MacCracken, S., Mastrandrea, P. R. & White, L. L., 2014. Climate Change 2014: Impacts, adaptation, and vulnerability: Part A: Global and sectoral aspects. Working Group II Contribution to the Fifth Assessment Report, Tech. rep., Intergovernmental Panel on Climate Change, Cambridge, UK.
- Fielding, E. J. & McKenzie, D., 2012. Lithospheric flexure in the Sichuan Basin and Longmen Shan at the eastern edge of Tibet, *Geophys. Res. Lett.*, **39**, L09311, doi: 10.1029/2012GL051680.

- Figueiredo, M. A. T., Nowak, R. D. & Wright, S. J., 2007. Gradient projection for sparse reconstruction: Application to compressed sensing and other inverse problems, *IEEE J. Select. Topics Signal Process.*, **1**(4), 586–597, doi: 10.1109/JSTSP.2007.910281.
- Finlayson, D. M., 1982. Geophysical differences in the lithosphere between Phanerozoic and Precambrian Australia, *Tectonophysics*, **84**, 287–312.
- Finlayson, D. M. & Mathur, S. P., 1984. Seismic refraction and reflection features of the lithosphere in northern and eastern Australia, and continental growth, *Annal. Geophys.*, **2**(6), 711–722.
- Finn, C. A., Moore, D., Damaske, D. & Mackey, T., 1999. The aeromagnetic legacy of Early Paleozoic subduction along the Pacific margin of Gondwana, *Geology*, **27**(12), 1087–1090.
- Fiquet, G., 2001. Mineral phases of the earth's mantle, *Z. Kristallogr.*, **2176**, 248–271.
- Fischer, D. & Michel, V., 2012. Sparse regularization of inverse gravimetry—case study: spatial and temporal mass variations in South America, *Inv. Probl.*, **28**, 065012, doi: 10.1088/0266–5611/28/6/065012.
- Fischer, K. M., 2002. Flow and fabric deep down, *Nature*, **415**, 745–748.
- Fischer, K. M., 2002. Waning buoyancy in the crustal roots of old mountains, *Nature*, **417**(6892), 933–936.
- Fischer, K. M. & van der Hilst, R. D., 1999. A seismic look under the continents, *Science*, **285**(5432), 1365–136.
- Fischer, K. M., Fouch, M. J., Wiens, D. A. & Boettcher, M. S., 1998. Anisotropy and flow in Pacific subduction zone back-arcs, *Pure Appl. Geophys.*, **151**(2–4), 463–475.
- Fischer, R. A., Campbell, A. J., Chidester, B. A., Reaman, D. M., Thompson, E. C., Pigott, J. S., Prakapenka, V. B. & Smith, J. S., 2018. Equations of state and phase boundary for stishovite and CaCl_2 -type SiO_2 , *Ann. Math.*, **103**(5), 792–802, doi: 10.2138/am-2018-6267.
- Fisher, N., Lewis, T. & Embleton, B. J. J., 1987. *Statistical Analysis of Spherical Data*, Cambridge Univ. Press, New York.
- Fishwick, S., Kennett, B. L. N. & Reading, A. M., 2005. Contrasts in lithospheric structure within the Australian Craton — Insights from surface wave tomography, *Earth Planet. Sci. Lett.*, **231**(3–4), 163–176.
- Flanagan, M. P. & Shearer, P. M., 1998. Global mapping of topography on transition zone velocity discontinuities by stacking SS precursors, *J. Geophys. Res.*, **103**(B2), 2673–2692.
- Flandrin, P., 1988, Maximum signal energy concentration in a time-frequency domain, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, vol. 4, pp. 2176–2179, IEEE.
- Flandrin, P., 1998. *Temps-Fréquence*, Hermès, Paris, 2nd edn.
- Flandrin, P., 1999. *Time-Frequency/Time-Scale Analysis*, Academic Press, San Diego, Calif.

- Flechtner, F., Gruber, T., Güntner, A., Manda, M., Rothacher, M., Schöne, T. & Wickert, J., eds., 2010. *System Earth via Geodetic-Geophysical Space Techniques*, Advanced Technologies in Earth Sciences, Springer, Berlin, Germany.
- Flesch, L. M., Holt, W. E., Haines, A. J. & Shen-Tu, B., 2000. Dynamics of the Pacific-North American plate boundary in the Western United States, *Science*, **287**, 834–836.
- Flesch, L. M., Holt, W. E., Silver, P. G., Stephenson, M., Wang, C.-Y. & Chan, W. W., 2005. Constraining the extent of crustmantle coupling in central Asia using GPS, geologic, and shear wave splitting data, *Earth Planet. Sci. Lett.*, **238**, 248–268, doi: 10.1016/j.epsl.2005.06.023.
- Fodor, I. K. & Stark, P. B., 2000. Multitaper spectrum estimation for time series with gaps, *IEEE T. Signal Process.*, **48**(12), 3472–3483.
- Fomel, S., 2009. Adaptive multiple subtraction using regularized nonstationary regression, *Geophysics*, **74**(1), V25–V33, doi: 10.1190/1.3043447.
- Fomel, S. & Claerbout, J. F., 2009. Guest editors' introduction: Reproducible research, *Comput. Sci. Eng.*, **11**, 5–7.
- Förste, C., Flechtner, F., Schmidt, R., Meyer, U., Stubenvoll, R., Barthelmes, F., Neumayer, R. K. H., Rothacher, M., Reigber, C., Biancale, R., Bruinsma, S., Lemoine, J.-M. & Raimondo, J. C., 2005. A new high resolution global gravity field model derived from combination of GRACE and CHAMP mission and altimetry/gravimetry surface gravity data, *Geophys. Res. Abstr.*, **7**, 04561.
- Forsyth, D. W., 1975. The early structural evolution and anisotropy of the oceanic upper mantle, *Geophys. J. R. Astron. Soc.*, **43**, 103–162.
- Forsyth, D. W., 1985. Subsurface loading and estimates of the flexural rigidity of continental lithosphere, *J. Geophys. Res.*, **90**(B14), 12623–12632.
- Forsyth, D. W. & Detrick, R. S., 2003. Probing geodynamic processes beneath the sea floor, *Eos Trans. AGU*, **84**(47), 517–528.
- Forsyth, D. W. & the MELT Seismic Team, 1998. Imaging the deep seismic structure beneath a mid-ocean ridge: The MELT experiment, *Science*, **280**(5367), 1215–1218, doi: 10.1126/science.280.5367.1215.
- Forte, A. & Perry, H. K. C., 2000. Geodynamic evidence for a chemically depleted continental tectosphere, *Science*, **290**, 1940–1944.
- Forte, A. M. & Mitrovica, J. X., 2001. Deep-mantle high-viscosity flow and thermochemical structure inferred from seismic and geodynamic data, *Nature*, **410**(6832), 1049–1056, doi: 10.1038/35074000.
- Forte, A. M., Dziewoński, A. M. & O'Connell, R. J., 1995. Continent-ocean chemical heterogeneity in the mantle based on seismic tomography, *Science*, **268**(5209), 386–388.

- Forte, A. M., Dziewoński, A. M. & O'Connell, R. J., 1995. Thermal and chemical heterogeneity in the mantle: A seismic and geodynamic study of continental roots, *Earth Planet. Sci. Lett.*, **92**, 45–55.
- Fortune, S., 1987. A sweepline algorithm for Voronoi diagrams, *Algorithmica*, pp. 153–174.
- Foti, S., 2000, *Multistation Methods for Geotechnical Characterization Using Surface Waves*, Ph.D. thesis, Politecnico di Torino, Torino, Italy.
- Fouch, M. J., Fischer, K. M., Parmentier, E. M., Wyssession, M. E. & Clarke, T. J., 2000. Shear wave splitting, continental keels, and patterns of mantle flow, *J. Geophys. Res.*, **105**(B3), 6255–6275.
- Foufoula-Georgiou, E. & Kumar, P., eds., 1994. *Wavelets in Geophysics*, Academic Press, San Diego, Calif.
- Fougère, P. F., 1963. Spherical harmonic analysis 1. A new method and its verification, *J. Geophys. Res.*, **68**(4), 1131–1139.
- Fougère, P. F., 1965. Spherical harmonic analysis: 2. A new model derived from magnetic observatory data for epoch 1960.0, *J. Geophys. Res.*, **70**(9), 2171–2179.
- Fougère, P. F., 1966. A defense of the Gram-Schmidt orthogonalization procedure applied to spherical harmonic analysis, *J. Geophys. Res.*, **71**(21), 5171–5174.
- Foulger, G. R. & Natland, J. H., 2003. Is "hotspot" volcanism a consequence of plate tectonics?, *Science*, **300**(5621), 921–922, doi: 10.1126/science.1083376.
- Fournier, A., Bunge, H.-P., Hollerbach, R. & Vilotte, J.-P., 2004. Application of the spectral-element method to the axisymmetric Navier-Stokes equation, *Geophys. J. Int.*, **156**, 682–700, doi: 10.1111/j.1365–246X.2004.02149.x.
- Fowler, C. M. R., 1990. *The Solid Earth*, Cambridge Univ. Press, New York.
- Fox, C. G., Dziak, R. P., Matsumoto, H. & Schreiner, A. E., 1993. Potential for monitoring low-level seismicity on the Juan-de-Fuca ridge using military hydrophone arrays, *Mar. Tech. Soc. J.*, **27**(4), 22–30.
- Fox, C. G., Matsumoto, H. & Lau, T.-K. A., 2001. Monitoring Pacific Ocean seismicity from an autonomous hydrophone array, *J. Geophys. Res.*, **106**, 1347–1352, doi: 10.1029/2000JB900404.
- Franklin, J. N., 1970. Well-posed stochastic extensions of ill-posed linear problems, *J. Math. Anal. App.*, **31**(3), 682–716.
- Frawley, J. J. & Taylor, P. T., 2004. Paleo-pole positions from martian magnetic anomaly data, *Icarus*, **172**, 316–327, doi: 10.1016/j.icarus.2004.07.025.
- Frazer, G. & Boashash, B., 1994, Multiple window spectrogram and time-frequency distributions, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, vol. 4, pp. 293–296, IEEE.

- Frederiksen, A. W. & Bostock, M. G., 2000. Modelling teleseismic waves in dipping anisotropic structures, *Geophys. J. Int.*, **141**, 401–412.
- Frederiksen, A. W., Bostock, M. G., VanDecar, J. C. & Cassidy, J. F., 1998. Seismic structure of the upper mantle beneath the northern Canadian Cordillera from teleseismic travel-time inversion, *Tectonophysics*, **294**, 43–55.
- Frederiksen, A. W., Bostock, M. G. & Cassidy, J. F., 2001. S-wave velocity structure of the Canadian upper mantle, *Phys. Earth Planet. Inter.*, **124**(3–4), 175–191.
- Freedden, W., 1981. On spherical spline interpolation and approximation, *Math. Meth. Appl. Sc.*, **3**(44), 551–575.
- Freedden, W., 1981. On approximation by harmonic splines, *Manuscr. Geod.*, **6**, 193–244.
- Freedden, W., 1984. Spherical spline interpolation — basic theory and computational aspects, *J. Comp. Appl. Math.*, **11**(3), 367–375, doi: 10.1016/0377-0427(84)90011-6.
- Freedden, W., 1999. *Multiscale modelling of spaceborne geodata*, Teubner Verlag, Stuttgart.
- Freedden, W., 2010, Geomathematics: Its role, its aim, and its potential, in *Handbook of Geomathematics*, edited by W. Freedden, M. Z. Nashed, & T. Sonar, chap. 1, pp. 3–42, doi: 10.1007/978-3-642-01546-5_1, Springer, Heidelberg, Germany.
- Freedden, W., 2015, Geomathematics: Its role, its aim, and its potential, in *Handbook of Geomathematics*, edited by W. Freedden, M. Z. Nashed, & T. Sonar, chap. 1, pp. 3–78, doi: 10.1007/978-3-642-54551-1, Springer, Heidelberg, Germany.
- Freedden, W. & Maier, T., 2003. Spectral and multiscale signal-to-noise thresholding of spherical vector fields, *Comput. Geosci.*, **7**, 215–250.
- Freedden, W. & Michel, V., 1999. Constructive approximation and numerical methods in geodetic research today — an attempt at a categorization based on an uncertainty principle, *J. Geod.*, **73**(9), 452–465.
- Freedden, W. & Michel, V., 2000, Least-squares geopotential approximation by windowed Fourier transform and wavelet transform, in *Wavelets in the Geosciences*, edited by R. Klees & R. H. N. Haagmans, vol. 90 of **Lecture Notes in Earth Sciences**, pp. 189–241, Springer, Berlin, Germany.
- Freedden, W. & Michel, V., 2004. Orthogonal zonal, tesseral and sectorial wavelets on the sphere for the analysis of satellite data, *Adv. Comput. Math.*, **21**(1–2), 181–217.
- Freedden, W. & Michel, V., 2004. *Multiscale Potential Theory*, Birkhäuser, Boston, Mass.
- Freedden, W. & Nashed, M. Z., 2018. Inverse gravimetry: background material and multiscale mollifier approaches, *Intern. J. Geomath.*, **9**(2), 199–264, doi: 10.1007/s13137-018-0103-5.
- Freedden, W. & Schreiner, M., 1995. Non-orthogonal expansions on the sphere, *Math. Meth. Appl. Sc.*, **18**, 83–120.

- Freedden, W. & Schreiner, M., 1998. Orthogonal and nonorthogonal multiresolution analysis, scale discrete and exact fully discrete wavelet transform on the sphere, *Constr. Approx.*, **14**, 493–515.
- Freedden, W. & Schreiner, M., 1998. An integrated wavelet concept of physical geodesy, *J. Geod.*, **72**(5), 259–281.
- Freedden, W. & Schreiner, M., 2009. *Spherical Functions of Mathematical Geosciences: A Scalar, Vectorial, and Tensorial Setup*, Springer, Berlin, Germany.
- Freedden, W. & Schreiner, M., 2010, Special functions in mathematical geosciences: An attempt at a categorization, in *Handbook of Geomathematics*, edited by W. Freedden, M. Z. Nashed, & T. Sonar, chap. 31, pp. 925–948, doi: 10.1007/978-3-642-01546-5_31, Springer, Heidelberg, Germany.
- Freedden, W. & Windheuser, U., 1997. Combined spherical harmonic and wavelet expansion — A future concept in Earth's gravitational determination, *Appl. Comput. Harmon. Anal.*, **4**, 1–37.
- Freedden, W., Gervens, T. & Schreiner, M., 1998. *Constructive Approximation on the Sphere*, Clarendon Press, Oxford, UK.
- Freedden, W., Michel, V. & Simons, F. J., 2018, Spherical-harmonics based special function systems and constructive approximation methods, in *Handbook of Mathematical Geodesy*, edited by W. Freedden & M. Z. Nashed, pp. 753–819, doi: 10.1007/978-3-319-57181-2_12, Springer, Berlin, Germany.
- Freedman, M. H. & Press, W. H., 1996. Truncation of wavelet matrices: fedge effects and the reduction of topological control, *Linear Algebr. Appl.*, **234**, 1–19.
- French, S. W. & Romanowicz, B., 2015. Broad plumes rooted at the base of the Earth's mantle beneath major hotspots, *Nature*, **525**, 95–99, doi: 10.1038/nature14876.
- Fretwell, P., Pritchard, H. D., Vaughan, D. G., Bamber, J. L., Barrand, N. E., Bell, R., Bianchi, C., Bingham, R. G., Blankenship, D. D., Casassa, G., Catania, G., Callens, D., Conway, H., Cook, A. J., Corr, H. F. J., Damaske, D., Damm, V., Ferraccioli, F., Forsberg, R., Fujita, S., Gim, Y., Gogineni, P., Griggs, J. A., Hindmarsh, R. C. A., Holmlund, P., Holt, J. W., Jacobel, R. W., Jenkins, A., Jokat, W., Jordan, T., King, E. C., Kohler, J., Krabill, W., Riger-Kusk, M., Langley, K. A., Leitchenkov, G., Leuschen, C., Luyendyk, B. P., Matsuoka, K., Mouginot, J., Nitsche, F. O., Nogi, Y., Nost, O. A., Popov, S. V., Rignot, E., Rippin, D. M., Rivera, A., Roberts, J., Ross, N., Siegert, M. J., Smith, A. M., Steinhage, D., Studinger, M., Sun, B., Tinto, B. K., Welch, B. C., Wilson, D., Young, D. A., Xiangbin, C. & Zirizzotti, A., 2013. Bedmap2: improved ice bed, surface and thickness datasets for Antarctica, *The Cryosphere*, **7**, 375–393, doi: 10.5194/tc-7-375-2013.
- Freybourger, M., Gaherty, J. B. & Jordan, T. H., 2001. Structure of the Kaapvaal craton from surface waves, *Geophys. Res. Lett.*, **28**(13), 2489–2492.
- Friederich, W., Wielandt, E. & Stange, S., 1993. Multiple forward scattering of surface waves: Comparison with an exact solution and Born single-scattering methods, *Geophys. J. Int.*, **112**(2), 264–275, doi: 10.1111/j.1365-246X.1993.tb01454.x.

- Friedrich, M., 2008. Backstory: Late glacial trees, *Nature Geosci.*, **1**(4), E8, doi: 10.1038/ngeo169.
- Frost, D. J., 2008. The upper mantle and transition zone, *Elements*, **4**(3), 171–176, doi: 10.2113/gselements.4.3.171.
- Fuentes, M., 2007. Approximate likelihood for large irregularly spaced spatial data, *J. Acoust. Soc. Am.*, **102**(477), 321–331, doi: 10.1198/016214506000000852.
- Fukao, Y., Widiyantoro, S. & Obayashi, M., 2001. Stagnant slabs in the upper and lower mantle transition region, *Rev. Geophys.*, **39**(3), 291–323, doi: 10.1029/1999RG000068.
- Furumura, M., Kennett, B. L. N. & Furumura, T., 1998. Anomalous surface waves associated with deep earthquakes, generated at an ocean ridge, *Geophys. J. Int.*, **134**, 663–676.
- Furumura, M., Kennett, B. L. N. & Furumura, T., 1999. Seismic wavefield calculation for laterally heterogeneous Earth models, II, The influence of upper mantle heterogeneity, *Geophys. J. Int.*, **139**, 623–644.
- Furumura, T. & Kennett, B. L. N., 1998. On the nature of regional seismic phases, III, The influence of crustal heterogeneity on the wavefield for subduction earthquakes: the 1985 Michoacan and 1995 Copala, Guerrero, Mexico earthquakes, *Geophys. J. Int.*, **135**, 1060–1084.
- Furumura, T., Kennett, B. L. N. & Furumura, M., 1998. Seismic wavefield calculation for laterally heterogeneous whole Earth models using the pseudospectral method, *Geophys. J. Int.*, **135**, 845–860.
- Gabor, D., 1946. Theory of communication, *J. of the IEEE*, **93**, 429–457.
- Gabriels, P., Snieder, R. & Nolet, G., 1987. In situ measurements of shear-wave velocity in sediments with higher-mode Rayleigh waves, *Geophys. Prospect.*, **35**(2), 187–196, doi: 10.1111/j.1365-2478.1987.tb00812.x.
- Gaffney, C. F. & Gater, J., 2003. *Revealing the buried past: Geophysics for archaeologists*, Tempus Stroud.
- Gagała, Ł., Ratschbacher, L., Ringenbach, J.-C., Kufner, S.-K., Schurr, B., Dedow, R., Abdulhameed, S., Garzic, E. L., Gadoev, M. & Oimahmadov, I., 2020. Tajik basin and southwestern Tian Shan, northwestern India-Asia collision zone: 1. Structure, kinematics, and salt tectonics in the Tajik fold-and-thrust belt of the western foreland of the Pamir, *Tectonics*, **39**(5), e2019TC005871, doi: 10.1029/2019TC005871.
- Gaherty, J. B. & Jordan, T. H., 1995. Lehmann discontinuity as the base of an anisotropic layer beneath continents, *Science*, **268**, 1468–1471.
- Gaherty, J. B., Jordan, T. H. & Gee, L. S., 1996. Seismic structure of the upper mantle in a central Pacific corridor, *J. Geophys. Res.*, **101**(B10), 22291–22309.
- Gaherty, J. B., Kato, M. & Jordan, T. H., 1999. Seismological structure of the upper mantle: A regional comparison of seismic layering, *Phys. Earth Planet. Inter.*, **110**, 21–41.

- Galanti, E., Kaspi, Y., Simons, F. J., Durante, D., Parisi, M. & Bolton, S. J., 2019. Determining the depth of Jupiter's Great Red Spot with Juno: A Slepian approach, *Astroph. J. Lett.*, **874**, L24, doi: 10.3847/2041-8213/ab1086.
- Gao, S. S., Silver, P. G., Liu, K. H. & the Kaapvaal Seismic Group, 2002. Mantle discontinuities beneath Southern Africa, *Geophys. Res. Lett.*, **29**(10), 1491, doi: 10.1029/2001GL013834.
- Garcia, R. F., Chevrot, S. & Calvet, M., 2009. Statistical study of seismic heterogeneities at the base of the mantle from *PKP* differential traveltimes, *Geophys. J. Int.*, **179**(3), 1607–1616.
- Gardner, A. S., Moholdt, G., Wouters, B., Wolken, G. J., Burgess, D. O., Sharp, M. J., Cogley, J. G., Braun, C. & Labine, C., 2011. Sharply increased mass loss from glaciers and ice caps in the Canadian Arctic Archipelago, *Nature*, **473**(7347), 357–360, doi: 10.1038/nature10089.
- Gardner, A. S., Moholdt, G., Arendt, A. A. & Wouters, B., 2012. Accelerated contributions of Canada's Baffin and Bylot Island glaciers to sea level rise over the past half century, *The Cryosphere*, **6**, 1103–1125, doi: 10.5194/tc-6-1103-2012.
- Gardner, A. S., Moholdt, G., Cogley, J. G., Wouters, B., Arendt, A. A., Wahr, J., Berthier, E., Hock, R., Pfeffer, W. T., Kaser, G., Ligtenberg, S. R. M., Bolch, T., Sharp, M. J., Hagen, J. O., van den Broeke, M. R. & Paul, F., 2013. A reconciled estimate of glacier contributions to sea level rise: 2003 to 2009, *Science*, **340**(6134), 852–857, doi: 10.1126/science.1234532.
- Garnero, E. J., McNamara, A. K. & Shim, S.-H., 2016. Continent-sized anomalous zones with low seismic velocity at the base of Earth's mantle, *Nature Geosci.*, **9**(7), 481–489, doi: 10.1038/NGEO2733.
- Gatterdam, R. W., 81. The planimeter as an example of Green's Theorem, *Am. Math. Mon.*, **88**(9), 701–704, doi: 10.1080/00029890.1981.11995347.
- Gauch, H. G., 2003. *Scientific method in practice*, Cambridge Univ. Press, Cambridge, UK.
- Gauss, C. F., 1839, Allgemeine Theorie des Erdmagnetismus, in *Resultate aus den Beobachtungen des magnetischen Vereins im Jahre 1838*, edited by C. F. Gauss & W. Weber, pp. 1–57, Weidmannsche Buchhandlung, Leipzig, Germany.
- Gauthier, O., Virieux, J. & Tarantola, A., 1986. Two-dimensional nonlinear inversion of seismic waveforms: Numerical results, *Geophysics*, **51**(7), 1387–1403.
- Gautier, J.-M., Oelkers, E. H. & Schott, J., 2001. Are quartz dissolution rates proportional to B. E. T. surface areas?, *Geochim. Cosmochim. Acta*, **65**(7), 1059–1070.
- GEBCO Bathymetric Compilation Group, 2019, The GEBCO_2019 grid—A continuous terrain model of the global oceans and land, Tech. rep., British Oceanographic Data Centre, National Oceanography Centre, NERC.
- Gee, L. S. & Jordan, T. H., 1992. Generalized seismological data functionals, *Geophys. J. Int.*, **111**(2), 363–390, doi: 10.1111/j.1365-246X.1992.tb00584.x.

- Gelchinsky, B. T. & Shtivelman, V., 1983. Automatic picking of first arrivals and parameterization of traveltime curves, *Geophys. Prospect.*, **31**(6), 915–928, doi: 10.1111/j.1365–2478.1983.tb01097.x.
- Gendron, P., Ebel, J. & Manolakis, D., 2000. Rapid joint detection and classification with wavelet bases via Bayes theorem, *B. Seismol. Soc. Am.*, **90**(3), 764–774, doi: 10.1785/0119990103.
- Geng, J., Chen, X., Pan, Y., Mao, S., Li, C., Zhou, J. & Zhang, K., 2019. PRIDE PPP-AR: an open-source software for GPS PPP ambiguity resolution, *GPS Solut.*, **23**(4), 1–10, doi: 10.1007/s10291–019–0888–1.
- Geng, J., Chen, X., Pan, Y. & Zhao, Q., 2019. A modified phase clock/bias model to improve PPP ambiguity resolution at Wuhan University, *J. Geod.*, **93**(10), 2053–2067, doi: 10.1007/s00190–019–01301–6.
- Geng, Y., Innanen, K. & Pan, W., 2020. Subspace method for multi-parameter FWI, *Commun. Math. Phys.*, **28**, 228–248, doi: 10.4208/cicp.OA–2018–0087.
- Genova, A., Goossens, S., Lemoine, F. G., Mazarico, E., Neumann, G. A., Smith, D. E. & Zuber, M. T., 2016. Seasonal and static gravity field of Mars from MGS, Mars Odyssey and MRO radio science, *Icarus*, **272**, 228 – 245, doi: 10.1016/j.icarus.2016.02.050.
- Gerbault, M., Burov, E. B., Poliakov, A. N. B. & Daignières, M., 1999. Do faults trigger folding in the lithosphere?, *Geophys. Res. Lett.*, **26**(2), 271–274.
- Gerhards, C., 2011. Spherical decompositions in a global and local framework: theory and an application to geomagnetic modeling, *Intern. J. Geomath.*, **1**(2), 205–256, doi: 10.1007/s13137–010–0011–9.
- Gerhards, C., 2012. Locally supported wavelets for the separation of spherical vector fields with respect to their sources, *Int. J. Wavelets Multiresolut. Inf. Process.*, **10**(4), 1250034, doi: 10.1142/S0219691312500348.
- Gerhards, C., 2014. A combination of downward continuation and local approximation for harmonic potentials, *Inv. Probl.*, **30**(8), 085004, doi: 10.1088/0266–5611/30/8/085004.
- Gerhards, C., 2014. A multiscale power spectrum for the analysis of the lithospheric magnetic field, *Intern. J. Geomath.*, **5**, 63–79, doi: 10.1007/s13137–013–0053–x.
- Gerstoft, P. & Schmidt, H., 1991. A boundary element approach to ocean seismoacoustic facet reverberation, *J. Acoust. Soc. Am.*, **89**(4), 1629–1642.
- Gertner, J., 2007. The future is drying up, *The New York Times Magazine*, pp. 68–77, 104 & 154–155.
- Gerver, M. L. & Markushevich, V. M., 1966. Determination of a seismic wave velocity from the travel time curve, *Geophys. J. R. Astron. Soc.*, **11**, 165–173.
- Gerya, T., 2019. *Introduction to Numerical Geodynamic Modelling*, Cambridge Univ. Press, Cambridge, UK.

- Gesch, D., Verdin, K. L. & Greenlee, S. K., 1999. New land surface digital elevation model covers the Earth, *Eos Trans. AGU*, **80**(6), 69–70.
- Ghaoui, L. E. & Lebret, H., 1997. Robust solutions to least-squares problems with uncertain data, *SIAM J. Mat. Anal. Appl.*, **18**(4), 1035–1064, doi: 10.1137/S0895479896298130.
- Ghelichkhan, S. & Bunge, H.-P., 2016. The compressible adjoint equations in geodynamics: derivation and numerical assessment, *Intern. J. Geomath.*, **7**(1), 1–30, doi: 10.1007/s13137-016-0080-5.
- Ghelichkhan, S., Bunge, H.-P. & Oeser, J., 2021. Global mantle flow retrodictions for the early Cenozoic using an adjoint method: evolving dynamic topographies, deep mantle structures, flow trajectories and sublithospheric stresses, *Geophys. J. Int.*, **226**(2), 1432–1460, doi: 10.1093/gji/ggab108.
- Ghil, M., Allen, M. R., Dettinger, M. D., Ide, K., Kondrashov, D., Mann, M. E., Robertson, A. W., Saunders, A., Tian, Y., Varadi, F. & Yiou, P., 2001. Advanced spectral methods for climatic time series, *Rev. Geophys.*, **40**(1), 1–41, doi: 10.1029/2001RG000092.
- Gholami, A. & Siahkoobi, H. R., 2010. Regularization of linear and non-linear geophysical ill-posed problems with joint sparsity constraints, *Geophys. J. Int.*, **180**(2), 871–882, doi: 10.1111/j.1365-246X.2009.04453.x.
- Ghosh, A., Holt, W. E., Wen, L. & Flesch, L. M., 2008. Joint modeling of lithosphere and mantle dynamics elucidating lithosphere-mantle coupling, *Geophys. Res. Lett.*, **35**, L16309, doi: 10.1029/2008GL034365.
- Ghosh, A., Holt, W. E. & Flesch, L. M., 2010. Contribution of gravitational potential energy differences to the global stress field, *Geophys. J. Int.*, **179**(2), 787–812, doi: 10.1111/j.1365-246X.2009.04326.x.
- Gibbard, P., 2007. Europe cut adrift, *Nature*, **448**, 259–260.
- Gilbert, E. N. & Slepian, D., 1977. Doubly orthogonal concentrated polynomials, *SIAM J. Math. Anal.*, **8**(2), 290–319.
- Gilbert, F., 1970. Excitation of the normal modes of the Earth by earthquake sources, *Geophys. J. R. Astron. Soc.*, **22**, 223–226.
- Gilbert, F., 1971. Ranking and winnowing gross Earth data for inversion and resolution, *Geophys. J. Int.*, **23**(1), 125–128, doi: 10.1111/j.1365-246X.1971.tb01807.x.
- Gilbert, F., 1980, An introduction to low-frequency seismology, in *Physics of the Earth's Interior*, edited by A. M. Dziewoński & E. Boschi, vol. 4478, pp. 41–81, Int. School of Physics Enrico Fermi.
- Gilbert, F. & Dziewoński, A. M., 1975. An application of normal mode theory to the retrieval of structural parameters and source mechanisms from seismic spectra, *Phil. Trans. R. Soc. London, Ser. A*, **278**(1280), 187–269.

- Giles, M. B. & Pierce, N. A., 2000. An introduction to the adjoint approach to design, *Flow Turbul. Combust.*, **65**(3–4), 393–415.
- Girardin, N. & Farra, V., 1998. Azimuthal anisotropy in the upper mantle from observations of *P*-to-*S* converted phases: Application to southeast Australia, *Geophys. J. Int.*, **133**, 615–629.
- Glatzmaier, G. A., 2014. *Introduction to Modeling Convection in Planets and Stars: Magnetic Field, Density Stratification, Rotation*, Princeton Univ. Press, Princeton, NJ.
- Glatzmaier, G. A., Coe, R. S., Hongre, L. & Roberts, P. H., 1999. The role of the Earth's mantle in controlling the frequency of geomagnetic reversals, *Nature*, **401**, 885–890.
- Gledhill, K. R., 1985. An earthquake detector employing frequency domain techniques, *B. Seismol. Soc. Am.*, **75**(6), 1827–1835.
- Gneiting, T., Ševčíková, H., Percival, D. B., Schlather, M. & Jiang, Y., 2006. Fast and exact simulation of large Gaussian lattice systems in \mathbb{R}^2 : Exploring the limits, *J. Comput. Graph. Stat.*, **15**(3), 483–501, doi: 10.1198/106186006X128551.
- Gneiting, T., Kleiber, W. & Schlather, M., 2010. Matérn cross-covariance functions for multivariate random fields, *J. Am. Stat. Assoc.*, **105**(491), 1–11, doi: 10.1198/jasa.2010.tm09420.
- Gneiting, T., Ševčíková, H. & Percival, D. B., 2012. Estimators of fractal dimension: Assessing the roughness of time series and spatial data, *Stat. Sci.*, **27**(2), 247–277, doi: 10.1214/11-STS370.
- Godey, S., Deschamps, F., Trampert, J. & Snieder, R., 2004. Thermal and compositional anomalies beneath the North American continent, *J. Geophys. Res.*, **109**, B01308, doi: 10.1029/2002JB002263.
- Godio, A. & Piro, S., 2005. Integrated data processing for archeological magnetic surveys, *The Leading Edge*, **24**(11), 1138–1144.
- Goes, S. & van der Lee, S., 2002. Thermal structure of the North American uppermost mantle inferred from seismic tomography, *J. Geophys. Res.*, **107**(B3), 2050, doi: 10.1029/2000JB000049.
- Goes, S., Govers, R. & Vacher, P., 2000. Shallow mantle temperatures under Europe from *P* and *S* wave tomography, *J. Geophys. Res.*, **105**(B5), 11153–11169.
- Goes, S., Cammarano, F. & Hansen, U., 2004. Synthetic seismic signature of thermal mantle plumes, *Earth Planet. Sci. Lett.*, **218**, 403–419, doi: 10.1016/S0012-821X(03)00680-0.
- Goes, S., Simons, F. J. & Yoshizawa, K., 2005. Seismic constraints on temperature of the Australian uppermost mantle, *Earth Planet. Sci. Lett.*, **236**(1–2), 227–237, doi: 10.1016/j.epsl.2005.05.001.
- Goff, J. A., 1991. A global and regional stochastic analysis of near-ridge abyssal hill morphology, *J. Geophys. Res.*, **96**(B13), 21713–21737, doi: 10.1029/91JB02275.

- Goff, J. A. & Arbic, B. K., 2010. Global prediction of abyssal hill roughness statistics for use in ocean models from digital maps of paleo-spreading rate, paleo-ridge orientation, and sediment thickness, *Ocean Modelling*, **32**(1–2), 36–43, doi: 10.1016/j.ocemod.2009.10.001.
- Goff, J. A. & Jordan, T. H., 1988. Stochastic modeling of seafloor morphology: Inversion of Sea Beam data for second-order statistics, *J. Geophys. Res.*, **93**(B11), 13589–13608, doi: 10.1029/JB093iB11p13589.
- Goff, J. A. & Jordan, T. H., 1989. Stochastic modeling of seafloor morphology: Resolution of topographic parameters by Sea Beam data, *IEEE J. Ocean. Eng.*, **14**(4), 326–337.
- Goff, J. A. & Jordan, T. H., 1989. Stochastic modeling of seafloor morphology: A parameterized Gaussian model, *Geophys. Res. Lett.*, **16**(1), 45–48.
- Goff, J. A., Jordan, T. H., Edwards, M. H. & Fornari, D. J., 1991. Comparison of a stochastic seafloor model with SeaMARC II bathymetry and sea beam data near the East Pacific Rise 13°–15° N, *J. Geophys. Res.*, **96**(B3), 3867–3885.
- Goff, J. A., Holliger, K. & Levander, A., 1994. Modal fields: A new method for characterization of random seismic velocity heterogeneity, *Geophys. Res. Lett.*, **21**(6), 493–496, doi: 10.1029/94GL00311.
- Goforth, T. & Herrin, E., 1981. An automatic seismic signal detection algorithm based on the Walsh transform, *B. Seismol. Soc. Am.*, **71**(4), 1351–1360.
- Goins, N., Dainty, A. & Toksöz, M. N., 1981. Lunar seismology: the internal structure of the moon, *J. Geophys. Res.*, **86**, 5061–5074.
- Goldstein, P. & Snoke, A., 2005. SAC availability for the IRIS community, *IRIS DMC Electronic Newsletter*, **7**(1).
- Goldstein, P., Dodge, D., Firpo, M. & Minner, L., 2003, SAC2000: Signal processing and analysis tools for seismologists and engineers, in *International Handbook of Earthquake and Engineering Seismology, Part B*, edited by W. H. K. Lee, H. Kanamori, P. C. Jennings, & C. Kisslinger, vol. 81 of **International Geophysics**, pp. 1613–1614, doi: 10.1016/S0074–6142(03)80284–X, Academic Press.
- Goldstein, R. M., 1965. Mars: Radar observations, *Science*, **150**(3704), 1715–1717.
- Goleby, B. R., Shaw, R. D., Wright, C. & Kennett, B. L. N., 1989. Geophysical evidence for “thick-skinned” crustal deformation in central Australia, *Nature*, **337**(6205), 325–330.
- Golle, O., Dumoulin, C., Choblet, G. & Čadež, O., 2012. Topography and geoid induced by a convecting mantle beneath an elastic lithosphere, *Geophys. J. Int.*, **189**(1), 55–72, doi: 10.1111/j.1365–246X.2012.05364.x.
- Golombek, M. P. & Anderson, F. S., 2001. Martian wrinkle ridge topography: Evidence for subsurface faults from MOLA, *J. Geophys. Res.*, **106**(E5), 23811–23821.

- Golub, G. H. & van Loan, C. F., 1980. An analysis of the total least squares problem, *SIAM J. Numer. Anal.*, **17**(6), 883–893, doi: 10.1137/0717073.
- Golub, G. H. & van Loan, C. F., 1989. *Matrix Computations*, Johns Hopkins Univ. Press, Baltimore, Md., 2nd edn.
- Gomes, A., Peterson, J., Bitlis, S., Fan, C. & Buehring, R., 2019. Assisting salt model building with reflection full-waveform inversion, *Interpretation*, **7**(2), SB43–SB52, doi: 10.1190/int-2018-0155.1.
- Gómez-Ortiz, D., Tejero, R., Ruiz, J., Babín-Vinch, R. & González-Casado, J. M., 2005. Estimating the effective elastic thickness of the lithosphere of the Iberian peninsula based on multitaper spectral analysis, *Geophys. J. Int.*, **160**(2), 729–735, doi: 10.1111/j.1365-246X.2004.02499.X.
- Goncharov, A. G., Lizinsky, M. D., Collins, C. D. N., Kalnin, K. A., Fomin, T. N., Drummond, B. J., Goleby, B. R. & Platonenkova, L. N., 1998, Intra-crustal “seismic isostasy” in the Baltic Shield and Australian Precambrian cratons from deep seismic profiles and the Kola Superdeep Bore Hole data, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klootwijk, vol. 26 of **Geodyn. Ser.**, pp. 119–138, Amer. Geophys. Union, Washington, D. C.
- Goncz, J. H. & Cleary, J. R., 1976. Variations in the structure of the upper mantle beneath Australia, from Rayleigh wave observations, *Geophys. J. R. Astron. Soc.*, **44**(2), 507–516.
- Goncz, J. H., Hales, A. L. & Muirhead, K. J., 1975. Analysis to extended periods of Rayleigh and Love wave dispersion across Australia, *Geophys. J. R. Astron. Soc.*, **41**(1), 81–108.
- González, A., 2010. Measurement of areas on a sphere using Fibonacci and latitude-longitude lattices, *Math. Geosc.*, **42**(1), 49–64.
- González, J. A. & del Olmo, M. A., 1998. Coherent states on the circle, *J. Phys. A: Math. Gen.*, **31**, 8841–8857.
- Goodman, N. R., 1963. Statistical analysis based on a certain multivariate complex Gaussian distribution (an introduction), *Ann. Math. Stat.*, **34**(1), 152–177.
- Goodman, N. R., 1965, Statistical tests for stationarity within the framework of harmonizable processes, No 65–28, Rocketdyne Research Report.
- Goossens, S., 2010. Applying spectral leakage corrections to gravity field determination from satellite tracking data, *Geophys. J. Int.*, **181**(3), 1459–1472, doi: 10.1111/j.1365-246X.2010.04585.x.
- Goossens, S., Ishihara, Y., Matsumoto, K. & Sasaki, S., 2012. Local lunar gravity field analysis over the South Pole-Aitken basin from SELENE farside tracking data, *J. Geophys. Res.*, **117**, E02005, doi: 10.1029/2011JE003831.
- Goren, L., Fox, M. & Willett, S. D., 2014. Tectonics from fluvial topography using formal linear inversion: Theory and applications to the Inyo Mountains, California, *J. Geophys. Res.*, **119**(8), 1651–1681, doi: 10.1002/2014JF003079.

- Górski, K. M., 1994. On determining the spectrum of primordial inhomogeneity from the *cobe* DMR sky maps — Method, *Astroph. J.*, **430**(2), L85–L88.
- Górski, K. M., Hivon, E., Banday, A. J., Wandelt, B. D., Hansen, F. K., Reinecke, M. & Bartelman, M., 2005. HEALPix: A framework for high-resolution discretization and fast analysis of data distributed on the sphere, *Astroph. J.*, **622**, 759–771.
- Got, J.-L., Fréchet, J. & Klein, F. W., 1994. Deep fault plane geometry inferred from multiplet relative relocation beneath the south flank of Kilauea, *J. Geophys. Res.*, **99**(B8), 15375–15386.
- Gouédard, P., Stehly, L., Brenguier, F., Campillo, M., de Verdière, C. Y., Larose, E., Margerin, L., Roux, P., Sánchez-Sesma, F. J., Shapiro, N. M. & Weaver, R. L., 2008. Cross-correlation of random fields: Mathematical approach and applications, *Geophys. Prospect.*, **56**(3), 375–393, doi: 10.1111/j.1365–2478.2007.00684.x.
- Gouédard, P., Yao, H., Ernst, F. & van der Hilst, R. D., 2012. Surface wave eikonal tomography in heterogeneous media using exploration data, *Geophys. J. Int.*, **191**(2), 781–788, doi: 10.1111/j.1365–246X.2012.05652.x.
- Gough, D. I., 1974. Electrical conductivity under western North America in relation to heat flow, seismology and structure, *J. Geomagn. Geoelectr.*, **26**, 105–123.
- Gough, D. I., 1986. Seismic reflectors, conductivity, water and stress in the continental crust, *Nature*, **323**, 143–144.
- Gould, J. & the Argo Science Team, 2004. Argo profiling floats bring new era of in situ ocean observations, *Eos Trans. AGU*, **85**(19), 179 & 190–191, doi: 10.1029/2004EO190002.
- Gould, W. J., 2005. From Swallow floats to Argo—The development of neutrally buoyant floats, *Deep-Sea Res. II*, **52**(3–4), 529–543, doi: 10.1016/j.dsr2.2004.12.005.
- Goutorbe, B., Poort, J., Lucazeau, F. & Raillard, S., 2011. Global heat flow trends resolved from multiple geological and geophysical proxies, *Geophys. J. Int.*, **187**, 1405–1419, doi: 10.1111/j.1365–246X.2011.05228.x.
- Gouveai, W. P. & Scales, J. A., 1997. Resolution of seismic waveform inversion: Bayes versus Occam, *Inv. Probl.*, **13**(2), 323–349.
- Gouveia, W. P. & Scales, J. A., 1998. Bayesian seismic waveform inversion: Parameter estimation and uncertainty analysis, *J. Geophys. Res.*, **103**(B2), 2759–2779, doi: 10.1029/97JB02933.
- Gradshteyn, I. S. & Ryzhik, I. M., 2000. *Tables of Integrals, Series, and Products*, Academic Press, San Diego, Calif., 6th edn.
- Graeber, F. M., Houseman, G. A. & Greenhalgh, S. A., 2002. Regional teleseismic tomography of the western Lachlan Orogen and the Newer Volcanic Province, southeast Australia, *Geophys. J. Int.*, **149**, 249–266.

- Grafarend, E. W., Klapp, M. & Martinec, Z., 2010, Spacetime modeling of the Earth's gravity field by ellipsoidal harmonics, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 7, pp. 159–252, doi: 10.1007/978-3-642-01546-5_7, Springer, Heidelberg, Germany.
- Graham, S., Lambert, D. D., Shee, S. R., Smith, C. B. & Reeves, S., 1999. Re-Os evidence for Archean lithospheric mantle, *Geology*, **27**(5), 431–434.
- Grand, S. P., 1987. Tomographic inversion for shear velocity beneath the North American plate, *J. Geophys. Res.*, **92**(B13), 14065–14090.
- Grand, S. P., van der Hilst, R. D. & Widiyantoro, S., 1997. Global seismic tomography: A snapshot of convection in the Earth, *GSA Today*, **7**(4), 1–7.
- Grant, B., 2009. Right your writing. how to sharpen your writing and make your manuscripts more engaging, *The Scientist*, **23**(11), 65–67.
- Grapenthin, R., 2011. Computer programming for geosciences: Teach your students how to make tools, *Eos Trans. AGU*, **92**(50), 469–470.
- Gray, L. M. & Greeley, D. S., 1980. Source level model for propeller blade rate radiation for the world's merchant fleet, *J. Acoust. Soc. Am.*, **67**(2), 516–522, doi: 10.1121/1.383916.
- Grayson, D. K., 2000. Faunal extinction in an island society: Pygmy Hippopotamus hunters of Cyprus, *Geoarchaeology*, **15**(4), 379–381.
- Grebenitcharsky, R., 2003, *Numerical Solutions to Altimetry-Gravimetry Boundary Value Problems in Coastal Regions*, Ph.D. thesis, University of Calgary, Calgary, Canada.
- Green, R. G., White, R. S. & Greenfield, T., 2014. Motion in the north Iceland volcanic rift zone accommodated by bookshelf faulting, *Nature Geosci.*, **7**, 29–33, doi: 10.1038/geo2012.
- Gregg, P. M., Lin, J., Behn, M. D. & Montési, L. G. J., 2007. Spreading rate dependence of gravity anomalies along oceanic transform faults, *Nature*, **448**, 183–187, doi: 10.1038/nature05962.
- Griffin, W. L., O'Reilly, S. Y., Ryan, C. G., Gaul, O. & Ionov, D. A., 1998, Secular variation in the composition of subcontinental lithospheric mantle: Geophysical and geodynamic implications, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klootwijk, no. 26 in Geodyn. Ser., pp. 1–26, Amer. Geophys. Union, Washington, D. C.
- Griffin, W. L., O'Reilly, S. Y. & Ryan, C. G., 1999, The composition and origin of sub-continental lithospheric mantle, in *Mantle Petrology: Field Observations and High-Pressure Experimentation*, edited by Y. Fei, C. M. Bertka, & B. O. Mysen, no. 6 in Geochem. Soc. Spec. Pub., pp. 13–43, Geochem. Soc., Houston.
- Griffin, W. L., O'Reilly, S. Y., Afonso, J. C. & Begg, G. C., 2009. The composition and evolution of lithospheric mantle: a re-evaluation and its tectonic implications, *J. Petrol.*, **50**(7), 1185–1204, doi: 10.1093/petrology/egn033.

- Grilli, A. R., Merrill, J., Grilli, S. T., Spaulding, M. L. & Cheung, J. T., 2007, Experimental and numerical study of spar buoy-magnet/spring oscillators used as wave energy absorbers, in *Proc. 17th Int. Conf. Offshore Polar Eng.*, pp. 489–496, ISOPE.
- Grilli, A. R., Bastien, S., Grilli, S. T., Jr, R. S. & Spaulding, M. L., 2009, Small buoys for energy harvesting: Experimental and numerical modelling studies, in *Proc. Int. Conf. Ocean, Offshore Arctic Eng.*, pp. OMAE2009–80024, OMAE.
- Griot, D.-A. & Montagner, J.-P., 1998. Confrontation of mantle seismic anisotropy with two extreme models of strain, in Central Asia, *Geophys. Res. Lett.*, **25**(9), 1447–1450.
- Griot, D.-A., Montagner, J.-P. & Tapponnier, P., 1998. Phase velocity structure from Rayleigh and Love waves in Tibet and its neighboring regions, *J. Geophys. Res.*, **103**(B9), 21215–21232.
- Gripp, A. E. & Gordon, R. G., 1990. Current plate velocities relative to the hotspots incorporating the Nuvel-1 global plate motion model, *Geophys. Res. Lett.*, **17**(8), 1109–1112.
- Grishchuk, L. P. & Martin, J., 1997. Best unbiased estimates for the microwave background anisotropies, *Phys. Rev. D*, **56**(4), 1924–1938.
- Grohmann, C. H., Smith, M. J. & Riccomini, C., 2011. Multiscale analysis of topographic surface roughness in the Midland Valley, Scotland, *IEEE-GRS*, **49**(4), 1200–1213, doi: 10.1109/TGRS.2010.2053546.
- Gross, J. N., Watson, R. M., Sivaneri, V., Bar-Sever, Y. E., Bertiger, W. I. & Haines, B., 2015, Integration of inertial navigation into real-time GIPSY-x (RTGx), in *Proc. 28th Int. Techn. Meeting Sat. Div. (ION GNSS+ 2015)*, pp. 2560–2569, Inst. of Navig., Tampa, Florida.
- Gross, R. S. & Chao, B. F., 2006. The rotational and gravitational signature of the December 26, 2004 Sumatran earthquake, *Surv. Geophys.*, **27**(6), 615–632, doi: 10.1007/s10712–006–9008–.
- Grott, M. & Breuer, D., 2010. On the spatial variability of the Martian elastic lithosphere thickness: Evidence for mantle plumes?, *J. Geophys. Res.*, **115**, E03005, doi: 10.1029/2009JE003456.
- Grotzinger, J., Jordan, T. H., Press, F. & Siever, R., 2006. *Understanding Earth*, W. H. Freeman, New York, 5th edn.
- Grotzinger, J. P., Bowring, S. A., Saylor, B. Z. & Kaufman, A. J., 1995. Biostratigraphic and geochronologic constraints on early animal evolution, *Science*, **270**, 598–604.
- Grotzinger, J. P., Fike, D. A. & Fischer, W. W., 2011. Enigmatic origin of the largest-known carbon isotope excursion in Earth’s history, *Nature Geosci.*
- Grünbaum, F. A., 1981. Eigenvectors of a Toeplitz matrix: discrete version of the prolate spheroidal wave functions, *SIAM J. Alg. Disc. Meth.*, **2**(2), 136–141.
- Grünbaum, F. A., 1981. Toeplitz matrices commuting with tridiagonal matrices, *Lin. Alg. Appl.*, **40**, 25–36.

- Grünbaum, F. A., 2002. The Heisenberg inequality for the discrete Fourier transform, *Appl. Comput. Harmon. Anal.*, **15**, 163–167.
- Grünbaum, F. A. & Miranian, L., 2001, Magic of the prolate spheroidal functions in various setups, in *Wavelets: Applications in Signal and Image Processing IX*, edited by A. F. Laine, M. A. Unser, & A. Aldroubi, vol. 4478, pp. 151–162, doi: 10.1117/12.449698, SPIE.
- Grünbaum, F. A., Longhi, L. & Perlstadt, M., 1982. Differential operators commuting with finite convolution integral operators: some non-Abelian examples, *SIAM J. Appl. Math.*, **42**(5), 941–955.
- Gu, Y. J. & Dziewoński, A. M., 2002. Global variability of transition zone thickness, *J. Geophys. Res.*, **107**(B7), 2135, doi: 10.1029/2001JB000489.
- Gu, Y. J., Dziewoński, A. M. & Ekström, G., 2001. Preferential detection of the Lehmann discontinuity beneath continents, *Geophys. Res. Lett.*, **28**(24), 4655–4658.
- Gu, Y. J., An, Y., Sacchi, M., Schultz, R. & Ritsema, J., 2009. Mantle reflectivity structure beneath oceanic hotspots, *Geophys. J. Int.*, **178**(3), 1456–1472, doi : 10.1111/j.1365–246X.2009.04242.x.
- Gualtieri, L., Stutzmann, E., Capdeville, Y., Arduin, F., Schimmel, M., Mangeney, A. & Morelli, A., 2013. Modelling secondary microseismic noise by normal mode summation, *Geophys. J. Int.*, **193**(3), 1732–1745, doi: 10.1093/gji/ggt090.
- Gualtieri, L., Stutzmann, E., Farra, V., Capdeville, Y., Schimmel, M., Arduin, F. & Morelli, A., 2014. Modelling the ocean site effect on seismic noise body waves, *Geophys. J. Int.*, **197**(2), 1096–1106, doi: 10.1093/gji/ggu042.
- Gualtieri, L., Camargo, S. J., Pascale, S., Pons, F. M. E. & Ekström, G., 2018. The persistent signature of tropical cyclones in ambient seismic noise, *Earth Planet. Sci. Lett.*, **484**, 287–294, doi: 10.1016/j.epsl.2017.12.026.
- Gualtieri, L., Stutzmann, E., Juretzek, C., Hadziioannou, C. & Arduin, F., 2019. Global scale analysis and modelling of primary microseisms, *Geophys. J. Int.*, **218**(1), 560–572, doi: 10.1093/gji/ggz161.
- Gualtieri, L., Bachmann, E., Simons, F. J. & Tromp, J., 2020. The origin of secondary microseism Love waves, *Proc. Natl. Acad. Sci.*, **117**(47), 29504–29511, doi: 10.1073/pnas.2013806117.
- Gualtieri, L., Bachmann, E., Simons, F. J. & Tromp, J., 2021. Generation of secondary microseism Love waves: effects of bathymetry, 3-D structure, and source seasonality, *Geophys. J. Int.*, **226**(1), 192–219, doi: 10.1093/gji/ggab095.
- Guarnieri, A. M. & Prati, C., 1997. SAR interferometry: A “quick and dirty” coherence estimator for data browsing, *IEEE T. Geosci. Remote*, **35**(3), 660–669, doi: 10.1109/36.581984.
- Gubbins, D., 1983. Geomagnetic field analysis — I. Stochastic inversion, *Geophys. J. R. Astron. Soc.*, **73**(3), 641–652.

- Gubbins, D., 2004. *Time Series Analysis and Inverse Theory for Geophysicists*, Cambridge Univ. Press, Cambridge, UK.
- Gubbins, D. & Herrero-Bervera, E., eds., 2007. *Encyclopedia of Geomagnetism and Paleomagnetism*, Springer, Dordrecht, Neth.
- Gubbins, D. & Roberts, N., 1983. Use of the frozen flux approximation in the interpretation of archaeomagnetic and paleomagnetic data, *Geophys. J. R. Astron. Soc.*, **73**(3), 675–687.
- Gubbins, D., Jones, A. L. & Finlay, C. C., 2006. Fall in Earth’s magnetic field is erratic, *Science*, **312**, 900–902.
- Gubbins, D., Ivers, D., Masterton, S. M. & Winch, D. E., 2011. Analysis of lithospheric magnetization in vector spherical harmonics, *Geophys. J. Int.*, **187**, 99–117, doi: 10.1111/j.1365–246X.2011.05153.x.
- Gubbins, D., Sreenivasan, B., Mound, J. & Rost, S., 2011. Melting of the Earth’s inner core, *Nature*, **473**, 361–363, doi: 10.1038/nature10068.
- Gudkova, T. V. & Zharkov, V. N., 2002. The exploration of the lunar interior using torsional oscillations, *Planet. Space Sci.*, **50**, 1037–1048.
- Guevara, D., 2014, *Data collection and telemetry system design for marine instrumentation: The Son-O-Mermaid*, Master’s thesis, Univ. Rhode Island.
- Guillaumin, A. P., Sykulski, A. M., Olhede, S. C. & Simons, F. J., 2022. The debiased spatial Whittle likelihood, *J. R. Stat. Soc., Ser. B*, **84**(4), 1526–1557, doi: 10.1111/rssb.12539.
- Guillou-Frottier, L., Mareschal, J.-C., Jaupart, C., Gariépy, C., Lapointe, R. & Bienfait, G., 1995. Heat flow variations in the Grenville Province, Canada, *Earth Planet. Sci. Lett.*, **136**, 447–460.
- Guilloux, F., Faÿ, G. & Cardoso, J.-F., 2009. Practical wavelet design on the sphere, *Appl. Comput. Harmon. Anal.*, **26**, 143–160, doi: 10.1016/j.acha.2008.03.003.
- Guizar-Sicairos, M. & Gutiérrez-Vega, J. C., 2004. Computation of quasi-discrete Hankel transforms of integer order for propagating optical wave fields, *J. Opt. Soc. Am. A*, **21**(1), 53–58.
- Gulick, S. P. S., 2008. Backstory: Impact assessment, *Nature Geosci.*, **1**(2), E4, doi: 10.1038/ngeo121.
- Gulick, S. P. S., Barton, P. J., Christeson, G. L., Morgan, J. V., McDonald, M., Mendoza-Cervantes, K., Pearson, Z. F., Surendra, A., Urrutia-Fucugauchi, J., Vermeesch, P. M. & Warner, M. R., 2008. Importance of pre-impact crustal structure for the asymmetry of the Chicxulub impact crater, *Nature Geosci.*, **1**(2), 131–135, doi: 10.1038/ngeo103.
- Guðmundsson, Ó. & Sambridge, M., 1998. A regionalized upper mantle (RUM) seismic model, *J. Geophys. Res.*, **103**(B4), 7121–7136.
- Guðmundsson, O., Davies, J. H. & Clayton, R. W., 1990. Stochastic analysis of global traveltime data: mantle heterogeneity and random errors in the ISC data, *Geophys. J. Int.*, **102**(1), 25–43.

- Gung, Y., Panning, M. & Romanowicz, B., 2003. Global anisotropy and the thickness of continents, *Nature*, **422**, 707–711.
- Guo, J. Y., Duan, X. J. & Shum, C. K., 2010. Non-isotropic Gaussian smoothing and leakage reduction for determining mass changes over land and ocean using GRACE data, *Geophys. J. Int.*, **181**, 290–302, doi: 10.1111/j.1365-246X.2010.04534.x.
- Guo, J. Y., Huang, Z. W., Shum, C. K. & van der Wal, W., 2012. Comparisons among contemporary glacial isostatic adjustment models, *J. Geodyn.*, **61**, 129–137, doi: 10.1016/j.jog.2012.03.011.
- Gupta, S., Collier, J. S., Palmer-Felgate, A. & Potter, G., 2007. Catastrophic flooding origin of shelf valley systems in the English Channel, *Nature*, **448**, 342–345.
- Gurley, K. & Kareem, A., 1999. Applications of wavelet transforms in earthquake, wind and ocean engineering, *Eng. Struct.*, **21**(2), 149–167.
- Gurnis, M., 1986. Quantitative bounds on the size spectrum of isotopic heterogeneity within the mantle, *Nature*, **323**, 317–320, doi: 10.1038/323317a0.
- Gurnis, M., 1988. Large-scale mantle convection and the aggregation and dispersal of supercontinents, *Nature*, **332**, 695–699.
- Gurnis, M., 1990. Ridge spreading, subduction, and sea level fluctuations, *Science*, **250**, 970–972.
- Gurnis, M., 1992. Rapid continental subsidence following the initiation and evolution of subduction, *Science*, **255**, 1556–1558.
- Gurnis, M., Müller, R. D. & Moresi, L., 1998. Cretaceous vertical motion of Australia and the Australian-Antarctic discordance, *Science*, **279**, 1499–1504.
- Gurrola, H., Minster, J. B. & Owens, T., 1994. The use of velocity spectrum for stacking receiver functions and imaging upper mantle discontinuities, *Geophys. J. Int.*, **117**(2), 427–440, doi: 10.1111/j.1365-246X.1994.tb03942.x.
- Guseinov, I. I., 1995. On the evaluation of multielectron molecular integrals over Slater-type orbitals using binomial coefficients, *J. Mol. Struct. (Theochem)*, **335**, 17–20.
- Guseinov, I. I., Özmen, A., Atav, Ü. & Yüksel, H., 1995. Computation of Clebsch-Gordan and Gaunt coefficients using binomial coefficients, *J. Comput. Phys.*, **122**, 343–347.
- Gutenberg, B., 1913. Über die konstitution des erdinnern, erschlossen aus erdbebenbeobachtungen, *Physikalische Zeitschrift*, **14**, 1217–1218.
- Guttorp, P. & Gneiting, T., 2006. Studies in the history of probability and statistics XLIX. On the Matérn correlation family, *Biometrika*, **93**(4), 989–995.
- Guyodo, Y. & Valet, J.-P., 1999. Global changes in intensity of the Earth's magnetic field during the past 800 kyr, *Nature*, **399**, 249–252.

- Guyon, X., 1982. Parameter estimation for a stationary process on a d -dimensional lattice, *Biometrika*, **69**(1), 95–105, doi: 10.1093/biomet/69.1.95.
- Gwavava, O., Swain, C. J. & Podmore, F., 1996. Mechanisms of isostatic compensation of the Zimbabwe and Kaapvaal cratons, the Limpopo belt and the Mozambique basin, *Geophys. J. Int.*, **127**, 635–650.
- Haar, A., 1909. Zur Theorie des orthogonalen Funktionensysteme, *Math. Annal.*, **69**(3), 331–371, doi: 10.1007/BF01456326.
- Hable, S., Sigloch, K., Stutzmann, E., Kiselev, S. & Barruol, G., 2019. Tomography of crust and lithosphere in the western Indian Ocean from noise cross-correlations of land and ocean bottom seismometers, *Geophys. J. Int.*, **219**(2), 924–944, doi: 10.1093/gji/ggz333.
- Hacker, B. R., Peacock, S. M., Abers, G. A. & Holloway, S. D., 2003. Subduction factory 2. Are intermediate-depth earthquakes in subducting slabs linked to metamorphic dehydration reactions?, *J. Geophys. Res.*, **108**(B1), 2030, doi: 10.1029/2001JB001129.
- Haddad, D. & Watts, A. B., 1999. Subsidence history, gravity anomalies, and flexure of the north-east Australian margin in Papua New Guinea, *Tectonics*, **18**(5), 827–842.
- Hadjisavvas, S., ed., 2010. *Cyprus: Crossroads of Civilizations*, The Government of the Republic of Cyprus, Nicosia, Cyprus.
- Hager, B. H., 1984. Subducted slabs and the geoid: Constraints on mantle rheology and flow, *J. Geophys. Res.*, **89**(B7), 6003–6015.
- Hager, B. H., 1991, Mantle viscosity: A comparison of models from postglacial rebound and from the geoid, plate driving forces, and advected heat flux, in Sabadini et al. (1991), pp. 493–513.
- Hager, B. H. & Clayton, R. W., 1989, Constraints on the structure of mantle convection using seismic observations, flow models, and the geoid, in *Mantle Convection: Plate Tectonics and global dynamics*, edited by W. R. Peltier, vol. 4 of **The fluid mechanics of astrophysics and geophysics**, chap. 9, p. 881, Gordon and Breach Science Publishers, New York.
- Hager, B. H. & O’Connell, R. J., 1979. Kinematic models of large-scale flow in the Earth’s mantle, *J. Geophys. Res.*, **84**(B3), 1031–1048.
- Hager, B. H. & O’Connell, R. J., 1981. A simple global model of plate dynamics and mantle convection, *J. Geophys. Res.*, **86**(B6), 4843–4867.
- Hager, B. H. & Richards, M. A., 1989. Long-wavelength variations in earth’s geoid: Physical models and dynamical implications, *Phil. Trans. R. Soc. London, Ser. A*, **328**(1599), 309–327.
- Hager, B. H., Clayton, R. W., Richards, M. A., Comer, R. P. & Dziewoński, A. M., 1985. Lower mantle heterogeneity, dynamic topography and the geoid, *Nature*, **313**(541-545).
- Haimes, Y. Y. & Li, D., 1988. Hierarchical multiobjective analysis for large-scale systems: Review and current status, *Automatica*, **24**(1), 53–69, doi: 10.1016/0005–1098(88)90007–6.

- Haines, G. V., 1985. Spherical cap harmonic analysis, *J. Geophys. Res.*, **90**(B3), 2583–2591.
- Haines, G. V., 1985. Spherical cap harmonic analysis of geomagnetic secular variation over Canada 1960–1983, *J. Geophys. Res.*, **90**(B14), 12563–12574.
- Haldorsen, J. B. U., Miller, D. E. & Walsh, J. J., 1994. Multichannel Wiener deconvolution of vertical seismic profiles, *Geophysics*, **10**(1500–1511, doi: 10.1190/1.1443540).
- Haldorsen, J. B. U., Miller, D. E. & Walsh, J. J., 1995. Walk-away VSP using drill noise as a source, *Geophysics*, **4**(978–997, doi: 10.1190/1.1443863).
- Hales, A. L. & Roberts, J. L., 1970. Shear velocities in the lower mantle and the radius of the core, *B. Seismol. Soc. Am.*, **60**, 1427–1436.
- Hall, B. C. & Mitchell, J. J., 2002. Coherent states on spheres, *J. Math. Phys.*, **43**(3), 1211–1236.
- Halliday, A. N. & Drake, M. J., 1999. Origin of Earth and moon - Colliding theories, *Science*, **283**(5409), 1861–1863.
- Hambrey, M. J., 1987. Radioglaciology, *Earth Sci. Rev.*, **24**(4), 283–284, doi: 10.1016/0012–8252(87)90067–5.
- Hamburger, M. W. & Taber, J., 2004. Focusing on seismology education, *Eos Trans. AGU*, **85**(12).
- Hamburger, M. W., Pavlis, G. L., Phinney, R. A., Steinberg, D., Owens, T. J. & Hall-Wallace, M., 2001. New science education initiative brings seismology into the classroom, *Eos Trans. AGU*, **82**, 266–267.
- Hamilton, A. J. S., 1997. Towards optimal measurement of power spectra – I. Minimum variance pair weighting and the Fischer matrix, *Mon. Not. R. Astron. Soc.*, **289**, 285–294.
- Hamilton, A. J. S., 1997. Towards optimal measurement of power spectra – II. A basis of positive, compact, statistically orthogonal kernels, *Mon. Not. R. Astron. Soc.*, **289**, 285–294.
- Hamilton, A. J. S., 2009. Power spectrum estimation. I. Basics, *Data Analysis in Cosmology*, pp. 415–431.
- Hamilton, A. J. S., 2009. Power spectrum estimation II. Linear maximum likelihood, *Data Analysis in Cosmology*, pp. 433–456.
- Hammond, J. O. S., England, R., Rawlinson, N., Curtis, A., Sigloch, K., Harmon, N. & Baptie, B., 2019. The future of passive seismic acquisition, *Astron. Geoph.*, **60**(2), 2.37–2.42, doi: 10.1093/astrogeo/atz102.
- Han, D. & Wahr, J., 1995. The viscoelastic relaxation of a realistically stratified earth, and a further analysis of postglacial rebound, *Geophys. J. Int.*, **120**, 287–311.
- Han, S.-C., 2008. Improved regional gravity fields on the Moon from Lunar Prospector tracking data by means of localized spherical harmonic functions, *J. Geophys. Res.*, **113**, E11012, doi: 10.1029/2008JE003166.

- Han, S.-C. & Ditmar, P., 2007. Localized spectral analysis of global satellite gravity fields for recovering time-variable mass redistributions, *J. Geod.*, **82**(7), 423–430, doi: 10.1007/s00190-007-0194-5.
- Han, S.-C. & Simons, F. J., 2008. Spatiospectral localization of global geopotential fields from the Gravity Recovery and Climate Experiment (GRACE) reveals the coseismic gravity change owing to the 2004 Sumatra-Andaman earthquake, *J. Geophys. Res.*, **113**, B01405, doi: 10.1029/2007JB004927.
- Han, S.-C., Shum, C. K., Jekeli, C. & Alsdorf, D., 2005. Improved estimation of terrestrial water storage changes from GRACE, *Geophys. Res. Lett.*, **32**, 7302, doi: 10.1029/2005GL022382.
- Han, S.-C., Shum, C. K., Jekeli, C., Kuo, C.-Y., Wilson, C. & Seo, K.-W., 2005. Non-isotropic filtering of GRACE temporal gravity for geophysical signal enhancement, *Geophys. J. Int.*, **163**, 18–25, doi: 10.1111/j.1365-246X.2005.02756.x.
- Han, S.-C., Shum, C. K., Bevis, M., Ji, C. & Kuo, C.-Y., 2006. Crustal dilatation observed by GRACE after the 2004 Sumatra-Andaman earthquake, *Science*, **313**, 658–662, doi: 10.1126/science.1128661.
- Han, S.-C., Shum, C. K. & Jekeli, C., 2006. Precise estimation of in situ geopotential differences from GRACE low-low satellite-to-satellite tracking and accelerometer data, *J. Geophys. Res.*, **111**(B4), B04411, doi: 10.1029/2005JB003719.
- Han, S.-C., Rowlands, D. D., Luthcke, S. B. & Lemoine, F. G., 2008. Localized analysis of satellite tracking data for studying time-variable Earth's gravity fields, *J. Geophys. Res.*, **113**, B06401, doi: 10.1029/2007JB005218.
- Han, S.-C., Sauber, J., Luthcke, S. B., Ji, C. & Pollitz, F. F., 2008. Implications of postseismic gravity change following the great 2004 Sumatra-Andaman earthquake from the regional harmonic analysis of GRACE inter-satellite tracking data, *J. Geophys. Res.*, **113**, B11413, doi: 10.1029/2008JB005705.
- Han, S.-C., Mazarico, E. & Lemoine, F. G., 2009. Improved nearside gravity field of the Moon by localizing the power law constraint, *Geophys. Res. Lett.*, **36**, L11203, doi: 10.1029/2009GL038556.
- Han, S.-C., Riva, R., Sauber, J. & Okal, E., 2013. Source parameter inversion for recent great earthquakes from a decade-long observation of global gravity fields, *J. Geophys. Res.*, **118**, 1240–1267, doi: 10.1002/jgrb.50116.
- Hand, E., 2015. Ocean robots listen for earthquake echoes, *Science*, **349**(6252), 1033, doi: 10.1126/science.349.6252.1033.
- Hand, E., 2015. Mantle plumes seen rising from Earth's core, *Science*, **349**(6252), 1032–1033, doi: 10.1126/science.349.6252.1032.
- Hand, M. & Sandiford, M., 1999. Intraplate deformation in central Australia, the link between subsidence and fault reactivation, *Tectonophysics*, **305**, 121–140.

- Handcock, M. S. & Stein, M. L., 1993. A Bayesian analysis of kriging, *Technom.*, **35**(4), 403–410.
- Handcock, M. S. & Wallis, J. R., 1994. An approach to statistical spatial-temporal modeling of meteorological fields, *J. Acoust. Soc. Am.*, **89**(426), 368–378.
- Handler, M. R. & Bennett, V. C., 2001. Constraining continental structure by integrating Os isotopic ages of lithospheric mantle structure with geophysical and crustal data; An example from southeastern Australia, *Tectonics*, **20**(2), 177–188.
- Handler, M. R., Bennett, V. & Esat, T., 1997. The persistence of off-cratonic lithospheric mantle: Os isotopic systematics of variably metasomatised southeast Australian xenoliths, *Earth Planet. Sci. Lett.*, **151**(1–2), 61–75.
- Hanna, E., Huybrechts, P., Steffen, K., Cappelen, J., Huff, R., Shuman, C., Irvine-Fynn, T., Wise, S. & Griffiths, M., 2008. Increased runoff from melt from the Greenland Ice Sheet: a response to global warming, *J. Climate*, **21**(2), 331–341, doi: 10.1175/2007JCLI1964.1.
- Hanna, E., Navarro, F. J., Pattyn, F., Domingues, C. M., Fettweis, X., Ivins, E. R., Nicholls, R. J., Ritz, C., Smith, B., Tulaczyk, S., Whithouse, P. L. & Zwally, H. J., 2013. Ice-sheet mass balance and climate change, *Nature*, **498**(7452), 51–59, doi: 10.1038/nature12238.
- Hannan, E. J., 1996. Spectral analysis for geophysical data, *Geophys. J. Int.*, **11**(1–2), 225–236.
- Hannan, E. J. & Thomson, P. J., 1971. The estimation of coherence and group delay, *Biometrika*, **58**(3), 469–481.
- Hannan, E. J. & Thomson, P. J., 1973. Estimating group delay, *Biometrika*, **60**(2), 241–253.
- Hansen, E. W., 1985. Fast Hankel transform algorithm, *IEEE T. Acoust. Speech Signal Process.*, **33**(3), 666–671.
- Hansen, J., 2004. Defusing the global warming time bomb, *Sc. Am.*, pp. 68–77.
- Hansen, L. N., Zimmerman, M. E. & Kohlstedt, D. L., 2012. Laboratory measurements of the viscous anisotropy of olivine aggregates, *Nature*, **492**, 415–418, doi: 10.1038/nature11671.
- Hansen, P. C., 1992. Analysis of discrete ill-posed problems by means of the L-curve, *SIAM Rev.*, **34**(4), 561–580, doi: 10.1137/1034115.
- Hansen, P. C., 2000. The L-curve and its use in the numerical treatment of inverse problems, in *Computational Inverse Problems in Electrocardiology*, edited by P. Johnston, vol. 4 of **Advances in Computational Bioengineering**, WIT Press.
- Hansen, P. C., 2010. *Discrete inverse problems: insights and algorithms*, SIAM, Philadelphia, Penn.
- Hansen, T. M., Journal, A. G., Tarantola, A. & Mosegaard, K., 2006. Linear inverse Gaussian theory and geostatistics, *Geophysics*, **71**(6), R101–R111, doi: 10.1190/1.2345195.
- Hanssen, A., 1997. Multidimensional multitaper spectral estimation, *Signal Process.*, **58**, 327–332.

- Hanssen, A. & Scharf, L. L., 2003. A theory of polyspectra for nonstationary stochastic processes, *IEEE T. Signal Process.*, **51**(5), 1243–1252.
- Hara, T., 1997. Centroid moment tensor inversion of low-frequency seismic spectra using Green's functions for aspherical earth models, *Geophys. J. Int.*, **130**, 251–256.
- Hara, T. & Geller, R. J., 2000. Simultaneous waveform inversion for three-dimensional earth structure and earthquake source parameters considering a wide range of modal coupling, *Geophys. J. Int.*, **142**(2), 539–550.
- Hara, T., Tsuboi, S. & Geller, R. J., 1993. Inversion for laterally heterogeneous upper mantle *S*-wave velocity structure using iterative waveform inversion, *Geophys. J. Int.*, **115**, 667–698.
- Haralick, R. M., 1979. Statistical and structural approaches to texture, *Proc. IEEE*, **67**(5), 786–804.
- Harbrecht, H., Pereverzev, S. & Schnieder, R., 2003. Self-regularization by projection for noisy pseudodifferential equations of negative order, *Numer. Math.*, **95**(1), 123–143.
- Hardy, G. H., 1933. A theorem concerning Fourier transforms, *J. Lond. Math. Soc.*, **8**, 227–231.
- Harig, C. & Simons, F. J., 2012. Mapping Greenland's mass loss in space and time, *Proc. Natl. Acad. Sci.*, **109**(49), 19934–19937, doi: 10.1073/pnas.1206785109.
- Harig, C. & Simons, F. J., 2012. Mass loss over the Greenland ice sheet from GRACE: A reappraisal, *Geophys. Res. Abstr.*, **14**, 13039.
- Harig, C. & Simons, F. J., 2015. Accelerated West Antarctic ice mass loss continues to outpace East Antarctic gains, *Earth Planet. Sci. Lett.*, **415**, 134–141, doi: 10.1016/j.epsl.2015.01.029.
- Harig, C. & Simons, F. J., 2016. Ice mass loss in Greenland, the Gulf of Alaska, and the Canadian Archipelago: Seasonal cycles and decadal trends, *Geophys. Res. Lett.*, **43**(7), 3150–3159, doi: 10.1002/2016GL067759.
- Harig, C., Zhong, S. & Simons, F. J., 2010. Constraints on upper-mantle viscosity inferred from the flow-induced pressure gradient across a continental keel, *Geochem. Geophys. Geosys.*, **11**(6), Q06004, doi: 10.1029/2010GC003038.
- Harig, C., Lewis, K. W., Plattner, A. & Simons, F. J., 2015. A suite of software analyzes data on the sphere, *Eos Trans. AGU*, **96**(6), 18–22, doi: 10.1029/2015EO025851.
- Harnett, D. L. & Murphy, J. L., 1975. *Introductory statistical analysis*, Addison-Wesley, Reading, Mass.
- Harris, F. J., 1978. On the use of windows for harmonic analysis with the discrete Fourier transform, *Proc. IEEE*, **66**(1), 51–83.
- Harrison, C. G. A., 2000. Questions about magnetic lineations in the ancient crust of Mars, *Science*, **287**, 547a, doi: 10.1126/science.287.5453.547a.

- Harrison, C. G. A. & Bonatti, E., 1981, The oceanic lithosphere, in *The Sea*, vol. 7, pp. 21–48, John Wiley, New York.
- Harrison, K. P. & Grimm, R. E., 2002. Controls on Martian hydrothermal systems: Application to valley network and magnetic anomaly formation, *JGR*, **107**(E5), 5025, doi: 10.1029/2001JE001616.
- Hart, R. S., Anderson, D. L. & Kanamori, H., 1977. The effect of attenuation on gross earth models, *J. Geophys. Res.*, **82**, 1647–1654.
- Hashin, Z. & Shtrikman, S., 1962. A variational approach to the theory of the effective magnetic permeability of multiphase materials, *J. Appl. Phys.*, **33**(16), 3125–3131.
- Haskard, K. A., Cullis, B. R. & Verbyla, A. P., 2007. Anisotropic Matérn correlation and spatial prediction using REML, *J. Agri. Biol. Envir. Stat.*, **12**(2), 147–160, doi: 10.1198/108571107X196004.
- Haskell, N. A., 1953. The dispersion of surface waves on multilayered media, *B. Seismol. Soc. Am.*, **43**(1), 18–34.
- Hasselmann, K., 1963. A statistical analysis of the generation of microseisms, *Rev. Geophys.*, **1**(2), 177–210, doi: 10.1029/RG001i002p00177.
- Hastings, W. K., 1970. Monte Carlo sampling methods using Markov chains and their applications, *Biometrika*, **57**(1), 97–108.
- Hauksson, E. & Shearer, P., 2005. Southern California hypocenter relocation with waveform cross-correlation, Part 1: Results using the double-difference method, *B. Seismol. Soc. Am.*, **95**(3), 896–903, doi: 10.1785/0120040167.
- Haupt, J. & Nowak, R., 2012, Adaptive sensing for sparse recovery, in *Compressed Sensing: Theory and Applications*, edited by Y. C. Eldar & G. Kutyniok, chap. 6, pp. 269–304, Cambridge Univ. Press, Cambridge, UK.
- Hauri, E. H., 1996. Major-element variability in the Hawaiian mantle plume, *Nature*, **382**, 415–419.
- Hauser, M. G. & Peebles, P. J. E., 1973. Statistical analysis of catalogs of extragalactic objects. II. The Abell catalog of rich clusters, *Astroph. J.*, **185**, 757–785.
- Hawkesworth, C. J., Kempton, P. D., Rogers, N. W., Ellam, R. M. & van Calsteren, P. W., 1990. Continental mantle lithosphere, and shallow level enrichment processes in the Earth’s mantle, *Earth Planet. Sci. Lett.*, **96**, 256–268.
- Hay, C. C., Morrow, E., Kopp, R. E. & Mitrovica, J. X., 2013. Estimating the sources of global sea level rise with data assimilation techniques, *Proc. Natl. Acad. Sc.*, **110**(suppl. 1), 3692–3699, doi: 10.1073/pnas.1117683109.
- Haykin, S., ed., 1991. *Advances in Spectrum Analysis and Array Processing*, vol. 1, Prentice-Hall, Englewood Cliffs, N. J.

- Hays, J. D., Imbrie, J. & Shackleton, N. J., 1976. Variations in the earth's orbit: Pacemaker of the ice ages, *Science*, **194**(4270), 1121–1132.
- Head, J. W. & Pratt, S., 2001. Extensive Hesperian-aged south polar ice sheet on Mars: Evidence for massive melting and retreat, and lateral flow and ponding of meltwater, *J. Geophys. Res.*, **106**(E6), 12275–12299, doi: 10.1029/2000JE001359.
- Heagarty, P. J. & Zeger, S. L., 2000. Marginalized multilevel models and likelihood inference, *Statistical Science*, **15**, 1–19.
- Hedlin, M. A. H. & Shearer, P. M., 2000. An analysis of large-scale variations in small-scale mantle heterogeneity using Global Seismographic Network recordings of precursors to *PKP*, *J. Geophys. Res.*, **105**(B6), 13655–13673, doi: 10.1029/2000JB900019.
- Heidbach, O., Barth, A., Connolly, P., Fuchs, K., Müller, B., Tingay, M., Reinecker, J., Sperner, B. & Wenzel, F., 2004. Stress maps in a minute: The 2004 World Stress Map release, *Eos Trans. AGU*, **85**(49), 521.
- Heilbronner, R. & Barrett, S., 2014. *Image Analysis in Earth Sciences. Microstructures and Textures of Earth Materials*, Springer, New York, NY.
- Heiskanen, W. A. & Moritz, H., 1967. *Physical Geodesy*, Freeman, San Francisco, Calif.
- Helbig, K., 1996, Kelvin and the early history of seismic anisotropy, in *Seismic Anisotropy*, edited by E. Fjaer, R. M. Holt, & J. S. Rathore, pp. 15–36, Society of Exploration Geophysicists, Tulsa, OK.
- Helbig, K., 1996, Representation and approximation of elastic tensors, in *Seismic Anisotropy*, edited by E. Fjaer, R. M. Holt, & J. S. Rathore, pp. 37–75, Society of Exploration Geophysicists, Tulsa, OK.
- Held, S., 1992. *Pleistocene fauna and Holocene humans: A gazetteer of paleontological and early archaeological sites on Cyprus*, vol. 95 of **Studies in Mediterranean Archaeology**, Paul Åströms Förlag, Jonsered, Sweden.
- Helfrich, G., Wookey, J. & Bastow, I., 2013. *The Seismic Analysis Code. A Primer and User's Guide*, Cambridge Univ. Press, Cambridge, UK.
- Helfrich, G. R., 2000. Topography of the transition zone seismic discontinuities, *Rev. Geophys.*, **38**(1), 141–158, doi: 10.1029/1999RG000060.
- Helfrich, G. R. & Wood, B. J., 2001. The Earth's mantle, *Nature*, **412**(6846), 501–507, doi: 10.1038/35087500.
- Hello, Y. & Nolet, G., 2020, Floating seismographs (MERMAIDS), in *Encyclopedia of Solid Earth Geophysics*, edited by H. K. Gupta, Encyclopedia of Earth Sciences, pp. 1–6, doi: 10.1007/978-3-030-10475-7_248-1, Springer, New York.
- Hello, Y., Ogé, A., Sukhovich, A. & Nolet, G., 2011. Modern mermaids: New floats image the deep Earth, *Eos Trans. AGU*, **92**(40), 337–338, doi: 10.1029/2011EO400001.

- Helm, V., Humbert, A. & Miller, H., 2014. Elevation and elevation change of Greenland and Antarctica derived from CryoSat-2, *The Cryosphere*, **8**, 1539–1559, doi: 10.5194/tc-8-1539-2014.
- Hemingway, D. & Garrick-Bethell, I., 2012. Magnetic field direction and lunar swirl morphology: Insights from Airy and Reiner Gamma, *J. Geophys. Res.*, **117**, E10012, doi: 10.1029/2012JE004165.
- Hemmat, A. A., Dehghan, M. A. & Skopina, M., 2005. Ridge wavelets on the ball, *J. Approx. Theory*, **136**(2), 129–139.
- Herglotz, G., 1905. Über die elastizität der erde bei berücksichtigung ihrer variablen dichte, *Zeitschrift für Mathematik und Physik*, **52**, 275–299.
- Herman, F., Seward, D., Valla, P. G., Carter, A., Kohn, B., Willett, S. D. & Ehlers, T. A., 2013. Worldwide acceleration of mountain erosion under a cooling climate, *Nature*, **504**, 423–426, doi: 10.1038/nature12877.
- Herman, G. T., ed., 1979. *Image Reconstruction from Projections*, vol. 32 of **Topics in applied physics**, Springer, New York.
- Hernlund, J. W. & Houser, C., 2008. On the statistical distribution of seismic velocities in Earth's deep mantle, *Earth Planet. Sci. Lett.*, **265**(3–4), 423–437.
- Herrick, R. R., Stahlke, D. L. & Sharpton, V. L., 2012. Fine-scale Venusian topography from Magellan stereo data, *Eos Trans. AGU*, **93**(12), 125–126.
- Herring, T. A., 1996. The Global Positioning System, *Sc. Am.*, **274**(2), 44–50.
- Herring, T. A., 1998. Appreciate the gravity, *Nature*, **391**, 434–435.
- Herring, T. A., Melbourne, T. I., Murray, M. H., Floyd, M. A., Walter M. Szeliga, R. W. K., Phillips, D. A., Puskas, C. M., Santillan, M. & Wang, L., 2016. Plate Boundary Observatory and related networks: GPS data analysis methods and geodetic products, *Rev. Geophys.*, **54**, 759–808, doi: 10.1002/2016RG000529.
- Herrmann, F. J., 2001. Singularity characterization by monoscale analysis: Application to seismic imaging, *Appl. Comput. Harmon. Anal.*, **11**(1), 64–88.
- Herrmann, F. J. & Bernabé, Y., 2004. Seismic singularities at upper-mantle phase transitions: a site percolation model, *Geophys. J. Int.*, **159**(3), 949–960.
- Herrmann, F. J. & Hennenfent, G., 2008. Non-parametric seismic data recovery with curvelet frames, *Geophys. J. Int.*, **173**, 233–248, doi: 10.1111/j.1365-246X.2007.03698.x.
- Herrmann, F. J., Friedlander, M. P. & Yilmaz, Ö., 2012. Fighting the curse of dimensionality: Compressive sensing in exploration seismology, *IEEE Signal Process. Mag.*, **29**(3), 88–100, doi: 10.1109/MSP.2012.2185859.

- Herzberg, C., Condie, K. & Korenaga, J., 2010. Thermal history of the Earth and its petrological expression, *Earth Planet. Sci. Lett.*, **292**, 79–88, doi: 10.1016/j.epsl.2010.01.022.
- Herzfeld, U. & Zahner, O., 2001. A connectionist-geostatistical approach to automated image classification, applied to the analysis of crevasse patterns in surging ice, *Comput. Geosci.*, **27**, 499–512, doi: 10.1016/S0098–3004(00)00089–3.
- Herzfeld, U. C., 1992. Least-squares collocation, geophysical inverse theory and geostatistics: a bird's eye view, *Geophys. J. Int.*, **111**(2), 237–249, doi: 10.1111/j.1365–246X.1992.tb00573.x.
- Herzfeld, U. C. & Higginson, C. A., 1996. Automated geostatistical seafloor classification — Principles, parameters, feature vectors, and discrimination criteria, *Comput. Geosci.*, **22**(1), 35–52, doi: 10.1016/0098–3004(96)89522–7.
- Herzfeld, U. C. & Overbeck, C., 1999. Analysis and simulation of scale-dependent fractal surfaces with application to seafloor morphology, *Comput. Geosci.*, **25**(1), 979–1007, doi: 10.1016/S0098–3004(99)00062–X.
- Herzfeld, U. C., Kim, I. I. & Orcutt, J. A., 1995. Is the ocean floor a fractal?, *Math. Geol.*, **27**(3), 421–462, doi: 10.1007/BF02084611.
- Hess, H. H., 1964. Seismic anisotropy of the uppermost mantle under oceans, *Nature*, **203**(4945), 629–631, doi: 10.1038/203629a0.
- Hesse, K., Sloan, I. H. & Womersley, R. S., 2010. Numerical integration on the sphere, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 40, pp. 1187–1219, doi: 10.1007/978–3–642–01546–5_40, Springer, Heidelberg, Germany.
- Hestenes, M. R. & Stiefel, E., 1952. Methods of conjugate gradients for solving linear systems, *J. Res. Nat. Bur. Stand.*, **49**(6), 409–436.
- Heuser, H., 1975. *Funktionalanalysis*, Teubner Verlag, Stuttgart.
- Hey, R., Martinez, F., Höskuldsson, A. & Benediktsdóttir, A., 2010. Propagating rift model for the V-shaped ridges south of Iceland, *Geochem. Geophys. Geosys.*, **11**(3), Q03011, doi: 10.1029/2009GC002865.
- Higgins, W. E. & Munson, D. C., 1987. An algorithm for computing general integer-order Hankel transforms, *IEEE T. Acoust. Speech Signal Process.*, **35**(1), 86–97.
- Hilb, E., 1919. Über die Laplacesche Reihe, *Math. Z.*, **5**, 17.
- Hill, M. N., 1963. Single-ship seismic refraction shooting, in *The Sea*, vol. 3, pp. 39–46, John Wiley, New York.
- Hillis, R. R., Meyer, J. J. & Reynolds, S. D., 1998. The Australian stress map, *Explor. Geophys.*, **29**, 420–427.
- Hillis, R. R., Enever, J. R. & Reynolds, S. D., 1999. In situ stress field of eastern Australia, *Aust. J. Earth Sci.*, **46**, 813–825.

- Hingee, M. H., Tkalčić, H., Fichtner, A. & Sambridge, M., 2011. Moment tensor inversion using a 3-D structural model: Applications for the Australian region, *Geophys. J. Int.*, **184**(2), 949–964, doi: 10.1111/j.1365–246X.2010.04897.x.
- Hinkley, D. V., 1969. On the ratio of two correlated normal random variables, *Biometrika*, **56**(3), 635–639.
- Hinshaw, G., Spergel, D. N., Verde, L., Hill, R. S., Meyer, S. S., Barnes, C., Bennett, C. L., Halpern, M., Jarosik, N., Kogut, A., Komatsu, E., Limon, M., Page, L., Tucker, G. S., Weiland, J. L., Wollack, E. & Wright, E. L., 2003. First-year *Wilkinson Microwave Anisotropy Probe* (WMAP) observations: The angular power spectrum, *Astroph. J. Supp. Ser.*, **148**, 135–159.
- Hipkin, R. G., 2001. The statistics of pink noise on a sphere: applications to mantle density anomalies, *Geophys. J. Int.*, **144**, 259–270.
- Hirano, N., Takahashi, E., Yamamoto, J., Abe, N., Ingle, S. P., Kaneoka, I., Hirata, T., Kimura, J.-I., Ishii, T., Ogawa, Y., Machida, S. & Suyehiro, K., 2006. Volcanism in response to plate flexure, *Science*, **313**(5792), 1426–1428, doi: 10.1126/science.1128235.
- Hirata, K., Aoyagi, M., Mikada, H., Kawaguchi, K., Kaiho, Y., Iwase, R., Morita, S., Fujisawa, I., Sugioka, H., Mitsuzawa, K., Suyehiro, K., Kinoshita, H. & Fujiwara, N., 2002. Real-time geophysical measurements on the deep seafloor using submarine cable in the Southern Kurile subduction zone, *IEEE J. Ocean. Eng.*, **27**(2), 170–181, doi: 10.1109/JOE.2002.1002471.
- Hirose, K., 2002. Phase transitions in pyrolitic mantle around 670-km depth: Implications for upwelling of plumes from the lower mantle, *J. Geophys. Res.*, **107**(B4), 2078, doi: 10.1029/2001JB000597.
- Hirth, G. & Kohlstedt, D., 2003, Rheology of the upper mantle and the mantle wedge: A view from the experimentalists, in *Inside the Subduction Factory*, edited by J. Eiler, vol. 138, pp. 83–105, doi: 10.1029/138GM06, Amer. Geophys. Union, Washington, D. C.
- Hirth, G. & Kohlstedt, D. L., 1996. Water in the oceanic upper mantle: Implications for rheology, melt extraction and the evolution of the lithosphere, *Earth Planet. Sci. Lett.*, **144**(1–2), 93–108.
- Hitczenko, M. & Stein, M. L., 2012. Some theory for anisotropic processes on the sphere, *Stat. Method.*, **9**(1), 211–227, doi: 10.1038/371083a0.
- Hivon, E., Górski, K. M., Netterfield, C. B., Crill, B. P., Prunet, S. & Hansen, F., 2002. MASTER of the cosmic microwave background anisotropy power spectrum: A fast method for statistical analysis of large and complex cosmic microwave background data sets, *Astroph. J.*, **567**, 2–17.
- Hjörleifsdóttir, V., 2007, *Earthquake Source Characterization Using 3d Numerical Modeling*, Ph.D. thesis, California Institute of Technology, Pasadena, Calif.
- Hloupis, G. & Vallianatos, F., 2013. Wavelet-based rapid estimation of earthquake magnitude oriented to early warning, *IEEE Geosci. Remote Sens. Lett.*, **10**(1), 43–47.

- Ho-Liu, P., Montagner, J.-P. & Kanamori, H., 1989. Comparison of iterative back-projection inversion and generalized inversion without blocks: Case studies in attenuation tomography, *Geophys. J. Int.*, **97**, 19–29.
- Hobson, E. W., 1955. *The theory of spherical and ellipsoidal harmonics*, Chelsea Pub. Co, Chelsea, NY.
- Hobson, M. P. & Magueijo, J., 1996. Observability of secondary Doppler peaks in the cosmic microwave background radiation power spectrum by experiments with small fields, *Mon. Not. R. Astron. Soc.*, **283**, 1133–1146.
- Hodgkiss, W. S. & Anderson, V. C., 1983. Acoustic positioning for an array of freely drifting infrasonic sensors, *IEEE J. Ocean. Eng.*, **8**(3), 116–119.
- Hoerl, A. E. & Kennard, R. W., 1970. Ridge regression: Biased estimation for nonorthogonal problems, *Technom.*, **12**(1), 55–67.
- Hoerl, A. E. & Kennard, R. W., 1970. Ridge regression: Applications to nonorthogonal problems, *Technom.*, **12**(1), 69–82.
- Hoernle, K., Zhang, Y.-S. & Graham, D., 1995. Seismic and geochemical evidence for large-scale mantle upwelling beneath the eastern Atlantic and western and central Europe, *Nature*, **374**, 34–39.
- Hoffman, P. F., 1990. Geological constraints on the origin of the mantle root beneath the Canadian shield., *Phil. Trans. R. Soc. London, Ser. A*, **331**, 523–532.
- Hofmann, A. W., 1997. Mantle geochemistry: the message from oceanic volcanism, *Nature*, **385**(6613), 219–229, doi: 10.1038/385219a0.
- Hofmann-Wellenhof, B. & Moritz, H., 2006. *Physical Geodesy*, Springer, New York, 2nd edn.
- Hofmeister, A. M., 1999. Mantle values of thermal conductivity and the geotherm from phonon lifetimes, *Science*, **283**, 1699–1706.
- Hogan, J. A. & Lakey, J. D., 2012, Thomson's multitaper method and applications to channel modeling, in *Duration and bandwidth limiting: Prolate functions, sampling, and applications*, chap. 3, pp. 91–127, doi: 10.1007/978-0-8176-8307-8_3, Birkhäuser.
- Holcomb, L. G., 1989, A direct method for calculating instrument noise levels in side-by-side seismometer evaluations, Open-file report 89-214, U. S. Dept. Interior, Geological Survey.
- Hollerbach, R., 1996. On the theory of the geodynamo, *Phys. Earth Planet. Inter.*, **98**(3–4), 163–185, doi: 10.1016/S0031-9201(96)03185-8.
- Holme, R. & Bloxham, J., 1995. Alleviation of the Backus effect in geomagnetic field modelling, *Geophys. Res. Lett.*, **22**(13), 1641–1644.
- Holme, R. & Bloxham, J., 1996. The treatment of attitude errors in satellite geomagnetic data, *Phys. Earth Planet. Inter.*, **98**(3–4), 221–233.

- Holmes, S. A. & Featherstone, W. E., 2002. A unified approach to the Clenshaw summation and the recursive computation of very high degree and order normalised associated Legendre functions, *J. Geod.*, **76**, 279–299.
- Holschneider, M., Chambodut, A. & Mandeau, M., 2003. From global to regional analysis of the magnetic field on the sphere using wavelet frames, *Phys. Earth Planet. Inter.*, **135**, 107–124.
- Holschneider, M., Diallo, M. S., Kulesh, M., Ohrnberger, M., Lück, E. & Scherbaum, F., 2005. Characterization of dispersive surface waves using continuous wavelet transforms, *Geophys. J. Int.*, **163**(2), 463–478, doi: 10.1111/j.1365-246X.2005.02787.x.
- Holt, W. E., 2000. Correlated crust and mantle strain fields in Tibet, *Geology*, **28**(1), 67–70.
- Holtzman, B., Kohlstedt, D. L., Zimmerman, M. E., Heidelbach, F., Hiraga, T. & Hustoft, J., 2003. Melt segregation and strain partitioning: Implications for seismic anisotropy and mantle flow, *Science*, **301**, 1227–1230.
- Homeier, H. H. H. & Steinborn, E. O., 1996. Some properties of the coupling coefficients of real spherical harmonics and their relation to Gaunt coefficients, *J. Mol. Struct. (Theochem)*, **368**, 31–37.
- Honda, S., 1986. Strong anisotropic flow in a finely layered asthenosphere, *Geophys. Res. Lett.*, **13**(13), 1454–1457, doi: 10.1029/GL013i013p01454.
- Hood, L. L. & Zakharian, A., 2001. Mapping and modeling of magnetic anomalies in the northern polar region of Mars, *J. Geophys. Res.*, **106**(E7), 14601–14619, doi: 10.1029/2000JE001304.
- Hood, L. L., Young, C. N., Richmond, N. C. & Harrison, K. P., 2005. Modeling of major martian magnetic anomalies: Further evidence for polar reorientations during the Noachian, *Icarus*, **177**(1), 144–173, doi: 10.1016/j.icarus.2005.02.008.
- Hood, L. L., Richmond, N. C., Harrison, K. P. & Lillis, R. J., 2007. East–west trending magnetic anomalies in the Southern Hemisphere of Mars: Modeling analysis and interpretation, *Icarus*, **191**(1), 113–131, doi: 10.1016/j.icarus.2007.04.025.
- Hood, L. L., Harrison, K. P., Langlais, B., Lillis, R. J., Poulet, F. & Williams, D. A., 2010. Magnetic anomalies near Apollinaris Patera and the Medusae Fossae Formation in Lucus Planum, Mars, *Icarus*, **208**(1), 118–131, doi: 10.1016/j.icarus.2010.01.009.
- Hoogenboom, T. & Smrekar, S. E., 2006. Elastic thickness estimates for the northern lowlands of Mars, *ESPL*, **248**(3–4).
- Hoogenboom, T., Smrekar, S. E., Anderson, F. S. & Houseman, G., 2004. Admittance survey of type 1 coronae on Venus, *J. Geophys. Res.*, **109**, E03002, doi: 10.1029/2003JE002171.
- Hoogenboom, T., Houseman, G. & Martin, P., 2005. Elastic thickness estimates for coronae associated with chasmata on Venus, *J. Geophys. Res.*, **110**, E09003, doi: 10.1029/2004JE002394.

- Hoover, R. C., Maciejewski, A. A. & Roberts, R. G., 2008, Pose detection of 3-D objects using S^2 -correlated images and discrete spherical harmonic transforms, in *2008 IEEE International Conference on Robotics and Automation*, pp. 993–998, IEEE.
- Horbach, A., Bunge, H.-P. & Oeser, J., 2014. The adjoint method in geodynamics: derivation from a general operator formulation and application to the initial condition problem in a high resolution mantle circulation model, *Intern. J. Geomath.*, **5**(2), 163–194, doi: 10.1007/s13137-014-0061-5.
- Horn, R. A. & Johnson, C. R., 1990. *Matrix Analysis*, Cambridge Univ. Press, Cambridge, UK.
- Hornby, P., Boschetti, F. & Horowitz, F. G., 1999. Analysis of potential field data in the wavelet domain, *Geophys. J. Int.*, **137**(1), 175–196.
- Horwath, M. & Dietrich, R., 2009. Signal and error in mass change inferences from GRACE: the case of Antarctica, *Geophys. J. Int.*, **177**, 849–864, doi: 10.1111/j.1365-246X.2009.04139.x.
- Horwath, M., Legrésy, B., Rémy, F., Blarel, F. & Lemoine, J.-M., 2012. Consistent patterns of Antarctic ice sheet interannual variations from ENVISAT radar altimetry and GRACE satellite gravimetry, *Geophys. J. Int.*, **189**, 863–876, doi: 10.1111/j.1365-246X.2012.05401.x.
- Hosseini, K., Matthews, K. J., Sigloch, K., Shephard, G. E., Domeier, M. & Tsekhmistrenko, M., 2018. SubMachine: Web-based tools for exploring seismic tomography and other models of Earth’s deep interior, *Geochem. Geophys. Geosys.*, **19**(5), 1464–1483, doi: 10.1029/2018GC007431.
- Houseman, G. A. & Molnar, P., 1997. Gravitational (Rayleigh-Taylor) instability of a layer with nonlinear viscosity and convective thinning of continental lithosphere, *Geophys. J. Int.*, **128**, 125–150.
- Houseman, G. A., McKenzie, D. P. & Molnar, P., 1981. Convective instability of a thickened boundary-layer and its relevance for the thermal evolution of continental convergent belts, *J. Geophys. Res.*, **86**, 6115–6132.
- Houser, C., 2019. Earth’s rugged lower mantle, *Science*, **363**(6428), 696–697, doi: 10.1126/science.aaw4601.
- Houser, C. & Williams, Q., 2009. The relative wavelengths of fast and slow velocity anomalies in the lower mantle: Contrary to the expectations of dynamics?, *Phys. Earth Planet. Inter.*, **176**(3–04), 187–197.
- Houser, C., Masters, G., Shearer, P. & Laske, G., 2008. Shear and compressional velocity models of the mantle from cluster analysis of long-period waveforms, *Geophys. J. Int.*, **174**, 195–212, doi: 10.1111/j.1365-246X.2008.03763.x.
- Huang, C. L. & Liao, X. H., 2003. Comment on ‘representation of the elastic-gravitational excitation of a spherical Earth model by generalized spherical harmonics’ by Phinney & Burridge, *Geophys. J. Int.*, **155**(2), 669–678.

- Huang, H., Zhang, C., Ding, W., Zhu, X., Sun, G. & Wang, H., 2020. Design of the depth controller for a floating ocean seismograph, *J. Mar. Sci. Eng.*, **8**(3), 166, doi: 10.3390/jmse8030166.
- Huang, Y. & Schuster, G. T., 2018. Full-waveform inversion with multisource frequency selection of marine streamer data, *Geophys. Prospect.*, **66**(7), 1243–1257, doi: 10.1111/1365-2478.12588.
- Hubbard, B. B., 1998. *The world according to wavelets : the story of a mathematical technique in the making*, A. K. Peters, Wellesley, Mass.
- Huber, P. J., 1964. Robust estimation of a location parameter, *Ann. Math. Stat.*, **35**(1), 73–101.
- Huber, P. J., 1972. Robust statistics: A review, *Ann. Math. Stat.*, **43**(4), 1041–1067.
- Huber-Carol, C., Balakrishnan, N., Nikulin, M. S. & Mesbah, M., eds., 2002. *Goodness-of-fit tests and model validity*, Statistics for industry and technology, Birkhäuser, Boston, Mass.
- Hudson, J. A. & Heritage, J. R., 1981. The use of the Born approximation in seismic scattering problems, *Geophys. J. Int.*, **66**(1), 221–240, doi: 10.1111/j.1365-246X.1981.tb05954.x.
- Hudson, J. A. & Knopoff, L., 1967. Statistical properties of Rayleigh waves due to scattering by topography, *B. Seismol. Soc. Am.*, **57**(1), 83–90.
- Hughes, C. W., Tamisiea, M. E., Bingham, R. J. & Williams, J., 2012. Weighing the ocean: Using a single mooring to measure changes in the mass of the ocean, *Geophys. Res. Lett.*, **39**(17), L17602, doi: 10.1029/2012GL052935.
- Hulot, G., Eymin, C., Langlais, B., Manda, M. & Olsen, N., 2002. Small-scale structure of the geodynamo inferred from Oersted and Magsat satellite data, *Nature*, **416**, 620–623.
- Humler, E. & Besse, J., 2002. A correlation between mid-ocean-ridge basalt chemistry and distance to continents, *Nature*, **419**, 607–609.
- Humphreys, E. D. & Clayton, R. W., 1988. Adaptation of back projection tomography to seismic travel time problems, *J. Geophys. Res.*, **93**(B2), 1073–1085.
- Hung, S.-H., Dahlen, F. A. & Nolet, G., 2000. Fréchet kernels for finite-frequency traveltimes — II. Examples, *Geophys. J. Int.*, **141**(1), 175–203, doi: 10.1046/j.1365-246X.2000.00072.x.
- Hung, S.-H., Dahlen, F. A. & Nolet, G., 2001. Wavefront healing: a banana-doughnut perspective, *Geophys. J. Int.*, **146**, 289–312, doi: 10.1046/j.1365-246x.2001.01466.x.
- Hung, S.-H., Shen, Y. & Chiao, L.-Y., 2004. Imaging seismic velocity structure beneath the Iceland hot spot: A finite frequency approach, *J. Geophys. Res.*, **109**(B8), B08305, doi: 10.1029/2003JB002889.
- Hung, S.-H., Chen, W.-P., Chiao, L.-Y. & Tseng, T.-L., 2010. First multi-scale, finite-frequency tomography illuminates 3D anatomy of the Tibetan Plateau, *Geophys. Res. Lett.*, **37**, L06304, doi: 10.1029/2009GL041875.

- Huss, M., 2013. Density assumptions for converting geodetic glacier volume change to mass change, *The Cryosphere*, **7**(3), 877–887, doi: 10.5194/tc-7-877-2013.
- Hutko, A. R., Lay, T., Garnero, E. J. & Revenaugh, J., 2006. Seismic detection of folded, subducted lithosphere at the core-mantle boundary, *Nature*, **44**, 333–336.
- Huybrechts, P., 2002. Sea-level changes at the LGM from ice-dynamic reconstructions of the Greenland and Antarctic ice sheets during the glacial cycles, *Quat. Sci. Rev.*, **21**, 203–321, doi: 10.1016/S0277-3791(01)00082-8.
- Hwang, C., 1993. Spectral analysis using orthonormal functions with a case study on sea surface topography, *Geophys. J. Int.*, **115**, 1148–1160.
- Hwang, C. & Chen, S.-K., 1997. Fully normalized spherical cap harmonics: Application to the analysis of sea-level data from TOPEX/POSEIDON and ERS-1, *Geophys. J. Int.*, **129**, 450–460.
- Hyndman, R. D. & Wang, K., 1995. The rupture zone of Cascadia great earthquakes from current deformation and the thermal regime, *J. Geophys. Res.*, **100**(B11), 22133–22154.
- Hynek, B. M., Beach, M. & Hoke, M. R. T., 2010. Updated global map of Martian valley networks and implications for climate and hydrologic processes, *J. Geophys. Res.*, **115**(E9), E09008 doi: 10.1029/2009JE003548.
- Hynek, B. M., Robbins, S. J., Šrámek, O. & Zhong, S., 2011. Geological evidence for a migrating Tharsis plume on early Mars, *Earth Planet. Sci. Lett.*, **310**, 327–333, doi: 10.1016/j.epsl.2011.08.020.
- ichiro Karato, S., 1989, Defects and plastic deformation in olivine, in *Rheology of Solids and of the Earth*, edited by S. ichiro Karato & M. Toriumi, chap. 11, pp. 176–208, Oxford Univ. Press, Oxford, UK.
- ichiro Karato, S., 1995. Effects of water on seismic wave velocities in the upper mantle, *Proc. Japan Acad., Ser. B*, **71**(2), 61–66.
- Igel, H., Mora, P. & Rioulet, B., 1995. Anisotropic wave propagation through finite-difference grids, *Geophysics*, **60**, 1203–1216.
- III, R. P. I., Tanaka, K. L. & Robbins, S. J., 2013. Distribution of Early, Middle, and Late Noachian cratered surfaces in the Martian highlands: Implications for resurfacing events and processes, *J. Geophys. Res.*, **118**, 278–291, doi: 10.1002/jgre.20053.
- Ilk, K. H., 1983. Ein Beitrag zur Dynamik ausgedehnter Körper: Gravitationswechselwirkung, *Deutsche Geodätische Kommission*, **C**(288).
- Immerzeel, W. W., van Beek, L. P. H. & Bierkens, M. F. P., 2010. Climate change will affect the Asian water towers, *Science*, **328**(5984), 1382–1385, doi: 10.1126/science.1183188.
- Ince, D. C., Hatton, L. & Graham-Cumming, J., 2012. The case for open computer programs, *Nature*, **482**(7386), 485–488, doi: 10.1038/nature10836.

- International Seismological Centre, 2016, *On-line Bulletin*, Internatl. Seismol. Cent., Thatcham, UK, <http://www.isc.ac.uk>.
- Irving, J. C. E. & Deuss, A., 2011. Hemispherical structure in inner core velocity anisotropy, *J. Geophys. Res.*, **116**(B4), B04307, doi: 10.1029/2010JB007942.
- Irving, J. C. E. & Deuss, A., 2011. Stratified anisotropic structure at the top of Earth's inner core: A normal mode study, *Phys. Earth Planet. Inter.*, **186**(1–2), 59–69, doi: 10.1016/j.pepi.2011.03.003.
- Irving, J. C. E., Cottaar, S., Lekić, V. & Wu, W., 2017. Normal mode derived models of the physical properties of Earth's outer core, *Eos Trans. AGU*, pp. Fall Meet. Suppl., Abstract DI31B–04.
- Irving, J. C. E., Cottaar, S. & Lekić, V., 2018. Seismically determined elastic parameters for Earth's outer core, *Science Adv.*, **4**(6), eaar2538, doi: 10.1126/sciadv.aar2538.
- Isaak, D. G., Cohen, R. E. & Mehl, M. J., 1990. Calculated elastic and thermal properties of MgO at high pressures and temperatures, *J. Geophys. Res.*, **95**(B5), 7055–7067.
- Ishii, M. & Tromp, J., 1999. Normal-mode and free-air gravity constraints on lateral variations in velocity and density of Earth's mantle, *Science*, **285**, 1231–1236.
- Isse, T., Shiobara, H., Fukao, Y., Mochizuki, K., Kanazawa, T., Sugioka, H., Kodaira, S., Hino, R. & Suetsugu, D., 2004. Rayleigh wave phase velocity measurements across the Philippine sea from a broad-band OBS array, *Geophys. J. Int.*, **158**(1), 257–266, doi: 10.1111/j.1365–246X.2004.02322.x.
- Isserlis, L., 1916. On certain probable errors and correlation coefficients of multiple frequency distributions with skew regression, *Biometrika*, **11**(3), 185–190.
- Isserlis, L., 1918. On a formula for the product-moment coefficient of any order of a normal frequency distribution in any number of variables, *Biometrika*, **12**(1–2), 134–139.
- Ita, J. & Stixrude, L., 1992. Petrology, elasticity, and composition of the mantle transition zone, *J. Geophys. Res.*, **97**(B5), 6849–6866, doi: 10.1029/92JB00068.
- Ito, E., Akaogi, M., Topor, L. & Navrotsky, A., 1990. Negative pressure-temperature slopes for reactions forming MgSiO_3 perovskite from calorimetry, *Science*, **249**(4974), 1275–1278, doi: 10.1126/science.249.4974.1275.
- Ito, G. & Lin, J., 1995. Mantle temperature anomalies along the present and paleoaxes of the galápagos spreading center as inferred from gravity analyses, *J. Geophys. Res.*, **100**(B3), 3733–3745.
- Ito, G. & Taira, A., 2000. Compensation of the Ontong Java Plateau by surface and subsurface loading, *J. Geophys. Res.*, **105**(B5), 11171–11183.
- Ivanic, J. & Ruedenberg, K., 1996. Rotation matrices for real spherical harmonics. Direct determination by recursion, *J. Phys. Chem. A*, **100**(15), 6342–6347.

- Ivanic, J. & Ruedenberg, K., 1998. Correction: Rotation matrices for real spherical harmonics. Direct determination by recursion, *J. Phys. Chem. A*, **102**(45), 9099–9100.
- Ivanov, J., Miller, R. D., Xia, J., Steeples, D. & Park, C. B., 2006. Joint analysis of refractions with surface waves: An inverse solution to the refraction-traveltime problem, *Geophysics*, **71**(6), R131–R138, doi: 10.1190/1.2360226.
- Ivanov, M. A. & Head, J. W., 2011. Global geological map of Venus, *Planet. Space Sci.*, **59**(13), 1559–1600, doi: 10.1016/j.pss.2011.07.008.
- Ivins, E. R., James, T. S., Wahr, J., Schrama, E. J. O., Landerer, F. W. & Simon, K. M., 2013. Antarctic contribution to sea level rise observed by GRACE with improved GIA correction, *J. Geophys. Res.*, **118**, 3126–3141, doi: 10.1002/jgrb.50208.
- Jackson, A., Jonkers, A. R. T. & Walker, M. R., 2000. Four centuries of geomagnetic secular variation from historical records, *Phil. Trans. R. Soc. London, Ser. A*, **358**(1768), 957–990, doi: 10.1098/rsta.2000.0569.
- Jackson, D. D., 1979. The use of a priori data to resolve non-uniqueness in linear inversion, *Geophys. J. R. Astron. Soc.*, **57**, 137–157.
- Jackson, I., ed., 1998. *The Earth's mantle, Composition, structure, and evolution*, Cambridge Univ. Press.
- Jackson, J., 2002. Strength of the continental lithosphere, *GSA Today*, **12**(9), 4–10.
- Jackson, J., McKenzie, D., Priestley, K. & Emmerson, B., 2008. New views on the structure and rheology of the lithosphere, *J. Geol. Soc.*, **165**, 453–465.
- Jackson, J. D., 1962. *Classical electrodynamics*, John Wiley, New York.
- Jackson, J. I., Meyer, C. H., Nishimura, D. G. & Macovski, A., 1991. Selection of a convolution function for Fourier inversion using gridding, *IEEE T. Med. Imag.*, **10**(3), 473–478.
- Jacob, D. E., Viljoen, K. S., Grassineau, N. & Jagoutz, E., 2000. Remobilization in the cratonic lithosphere recorded in polycrystalline diamond, *Science*, **289**, 1182–1185.
- Jacob, K. H., 1970. Three-dimensional seismic ray tracing in a laterally heterogeneous spherical Earth, *J. Geophys. Res.*, **75**(32), 6675–6689.
- Jacob, R. W. & Hermance, J. F., 2004. Assessing the precision of GPR velocity and vertical two-way travel time estimates, *J. Environ. Eng. Geophys.*, **9**(3), 143–153.
- Jacob, T., Wahr, J., Pfeffer, W. T. & Swenson, S., 2012. Recent contributions of glaciers and ice caps to sea level rise, *Nature*, **482**(7386), 514–518, doi: 10.1038/nature10847.
- Jacobsen, S. B., 2003. How old is planet Earth?, *Science*, **300**, 1513–1514.
- Jaffe, A. H., Bond, J. R., Ferreira, P. G. & Knox, L. E., 1999, CMB likelihood functions for beginners and experts, in *3 K Cosmology: EC-TMR Conference*, edited by L. Maiani, F. Melchiorri, & N. Vittorio, pp. 249–265, Amer. Inst. Phys.

- Jahn, K. & Bokor, N., 2012. Vector Slepian basis functions with optimal energy concentration in high numerical aperture focusing, *Optics Comm.*, **285**, 2028–2038, doi: 10.1016/j.optcom.2011.11.107.
- Jahn, K. & Bokor, N., 2013. Solving the inverse problem of high numerical aperture focusing using vector Slepian harmonics and vector Slepian multipole fields, *Optics Comm.*, **288**, 13–16, doi: 10.1016/j.optcom.2012.09.051.
- Jahn, K. & Bokor, N., 2014. Revisiting the concentration problem of vector fields within a spherical cap: A commuting differential operator solution, *J. Fourier Anal. Appl.*, **288**(2), 421–451.
- Jain, S., Papadakis, M., Upadhyay, S. & Azencott, R., 2012. Rigid motion invariant classification of 3-D textures, *IEEE T. Image Proc.*, **21**(5), 2449–2463, doi: 10.1109/TIP.2012.2185939.
- Jakob-Chien, R. & Alpert, B. K., 1997. A fast spherical filter with uniform resolution, *J. Comput. Phys.*, **136**(2), 580–584.
- James, D., 2002. How old roots lose their bounce, *Nature*, **417**(6892), 911–912.
- James, D. E., Fouch, M. J., VanDecar, J. C., van der Lee, S. & Kaapvaal Seismic Group, 2001. Tectospheric structure beneath southern Africa, *Geophys. Res. Lett.*, **28**(13), 2485–2488.
- James, P. B., Zuber, M. T. & Phillips, R. J., 2013. Crustal thickness and support of topography on Venus, *J. Geophys. Res.*, **118**, 859–875, doi: 10.1029/2012JE004237.
- Jamet, G., Guennou, C., Guillon, L., Mazoyer, C. & Royer, J.-Y., 2013. *T*-wave generation and propagation: A comparison between data and spectral element modeling, *J. Acoust. Soc. Am.*, **134**(4), 3376–3385, doi: 10.1121/1.4818902.
- Janiszewski, H. A. & Abers, G. A., 2015. Imaging the plate interface in the Cascadia seismogenic zone: New constraints from offshore receiver functions, *Seismol. Res. Lett.*, **86**(5), 1261–1269, doi: 10.1785/0220150104.
- Jaupart, C. & Mareschal, J.-C., 1999. Thermal structure and thickness of continental roots, *Lithos*, **48**(1–4), 93–114.
- Jaupart, C., Mareschal, J.-C., Guillou-Frottier, L. & Davaille, A., 1998. Heat flow and thickness of the lithosphere in the Canadian Shield, *J. Geophys. Res.*, **103**(B7), 15269–15286.
- Jawerth, B. & Sweldens, W., 1994. An overview of wavelet-based multiresolution analyses, *SIAM Rev.*, **36**(3), 377–412.
- Jeanloz, R. & Morris, S., 1987. Is the mantle geotherm subadiabatic?, *Geophys. Res. Lett.*, **14**(4), 335–338.
- Jeanloz, R. & Richter, F. M., 1979. Convection, composition, and the thermal state of the lower mantle, *J. Geophys. Res.*, **84**(B10), 5479–5504.
- Jeans, J., 1923. The propagation of earthquake waves, *Proc. R. Soc. London, Ser. A*, **102**(718), 554–574.

- Jech, J. & Psencik, I., 1989. First-order perturbation method for anisotropic media, *Geophys. J. Int.*, **99**, 369–376.
- Jeddi, Z., Voss, P. H., Sørensen, M. B., Danielsen, F., Dahl-Jensen, T., Larsen, T. B., Nielsen, G., Hansen, A., Jakobsen, P. & Frederiksen, P. O., 2020. Citizen seismology in the Arctic, *Front. Earth Sci.*, **8**, 139, doi: 10.3389/feart.2020.00139.
- Jeffreys, H., 1926. On the nature of isostasy, *Gerlands Beitrage zur Geophysik*, **15**(2), 167–186.
- Jeffreys, H., 1961. Small corrections in the theory of surface waves, *Geophys. J. R. Astron. Soc.*, **6**, 115–117.
- Jeffreys, H. & Jeffreys, B. S., 1988. *Methods of Mathematical Physics*, Cambridge Univ. Press, Cambridge, UK, 3rd edn.
- Jekeli, C., 1996. Spherical harmonic analysis, aliasing, and filtering, *J. Geod.*, **70**(4), 214–223.
- Jekeli, C., 1999. The determination of gravitational potential differences from satellite-to-satellite tracking, *Celestial Mechanics and Dynamical Astronomy*, **75**, 85–101.
- Jekeli, C., 2007. Potential theory and static gravity field of the Earth, in *Treatise on Geophysics*, edited by T. A. Herring, vol. 3, pp. 11–42, doi: 10.1016/B978-044452748-6.00054-7, Elsevier, Amsterdam, Neth.
- Jekeli, C., Lee, J. K. & Kwon, J. H., 2007. On the computation and approximation of ultra-high-degree spherical harmonic series, *J. Geod.*, **81**, 603–615, doi: 10.1007/s00190-006-0123-z.
- Jekeli, C., Yang, H. J. & Ahlgren, K., 2013. Using isostatic gravity anomalies from spherical harmonic models and elastic plate compensation to interpret the lithosphere of the Bolivian Andes, *Geophysics*, **78**(3), G41–G53, doi: 10.1190/GEO2012-0378.1.
- Jellinek, A. M., Lenardic, A. & Manga, M., 2002. The influence of interior mantle temperature on the structure of plumes: Heads for Venus, Tails for the Earth, *Geophys. Res. Lett.*, **29**(11), 1532, doi: 10.1029/2001GL014624.
- Jellinek, A. M., Gonnermann, H. M. & Richards, M. A., 2003. Plume capture by divergent plate motions: implications for the distribution of hotspots, geochemistry of mid-ocean ridge basalts, and estimates of the heat flux at the core-mantle boundary, *Earth Planet. Sci. Lett.*, **205**, 361–378.
- Jenkins, J., Cottaar, S., White, R. S. & Deuss, A., 2016. Depressed mantle discontinuities beneath Iceland: Evidence of a garnet controlled 660 km discontinuity?, *Earth Planet. Sci. Lett.*, **433**, 159–168, doi: 10.1016/j.epsl.2015.10.053.
- Jenkins, J., Deuss, A. & Cottaar, S., 2017. Converted phases from sharp 1000 km depth mid-mantle heterogeneity beneath Western Europe, *Earth Planet. Sci. Lett.*, **459**, 196–207, doi: 10.1016/j.epsl.2016.11.031.
- Jensen, A. & la Cour-Harbo, A., 2001. *Ripples in Mathematics*, Springer, Berlin, Germany.

- Jeong, J. & Williams, W. J., 1992. Alias-free generalized discrete-time time-frequency distributions, *IEEE T. Signal Process.*, **40**(11), 2757–2765, doi: 10.1109/78.165662.
- Ji, S., Rondenay, S., Mareschal, M. & Sénéchal, G., 1996. Obliquity between seismic and electrical anisotropies as a potential indicator of movement sense for ductile shear zones in the upper mantle, *Geology*, **24**(11), 1033–1036.
- jia Su, W., Woodward, R. L. & Dziewoński, A. M., 1992. Deep origin of mid-ocean-ridge seismic velocity anomalies, *Nature*, **360**, 149–152, doi: 10.1038/360149a0.
- Jiménez-Díaz, A., Ruiz, J., Kirby, J. F., Romeo, I., Tejero, R. & Capote, R., 2015. Lithospheric structure of Venus from gravity and topography, *Icarus*, **260**, 215–231.
- Johnsen, S. & Lohmann, K. J., 2008. Magnetoreception in animals, *Physics Today*, **61**(3), 29–35.
- Johnson, C. E. & Richter, F. M., 1979. Stereoviews of seismicity associated with subduction zones, *J. Geol.*, **87**(5), 467–474.
- Johnson, C. L. & Phillips, R. J., 2005. Evolution of the Tharsis region of Mars: insights from magnetic field observations, *Earth Planet. Sci. Lett.*, **230**, 241–254, doi: 10.1016/j.epsl.2004.10.038.
- Johnson, G. C., Lyman, J. M. & Purkey, S. G., 2015. Informing Deep Argo array design using Argo and full-depth hydrographic section data, *J. Atmos. Ocean Tech.*, **32**, 2187–2198, doi: 10.1175/JTECH-D-15-0139.1.
- Johnson, J. S., Bentley, M. J., Smith, J. A., Finkel, R. C., Rood, D. H., Gohl, K., Balco, G., Larter, R. D. & Schaefer, J. M., 2014. Rapid thinning of Pine Island Glacier in the Early Holocene, *Science*, **343**(6174), 999–1001, doi: 10.1126/science.1247385.
- Johnson, N. L. & Kotz, S., 1973. *Continuous Univariate Distributions*, vol. 2, John Wiley, New York.
- Johnson, R. H., Northrop, J. & Eppley, R., 1963. Sources of Pacific *T* phases, *J. Geophys. Res.*, **68**(14), 4251–4260, doi: 10.1029/JZ068i014p04251.
- Johnson, R. W., ed., 1989. *Intraplate Volcanism in Eastern Australia and New Zealand*, Cambridge Univ. Press, New York.
- Johnson, T. V., 2005. Geology of the icy satellites, *Space Sci. Rev.*, **116**, 401–420, doi: 10.1007/s11214-005-1963-1.
- Johnstone, I. M. & Silverman, B. W., 1997. Wavelet threshold estimators for data with correlated noise, *J. R. Stat. Soc., Ser. B*, **59**(2), 319–351.
- Jol, H. M., 2009. *Ground Penetrating Radar Theory and Applications*, Elsevier, Amsterdam, Neth., 1st edn.
- Jones, C. H., 2003. How faults accommodate plate motion, *Science*, **300**, 1105–1106.

- Jones, N., 2014. Global seismic network takes to the seas, *Nature*, **507**(7491), 151, doi: 10.1038/507151a.
- Jones, R. H., 1963. Stochastic processes on a sphere, *Ann. Math. Stat.*, **34**(1), 213–218.
- Joos, F., Plattner, G.-K., Stocker, T. F., Körtzinger, A. & Wallace., D. W. R., 2003. Trends in marine dissolved oxygen: Implications for ocean circulation changes and the carbon budget, *Eos Trans. AGU*, **84**, 197–204.
- Jordan, T. H., 1975. Lateral heterogeneity and mantle dynamics, *Nature*, **257**, 745–750.
- Jordan, T. H., 1975. The continental tectosphere, *Rev. Geophys. Space Phys.*, **13**(3), 1–12.
- Jordan, T. H., 1978. Composition and development of the continental tectosphere, *Nature*, **274**, 544–548.
- Jordan, T. H., 1979, Mineralogies, densities and seismic velocities of garnet lherzolites and their geophysical implications, in *The mantle sample: Inclusions in kimberlites and other volcanics*, edited by F. R. Boyd & H. O. A. Meyer, vol. 2 of **Proc. Second Int. Kimberlite Conf.**, pp. 1–14, Amer. Geophys. Union, Washington, D. C.
- Jordan, T. H., 1979. Structural geology of the Earth's interior, *Proc. Natl. Acad. Sc.*, **76**(9), 4192–4200.
- Jordan, T. H., 1980, Earth structure from seismological observations, in *Physics of the Earth's Interior*, edited by A. M. Dziewoński & E. Boschi, vol. 78 of **Proceedings of the International School of Physics "Enrico Fermi"; Course LXXVIII**, pp. 1–40, Tipografia Compositori, Bologna, Varenna, Italy.
- Jordan, T. H., 1981. Continents as a chemical boundary layer, *Phil. Trans. R. Soc. London, Ser. A*, **301**, 359–373.
- Jordan, T. H., 1981. Global tectonic regionalization for seismological data analysis, *B. Seismol. Soc. Am.*, **71**(4), 1131–1141.
- Jordan, T. H., 1988. Structure and formation of the continental tectosphere, *J. Petrol.*, **Spec. Lithosphere Iss.**, 11–37.
- Jordan, T. H. & Franklin, J. N., 1971. Optimal solutions to a linear inverse problem in geophysics, *Proc. Natl. Acad. Sc.*, **68**(2), 291–293.
- Jordan, T. H. & Minster, J.-B., 1972, Application of a stochastic inverse to the geophysical inverse problem, in *Mathematics of Profile Inversion*, edited by L. Colin, no. X-62150 in NASA Tech. Mem., pp. 736–747, NASA Ames Research Center, Moffett Field, Calif.
- Jordan, T. H., Puster, P., Glatzmaier, G. A. & Tackley, P. J., 1993. Comparisons between seismic Earth structures and mantle flow models based on radial correlation functions, *Science*, **261**(5127), 1427–1431.

- Jost, M. L. & Herrmann, R. B., 1989. A student's guide to and review of moment tensors, *Seismol. Res. Lett.*, **60**(2), 37–57, doi: 10.1785/gssrl.60.2.37.
- Joswig, M., 1990. Pattern recognition for earthquake detection, *B. Seismol. Soc. Am.*, **80**(1), 170–186.
- Joubert, C., Nolet, G., Sukhovich, A., Ogé, A., Argentino, J.-F. & Hello, Y., 2015. Hydrophone calibration at very low frequencies, *B. Seismol. Soc. Am.*, **105**(3), 1797–1802, doi: 10.1785/0120140265.
- Joubert, C., Nolet, G., Bonnieux, S., Deschamps, A., Dessa, J.-X. & Hello, Y., 2016. *P*-delays from floating seismometers (MERMAID), Part I: Data processing, *Seismol. Res. Lett.*, **87**(1), 73–80, doi: 10.1785/0220150111.
- Joughin, I. & Tulaczyk, S., 2002. Positive mass balance of the Ross Ice Streams, West Antarctica, *Science*, **295**(5554), 476–480, doi: 10.1126/science.1066875.
- Joughin, I., Smith, B. E. & Medley, B., 2014. Marine ice sheet collapse potentially under way for the Thwaites Glacier Basin, West Antarctica, *Science*, **344**(6185), 735–738, doi: 10.1126/science.1249055.
- Journel, A. G. & Huijbregts, C. J., 1978. *Mining Geostatistics*, Academic Press, San Diego, Calif.
- Jr, C. W. W. & Richards, M. A., 1993. A detailed map of the 660-kilometer discontinuity beneath the Izu-Bonin subduction zone, *Science*, **261**, 1424–1427.
- Juang, P., Oki, H., Wang, Y., Martonosoi, M., Peh, L.-S. & Rubenstein, D., 2002, Energy-efficient computing for wildlife tracking: Design tradeoffs and early experiences with ZebraNet, in *APSLOS-X*, San Jose.
- Judd, J. S., Charléty, J., Nolet, G., Simons, F. J., Daubechies, I., Vetter, P., Voronin, S., Vonesch, C. & Loris, I., 2010. The computation of finite-frequency kernels without the paraxial approximation, *Geophys. Res. Abstr.*, **12**, 10888.
- Judenherc, S., Granet, M. & Boumbar, N., 1999. Two-dimensional anisotropic tomography of lithosphere beneath France using regional arrival times, *J. Geophys. Res.*, **104**(B6), 13201–13215.
- Julian, B., 2002. Seismological detection of slab metamorphism, *Science*, **296**, 1625–1626.
- Julian, B. R. & Anderson, D. L., 1968. Travel times, apparent velocities and amplitudes of body waves, *B. Seismol. Soc. Am.*, **58**(1), 339–366.
- Jung, H. & Karato, S., 2001. Water-induced fabric transitions in olivine, *Science*, **293**(5534), 1460–1463.
- Jungman, G., Kamionkowski, M., Kosowsky, A. & Spergel, D. N., 1996. Cosmological-parameter determination with microwave background maps, *Phys. Rev. D*, **54**(2), 1332–1344, doi: 10.1103/PhysRevD.54.1332.

- Kääb, A., Berthier, E., Nuth, C., Gardelle, J. & Arnaud, Y., 2012. Contrasting patterns of early twenty-first-century glacier mass change in the Himalayas, *Nature*, **488**(7412), 495–498, doi: 10.1038/nature11324.
- Kafka, A. L., Schlesinger-Miller, E. A. & Barstow, N. L., 1985. Earthquake activity in the greater New York City area: magnitudes, seismicity, and geologic structures, *B. Seismol. Soc. Am.*, **75**(5), 1285–1300, doi: 10.1785/BSSA0750051285.
- Kafka, A. L., Winslow, M. A. & Barstow, N. L., 1989, Earthquake activity in the greater new york city area: A fault finder's guide, in *Field Trip Guidebook, 61st Annual Meeting, New York State Geological Association*, pp. 177–205.
- Kagan, Y. Y., 1991. 3-D rotation of double-couple earthquake sources, *Geophys. J. Int.*, **106**, 709–716.
- Kagan, Y. Y., 2003. Accuracy of modern global earthquake catalogs, *Phys. Earth Planet. Inter.*, **135**(2–3), 173–209, doi: 10.1016/S0031-9201(02)00214-5.
- Kaipio, J. & Somersalo, E., 2007. Statistical inverse problems: discretization, model reduction and inverse crimes, *J. Comput. Appl. Math.*, **198**(2), 493–504, doi: 10.1016/j.cam.2005.09.027.
- Kaipio, J. P. & Somersalo, E., 2005. *Statistical and computational inverse problems*, vol. 160 of **Applied Mathematical Sciences**, Springer, New York.
- Kakarala, R. & Mao, D., 2010, A theory of phase-sensitive rotation invariance with spherical harmonic and moment-based representations, in *IEEE CVPR 2006 Conference on Computer Vision and Pattern Recognition*, pp. 105–112, IEEE.
- Kalkan, E., 2016. An automatic *p*-phase arrival-time picker, *B. Seismol. Soc. Am.*, **106**(3), 971–986, doi: 10.1785/0120150111.
- Kalnins, L., Simons, F. J., Kirby, J., Wang, D. & Olhede, S., 2015. Flexural anisotropy in the continental lithosphere: How robust are our estimates?, *Geophys. Res. Abstr.*, **17**, 11023.
- Kalnins, L. M. & Watts, A. B., 2009. Spatial variations in effective elastic thickness in the Western Pacific Ocean and their implications for Mesozoic volcanism, *Earth Planet. Sci. Lett.*, **286**(1–2), 89–100, doi: 10.1016/j.epsl.2009.06.018.
- Kalnins, L. M., Simons, F. J., Kirby, J. F., Wang, D. V. & Olhede, S. C., 2015. On the robustness of estimates of mechanical anisotropy in the continental lithosphere: A North American case study and global reanalysis, *Earth Planet. Sci. Lett.*, **419**, 43–51, doi: 10.1016/j.epsl.2015.02.041.
- Kaminski, É., 2002. The influence of water on the development of lattice preferred orientation in olivine aggregates, *Geophys. Res. Lett.*, **29**(12), 1576, doi: 10.1029/2002GL014710.
- Kaminski, É. & Ribe, N. M., 2001. A kinematic model for recrystallization and texture development in olivine polycrystals, *Earth Planet. Sci. Lett.*, **189**(3–4), 253–267.
- Kaminski, É. & Ribe, N. M., 2002. Timescales for the evolution of seismic anisotropy in mantle flow, *Geochem. Geophys. Geosys.*, **3**(8), 1051, doi: 10.1029/2001GC000222.

- Kamionkowski, M., Kosowsky, A. & Stebbins, A., 1997. Statistics of Cosmic Microwave Background polarization, *Phys. Rev. D*, **55**(12), 7368–7388.
- Kammann, P., 2005, *Modelling seismic wave propagation using time-dependent Cauchy-Navier splines*, Diploma thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern.
- Kammann, P. & Michel, V., 2006. Time-dependent Cauchy-Navier splines and their application to seismic wave front propagation, *Schriften zur Funktionalanalysis und Geomathematik*, **26**.
- Kammann, P. & Michel, V., 2008. Time-dependent Cauchy-Navier splines and their application to seismic wave front propagation, *Z. Angew. Math. Mech.*, **88**(3), 155–178, doi: 10.1002/zamm.200610362.
- Kanamori, H., 1976. Re-examination of the earth's free oscillations excited by the Kamchatka earthquake of November 4, 1952, *Phys. Earth Planet. Inter.*, **11**, 216–226.
- Kanamori, H., 2004. The diversity of the physics of earthquakes, *Proc. Jpn. Acad., Ser. B*, **80**(8), 297–316.
- Kanamori, H., 2005. Real-time seismology and earthquake damage mitigation, *Annu. Rev. Earth Planet. Sc.*, **33**, 195–214, doi: 10.1146/annurev.earth.33.092203.122626.
- Kanamori, H. & Anderson, D. L., 1975. Theoretical basis of some empirical relations in seismology, *B. Seismol. Soc. Am.*, **65**(5), 1073–1095.
- Kanamori, H. & Anderson, D. L., 1975. Amplitude of the earth's free oscillations and long-period characteristics of the earthquake source, *J. Geophys. Res.*, **80**(8), 1075–1078.
- Kanamori, H. & Anderson, D. L., 1977. Importance of physical dispersion in surface wave and free oscillation problems: Review, *Rev. Geophys. Space Phys.*, **15**(1), 105–112.
- Kane, M. F. & Pakiser, L. C., 1961. Geophysical study of subsurface structure in southern Owens Valley, California, *Geophysics*, **26**(1), 12–26, doi: 10.1190/1.1438835.
- Kang, S., Xu, Y., You, Q., Flügel, W.-A., Pepin, N. & Yao, T., 2010. Review of climate and cryospheric changes in the Tibetan Plateau, *Environ. Res. Lett.*, **5**(1), 015101, doi: 10.1088/1748-9326/5/1/015101.
- Kanwal, R. P., 1971. *Linear Integral Equations; Theory and Technique*, Academic Press, New York.
- Karamzadeh, N., Javan, D. G. & Reza, A. M., 2011. Automatic earthquake signal onset picking based on the continuous wavelet transform, *IEEE T. Geosci. Remote*, **51**(5), 2666–2674, doi: 10.1109/TGRS.2012.2213824.
- Karaoğlu, H. & Romanowicz, B., 2018. Inferring global upper-mantle shear attenuation structure by waveform tomography using the spectral element method, *Geophys. J. Int.*, **213**(3), 1536–1558, doi: 10.1093/gji/ggy030.

- Kárason, H. & van der Hilst, R. D., 2000, Constraints on mantle convection from seismic tomography, in *The History and Dynamics of Global Plate Motions*, edited by M. A. Richards, R. G. Gordon, & R. D. van der Hilst, vol. 121 of **Geophysical Monograph**, pp. 277–288, Amer. Geophys. Union, Washington, D. C.
- Karato, S., 1992. On the Lehmann discontinuity, *Geophys. Res. Lett.*, **22**, 2255–2258.
- Karato, S., 1993. Importance of anelasticity in the interpretation of seismic tomography, *Geophys. Res. Lett.*, **20**(15), 1623–1626.
- Karato, S. & Spetzler, H. A., 1990. Defect microdynamics in minerals and solid-state mechanisms of seismic wave attenuation and velocity dispersion in the mantle, *Rev. Geophys.*, **28**(4), 399–421.
- Karato, S. & Wu, P., 1993. Rheology of the upper mantle: A synthesis, *Science*, **260**, 771–778.
- Karato, S., Zhang, S., Zimmerman, M. E., Daines, M. J. & Kohlstedt, D. L., 1998. Experimental studies of shear deformation of mantle materials: Towards structural geology of the mantle, *Pure Appl. Geophys.*, **151**, 589–603, doi: 10.1007/s000240050131.
- Karato, S.-I., 1998. Seismic anisotropy in the deep mantle, boundary layers and the geometry of mantle convection, *Pure Appl. Geophys.*, **151**, 565–587.
- Karato, S.-I. & Li, P., 1992. Diffusion creep in perovskite: Implications for the rheology of the lower mantle, *Science*, **255**, 1238–1240.
- Karki, B. B., Stixrude, L. & Wentzcovitch, R. M., 2001. High-pressure elastic properties of major materials of earth's mantle from first principles, *Rev. Geophys.*, **39**(4), 507–534.
- Karner, G. D., 1982. Spectral representation of isostatic models, *BMR J. Aust. Geol. Geophys.*, **7**, 55–62.
- Karner, G. D. & Watts, A. B., 1983. Gravity-anomalies and flexure of the lithosphere at mountain ranges, *J. Geophys. Res.*, **88**(B12), 449–477.
- Karner, G. D., Steckler, M. S. & Thorne, J. A., 1983. Long-term thermo-mechanical properties of the continental lithosphere, *Nature*, **304**, 250–253.
- Karner, G. D., Byamungu, B. R., Ebinger, C. J., Kampunzu, A. B., Mukasa, R. K., Nyakaana, J., Rubondo, E. N. T. & Upcott, N. M., 2000. Distribution of crustal extension and regional basin architecture of the Albertine rift system, East Africa, *Mar. Petr. Geol.*, **17**(1131–1150).
- Karoui, A. & Moumni, T., 2008. New efficient methods of computing the prolate spheroidal wave functions and their corresponding eigenvalues, *Appl. Comput. Harmon. Anal.*, **24**(3), 269–289.
- Karpychev, M. & Fleitout, L., 2000. Long-wavelength geoid: The effect of continental roots and lithosphere thickness variations, *Geophys. J. Int.*, **143**, 945–963.
- Kasahara, J., 2002. Tides, earthquakes, and volcanoes, *Science*, **297**(5580), 348–349.

- Kaspi, Y., Hubbard, W. B., Showman, A. P. & Flierl, G. R., 2010. Gravitational signature of Jupiter's internal dynamics, *Geophys. Res. Lett.*, **37**(1), L01204, doi: 10.1029/2009GL041385.
- Katzman, R., Zhao, L. & Jordan, T. H., 1998. High-resolution, two-dimensional vertical tomography of the Central Pacific mantle using *scs* reverberations and frequency-dependent travel times, *J. Geophys. Res.*, **103**(B8), 17933–17971.
- Käufel, P., Valentine, A. P., O'Toole, T. B. & Trampert, J., 2014. A framework for fast probabilistic centroid-moment-tensor determination—inversion of regional static displacement measurements, *Geophys. J. Int.*, **196**(3), 1676–1693, doi: 10.1093/gji/ggt473.
- Käufel, P., Valentine, A. P., O'Toole, T. B. & Trampert, J., 2014. A framework for fast probabilistic centroid-moment-tensor determination—inversion of regional static displacement measurements, *Geophys. J. Int.*, **196**(3), 1676–1693, doi: 10.1093/gji/ggt473.
- Käufel, P., Valentine, A., de Wit, R. & Trampert, J., 2015. Robust and fast probabilistic source parameter estimation from near-field displacement waveforms using pattern recognition, *B. Seismol. Soc. Am.*, **105**(4), 2299–2312, doi: 10.1785/0120150010.
- Kaufmann, K. & Baumeister, W., 1989. Single-centre expansion of Gaussian basis functions and the angular decomposition of their overlap integrals, *J. Phys. B: Mol. Opt. Phys.*, **22**, 1–12.
- Kaula, W. M., 1967. Theory of statistical analysis of data distributed over a sphere, *Rev. Geophys.*, **5**(1), 83–107, doi: 10.1029/RG005i001p00083.
- Kaula, W. M., 1967. Geophysical applications of satellite determinations of the Earth's gravitational field, *Space Sci. Rev.*, **7**, 769–794.
- Kaula, W. M., 1968. *An Introduction to Planetary Physics. The Terrestrial Planets*, John Wiley, New York.
- Kaula, W. M., 1996. Regional gravity field on Venus from tracking of Magellan cycles 5 and 6, *J. Geophys. Res.*, **101**(E2), 4683–4690.
- Kaula, W. M., 2000. *Theory of satellite geodesy: Applications of satellites to geodesy*, Dover, Mineola, NY.
- Kawakatsu, H., 1983. Can 'pure-path' models explain free oscillation data?, *Geophys. Res. Lett.*, **10**(3), 186–189.
- Kawakatsu, H., 2012. At the bottom of the oceanic plate, *Science*, **335**(6075), 1448–1449, doi: 10.1126/science.1219658.
- Kawakatsu, H. & Niu, F., 1994. Seismic evidence for a 920-km discontinuity in the mantle, *Nature*, **371**(6495), 301–305, doi: 10.1038/371301a0.
- Kay, I., Sol, S., Kendall, J.-M., Thomson, C., White, D., Asudeh, I., Roberts, B. & Francis, D., 1999. Shear wave splitting observations in the Archean craton of Western Superior, *Geophys. Res. Lett.*, **26**(17), 2669–2672.

- Kay, S. M. & Marple, S. L., 1981. Spectrum analysis: A modern perspective, *Proc. IEEE*, **69**, 1380–1419.
- Kazei, V., Ovcharenko, O., Alkhalifah, T. & Simons, F. J., 2019, Realistically textured random velocity models for deep learning applications, in *Conf. Proc.*, vol. 2019, pp. 1–5, doi: 10.3997/2214–4609.201901340, Eur. Assoc. Geosci. Eng., 81st EAGE Conf. Exhib.
- Kebe, H.-W., 1978, *Optimierung verankerter akustischer Aufnehmersysteme für refraktionsseismische Messungen auf See unter Berücksichtigung der Einwirkungen des Seeganges und des Anströmens*, Ph.D. thesis, University of Hamburg, Hamburg, Germany, Hamburger Geophysikalische Einzelschriften, Reihe A, Heft 36.
- Kebe, H.-W., 1981. Self-noise measurements using a moored sonobuoy with a suspended hydrophone, *Marine Geophys. Res.*, **5**(2), 207–220.
- Keers, H., Rondenay, S., Harlap, Y. & Nordmo, I., 2014. Resources for computational geophysics courses, *Eos Trans. AGU*, **95**(37), 335–336, doi: 10.1002/2014EO370006.
- Keilis-Borok, V. I., Neigauz, M. G. & Shkadinskaya, G. V., 1965. Application of the theory of eigenfunctions to the calculations of surface wave velocities, *Rev. Geophys.*, **3**(1), 105–109.
- Kelbert, A., Egbert, G. D. & Schultz, A., 2008. Non-linear conjugate gradient inversion for global EM induction: Resolution studies, *Geophys. J. Int.*, **173**(2), 365–381, doi: 10.1111/j.1365–246X.2008.03717.x.
- Keller, S. A., 2010. Vital statistics, *Nature*, **467**, 914.
- Keller, W. R., Anderson, D. L. & Clayton, R. W., 2000. Resolution of tomographic models of the mantle beneath iceland, *Geophys. Res. Lett.*, **27**(234), 3993–3996.
- Kelley, D. S., Delaney, J. R. & the Cabled Array Team, 2016, NSF’s cabled array: A wired tectonic plate and overlying ocean, in *OCEANS 2016 MTS/IEEE Monterey*, pp. 1–10, doi: 10.1109/OCEANS.2016.7761398, Proc. IEEE.
- Kelley, M. C., 2009. *The Earth’s ionosphere: Plasma Physics and Electrodynamics*, Elsevier, Amsterdam, Neth.
- Kellogg, L., Hager, B. H. & van der Hilst, R. D., 1999. Compositional stratification of the deep mantle, *Science*, **283**(5409), 1881–1884, doi: 10.1126/science.283.5409.1881.
- Kellogg, O. D., 1967. *Foundations of Potential Theory*, Springer, New York.
- Kelly, M. & Alio, D., 2013. Searching for bones, finding wisdom within the earth,, *News@Princeton*, pp. 12/02/2013, <http://vimeo.com/79706110>.
- Kendall, J.-M., 2000, Seismic anisotropy in the boundary layers of the mantle, in *Earth’s Deep Interior. Mineral Physics and tomography from the atomic to the global scale*, edited by S. Karato, A. Forte, R. Liebermann, G. Masters, & L. Stixrude, vol. 117 of **Geophysical Monograph**, pp. 133–159, Amer. Geophys. Union, Washington, D. C.

- Kendall, J.-M. & Silver, P. G., 1996. Constraints from seismic anisotropy on the nature of the lowermost mantle, *Nature*, **381**, 409–412.
- Kendall, J.-M., Stuart, G. W., Ebinger, C. J., Bastow, I. D. & Keir, D., 2005. Magma-assisted rifting in Ethiopia, *Nature*, **433**, 146–148.
- Kendall, M. G. & Stuart, A., 1969. *Advanced Theory of Statistics*, Griffin, London, UK.
- Kennedy, R. A. & Sadeghi, P., 2013. *Hilbert Space Methods in Signal Processing*, Cambridge Univ. Press, Cambridge, UK.
- Kennedy, R. A., Zhang, W. & Abhayapala, T. D., 2008, Spherical harmonic analysis and model-limited extrapolation on the sphere: Integral equation formulation, in *Proc. IEEE Int. Conf. Signal Process. Comm. Syst.*, pp. 1–6, doi: 10.1109/ICSPCS.2008.4813702, IEEE.
- Kennett, B. L. N., 1972. The connection between elastodynamic representation theorems and propagator matrices, *B. Seismol. Soc. Am.*, **62**(4), 973–983.
- Kennett, B. L. N., 1974. Reflections, rays, and reverberations, *B. Seismol. Soc. Am.*, **64**(6), 1685–1696.
- Kennett, B. L. N., 1984. Guided wave propagation in laterally varying media — I. Theoretical development, *Geophys. J. R. Astron. Soc.*, **79**, 235–255.
- Kennett, B. L. N., 1995. Approximations for surface-wave propagation in laterally varying media, *Geophys. J. Int.*, **122**, 470–478.
- Kennett, B. L. N., 2001. *The Seismic Wavefield*, vol. I: Introduction and Theoretical Development, Cambridge Univ. Press, Cambridge, UK.
- Kennett, B. L. N., 2001. *The Seismic Wavefield*, vol. II: Interpretation of Seismograms on Regional and Global Scales, Cambridge Univ. Press, Cambridge, UK.
- Kennett, B. L. N., 2003. Roots of the matter, *Nature*, **422**, 674–675.
- Kennett, B. L. N. & Bunge, H.-P., 2008. *Geophysical Continua*, Cambridge Univ. Press, Cambridge, UK.
- Kennett, B. L. N. & Engdahl, E. R., 1991. Traveltimes for global earthquake location and phase identification, *Geophys. J. Int.*, **105**, 429–465.
- Kennett, B. L. N. & Fichtner, A., 2012. A unified concept for comparison of seismograms using transfer functions, *Geophys. J. Int.*, **191**(3), 1403–1416, doi: 10.1111/j.1365–246X.2012.05693.x.
- Kennett, B. L. N. & Nolet, G., 1990. The interaction of the *s*-wavefield with upper mantle heterogeneity, *Geophys. J. Int.*, **101**, 751–762.
- Kennett, B. L. N. & Yoshizawa, K., 2002. A reappraisal of regional surface wave tomography, *Geophys. J. Int.*, **150**, 37–44.

- Kennett, B. L. N., Guðmundsson, Ó. & Tong, C., 1994. The upper-mantle *S*-velocity and *P*-velocity structure beneath Northern Australia from broad-band observations, *Phys. Earth Planet. Inter.*, **86**(1–3), 85–98.
- Kennett, B. L. N., Engdahl, E. R. & Buland, R., 1995. Constraints on seismic velocities in the Earth from traveltimes, *Geophys. J. Int.*, **122**(1), 108–124, doi: 10.1111/j.1365–246X.1995.tb03540.x.
- Kennett, B. L. N., Widiyantoro, S. & van der Hilst, R. D., 1998. Joint seismic tomography for bulk sound and shear wave speed in the Earth’s mantle, *J. Geophys. Res.*, **103**(B6), 12469–12493.
- Kent, J. T. & Mardia, K. V., 1996. Spectral and circulant approximations to the likelihood for stationary Gaussian random fields, *J. Stat. Plann. Infer.*, **50**, 379–394.
- Kerman, B. R., 1993. *Natural Physical Sources of Underwater Sound: Sea Surface Sound* (2), Springer, Dordrecht, Neth.
- Kerr, R., 2007. Scientists tell policymakers we’re all warming the world, *Science*, **315**(5813), 754–757, doi: 10.1126/science.315.5813.754.
- Kerr, R., 2007. Global warming is changing the world, *Science*, **316**(5822), 188–190, doi: 10.1126/science.316.5822.188.
- Kerr, R. A., 2003. Mantle plumes both tall and short?, *Science*, **302**(5651), 1643, doi: 10.1126/science.302.5651.1643.
- Kerr, R. A., 2006. Rising plumes in Earth’s mantle: Phantom or real?, *Science*, **313**(5794), 1726, doi: 10.1126/science.313.5794.1726.
- Kerr, R. A., 2013. The deep Earth machine is coming together, *Science*, **340**(6128), 22–24, doi: 10.1126/science.340.6128.22.
- Kesson, S. E., Fitz Gerald, J. D. & Shelley, J. M., 1998. Mineralogy and dynamics of a pyrolite lower mantle, *Nature*, **393**, 252–255.
- Keylis-Borok, V. I., 1959, The study of earthquake mechanism, in *The mechanics of faulting, with special reference to the fault-plane work*, vol. XX(2), pp. 279–294, Dominion Obs., Ottawa.
- Khalid, Z., Durrani, S., Kennedy, R. A. & Sadeghi, P., 2011, On the construction of low-pass filters on the unit sphere, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, pp. 4356–4359, IEEE.
- Khalid, Z., Durrani, S., Sadeghi, P. & Kennedy, R. A., 2012. Spatio-spectral analysis on the sphere using spatially localized spherical harmonics transform, *IEEE T. Signal Process.*, **60**(3), 1487–1492, doi: 10.1109/TSP.2011.2177265.
- Khan, A. & Mosegaard, K., 2001. New information on the deep lunar interior from an inversion of lunar free oscillation periods, *Geophys. Res. Lett.*, **28**(9), 1791–1794.
- Khan, A. & Mosegaard, K., 2002. An inquiry into the lunar interior — A non-linear inversion of the Apollo seismic data, *J. Geophys. Res.*, **107**(E6), doi: 10.1029/2001JE001658.

- Khan, A., Mosegaard, K., Williams, J. G. & Lognonné, P., 2004. Does the Moon possess a molten core? Probing the deep lunar interior using results from LLR and Lunar Prospector, *J. Geophys. Res.*, **109**, doi: 10.1029/2004JE002294.
- Khan, A., Boschi, L. & Connolly, J. A. D., 2009. On mantle chemical and thermal heterogeneities and anisotropy as mapped by inversion of global surface wave data, *J. Geophys. Res.*, **114**(B9), B09305, doi: 10.1029/2009JB006399.
- Khan, A., Boschi, L. & Connolly, J. A. D., 2011. Mapping the Earth's thermochemical and anisotropic structure using global surface wave data, *J. Geophys. Res.*, **116**(B1), B01301, doi: 10.1029/2010JB007828.
- Khan, S. A., Wahr, J., Bevis, M., Velicogna, I. & Kendrick, E., 2010. Spread of ice mass loss into northwest Greenland observed by GRACE and GPS, *Geophys. Res. Lett.*, **37**(6), L06501, doi: 10.1029/2010GL042460.
- Khare, K., 2007. Sampling theorem, bandlimited integral kernels and inverse problems, *Inv. Probl.*, **23**(4), 13950–1416, doi: 10.1088/0266–5611/23/4/003.
- Khare, K. & George, N., 2003. Sampling theory approach to prolate spheroidal wavefunctions, *J. Phys. A: Math. Gen.*, **36**(39), 10011–10021, doi: 10.1088/0305–4470/36/39/303.
- Khokhlov, A., Hulot, G. & Mouël, J.-L. L., 1997. On the Backus effect — I, *Geophys. J. Int.*, **130**(3), 701–703, doi: 10.1111/j.1365–246X.1997.tb01864.x.
- Khokhlov, A., Hulot, G. & Mouël, J.-L. L., 1999. On the Backus effect — II, *Geophys. J. Int.*, **137**(3), 816–820, doi: 10.1046/j.1365–246x.1999.00843.x.
- Kibblewhite, A. C. & Ewans, K. C., 1985. Wave-wave interactions, microseisms, and infrasonic ambient noise in the ocean, *J. Acoust. Soc. Am.*, **78**(3), 981–994, doi: 10.1121/1.392931.
- Kibblewhite, A. C. & Wu, C. Y., 1988. The theoretical description of wave–wave interactions as a noise source in the ocean, *J. Acoust. Soc. Am.*, **89**(5), 2241–2252, doi: 10.1121/1.400970.
- Kibblewhite, A. C. & Wu, C. Y., 1989. The generation of infrasonic ambient noise in the ocean by nonlinear interactions of ocean surface waves, *J. Acoust. Soc. Am.*, **85**(5), 1935–1945, doi: 10.1121/1.397847.
- Kibblewhite, A. C. & Wu, C. Y., 1989. A reexamination of the role of wave–wave interactions in ocean noise generation, *J. Acoust. Soc. Am.*, **85**(5), 1946–1957, doi: 10.1121/1.397848.
- Kido, M., Yuen, D. A. & Vincent, A. P., 2003. Continuous wavelet-like filter for a spherical surface and its application to localized admittance function on Mars, *Phys. Earth Planet. Inter.*, **135**, 1–14.
- Kim, D., Lekić, V., **J. C. E. Irving**, Schmerr, N., Knapmeyer-Endrun, B., Joshi, R., Panning, M., Tauzin, B., Karakostas, F., Maguire, R., Huang, Q., Khan, A., Giardini, D., Wieczorek, M. A., Lognonné, P. & Banerdt, W. B., 2021. Improving constraints on planetary interiors with PPs receiver functions, *J. Geophys. Res.*, **126**, e2021JE006983, doi: 10.1029/2021JE006983.

- Kim, M. C. & Tapley, B. D., 2000. Formation of surface spherical harmonic normal matrices and application to high-degree geopotential modeling, *J. Geod.*, **74**(3), 359–375.
- Kim, W. & Paola, C., 2007. Long-period cyclic sedimentation with constant tectonic forcing in an experimental relay ramp, *Geology*, **35**(4), 331–334, doi: 10.1130/G23194A.1.
- Kim, W., Paola, C., Swenson, J. B. & Voller, V. R., 2006. Shoreline response to autogenic processes of sediment storage and release in the fluvial system, *J. Geophys. Res.*, **111**, F04013, doi: 10.1029/2006JF000470.
- Kim, Y. H., Liu, Q. & Tromp, J., 2011. Adjoint centroid-moment tensor inversions, *Geophys. J. Int.*, **186**(1), 264–278, doi: j.1365–246X.2011.05027.x.
- Kind, R. & Vinnik, L. P., 1988. The upper-mantle discontinuities underneath the GRF array from *P*-to-*S* converted phases, *J. Geophys.*, **62**, 138–147.
- King, G. C. P., Stein, R. S. & Lin, J., 1994. Static stress changes and the triggering of earthquakes, *B. Seismol. Soc. Am.*, **84**(3), 935–953.
- King, M., Moore, P., Clarke, P. & Lavallée, D., 2006. Choice of optimal averaging radii for temporal GRACE gravity solutions, a comparison with gps and satellite altimetry, *Geophys. J. Int.*, **166**, 1–11, doi: 10.1111/j.1365–246X.2006.03017.x.
- King, M. A., 2013. Progress in modelling and observing Antarctic glacial isostatic adjustment, *Astron. Geoph.*, **54**(4), 4.33–4.38, doi: 10.1093/astrogeo/att122.
- King, M. A., Bingham, R. J., Moore, P., Whitehouse, P. K., Bentley, M. J. & Milne, G. A., 2012. Lower satellite-gravimetry estimates of Antarctic sea-level contribution, *Nature*, **491**(7425), 586–589, doi: 10.1038/nature11621.
- King, S. D., 2002. Geoid and topography over subduction zones: The effect of phase transformations, *J. Geophys. Res.*, **107**(B1), 2013, doi: 10.1029/2000JB000141.
- King, S. D. & Adam, C., 2014. Hotspot swells revisited, *Phys. Earth Planet. Inter.*, **235**, 66–83, doi: 10.1016/j.pepi.2014.07.006.
- King, S. D. & Ritsema, J., 2000. African hot spot volcanism: Small-scale convection in the upper mantle beneath cratons, *Science*, **290**, 1137–1140.
- King, S. D., Raefsky, A. & Hager, B. H., 1991. CONMAN, Vectorizing a finite-element code for incompressible 2-dimensional convection in the Earth’s mantle, *Phys. Earth Planet. Inter.*, **59**(3), 195–207.
- King-Hele, D., 1976. The shape of the Earth, *Science*, **192**(4246), 1293–1300, doi: 10.1126/science.192.4246.1293.
- Kirby, J. F., 2005. Which wavelet best reproduces the Fourier power spectrum?, *Comput. Geosc.*, **31**, 846–864.

- Kirby, J. F., 2014. Estimation of the effective elastic thickness of the lithosphere using inverse spectral methods: The state of the art, *Tectonophysics*, **631**, 87–116, doi: 10.1016/j.tecto.2014.04.021.
- Kirby, J. F. & Swain, C. J., 2004. Global and local isostatic coherence from the wavelet transform, *Geophys. Res. Lett.*, **31**(L24608), doi: 10.1029/2004GL021569.
- Kirby, J. F. & Swain, C. J., 2006. Mapping the mechanical anisotropy of the lithosphere using a 2D wavelet coherence, and its application to Australia, *Phys. Earth Planet. Inter.*, **158**(2–4), 122–138, doi: 10.1016/j.pepi.2006.03.022.
- Kirby, J. F. & Swain, C. J., 2008. An accuracy assessment of the fan wavelet coherence method for elastic thickness estimation, *Geochem. Geophys. Geosys.*, **9**(3), Q03022, doi: 10.1029/2007GC001773.
- Kirby, J. F. & Swain, C. J., 2008. Correction to “An accuracy assessment of the fan wavelet coherence method for elastic thickness estimation”, *Geochem. Geophys. Geosys.*, **9**(5), Q05021, doi: 10.1029/2008GC002071.
- Kirby, J. F. & Swain, C. J., 2009. A reassessment of spectral T_e estimation in continental interiors: The case of North America, *J. Geophys. Res.*, **114**(B8), B08401, doi: 10.1029/2009JB006356.
- Kirby, J. F. & Swain, C. J., 2011. Improving the spatial resolution of effective elastic thickness estimation with the fan wavelet transform, *Comput. Geosci.*, **37**(9), 1345–1354, doi: 10.1016/j.cageo.2010.10.008.
- Kirby, J. F. & Swain, C. J., 2013. Power spectral estimates using two-dimensional Morlet-fan wavelets with emphasis on the long wavelengths: jackknife errors, bandwidth resolution and orthogonality properties, *Geophys. J. Int.*, **194**, 78–99, doi: 10.1093/gji/ggt103.
- Kirby, J. F. & Swain, C. J., 2014. On the robustness of spectral methods that measure anisotropy in the effective elastic thickness, *Geophys. J. Int.*, **199**, 391–401, doi: 10.1093/gji/ggu265.
- Kirk, R. L. & Stevenson, D. J., 1989. The competition between thermal contraction and differentiation in the stress history of the Moon, *J. Geophys. Res.*, **94**, 12133–12144.
- Kitanidis, P. K. & Lane, R. W., 1985. Maximum likelihood parameter estimation of hydrologic spatial processes by the Gauss-Newton method, *J. Hydrol.*, **79**(1), 53–71.
- Klaeschen, D., Hobbs, R. W., Krahmann, G., Papenberg, C. & Vsemirnova, E., 2009. Estimating movement of reflectors in the water column using seismic oceanography, *Geophys. Res. Lett.*, **36**(24), doi: 10.1029/2009GL038973.
- Klees, R. & Haagmans, R. H. N., eds., 2000. *Wavelets in the Geosciences*, vol. 90 of **Lecture Notes in Earth Sciences**, Springer, Berlin, Germany.
- Klees, R., Revtova, E. A., Gunter, B. C., Ditmar, P., Oudman, E., Winsemius, H. C. & Savenije, H. H. G., 2008. The design of an optimal filter for monthly GRACE gravity models, *Geophys. J. Int.*, **175**, 417–432, doi: 10.1111/j.1365-246X.2008.03922.x.

- Klein, S. A. & Beutter, B., 1992. Minimizing and maximizing the joint space-spatial frequency uncertainty of Gabor-like functions: comment, *J. Opt. Soc. Amer. A*, **9**(2), 337–340.
- Kleiner, B., Martin, R. D. & Thomson, D. J., 1979. Robust estimation of power spectra, *J. R. Stat. Soc., Ser. B*, **41**(3), 313–351, doi: j.2517-6161.1979.tb01087.x.
- Klemperer, S. L., Hauge, T. A., Hauser, E. C., Oliver, J. E. & Potter, C. J., 1986. The Moho in the northern Basin and Range province, Nevada, along the COCORP 40°N seismic-reflection transect, *Geol. Soc. Amer. Bull.*, **97**(5), 603–618.
- Knapmeyer, M., 2004. TTBox: A MatLab toolbox for the computation of 1D teleseismic travel times, *Seismol. Res. Lett.*, **75**(6), 726–733, doi: 10.1785/gssrl.75.6.726.
- Knapmeyer, M., 2005. Numerical accuracy of travel-time software in comparison with analytic results, *Seismol. Res. Lett.*, **76**(1), 74–81, doi: 10.1785/gssrl.76.1.74.
- Knapp, C. H. & Carter, G. C., 1976. The generalized correlation method for estimation of time delay, *IEEE T. Acoust. Speech Signal Process.*, **24**(4), 320–327, doi: 10.1109/TASSP.1976.1162830.
- Knisley, J. & Shirley, K., 2012. *Calculus: A modern approach*, John Wiley.
- Knödel, K., Lange, G. & Voigt, H.-J., 2007. *Environmental Geology: Handbook of Field Methods and Case Studies*, Springer, New York.
- Knopoff, L., 1964. Q, *Rev. Geophys.*, **2**(4), 625–659.
- Knopoff, L., 1972. Observation and inversion of surface-wave dispersion, *Tectonophysics*, **13**(1–4), 497–519.
- Knopoff, L. & Hudson, J. A., 1964. Transmission of Love waves past a continental margin, *J. Geophys. Res.*, **69**(8), 1649–1653.
- Knopoff, L. & Schwab, F. A., 1968. Apparent initial phase of a source of Rayleigh waves, *J. Geophys. Res.*, **73**(2), 755–760.
- Knox, L., 1995. Determination of inflationary observables by cosmic microwave background anisotropy experiments, *Phys. Rev. D*, **52**(8), 4307–4318.
- Koch, K.-R. & Kusche, J., 2002. Regularization of geopotential determination from satellite data by variance components, *J. Geod.*, **76**(259–268), doi: 10.1007/s00190-002-0245-x).
- Kogan, M. & McNutt, M. K., 1993. Gravity field over Northern Eurasia and variations in the strength of the upper mantle, *Science*, **259**, 473–479.
- Kohler, M. D., Hafner, K., Park, J., Irving, J. C. E., Caplan-Auerbach, J., Collins, J., Berger, J., Tréhu, A. M., Romanowicz, B. & Woodward, R. L., 2020. A plan for a long-term, automated, broadband seismic monitoring network on the global seafloor, *Seismol. Res. Lett.*, **91**(3), 1343–1355, doi: 10.1785/0220190123.

- Kohlstedt, D. L., Evans, B. & Mackwell, S. J., 1995. Strength of the lithosphere: Constraints imposed by laboratory experiments, *J. Geophys. Res.*, **100**(B9), 17587–17602, doi: 10.1029/95JB01460.
- Kom, H. R. & von Frese, R. R. B., 2017. Utility of Slepian basis functions for modeling near-surface and satellite magnetic anomalies of the Australian lithosphere, *Earth Planets Space*, pp. 69–53, doi: 10.1186/s40623-017-0636-0.
- Komatitsch, D. & Tromp, J., 1999. Introduction to the spectral element method for three-dimensional seismic wave propagation, *Geophys. J. Int.*, **139**(3), 806–822, doi: 10.1046/j.1365-246x.1999.00967.x.
- Komatitsch, D. & Tromp, J., 1999. Introduction to the spectral element method for three-dimensional seismic wave propagation, *Geophys. J. Int.*, **139**(3), 806–822.
- Komatitsch, D. & Tromp, J., 2002. Spectral-element simulations of global seismic wave propagation — I. Validation, *Geophys. J. Int.*, **149**(2), 390–412, doi: 10.1046/j.1365-246X.2002.01653.x.
- Komatitsch, D. & Tromp, J., 2002. Spectral-element simulations of global seismic wave propagation — II. Three-dimensional models, oceans, rotation and self-gravitation, *Geophys. J. Int.*, **150**(1), 303–318, doi: 10.1046/j.1365-246X.2002.01716.x.
- Komatitsch, D. & Vilotte, J. P., 1998. The spectral element method: An efficient tool to simulate the seismic response of 2D and 3D geological structures, *B. Seismol. Soc. Am.*, **88**(2), 368–392.
- Komatitsch, D., Vilotte, J. P., Vai, R., Castillo-Covarrubias, J. M. & Sanchez-Sesma, F. J., 1999. The spectral element method for elastic wave equations, Application to 2-D and 3-D seismic problems, *Int. J. Numer. Meth. Eng.*, **45**(9), 1139–1164.
- Komatitsch, D., Barnes, C. & Tromp, J., 2000. Wave propagation near a fluid-solid interface: A spectral-element approach, *Geophysics*, **65**(2), 623–631, doi: 10.1190/1.1444758.
- Komatitsch, D., Barnes, C. & Tromp, J., 2000. Simulation of anisotropic wave propagation based upon a spectral element method, *Geophysics*, **65**(4), 1251–1260, doi: 10.1190/1.444816.
- Komatitsch, D., Ritsema, J. & Tromp, J., 2002. The spectral-element method, Beowulf computing, and global seismology, *Science*, **298**(5599), 1737–1742, doi: 10.1126/science.1076024.
- Komatitsch, D., Tsuboi, S. & Tromp, J., 2005. The spectral-element method in seismology, in *Seismic Earth: Array Analysis of Broadband Seismograms*, edited by A. Levander & G. Noll, vol. 157 of **Geophysical Monograph**, pp. 205–227, doi: 10.1029/157GM13, Amer. Geophys. Union.
- Komatitsch, D., Erlebacher, G., Göddeke, D. & Michéa, D., 2010. High-order finite-element seismic wave propagation modeling with MPI on a large GPU cluster, *J. Comput. Phys.*, **229**(20), 7692–7714, doi: 10.1016/j.jcp.2010.06.024.

- Komm, R. W., Gu, Y., Hill, F., Stark, P. B. & Fodor, I. K., 1999. Multitaper spectral analysis and wavelet denoising applied to helioseismic data, *Astroph. J.*, **519**, 401–421.
- Kong, Q., Allen, R. M. & Schreier, L., 2016. MyShake: Initial observations from a global smart-phone seismic network, *Geophys. Res. Lett.*, **43**(18), 9588–9594, doi: 10.1002/2016GL070955.
- Kono, M., 2007. Geomagnetism in perspective, in *Treatise on Geophysics*, edited by M. Kono, vol. 5, pp. 1–31, doi: 10.1016/B978-044452748-6.00086-9, Elsevier, Amsterdam, Neth.
- Konopliv, A. S., Banerdt, W. B. & Sjogren, W. L., 1999. Venus gravity: 180th degree and order model, *Icarus*, **139**, 3–18.
- Kopp, R. E., Simons, F. J., Mitrovica, J. X., Maloof, A. C. & Oppenheimer, M., 2009. Probabilistic assessment of sea level during the last interglacial stage, *Nature*, **462**, 863–867, doi: 10.1038/nature08686.
- Kopp, R. E., Simons, F. J., Mitrovica, J. X., Maloof, A. C. & Oppenheimer, M., 2013. A probabilistic assessment of sea level variations within the last interglacial stage, *Geophys. J. Int.*, **193**(2), 711–716, doi: 10.1093/gji/ggt029.
- Koppers, A. A. P., Becker, T. W., Jackson, M. G., Konrad, K., Müller, R. D., Romanowicz, B., Steinberger, B. & Whittaker, J. M., 2021. Mantle plumes and their role in earth processes, *Nat. Rev. Earth Env.*, **2**(6), 382–401, doi: 10.1038/s43017-021-00168-6.
- Korenaga, J., 2013. Initiation and evolution of plate tectonics on Earth: theories and observations, *Annu. Rev. Earth Planet. Sc.*, **41**, 117–151, doi: 10.1146/annurev-earth-050212-124208.
- Korenaga, J., 2013. Stacking with dual bootstrap resampling, *Geophys. J. Int.*, **195**(3), 2023–2036, doi: 10.1093/gji/ggt373.
- Korte, M. & Holme, R., 2003. Regularization of spherical cap harmonics, *Geophys. J. Int.*, **153**, 253–262, doi: 10.1046/j.1365-246X.2003.01898.x.
- Korth, H., Anderson, B. J., Acuña, M. H., Slavin, J. A., Tsyganenko, N. A., Solomon, S. C. & McNutt, Jr., R. L., 2004. Determination of the properties of Mercury's magnetic field by the MESSENGER mission, *Planet. Space Sci.*, **52**(8), 733–746, doi: 10.1016/j.pss.2003.12.008.
- Kosowsky, A., 2003. The Atacama Cosmology Telescope, *New Astron. Rev.*, **47**, 939–943.
- Kowalski, K. & Rembieliński, J., 2000. Quantum mechanics on a sphere and coherent states, *J. Phys. A: Math. Gen.*, **33**, 6035–6048.
- Kowalski, K. & Rembieliński, J., 2001. The Bargmann representation for the quantum mechanics on a sphere, *J. Math. Phys.*, **42**(9), 4138–4147.
- Kowalski, K. & Rembieliński, J., 2002. On the uncertainty relations and squeezed states for the quantum mechanics on a circle, *J. Phys. A: Math. Gen.*, **35**, 1405–1414.
- Kowalski, K. & Rembieliński, J., 2003. Reply the "comment on "on the uncertainty relations and squeezed states for the quantum mechanics on a circle"", *J. Phys. A: Math. Gen.*, **36**, 5695–5698.

- Kowalski, K., Rembieliński, J. & Papaloucas, L. C., 1996. Coherent states for a quantum particle on a circle, *J. Phys. A: Math. Gen.*, **29**, 4149–4167.
- Krebs, J. R., Anderson, J. E., Hinkley, D., Neelamani, R., Lee, S., Baumstein, A. & Lacasse, M.-D., 2009. Fast full-wavefield seismic inversion using encoded sources, *Geophysics*, **74**(6), WCC177–WCC188, doi: 10.1190/1.3230502.
- Krebs, J. R., Cha, Y. H., Lee, S., Dimitrov, P., Mullur, A. A., Downey, N. J. & S.Routh, P., 2013. Orthogonal source and receiver encoding, *United States Patent*, **10012745**.
- Kreemer, C. & Holt, W. E., 2001. A no-net-rotation model of present-day surface motions, *Geophys. Res. Lett.*, **28**(23), 4407–4410.
- Kreslavsky, M. A. & Head, J. W., 2000. Kilometer-scale roughness of Mars: Results from MOLA data analysis, *J. Geophys. Res.*, **105**(E11), 26695–26711, doi: 10.1029/2000JE001259.
- Krischer, L., Smith, J., Lei, W., Lefebvre, M., Ruan, Y., de Andrade, E. S., Podhorszki, N., Bozdağ, E. E. & Tromp, J., 2016. An Adaptable Seismic Data Format, *Geophys. J. Int.*, **207**(1), 1003–1011, doi: 10.1093/gji/ggw319.
- Kristeková, M., Kristek, J., Moczo, P. & Day, S. M., 2006. Misfit criteria for quantitative comparison of seismograms, *B. Seismol. Soc. Am.*, **96**(5), 1836–1850, doi: 10.1785/0120060012.
- Kroese, D. P. & Botev, Z. I., 2015, Spatial process simulation, in *Stochastic geometry, spatial statistics and random fields*, edited by V. Schmidt, chap. 12, pp. 369–404, doi: 10.1007/978-3-319-10064-7_12, Springer, Heidelberg, Germany.
- Kuang, W. L. & Bloxham, J., 1997. An Earth-like numerical dynamo model, *Nature*, **389**(6649), 371–374.
- Kubo, A. & Hiramatsu, Y., 1998. On presence of seismic anisotropy in the asthenosphere beneath continents and its dependence on plate velocity: Significance of reference frame selection, *Pure Appl. Geophys.*, **151**, 281–303.
- Kugler, S., Bohlen, T., Forbriger, T., Bussat, S. & Klein, G., 2007. Scholte-wave tomography for shallow-water marine sediments, *Geophys. J. Int.*, **168**(2), 551–570, doi: 10.1111/j.1365-246X.2006.03233.x.
- Kulesh, M., Holschneider, M., Diallo, M. S., Xie, Q., & Scherbaum, F., 2005. Modeling of wave dispersion using continuous wavelet transforms, *Pure Appl. Geophys.*, **162**, 843–855, doi: 10.1007/s00024-004-2644-9.
- Kullback, S. & Leibler, R. A., 1951. On information and sufficiency, *Ann. Math. Stat.*, **22**(1), 79–86, doi: 10.1214/aoms/1177729694.
- Kumar, P., 1995. A wavelet-based methodology for scale-space anisotropic analysis, *Geophys. Res. Lett.*, **22**(20), 2777–2780.

- Kumar, P. & Foufoula-Georgiou, E., 1994, Wavelet analysis in geophysics: An introduction, in *Wavelets in Geophysics*, edited by E. Foufoula-Georgiou & P. Kumar, pp. 1–43, Academic Press, San Diego, Calif.
- Kumar, P. & Foufoula-Georgiou, E., 1997. Wavelet analysis for geophysical applications, *Rev. Geophys.*, **35**(4), 385–412.
- Kump, L. R., 2011. The last great global warming, *Sci. Am.*, pp. 57–61.
- Kuo, B.-Y. & Forsyth, D. W., 1988. Gravity anomalies of the ridge-transform system in the South Atlantic between 31 and 34.5 S: Upwelling centers and variations in crustal thickness, *Mar. Geophys. Res.*, **10**, 205–232.
- Kuo, B.-Y., Forsyth, D. W. & Wyssession, M., 1987. Lateral heterogeneity and azimuthal anisotropy in the North Atlantic determined from *ss*–*S* differential travel times, *J. Geophys. Res.*, **92**(B7), 6421–6436, doi: 10.1029/JB092iB07p06421.
- Kuo, C., Lindberg, C. & Thomson, D. J., 1990. Coherence established between atmospheric carbon dioxide and global temperature, *Nature*, **343**, 709–714.
- Kusche, J., 2015, Time-variable gravity field and global deformation of the Earth, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, pp. 321–338, doi: 10.1007/978-3-642-54551-1_8, Springer, Heidelberg, Germany, 2nd edn.
- Kusche, J., Schmidt, R., Petrovic, S. & Rietbroek, R., 2009. Decorrelated GRACE time-variable gravity solutions by GFZ, and their validation using a hydrological model, *J. Geod.*, **83**, 903–913, doi: 10.1007/s00190-009-0308-3.
- Kushnir, A. F., Levshin, A. L. & Lokshantov, D. E., 1988, Determination of a regional velocity structure from surface wave seismograms recorded at a set of stations, in *Proceedings of the Sixth International Mathematical Geophysics Seminar*, edited by A. Vogel, R. Gorenflo, B. Kummer, & C. O. Ofoegbu, pp. 489–498, Free University of Berlin.
- Kuskov, O. L., 1995. Constitution of the Moon: 3. Composition of middle mantle from seismic data, *Phys. Earth Planet. Inter.*, **90**, 55–74.
- Kustowski, B., Ekström, G. & Dziewoński, A. M., 2008. Anisotropic shear-wave velocity structure of the Earth’s mantle: A global model, *J. Geophys. Res.*, **113**(B6), B06306, doi: 10.1029/2007JB005169.
- Kutyniok, G. & Lim, W.-Q., 2012, Shearlets on bounded domains, in *Approximation Theory XIII: San Antonio 2010*, edited by M. Neamtu & L. Schumaker, vol. 13 of **Springer Proceedings in Mathematics**, pp. 187–206, Springer.
- Kutyniok, G., Lemvig, J. & Lim, W.-Q., 2012, Compactly supported shearlets, in *Approximation Theory XIII: San Antonio 2010*, edited by M. Neamtu & L. Schumaker, vol. 13 of **Springer Proceedings in Mathematics**, pp. 163–186, Springer.

- Kwiatek, G., Plenkers, K., Nakatani, M., Yabe, Y. & Dresen, G., 2010. Frequency-magnitude characteristics down to magnitude -4.4 for induced seismicity recorded at Mponeng gold mine, South Africa, *B. Seismol. Soc. Am.*, **100**(3), 1165–1173, doi: 10.1785/0120090277.
- Kwiatkowski, L., Halloran, P. R., Mumby, P. J. & Stephenson, D. B., 2014. What spatial scales are believable for climate model projections of sea surface temperature?, *Clim. Dyn.*, **43**, 1483–1496, doi: 10.1007/s00382-013-1967-6.
- Labate, D., Lim, W.-Q., Kutyniok, G. & Weiss, G., 2005, Sparse multidimensional representation using shearlets, in *Wavelets XI*, edited by M. Papadakis, A. F. Laine, & M. A. Unser, vol. 5914, pp. 59140U, doi: 10.1117/12.613494, SPIE, Bellingham, WA.
- Lackner, K. S., 2003. A guide to co2 sequestration, *Science*, **300**, 1677–1678.
- ladbury, R., 1996. Geodynamo turns toward a stable magnetic field, *Physics Today*, **49**(1), 17–18, doi: 10.1063/1.2807456.
- Lai, C. G. & Rix, G. J., 1998, Simultaneous inversion of Rayleigh phase velocity and attenuation for near-surface site characterization, Tech. rep., School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, GA.
- Lai, C. G. & Rix, G. J., 1999, Inversion of multi-mode effective dispersion curves, in *Proceedings of the Second International Symposium on pre-failure deformation characteristics of geomaterials*, edited by M. Jamiolkowski, R. Lancellotta, & D. L. Presti, vol. 1, pp. 411–418, Balkema, Rotterdam.
- Lai, M. J., Shum, C. K., Baramidze, V. & Wenston, P., 2009. Triangulated spherical splines for geopotential reconstruction, *J. Geod.*, **83**, 695–708, doi: 10.1007/s00190-008-0283-0.
- Lai, S.-T. & Chiu, Y.-N., 1990. Exact computation of the $3 - j$ and $6 - j$ symbols, *Comput. Phys. Comm.*, **61**(3), 350–360.
- Lai, S.-T. & Chiu, Y.-N., 1992. Exact computation of the $9 - j$ symbols, *Comput. Phys. Comm.*, **70**(3), 544–556.
- Lailly, P., 1983, The seismic inverse problem as a sequence of before stack migrations, in *Conference on Inverse Scattering: Theory and Application*, edited by J. B. Bednar, R. Redner, E. Robinson, & A. Weglein, pp. 206–220, Soc. Industr. Appl. Math., Philadelphia, Penn.
- Laj, C., Mazaud, A., Weeks, R., Fuller, M. & Herrero-Bervera, E., 1991. Geomagnetic reversal paths, *Nature*, **351**, 447.
- Laj, C., Mazaud, A., Weeks, R., Fuller, M. & Herrero-Bervera, E., 1992. Geomagnetic reversal paths, *Nature*, **359**, 112–113.
- Lakshtanov, D. L., Sinogeikin, S. V., Litasov, K. D., Prakapenka, V. B., Hellwig, H., Wang, J., Sanches-Valle, C., Perrillat, J.-P., Chen, B., Somayazulu, M., Li, J., Ohtani, E. & Bass, J. D., 2007. The post-stishovite phase transition in hydrous alumina-bearing SiO_2 in the lower mantle of the earth, *Proc. Natl. Acad. Sc.*, **104**(34), 13588–13590, doi: 10.1073/pnas.0706113104.

- Lamb, S., 2002. Is it all in the crust?, *Nature*, **420**, 130–131.
- Lambeck, K., 1983. Structure and evolution of the intracratonic basins of central Australia, *Geophys. J. R. Astron. Soc.*, **74**, 843–886.
- Lambeck, K., 1988. *Geophysical Geodesy*, Oxford Univ. Press, New York.
- Lambeck, K. & Burgess, G., 1992. Deep crustal structure of the Musgrave Block, central Australia: Results from teleseismic travel-time anomalies, *Aust. J. Earth Sci.*, **39**, 1–19.
- Lambeck, K. & Nakiboglu, S. M., 1980. Seamount loading and stress in the ocean lithosphere, *J. Geophys. Res.*, **85**(B11), 6,403–6,418.
- Lambeck, K. & Nakiboglu, S. M., 1981. Seamount loading and stress in the ocean lithosphere, 2, Viscoelastic and elastic-viscoelastic models, *J. Geophys. Res.*, **86**(B8), 6,961–6,984.
- Lambeck, K. & Penney, C., 1984. Teleseismic travel time anomalies and crustal structure in central Australia, *Phys. Earth Planet. Inter.*, **34**, 46–56.
- Lambeck, K., McQueen, H. W. S., Stephenson, R. A. & Denham, D., 1984. The state of stress within the Australian continent, *Ann. Geophys.–Germany*, **2**(6), 723–742.
- Lambeck, K., Burgess, G. & Shaw, R. D., 1988. Teleseismic travel-time anomalies and deep crustal structure in central Australia, *Geophys. J. Int.*, **94**, 105–124.
- Lammlein, D., 1977. Lunar seismicity and tectonics, *Phys. Earth Planet. Inter.*, **14**, 224–273.
- Lana, X., Mills, G. F., Badal, J. & Canas, J. A., 1997. Objective regionalization of Rayleigh-wave dispersion data by clustering algorithms, *Geophys. J. Int.*, **129**, 421–438.
- Landais, F., Schmidt, F. & Lovejoy, S., 2017, Statistical analysis of the Martian topography, in *48th Lunar Planetary Science Conference*, p. 1829.
- Landau, H. J., 1960. On the recovery of a band-limited signal, after instantaneous companding and subsequent band limiting, *Bell Syst. Tech. J.*, **39**, 351–364.
- Landau, H. J., 1965. On the eigenvalue behavior of certain convolution equations, *Trans. Am. Math. Soc.*, **115**, 242–256.
- Landau, H. J., 1967. Necessary density conditions for sampling and interpolation of certain entire functions, *Acta Mathematica Uppsala*, **117**, 37–52.
- Landau, H. J., 1967. Sampling, data transmission, and the Nyquist rate, *Proc. IEEE*, **55**(10), 1701–1706.
- Landau, H. J. & Pollak, H. O., 1961. Prolate spheroidal wave functions, Fourier analysis and uncertainty — II, *Bell Syst. Tech. J.*, **40**(1), 65–84.
- Landau, H. J. & Pollak, H. O., 1962. Prolate spheroidal wave functions, Fourier analysis and uncertainty — III: The dimension of the space of essentially time- and band-limited signals, *Bell Syst. Tech. J.*, **41**(4), 1295–1336.

- Landau, H. J. & Widom, H., 1980. Eigenvalue distribution of time and frequency limiting, *J. Math. Anal. App.*, **77**(2), 469–481.
- Langel, R. A. & Estes, R. H., 1985. Large-scale, near-field magnetic fields from external sources and the corresponding induced internal field, *J. Geophys. Res.*, **90**(B3), 2487–2494.
- Langel, R. A. & Hinze, W. J., 1998. *The Magnetic Field of the Earth's Lithosphere: The Satellite Perspective*, Cambridge Univ. Press, Cambridge, UK.
- Langenheim, V. E. & Hauksson, E., 2001. Comparison between crustal density and velocity variations in Southern California, *Geophys. Res. Lett.*, **28**(16), 3087–3090.
- Langer, H., Falsaperla, S. & Thompson, G., 2003. Application of Artificial Neural Networks for the classification of the seismic transients at Soufrière Hills volcano, Montserrat, *Geophys. Res. Lett.*, **30**(21), 2090, doi: 10.1029/2003GL018082.
- Langereis, C. G., van Hoof, A. & Rochette, P., 1992. Longitudinal confinement of geomagnetic reversal paths as a possible sedimentary artefact, *Nature*, **358**, 226–230.
- Langlais, B. & Amit, H., 2008. The past Martian dynamo, *Science*, **321**, 1784–1785, doi: 10.1126/science.1162874.
- Langlais, B. & Purucker, M., 2007. A polar magnetic paleopole associated with Apollinaris Patera, Mars, *Planet. Space Sci.*, **55**, 270–279, doi: 10.1016/j.pss.2006.03.008.
- Langlais, B. & Quesnel, Y., 2008. New perspectives on Mars' crustal magnetic field, *C. R. Geosci.*, **340**, 791–800, doi: 10.1016/j.crte.2008.08.006.
- Langlais, B., Purucker, M. E. & Manda, M., 2004. Crustal magnetic field of Mars, *J. Geophys. Res.*, **109**(E2), E02008, doi: 10.1029/2003JE002048.
- Langlais, B., Lesur, V., Purucker, M. E., Connerney, J. E. P. & Manda, M., 2010. Crustal magnetic fields of terrestrial planets, *Space Sci. Rev.*, **152**(1), 223–249.
- Lanzerotti, L. J., Thomson, D. J., Meloni, A., Medford, L. V. & MacLennan, C. G., 1986. Electromagnetic study of the Atlantic continental margin using a section of a transatlantic cable, *J. Geophys. Res.*, **91**(B7), 7417–7427, doi: 10.1029/JB091iB07p07417.
- Larsen, T. B., Malevsky, A. V., Yuen, D. A. & Smedsmo, J. L., 1993. Temperature-dependent Newtonian and non-Newtonian convection: Implications for lithospheric processes, *Geophys. Res. Lett.*, **20**(23), 2595–2598.
- Larson, E. W. F. & Ekström, G., 2001. Global models of surface wave group velocity, *Pure Appl. Geophys.*, **158**, 1377–1399.
- Larson, E. W. F. & Ekström, G., 2002. Determining surface wave arrival angle anomalies, *J. Geophys. Res.*, **107**(B6), 2127, doi: 10.1029/2000JB000048.
- Larson, E. W. F., Tromp, J. & Ekström, G., 1998. Effects of slight anisotropy on surface waves, *Geophys. J. Int.*, **132**, 654–666.

- Larson, K. M. & Small, E. E., 2013. Using GPS to study the terrestrial water cycle, *Eos Trans. AGU*, **94**(52), 505–506, doi: 10.1002/2013EO520001.
- Laskar, J., Robutel, P., Joutel, F., Gastineau, M., Correia, A. C. M. & Levrard, B., 2004. A long-term numerical solution for the insolation quantities of the Earth, *Astron. Astroph.*, **428**(1), 261–285, doi: 10.1051/0004-6361:20041335.
- Laske, G. & Masters, G., 1996. Constraints on global phase velocity maps from long-period polarization data, *J. Geophys. Res.*, **101**(B7), 16059–16075, doi: 10.1029/96JB00526.
- Laske, G. & Masters, G., 1998. Surface-wave polarization data and global anisotropic structure, *Geophys. J. Int.*, **132**, 508–520.
- Laske, G. & Masters, G., 1999. Limits on differential rotation of the inner core from an analysis of the Earth's free oscillations, *Nature*, **402**, 66–69.
- Laske, G., Phipps Morgan, J. & Orcutt, J. A., 1999. First results from the Hawaiian SWELL pilot experiment, *Geophys. Res. Lett.*, **26**(22), 3397–3400.
- Laske, G., Phipps Morgan, J. & Orcutt, J. A., 2007. The Hawaiian SWELL pilot experiment — Evidence for lithosphere rejuvenation from ocean bottom surface wave data, *Geol. Soc. Am. Spec. Paper*, **430**, 209–233, doi: 10.1130/2007.2430(11).
- Latham, G., Ewing, M., Press, F. & Sutton, G., 1969. The Apollo passive seismic experiment, *Science*, **165**, 241–250.
- Lauritzen, P. H., Nair, R. D. & Ullrich, P. A., 2010. A conservative semi-Lagrangian multi-tracer transport scheme (CSLAM) on the cubed-sphere grid, *J. Comput. Phys.*, **229**(5), 1401–1424.
- Lavender, K. L., Davis, R. E. & Owens, W. B., 2000. Mid-depth recirculation observed in the interior Labrador and Irminger seas by direct velocity measurements, *Nature*, **407**, 66–69, doi: 10.1038/35024048.
- Lavier, L. L. & Steckler, M. S., 1997. The effect of sedimentary cover on the flexural strength of continental lithosphere, *Nature*, **389**(6650), 476–479.
- Lavier, L. L. & Steckler, M. S., 1998. The effect of sedimentary cover on the flexural strength of continental lithosphere, Correction, *Nature*, **392**(6678), 843.
- Law, R. D., Searle, M. P. & Simpson, R. L., 2004. Strain, deformation temperatures and vorticity of flow at the top of the Greater Himalayan Slab, Everest Massif, Tibet, *J. Geol. Soc. London*, **161**, 305–320.
- Lawrence, J. F. & Shearer, P. M., 2008. Imaging mantle transition zone thickness with *SdS*–*SS* finite-frequency sensitivity kernels, *Geophys. J. Int.*, **174**(1), 143–158, doi: 10.1111/j.1365-246X.2007.03673.x.
- Lawrence, K. P. & Phillips, R. J., 2003. Gravity/topography admittance inversion on Venus using niching genetic algorithms, *Geophys. Res. Lett.*, **30**(19), 1994, doi: 10.1029/2003GL017515.

- Lawson, C. L. & Hanson, R. J., 1974. *Solving Least Squares Problems*, Prentice-Hall, Englewood Cliffs, N. J.
- Lawson, C. L. & Hanson, R. J., 1995. *Solving Least Squares Problems*, no. 15 in Classics in Applied Mathematics, SIAM, Philadelphia, Penn.
- Lay, T. & Wallace, T. C., 1995. *Modern Global Seismology*, Academic Press, San Diego, Calif.
- Lay, T., Williams, Q. & Garnero, E. J., 1998. The core-mantle boundary layer and deep Earth dynamics, *Nature*, **392**, 461–1998.
- Lay, T., Kanamori, H., Ammon, C. J., Nettles, M., Ward, S. N., Aster, R. C., Beck, S. L., Bilek, S. L., Brudzinski, M. R., Butler, R., DeShon, H. R., Ekström, G., Satake, K. & Sipkin, S., 2005. The Great Sumatra-Andaman earthquake of 26 December 2004, *Science*, **308**(5725), 1127–1133.
- Lay, T., Hernlund, J. & Buffett, B., 2008. Core-mantle boundary heat flow, *Nature Geosci.*, **1**, 25–32, doi: 10.1038/ngeo.2007.44.
- Le Bras, R. & Mellman, G., 1994, Wavelet transforms and downward continuation, in *Wavelets and Their Applications*, edited by J. S. Byrnes, J. L. Byrnes, K. A. Hargreaves, & K. Berry, vol. 442 of **NATO ASI Series C: Mathematical and Physical Sciences**, pp. 291–296, Kluwer, Dordrecht, Neth.
- Le Bras, R., Mellman, G. & Peters, M., 1992, Wavelet transform method for downward continuation, in *SEG Tech. Prog. Expanded Abstracts*, pp. 889–892, doi: 10.1190/1.1822247, Soc. Explor. Geophys., New Orleans, La.
- le Meur, E. & Huybrechts, P., 1996. A comparison of different ways of dealing with isostasy: examples from modeling the Antarctic ice sheet during the last glacial cycle, *Ann. Glaciol.*, **23**, 309–317.
- Le Meur, E. & Huybrechts, P., 2001. A model computation of the temporal changes of surface gravity and geoidal signal induced by the evolving Greenland ice sheet, *Geophys. J. Int.*, **145**, 835–849.
- Leahy, G. M., 2009. Local variability in the 410-km mantle discontinuity under a hotspot, *Earth Planet. Sci. Lett.*, **288**(1–2), 158–163, doi: 10.1016/j.epsl.2009.09.018.
- Leahy, G. M. & Collins, J. A., 2009. Improved statistical processing for common-conversion-point stacked receiver functions, *B. Seismol. Soc. Am.*, **99**(2A), 914–921, doi: 10.1785/0120080263.
- Lebedev, S., Chevrot, S. & van der Hilst, R. D., 2002. Seismic evidence for olivine phase changes at the 410- and 660-kilometer discontinuities, *Science*, **296**(5571), 1300–1302, doi: 10.1126/science.1069407.
- Lebedev, S., Meier, T., Nolet, G. & van der Hilst, R. D., 2005. Automated multi-mode inversion of surface and *S* waveforms, *Geophys. J. Int.*, **162**, doi: 10.1111/j.1365–246X.2005.02708.x.

- Lee, C.-T., Yin, Q., Rudnick, R. L., Chesley, J. T. & Jacobson, S. B., 2000. Osmium isotopic evidence for Mesozoic removal of lithospheric mantle beneath the Sierra Nevada, California, *Science*, **289**, 1912–1916.
- Lee, C.-T., Yin, Q., Rudnick, R. L. & Jacobson, S. B., 2001. Preservation of ancient and fertile lithospheric mantle beneath the southwestern United States, *Nature*, **411**, 69–73.
- Lee, C.-T. A., Luffi, P. & Chin, E. J., 2011. Building and destroying continental mantle, *Annu. Rev. Earth Planet. Sc.*, **39**, 59–90, doi: 10.1146/annurev-earth-040610-133505.
- Lee, H., Shum, C. K., Yi, Y., Braun, A. & Kuo, C., 2008. Laurentia crustal motion observed using TOPEX/POSEIDON radar altimetry over land, *J. Geodyn.*, **46**, 182–193.
- Lee, H., Shum, C. K., Howat, I. M., Monaghan, A., Ahn, Y., Duan, J., Guo, J.-Y., Kuyo, C. & Wang, L., 2012. Continuously accelerating ice loss over Amundsen Sea catchment, West Antarctica, revealed by integrating altimetry and GRACE data, *Earth Planet. Sci. Lett.*, **321–322**, 74–80, doi: 10.1016/j.epsl.2011.12.040.
- Lees, J. M. & Park, J., 1995. Multiple-taper spectral analysis: A stand-alone C-subroutine, *Comput. Geosci.*, **21**(2), 199–236.
- Lees, J. M. & Ukawa, M., 1992. The South Fossa Magna, Japan, revealed by high-resolution P- and S-wave travel time tomography, *Tectonophysics*, **208**, 377–396.
- Lei, W., Ruan, Y., Bozdağ, E., Peter, D., Lefebvre, M., Komatitsch, D., Tromp, J., Hill, J., Podhorszki, N. & Pugmire, D., 2020. Global adjoint tomography—model GLAD-M25, *Geophys. J. Int.*, **223**(1), 1–21, doi: 10.1093/gji/ggaa253.
- Leistedt, B. & McEwen, J., 2012. Exact wavelets on the ball, *IEEE T. Signal Process.*, **60**(12), 6257–6268, doi: 10.1109/TSP.2012.2215030.
- Lekić, V. & Romanowicz, B., 2011. Inferring upper-mantle structure by full waveform tomography with the spectral element method, *Geophys. J. Int.*, **185**(2), 799–831, doi: 10.1111/j.1365-246X.2011.04969.x.
- Lemoine, F. G., Kenyon, S. C., Factor, J. K., Trimmer, R. G., Pavlis, N. K., Chinn, D. S., Cox, C. M., Klosko, S. M., Luthcke, S. B., Torrence, M. H., Wang, Y. M., Williamson, R. G., Pavlis, E. C., Rapp, R. H. & Olson, T. R., 1998. *The Development of the Joint NASA GSFC and the National Imagery and Mapping Agency (NIMA) Geopotential Model EGM96*, NASA Goddard Space Flight Cent., Greenbelt, Md.
- Lemoine, F. G., Pavlis, N. K., Kenyon, S. C., Rapp, R. H., Pavlis, E. C. & Chao, B. F., 1998. New high-resolution model developed for Earth's gravitational field, *Eos Trans. AGU*, **79**(9), 113–118.
- Lemoine, F. G., Smith, D. E., Rowlands, D. D., Zuber, M. T., Neumann, G. A., Chinn, D. S. & Pavlis, D. E., 2001. An improved solution of the gravity field of Mars (GMM-2B) from Mars Global Surveyor, *J. Geophys. Res.*, **106**(E10), 23359–23376.

- Lemoine, F. G. R., Smith, D. E., Zuber, M. T., Neumann, G. A. & Rowlands, D. D., 1997. A 70th degree lunar gravity model (GLGM-2) from Clementine and other tracking data, *J. Geophys. Res.*, **102**(E7), 16339–16359.
- Lemoine, J.-M., Bruinsma, S., Loyer, S., Biancale, R., Marty, J.-C., Perosanz, F. & Balmino, G., 2007. Temporal gravity field models inferred from GRACE data, *Adv. Space Res.*, **39**(10), 1620–1629, doi: 10.1016/j.asr.2007.03.062.
- Lenaerts, J. T. M., van den Broeke, M. R., van de Berg, W. J., van Meijgaard, E. & Munneke, P. K., 2012. A new, high-resolution surface mass balance map of Antarctica (1979–2010) based on regional atmospheric climate modeling, *Geophys. Res. Lett.*, **39**, L04501, doi: 10.1029/2011GL050713.
- Lenaerts, J. T. M., van Meijgaard, E., van den Broeke, M. R., Ligtenberg, S. R. M., Horwath, M. & Isaksson, E., 2013. Recent snowfall anomalies in Dronning Maud Land, East Antarctica, in a historical and future climate perspective, *Geophys. Res. Lett.*, **40**(11), 2684–2688, doi: 10.1002/grl.50559.
- Lenardic, A., 1997. On the heat flow variation from archaic cratons to proterozoic mobile belts, *J. Geophys. Res.*, **102**(B1), 709–721.
- Lenardic, A., 1998. On the partitioning of mantle heat loss below oceans and continents over time and its relationship to the Archaean paradox, *Geophys. J. Int.*, **134**(3), 706–720.
- Lenardic, A. & Moresi, L., 2000. A new class of equilibrium geotherms in the deep lithosphere of continents, *Earth Planet. Sci. Lett.*, **176**, 331–338.
- Lenardic, A. & Moresi, L., 2001. Heat flow scaling for mantle convection below a conducting lid: Resolving seemingly inconsistent modeling results regarding continental heat flow, *Geophys. Res. Lett.*, **28**(7), 1311–1314.
- Lenardic, A. & Moresi, L.-N., 1999. Some thoughts on the stability of cratonic lithosphere: Effects of bouyancy and viscosity, *J. Geophys. Res.*, **104**(B6), 12747–12758.
- Lenardic, A., Moresi, L. & Mühlhaus, H., 2000. The role of mobile belts for the longevity of deep cratonic lithosphere: The crumple zone model, *Geophys. Res. Lett.*, **27**(8), 1235–1238.
- Lenardic, A., Moresi, L.-N. & Mühlhaus, H., 2003. Longevity and stability of cratonic lithosphere: Insights from numerical simulations of coupled mantle convection and continental tectonics, *J. Geophys. Res.*, **108**(B6), 2303, doi: 10.1029/2002JB001859.
- Leonard, M., 2000. Comparison of manual and automatic onset time picking, *B. Seismol. Soc. Am.*, **90**(6), 1384–1390, doi: 10.1785/0120000026.
- Leonard, M. & Kennett, B. L. N., 1999. Multi-component autoregressive techniques for the analysis of seismograms, *Phys. Earth Planet. Inter.*, **113**(1–4), 247–263, doi: 10.1016/S0031–9201(99)00054–0.

- Lerner-Lam, A. L. & Jordan, T. H., 1983. Earth structure from fundamental and higher-mode waveform analysis, *Geophys. J. R. Astron. Soc.*, **75**, 759–797.
- Lessig, C. & Fiume, E., 2008. SOHO: Orthogonal and symmetric Haar wavelets on the sphere, *ACM Trans. Graph.*, **27**(1), 4, doi: 10.1145/1330511.1330515.
- Lessig, C. & Fiume, E., 2010, On the effective dimension of light transport, in *Eurographics Symposium on Rendering 2010*, edited by J. Lawrence & M. Stamminger, vol. 29 (4), pp. 1399–1403, doi: 10.1111/j.1467–8659.2010.01736.x, The Eurographics Association.
- Lessig, C., de Witt, T. & Fiume, E., 2012. Efficient and accurate rotation of finite spherical harmonics expansions, *J. Comput. Phys.*, **231**, 243–250, doi: 10.1016/j.jcp.2011.09.014.
- Lesur, V., 2006. Introducing localized constraints in global geomagnetic field modelling, *Earth Planets Space*, **58**(4), 477–483.
- Lesur, V. & Maus, S., 2006. A global lithospheric magnetic field model with reduced noise level in the Polar Regions, *Geophys. Res. Lett.*, **33**, L13304, doi: 10.1029/2006GL025826.
- Lev, E. & Hager, B. H., 2008. Rayleigh-Taylor instabilities with anisotropic lithospheric viscosity, *Geophys. J. Int.*, **173**(3), 806–814, doi: 10.1111/j.1365–246X.2008.03731.x.
- Lev, E. & Hager, B. H., 2008. Prediction of anisotropy from flow models: A comparison of three methods, *Geophys. J. Int.*, **9**(7), Q07014, doi: 10.1029/2008GC002032.
- Levander, A. & Nolet, G., 2005, Perspectives on array seismology and USArray, in *Seismic Earth: Array Analysis of Broadband Seismograms*, edited by A. Levander & G. Nolet, vol. 157 of **Geophysical Monograph**, pp. 1–6, Amer. Geophys. Union.
- Leven, J. H., Jackson, I. & Ringwood, A. E., 1981. Upper mantle seismic anisotropy and lithospheric decoupling, *Nature*, **289**, 234–239.
- Levenberg, K., 1944. A method for the solution of certain non-linear problems in least squares, *Quart. Appl. Math.*, **2**, 164–168.
- Lévêque, J.-J. & Cara, M., 1985. Inversion of multimode surface wave data: Evidence for sublithospheric anisotropy, *Geophys. J. R. Astron. Soc.*, **83**(3), 753–773.
- Lévêque, J.-J., Cara, M. & Rouland, D., 1991. Waveform inversion of surface wave data: Test of a new tool for systematic investigation of upper mantle structures, *Geophys. J. Int.*, **104**, 565–581.
- Lévêque, J.-J., Rivera, L. & Wittlinger, G., 1993. On the use of the checker-board test to assess the resolution of tomographic inversions, *Geophys. J. Int.*, **115**, 313–318.
- Lévêque, J.-J., Debayle, E. & Maupin, V., 1998. Anisotropy in the Indian Ocean upper mantle from Rayleigh- and Love-waveform inversion, *Geophys. J. Int.*, **133**, 529–540.
- Levin, S. A., 1984. Principle of reverse-time migration, *Geophysics*, **49**(5), 581–583, doi: 10.1190/1.1441693.

- Levy, A. V. & Montalvo, A., 1985. The tunneling algorithm for the global minimization of functions, *SIAM J. Sci. Stat. Comput.*, **6**(1), 15–29.
- Lewis, A., Challinor, A. & Turok, N., 2001. Analysis of CMB polarization on an incomplete sky, *Phys. Rev. D*, **65**, 023505.
- Lewis, B. T. R. & Dorman, L. M., 1970. Experimental isostasy, 2, An isostatic model for the U.S.A. derived from gravity and topographic data, *J. Geophys. Res.*, **75**(17), 3367–3386.
- Lewis, B. T. R. & Dorman, L. M., 1970. Correction to paper by Brian T. R. Lewis and LeRoy M. Dorman ‘An isostatic model for the U.S.A. derived from gravity and topographic data’, *J. Geophys. Res.*, **75**(23), 4482.
- Lewis, B. T. R. & Dorman, L. M., 1998. Recording teleseisms on the seafloor; an example from the Juan de Fuca plate, *B. Seismol. Soc. Am.*, **88**(1), 107–116.
- Lewis, K. & Simons, F. J., 2011. Structure and heterogeneity of the Martian crustal magnetic field, *Geophys. Res. Abstr.*, **13**, 13344.
- Lewis, K. W. & Simons, F. J., 2011, Spatial variability of the Martian crustal magnetic field, in *42nd Lunar Planetary Science Conference*, p. 2621.
- Lewis, K. W. & Simons, F. J., 2012. Local spectral variability and the origin of the Martian crustal magnetic field, *Geophys. Res. Lett.*, **39**, L18201, doi: 10.1029/2012GL052708.
- Lewis, K. W., Simons, F. J. & Eggers, G. L., 2013, Maximum-likelihood estimation of lithospheric thickness on Venus, in *44th Lunar Planetary Science Conference*, p. 2612.
- Lewis, K. W., Simons, F. J., Olhede, S. C. & Eggers, G. L., 2017, Maximum-likelihood analysis of planetary roughness, in *48th Lunar Planetary Science Conference*, p. 2608.
- Lewis, M. A. & Ben-Zion, Y., 2007. Examination of scaling between proposed early signals in *P* waveforms and earthquake magnitudes, *Geophys. J. Int.*, **171**(3), 1258–1268.
- Li, A., Fischer, K. M., Wyssession, M. E. & Clarke, T. J., 1998. Mantle discontinuities and temperature under the North American continental keel, *Nature*, **395**, 160–163.
- Li, C., Huang, L., Duric, N., Zhang, H. & Rowe, C., 2009. An improved automatic time-of-flight picker for medical ultrasound tomography, *Ultrasonics*, **49**(1), 61–72, doi: 10.1016/j.ultras.2008.05.005.
- Li, H., 1998. Identification of coherent structure in turbulent shear flow with wavelet correlation spectra, *J. Fl. Eng. — Trans. ASME*, **120**, 778–785.
- Li, J., Kuleli, H. S., Zhang, H. & Toksöz, M. N., 2011. Focal mechanism determination of induced microearthquakes in an oil field using full waveforms from shallow and deep seismic networks, *Geophysics*, **76**(6), WC87–WC101, doi: 10.1190/geo2011–0030.1.
- Li, S. & Mooney, W. D., 1998. Crustal structure of china from deep seismic sounding profiles, *Tectonophysics*, **288**, 105–113.

- Li, X., Aravkin, A. Y., van Leeuwen, T. & Herrmann, F. J., 2012. Fast randomized full-waveform inversion with compressive sensing, *Geophysics*, **77**(3), A13–A17.
- Li, X.-d. & Tanimoto, T., 1993. Waveforms of long-period body waves in a slightly aspherical Earth model, *Geophys. J. Int.*, **112**, 92–102.
- Li, X.-G., Sacchi, M. & Ulrych, T. J., 1996. Wavelet transform inversion with prior scale information, *Geophysics*, **61**(5), 1379–1385.
- Libbrecht, K. G., 1985. Practical considerations for the generation of large-order spherical harmonics, *Solar Physics*, **99**(1–2), 371–373.
- Lieb, V., Schmidt, M., Dettmering, D. & Börger, K., 2016. Combination of various observation techniques for regional modeling of the gravity field, *J. Geophys. Res.*, **121**, 3825–3845, doi: 10.1002/2015JB012586.
- Ligorriá, J. P. & Ammon, C. J., 1999. Iterative deconvolution and receiver-function estimation, *B. Seismol. Soc. Am.*, **89**(5), 1395–1400.
- Lilley, F. E. M., Woods, D. V. & Sloane, M. N., 1981. Electrical conductivity from Australian magnetometer arrays using spatial gradient data, *Phys. Earth Planet. Inter.*, **25**, 202–209.
- Lillis, R. J., Mitchell, D. L., Lin, R. P., Connerney, J. E. P. & Acuña, M. H., 2004. Mapping crustal magnetic fields at Mars using electron reflectometry, *Geophys. Res. Lett.*, **31**, L15702, doi: 10.1029/2004GL020189.
- Lillis, R. J., Bougher, S. W., Mitchell, D. L., Brain, D. A., Lin, R. P. & Acuña, M. H., 2008. Continuous monitoring of nightside upper thermospheric mass densities in the martian southern hemisphere over 4 martian years using electron reflectometry, *Icarus*, **194**, 562–574, doi: 10.1016/j.icarus.2007.09.031.
- Lillis, R. J., Frey, H. V., Manga, M., Mitchell, D. L., Lin, R. P., Acuña, M. H. & Bougher, S. W., 2008. An improved crustal magnetic field map of Mars from electron reflectometry: Highland volcano magmatic history and the end of the martian dynamo, *Icarus*, **194**(2), 575–596, doi: 10.1016/j.icarus.2007.09.032.
- Lillis, R. J., Dufek, J., Bleacher, J. E. & Manga, M., 2009. Demagnetization of crust by magmatic intrusion near the Arsia Mons volcano: Magnetic and thermal implications for the development of the Tharsis province, Mars, *J. Volcanol. Geoth. Res.*, **185**, 123–138, doi: 10.1016/j.jvolgeores.2008.12.007.
- Lillis, R. J., Purucker, M. E., Halekas, J. S., Louzada, K. L., Stewart-Mukhopadhyay, S. T., Manga, M. & Frey, H. V., 2010. Study of impact demagnetization at Mars using Monte Carlo modeling and multiple altitude data, *J. Geophys. Res.*, **115**, E07007, doi: 10.1029/2009JE003556.
- Lillis, R. J., Robbins, S., Manga, M., Halekas, J. S. & Frey, H. V., 2013. Time history of the Martian dynamo from crater magnetic field analysis, *J. Geophys. Res.*, **118**, 1488–1511, doi: 10.1002/jgre.20105.

- Lilly, J. M. & Park, J., 1995. Multiwavelet spectral and polarization analyses of seismic records, *Geophys. J. Int.*, **122**, 1001–1021.
- Lin, T. T. & Herrmann, F. J., 2007. Compressed wavefield extrapolation, *Geophysics*, **72**(5), SM77–SM93.
- Lin, Y., Abubakar, A. & Habashy, T. M., 2012. Seismic full-waveform inversion using truncated wavelet representations, in *SEG Tech. Prog. Expanded Abstracts*, pp. 1–6, doi: 10.1190/segam2012–0043.1, Soc. Explor. Geophys., Denver, Col.
- Lindberg, C. R. & Park, J., 1987. Multiple-taper spectral analysis of terrestrial free oscillations, II, *Geophys. J. R. Astron. Soc.*, **91**, 795–836.
- Linde, N. & Vrugt, J., 2013. Distributed soil moisture from crosshole ground-penetrating radar travel times using stochastic inversion, *Vadose Zone Journal*, **12**(1).
- Lindquist, M. A., Zhang, C. H., Glover, G., Shepp, L. & Yang, Q. X., 2006. A generalization of the two-dimensional prolate spheroidal wave function method for nonrectilinear MRI data acquisition methods, *IEEE T. Image Proc.*, **15**(9), 2792–2804, doi: 10.1109/TIP.2006.877314.
- Lindsey, N. J., Dawe, T. C. & Ajo-Franklin, J. B., 2019. Illuminating seafloor faults and ocean dynamics with dark fiber distributed acoustic sensing, *Science*, **366**(6469), 1103–1107, doi: 10.1126/science.aay5881.
- Linehan, D., 1940. Earthquakes in the West Indian region, *Eos Trans. AGU*, **21**(2), 229–232, doi: 10.1029/TR021i002p00229.
- Lineweaver, C. H. & Barbosa, D., 1996. Cosmic microwave background observations: implications for Hubble’s constant and the spectral parameters n and Q in cold dark matter critical density universes, *Astron. Astroph.*, **329**, 799–808.
- Lineweaver, C. H. & Barbosa, D., 1998. What can cosmic microwave background observations already say about cosmological parameters in open and critical-density cold dark matter models?, *Astroph. J.*, **496**, 624–63.
- Lineweaver, C. H., Barbosa, D., Blanchard, A. & Bartlett, J. G., 1997. Constraints on h , Ω_b and λ_0 from cosmic microwave background observations, *Astron. Astroph.*, **322**, 365–374.
- Linz, P., 1972. A method for computing Bessel function integrals, *Math. Comp.*, **26**(118), 509–513.
- Lipman, P. W., Prostka, H. J. & Christiansen, R. L., 1971. Evolving subduction zones in the western United States, as interpreted from igneous rocks, *Science*, **74**(411), 821–825, doi: 10.1126/science.174.4011.821.
- Liritzis, I. & Kosmatos, D., 1995. Solar-climate cycles in a tree-ring record from Parthenon, *J. Coast. Res.*, **Spec. Iss.**(17), 73–78.
- Lithgow-Bertelloni, C. & Guynn, J. H., 2004. Origin of the lithospheric stress field, *J. Geophys. Res.*, **109**, B01408, doi: 10.1029/2003JB002467.

- Lithgow-Bertelloni, C. & Richards, M. A., 1998. The dynamics of Cenozoic and Mesozoic plate motions, *Rev. Geophys.*, **36**, 27–78.
- Lithgow-Bertelloni, C. & Silver, P. G., 1998. Dynamic topography, plate driving forces and the African superswell, *Nature*, **395**(269–272).
- Lithgow-Bertelloni, C., Richards, M. A., Ricard, Y., O’Connell, R. J. & Engebretson, D. C., 1993. Toroidal-poloidal partitioning of plate motions since 120 ma, *Geophys. Res. Lett.*, **20**(5), 375–378.
- Little, C. M., Oppenheimer, M. & Urban, N. M., 2013. Upper bounds on twenty-first-century Antarctic ice loss assessed using a probabilistic framework, *Nat. Clim. Change*, **3**, 654–659, doi: 10.1038/nclimate1845.
- Little, C. M., Urban, N. M. & Oppenheimer, M., 2013. Probabilistic framework for assessing the ice sheet contribution to sea level change, *Proc. Natl. Acad. Sc.*, **110**(9), 1–6, doi: 10.1073/pnas.1214457110.
- Liu, H.-P. & Archambeau, C. B., 1975. The effect of anelasticity on periods of the earth’s free oscillations (toroidal modes), *Geophys. J. R. Astron. Soc.*, **43**, 795–814.
- Liu, H.-P. & Archambeau, C. B., 1976. Correction to "the effect of anelasticity on periods of the Earth’s free oscillations (toroidal modes)", *Geophys. J. R. Astron. Soc.*, **47**, 1–7.
- Liu, H.-P., Anderson, D. L. & Kanamori, H., 1976. Velocity dispersion due to anelasticity; implications for seismology and mantle composition, *Geophys. J. R. Astron. Soc.*, **47**, 41–58.
- Liu, M., Yuen, D. A., Zhao, W. & Honda, S., 1991. Development of diapiric structures in the upper mantle due to phase transitions, *Science*, **252**, 1836–1839.
- Liu, P. C., 1994, Wavelet spectrum analysis and ocean wind waves, in *Wavelets in Geophysics*, edited by E. Foufoula-Georgiou & P. Kumar, pp. 151–166, Academic Press, San Diego, Calif.
- Liu, Q. & Gu, Y. J., 2012. Seismic imaging: From classical to adjoint tomography, *Tectonophysics*, **566–567**, 31–66, doi: 10.1016/j.tecto.2012.07.006.
- Liu, Q. & Tromp, J., 2006. Finite-frequency sensitivity kernels based upon adjoint methods, *B. Seismol. Soc. Am.*, **96**(6), 2383–2397, doi: 10.1785/0120060041.
- Liu, Q. & Tromp, J., 2008. Finite-frequency sensitivity kernels for global seismic wave equation based upon adjoint methods, *Geophys. J. Int.*, **174**, 265–286, doi: 10.1111/j.1365–246X.2008.03798.x.
- Liu, Q., Polet, J., Komatitsch, D. & Tromp, J., 2004. Spectral-element moment tensor inversions for earthquakes in southern California, *B. Seismol. Soc. Am.*, **94**(5), 1748–1761, doi: 10.1785/012004038.
- Liu, Q., bin Waheed, U., Borisov, D., Simons, F. J., Gao, F. & Williamson, P., 2022. Full-waveform centroid moment tensor inversion of passive seismic data acquired at the hydrocarbon exploration scale, *Geophys. J. Int.*, **230**(3), 1725–1750, doi: 10.1093/gji/ggac137.

- Liu, T.-C. & van Veen, B. D., 1992. Multiple window based minimum variance spectrum estimation for multidimensional random fields, *IEEE T. Signal Process.*, **40**(3), 578–589, doi: 10.1109/78.120801.
- Liu, W., 2016, *Analysis of Martian topography via a parameterized spectral approach*, A. b., Princeton University.
- Liu, X. & Chen, B., 2000. Climatic warming in the Tibetan Plateau during recent decades, *Int. J. Climatol.*, **20**(14), 1729–1742, doi: 10.1002/1097-0088(20001130)20:14<1729::AID-JOC556>3.0.CO;2-Y.
- Liu, Y., Chang, X., Jin, D., He, R., Sun, H. & Zheng, Y., 2011. Reverse time migration of multiples for subsalt imaging, *Geophysics*, **76**(5), WB209–WB216, doi: 10.1190/geo2010-0312.1.
- Liu, Z., Hoffmann, J., Simons, F. J. & Tromp, J., 2021, Elastic full waveform inversion of VSP data from a complex anticline in northern Iraq, in *SEG Tech. Prog. Expanded Abstracts*, pp. 637–641, doi: 10.1190/segam2021-3582871.1, Soc. Explor. Geophys., Denver, Col.
- Liu, Z., Hoffmann, J., Simons, F. J. & Tromp, J., 2022, 3-D acoustic-elastic full-waveform inversion and migration of marine VSP data from Norway, in *SEG Tech. Prog. Expanded Abstracts*, pp. 797–801, doi: 10.1190/image2022-3750936.1, Soc. Explor. Geophys., Denver, Col.
- Lockman, A. B. & Allen, R. M., 2005. Single-station earthquake characterization for early warning, *B. Seismol. Soc. Am.*, **95**(6), 2029–2039, doi: 10.1785/0120040241.
- Lockwood, O. G. & Kanamori, H., 2006. Wavelet analysis of the seismograms of the 2004 Sumatra-Andaman earthquake and its application to tsunami early warning, *Geochem. Geophys. Geosys.*, **7**(9), Q09013, doi: 10.1029/2006GC001272.
- Logg, A., Andre-Mardal, K. & Wells, G. N., 2012. *Automated Solution of Differential Equations by the Finite Element Method: The FEniCS Book*, vol. 84 of **Lecture Notes in Computational Science and Engineering**, Springer, Berlin, Germany.
- Lognonné, P., 2005. Planetary seismology, *Annu. Rev. Earth Planet. Sc.*, **33**, 571–604, doi: 10.1146/annurev.earth.33.092203.122604.
- Lognonné, P. & Clévéde, E., 1997. Diffraction of long period Rayleigh waves by a slab: effects of mode coupling, *Geophys. Res. Lett.*, **24**(9), 1035–1038.
- Lognonné, P. & Clévéde, E., 2002, Chapter 10: Normal modes of the Earth and planets, in *International Handbook on Earthquake and Engineering Seismology*, edited by H. Kanamori, P. Jennings, & W. Lee, no. 81A in Int. Geophys. Ser., Academic Press, San Diego, Calif.
- Lognonné, P. & Mosser, B., 1993. Planetary seismology, *Surv. Geophys.*, **14**, 239–302.
- Lognonné, P., Giardini, D., Banerdt, B., Gagnepain-Beyneix, J., Mocquet, A., Spohn, T., Karczewski, J. F., Schibler, P., Cacho, S., Pike, W. T., Cavoit, C., Desautez, A., Favède, M., Gabsi, T., Simoulin, L., Striebig, N., Campillo, M., Deschamps, A., Hinderer, J., Lévêque, J. J., Montagner, J. P., Rivera, L., Benz, W., Breuer, D., Defraigne, P., Dehant, V., Fujimura, A., Mizutani,

- H. & Oberst, J., 2000. The NetLander very broad band seismometer, *Planet. Space Sci.*, **48**, 1289–1302.
- Lognonné, P., Gagnepain-Beyneix, J. & Chenet, H., 2003. A new seismic model of the Moon: Implications for structure, thermal evolution and formation of the Moon, *Earth Planet. Sci. Lett.*, **211**, 27–44.
- Lognonné, P., Banerdt, W. B., Pike, W. T., Giardini, D., Christensen, U., Garcia, R. F., Kawamura, T., Kedar, S., Knapmeyer-Endrun, B., Margerin, L., Nimmo, F., Panning, M., Tauzin, B., Scholz, J.-R., Antonangeli, D., Barkaoui, S., Beucler, E., Bissig, F., Brinkman, N., Calvet, M., Ceylan, S., Charalambous, C., Davis, P., van Driel, M., Drilleau, M., Fayon, L., Joshi, R., Kenda, B., Khan, A., Knapmeyer, M., Lekić, V., McClean, J., Mimoun, D., Murdoch, N., Pan, L., Perrin, C., Pinot, B., Pou, L., Menina, S., Rodriguez, S., Schmelzbach, C., Schmerr, N., Sollberger, D., Spiga, A., Stähler, S., Stott, A., Stutzmann, E., Tharimena, S., Widmer-Schmidrig, R., Andersson, F., Ansan, V., Beghein, C., Böse, M., Bozdağ, E., Clinton, J., Daubar, I., Delage, P., Fuji, N., Golombek, M., Grott, M., Horleston, A., Hurst, K., **Irving, J. C. E.**, Jacob, A., Knollenberg, J., Krasner, S., Krause, C., Lorenz, R., Michaut, C., Myhill, R., Nissen-Meyer, T., ten Pierick, J., Plesa, A. C., Quantin-Nataf, C., Robertsson, J., Rochas, L., Schimmel, M., Smrekar, S., Spohn, T., Teanby, N., Tromp, J., Vallade, J., Verdier, N., Vrettos, C., Weber, R., Banfield, D., Barrett, E., Bierwirth, M., Calcutt, S., Compaire, N., Johnson, C. L., Mance, D., Euchner, F., Kerjean, L., Mainsant, G., Mocquet, A., Rodriguez Manfredi, J. A., Pont, G., Laudet, P., Nebut, T., de Raucourt, S., Robert, O., Russell, C. T., Sylvestre-Baron, A., Tillier, S., Warren, T., Wieczorek, M., Yana, C. & Zweifel, P., 2020. Constraints on the shallow elastic and anelastic structure of Mars from InSight seismic data, *Nature Geosci.*, **13**(3), 213–220, doi: 10.1038/s41561-020-0536-y.
- Lois, A., Sokos, E., Martakis, N., Paraskevopoulos, P. & Tselentis, G.-A., 2013. A new automatic *s*-onset detection technique: Application in local earthquake data, *Geophysics*, **78**(1), KS1–KS11, doi: 10.1190/geo2012-0050.1.
- Long, M. D., de Hoop, M. V. & van der Hilst, R. D., 2008. Wave-equation shear wave splitting tomography, *Geophys. J. Int.*, **172**(1), 311–330, 10.1111/j.1365-246X.2007.03632.x.
- Long, M. D., Levander, A. & Shearer, P. M., 2014. An introduction to the special issue of Earth and Planetary Science Letters on USArray science, *Earth Planet. Sci. Lett.*, **402**, 1–5, doi: 10.1016/j.epsl.2014.06.016.
- Longuet-Higgins, M. S., 1950. A theory of the origin of microseisms, *Phil. Trans. R. Soc. London, Ser. A*, **243**(857), 1–35, doi: 10.1098/rsta.1950.0012.
- Longuevergne, L., Scanlon, B. R. & Wilson, C. R., 2010. GRACE hydrological estimates for small basins: Evaluating processing approaches on the High Plains Aquifer, USA, *Water Resources Res.*, **46**(11), W11517, doi: 10.1029/2009WR008564.
- Lopatka, A., 2019. Deploying seismometers where they're needed most: Underwater, *Phys. Today*, p. doi: 10.1063/PT.6.1.20190524a.
- Lopatka, A., 2021. Solving the century-old mystery of background Love waves, *Phys. Today*, **74**(1), 17–19, doi: 10.1063/PT.3.4651.

- Loris, I., 2008. L1Packv2: A Mathematica package for minimizing an ℓ_1 -penalized functional, *Comput. Phys. Comm.*, **179**, 895–902, doi: 10.1016/j.cpc.2008.07.010.
- Loris, I., 2009. On the performance of algorithms for the minimization of ℓ_1 -penalized functionals, *Inv. Probl.*, **25**, 035008, doi: 10.1088/0266–5611/25/3/035008.
- Loris, I. & Verhoeven, C., 2012. Iterative algorithms for total variation-like reconstructions in seismic tomography, *Intern. J. Geomath.*, **3**(2), 179–208, doi:10.1007/s13137–012–0036–3.
- Loris, I., Nolet, G., Daubechies, I. & Dahlen, F. A., 2007. Tomographic inversion using ℓ_1 -norm regularization of wavelet coefficients, *Geophys. J. Int.*, **170**(1), 359–370, doi: 10.1111/j.1365–246X.2007.03409.x.
- Loris, I., Simons, F. J., Daubechies, I. C., Nolet, G., Fornasier, M., Vetter, P. A., Judd, S. J. & Voronin, S., 2009. A new approach to global seismic tomography that promotes sparsity with a new three-dimensional wavelet transform in spherical geometry, *Eos Trans. AGU*, **90**(52), Fall Meet. Suppl., Abstract S31D–02.
- Loris, I., Douma, H., Nolet, G., Daubechies, I. & Regone, C., 2010. Nonlinear regularization techniques for seismic tomography, *J. Comput. Phys.*, **229**(3), 890–905, doi: 10.1016/j.jcp.2009.10.020.
- Loris, I., Simons, F. J., Daubechies, I., Nolet, G., Fornasier, M., Vetter, P., Judd, S., Voronin, S., Vonesch, C. & Charléty, J., 2010. A new approach to global seismic tomography based on regularization by sparsity in a novel 3D spherical wavelet basis, *Geophys. Res. Abstr.*, **12**, 6033.
- Loris, I., Simons, F. J., Daubechies, I. C., Nolet, G., Fornasier, M., Vetter, P. A., Judd, S. J., Voronin, S., Vonesch, C. & Charléty, J., 2010. Solving or resolving global tomographic models with spherical wavelets, and the scale and sparsity of seismic heterogeneity, *Abstract S41C-06 presented at 2010 Fall Meeting, AGU, San Francisco, Calif., 13–17 Dec.*
- Loughlin, P. J. & Tacer, B., 1997. Comments on the interpretation of instantaneous frequency, *IEEE Signal Process. Lett.*, **4**(5), 123–125.
- Love, A. E. H., 1909. The yielding of the Earth to disturbing forces, *Proc. R. Soc. London, Ser. A*, **82**, 73–88.
- Lovejoy, S., 2013. What is climate?, *Eos Trans. AGU*, **94**(1), 1–2, doi: 10.1002/2013EO010001.
- Løviknes, K., Jeddi, Z., Lars, L. O. & Barreyre, T., 2020. When clocks are not working: OBS time correction, *Seismol. Res. Lett.*, **91**, 2247–2258, doi: 10.1785/0220190342.
- Lowes, F. J., 1966. Mean-square values on sphere of spherical harmonic fields, *J. Geophys. Res.*, **71**(8), 2179.
- Lowes, F. J., 1974. Spatial power spectrum of the main geomagnetic field and extrapolation to core, *Geophys. J. R. Astron. Soc.*, **36**(3), 717–730.

- Lowes, F. J. & Winch, D. E., 2012. Orthogonality of harmonic potentials and fields in spheroidal and ellipsoidal coordinates: application to geomagnetism and geodesy, *Geophys. J. Int.*, **191**(2), 491–507, doi: 10.1111/j.1365–246X.2012.05590.x.
- Lowes, F. J., de Santis, A. & Duka, B., 1995. A discussion of the uniqueness of a Laplacian potential when given only partial field information on a sphere, *Geophys. J. Int.*, **121**(2), 579–584.
- Lowrie, W., 2007. *Fundamentals of Geophysics*, Cambridge Univ. Press, Cambridge, UK, 2nd edn.
- Lowrie, W., 2011. *A Students' Guide to Geophysical Equations*, Cambridge Univ. Press, Cambridge, UK, 1st edn.
- Lowry, A. R. & Pérez-Gussinyé, M., 2011. The role of crustal quartz in controlling Cordilleran deformation, *Nature*, **471**(7338), 353–357, doi: 10.1038/nature09912.
- Lowry, A. R. & Smith, R. B., 1994. Flexural rigidity of the Basin and Range–Colorado Plateau–Rocky Mountain transition from coherence analysis of gravity and topography, *J. Geophys. Res.*, **99**(B10), 20123–20140.
- Lowry, A. R. & Smith, R. B., 1995. Strength and rheology of the western U. S. Cordillera, *J. Geophys. Res.*, **100**(B9), 17947–17963.
- Loyer, S., 1994, *Topographie dynamique des océans. Etude de ces modes de représentation*, Master's thesis, Université Paul Sabatier, Toulouse, France.
- Lu, S.-Y. & Berryman, J. G., 1990. Inverse scattering, seismic traveltimes tomography, and neural networks, *Int. J. Imaging Sys. Techn.*, **2**, 112–118.
- Lubetkin, L. K. C. & Clark, M. M., 1988. Late Quaternary activity along the Lone Pine fault, eastern California, *Geol. Soc. Amer. Bull.*, **100**, 755–766.
- Lucas, S. B., Green, A., Hajnal, Z., White, D., Lewry, J., Ashton, K., Weber, W. & Clowes, R., 1993. Deep seismic profile across a Proterozoic collision zone: Surprises at depth, *Nature*, **363**, 339–342.
- Luh, P. C. & Dziewoński, A. M., 1976. Theoretical seismograms for the Colombian earthquake of 1970 July 31, *Geophys. J. R. Astron. Soc.*, **43**(3), 679–695, doi: 10.1111/j.1365–246X.1975.tb06187.x.
- Luh, P. C. & Dziewoński, A. M., 1976. Theoretical normal-mode spectra of a rotating elliptical Earth, *Geophys. J. R. Astron. Soc.*, **45**, 617–645, doi: 10.1111/j.1365–246X.1978.tb05347.x.
- Luo, J., Wu, R.-S. & Gao, F., 2018. Time-domain full waveform inversion using instantaneous phase information with damping, *J. Geophys. Eng.*, **15**(3), 1032–1041, doi: 10.1088/1742–2140/aaa984.
- Luo, Y. & Schuster, G. T., 1991. Wave-equation traveltimes inversion, *Geophysics*, **56**(5), 654–663, doi: 10.1190/1.1443081.

- Luo, Y., Zhu, H., Nissen-Meyer, T., Morency, C. & Tromp, J., 2009. Seismic modeling and imaging based upon spectral-element and adjoint methods, *The Leading Edge*, **28**(5), 568–574, doi: 10.1190/1.3124932.
- Luo, Y., Tromp, J., Denel, B. & Calandra, H., 2013. 3D coupled acoustic-elastic migration with topography and bathymetry based on spectral-element and adjoint methods, *Geophysics*, **78**(4), S193–S202, doi: 10.1190/geo2012–0462.1.
- Luo, Y., Modrak, R. & Tromp, J., 2015, Strategies in adjoint tomography, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, pp. 1943–2001, doi: 10.1007/2F978–3–642–27793–1_96–2, Springer, Heidelberg, Germany, 2nd edn.
- Luscombe, J. J. & Luban, M., 1998. Simplified recursive algorithm for Wigner $3j$ and $6j$ symbols, *Phys. Rev. E*, **57**(6), 7274–7277.
- Luthcke, S. B., Rowlands, D. D., Lemoine, F. G., Klosko, S. M., Chinn, D. & McCarthy, J. J., 2006. Monthly spherical harmonic gravity field solutions determined from GRACE inter-satellite range-rate data alone, *Geophys. Res. Lett.*, **33**(2), L02402, doi: 10.1029/2005GL024846.
- Luthcke, S. B., Zwally, H. J., Abdalati, W., Rowlands, D. D., Ray, R. D., Nerem, R. S., Lemoine, F. G., McCarthy, J. J. & Chinn, D. S., 2006. Recent Greenland ice mass loss by drainage system from satellite gravity observations, *Science*, **314**, 1286–1289.
- Luthcke, S. B., Arendt, A. A., Rowlands, D. D., McCarthy, J. J. & Larsen, C. F., 2008. Recent glacier mass changes in the Gulf of Alaska region from GRACE mascon solutions, *J. Glaciol.*, **54**(188), 767–777, doi: 10.3189/002214308787779933.
- Luthcke, S. B., Rowlands, D. D., Arendt, A., McCarthy, J. J., Zwally, H. J., Lemoine, F. G. & Boy, J. P., 2008, GRACE observations of land ice evolution, in *Proc. 2008 GRACE Science Team Meeting*, pp. 617–631, Center for Space Research, U. Texas Austin.
- Luthcke, S. B., Sabaka, T. J., Loomis, B. D., Arendt, A. A., McCarthy, J. J. & Camp, J., 2013. Antarctica, Greenland and Gulf of Alaska land-ice evolution from an iterated GRACE global mascon solution, *J. Glaciol.*, **59**(216), 613–631, doi: 10.3189/2013JoG12J147.
- Lykotrafitis, G., Rosakis, A. J. & Ravichandran, G., 2006. Self-healing pulse-like shear ruptures in the laboratory, *Science*, **313**(5794), 1765–1768, doi: 10.1126/science.1128359.
- Lyons, S. N., Sandwell, D. T. & Smith, W. H. F., 2000. Three-dimensional estimation of elastic thickness under the Louisville Ridge, *J. Geophys. Res.*, **105**(B6), 13239–13252.
- Ma, B. B., Nystuen, J. A. & Lien, R.-C., 2005. Prediction of underwater sound levels from rain and wind, *J. Acoust. Soc. Am.*, **117**(6), 3555–3565, doi: 10.1121/1.1910283.
- Ma, J., Rokhlin, V. & Wandzura, S., 1996. Generalized Gaussian quadrature rules for systems of arbitrary functions, *SIAM J. Numer. Anal.*, **33**(3), 971–996.
- Ma, Y. & Hale, D., 2012. Quasi-Newton full-waveform inversion with a projected Hessian matrix, *Geophysics*, **77**(5), R207–R216, doi: 10.1190/GEO2011–0519.1.

- Macario, A., Malinverno, A. & Haxby, W. F., 1995. On the robustness of elastic thickness estimates obtained using the coherence method, *J. Geophys. Res.*, **100**(B8), 15163–15172.
- Mackenzie, D., 2007. Mathematicians confront climate change, *SIAM News*, **40**(5).
- Mackenzie, D., 2009. Power from the oceans, *SIAM News*, **42**(6).
- MacKenzie, W. S. & Adams, A. E., 1994. *A color atlas of rocks and minerals in thin section*, Manson, London, UK.
- Macmillan, S., Maus, S., Bondar, T., Chambodut, A., Golovkov, V., Holme, R., Langlais, B., Lesur, V., Lowes, F., Lühr, H., Mai, W., Manda, M., Olsen, N., Rother, M., Sabaka, T., Thomson, A. & Wardinski, I., 2003. Ninth generation International Geomagnetic Reference Field Released, *Eos Trans. AGU*, **84**(46), 503.
- Macnab, R., 2009. Houston, we have a problem: Satellite altimetry skews ocean depths, *Eos Trans. AGU*, **90**(36), 312.
- Maddox, J., 2002. Slamming the door, *Nature*, **417**(6892), 903.
- Maeda, N., 1985. A method for reading and checking phase time in auto-processing system of seismic wave data, *Zisin (J. Seismol. Soc. Japan)*, **38**(3), 365–379, doi: 10.4294/zisin1948.38.3_365.
- Maeda, T. & Furumura, T., 2013. FDM simulation of seismic waves, ocean acoustic waves, and tsunamis based on tsunami-coupled equations of motion, *Pure Appl. Geophys.*, **170**, 109–127, doi: 10.1007/s00024-011-0430-z.
- Magazine, T., 1956. Taping the Earth, *Time*, **67**(20), 75.
- Maggi, A., Jackson, J. A., McKenzie, D. & Priestley, K., 2000. Earthquake focal depths, effective elastic thickness, and the strength of the continental lithosphere, *Geology*, **28**(6), 495–498.
- Maggi, A., Tape, C., Chen, M., Chao, D. & Tromp, J., 2009. An automated time-window selection algorithm for seismic tomography, *Geophys. J. Int.*, **178**(1), 257–281, doi: 10.1111/j.1365-246X.2009.04099.x.
- Magueijo, J. & Hobson, M. P., 1997. Ideal scales for weighing the Universe, *Phys. Rev. D*, **56**(4), 1908–1923.
- Main, D. J. & Hammon III, W. S., 2003. The application of Ground Penetrating Radar as a mapping technique at vertebrate fossil excavations in the Cretaceous of Texas, *Cretaceous Res.*, **24**(3), 335–345.
- Main, R. P., de Ricqlès, A., Horner, J. R. & Padian, K., 2005. The evolution and function of thyreophoran dinosaur scutes, *Paleobiology*, **31**(2), 291–314.
- Mainprice, D. & Silver, P. G., 1993. Interpretation of *sks*-waves using samples from the subcontinental lithosphere, *Phys. Earth Planet. Inter.*, **78**, 257–280.

- Malamud, B. D. & Turcotte, D. L., 1999. Self-affine time series: I. Generation and analyses, *Adv. Geophys.*, **40**, 1–90.
- Malevsky, A. V. & Yuen, D. A., 1992. Strongly chaotic non-Newtonian mantle convection, *Geophys. Astrophys Fluid Dyn.*, **65**(1-4), 149–171.
- Malik, N. & Lim, J. S., 1982. Properties of two-dimensional maximum entropy power spectrum estimates, *IEEE T. Acoust. Speech Signal Process.*, **30**, 788–798.
- Malinverno, A., 1991. Inverse square-root dependence of mid-ocean-ridge flank roughness on spreading rate, *Nature*, **352**, 58–60, doi: 10.1038/352058a0.
- Malischewsky, P. G., 2000. Some special solutions of Rayleigh’s equation and the reflections of body waves at a free surface, *Geofísica Intern.*, **39**(2), 155–160.
- Mallat, S., 1998. *A Wavelet Tour of Signal Processing*, Academic Press, San Diego, Calif.
- Mallat, S., 2008. *A Wavelet Tour of Signal Processing, The Sparse Way*, Academic Press, San Diego, Calif., 3rd edn.
- Mallat, S. G., 1989. Multiresolution approximations and wavelet orthonormal bases of $L^2(\mathbb{R})$, *Trans. Am. Math. Soc.*, **315**(1), 69–87.
- Mallat, S. G., 1989. Multifrequency channel decompositions of images and wavelet models, *IEEE T. Acoust. Speech Signal Process.*, **37**(12), 2091–2110.
- Maloof, A. C., Rose, C. V., Calmet, C. C., Beach, R., Samuels, B. M., Erwin, D. H., Poirier, G. R., Yao, N. & Simons, F. J., 2010. Possible animal body-fossils from pre-Marinoan limestones, South Australia, *Nature Geosci.*, **3**(9), 653–659, doi: 10.1038/ngeo934.
- Malvern, L. E., 1969. *Introduction to the Mechanics of a Continuous Medium*, Prentice-Hall, Englewood Cliffs, New Jersey.
- Mandelbrot, B., 1967. How long is the coast of Britain? Statistical self-similarity and fractional dimension, *Science*, **156**(3775), 636–638.
- Manga, M. & O’Connell, R. J., 1995. The tectosphere and postglacial rebound, *Geophys. Res. Lett.*, **22**(15), 1949–1952.
- Maniar, H. & Mitra, P. P., 2005. The concentration problem for vector fields, *Int. J. Bioelectromagn.*, **7**(1), 142–145.
- Mann, M. E. & Park, J., 1996. Joint spatiotemporal modes of surface temperature and sea level pressure variability in the northern hemisphere during the last century, *J. Climate*, **9**(9), 2137–2162.
- Mansinha, L., Stockwell, R. G., Lowe, R. P., Eramian, M. & Schincariol, R. A., 1997. Local S-spectrum analysis of 1-D and 2-D data, *Phys. Earth Planet. Inter.*, **103**(3–4), 329–336.

- Mantovani, M. S. M., de Freitas, S. R. C. & Shukowsky, W., 2001. Tidal gravity anomalies as a tool to measure rheological properties of the continental lithosphere: application to the South American Plate, *J. South Am. Earth Sci.*, **14**, 1–14.
- Mantovani, M. S. M., Shukowsky, W., de Freitas, S. R. C. & Neves, B. B. B., 2005. Lithosphere mechanical behavior inferred from tidal gravity anomalies: a comparison of Africa and South America, *Earth Planet. Sci. Lett.*, **230**, 397–412.
- Manzi, M. S. D., Durrheim, R. J., Hein, K. A. A. & King, N., 2012. 3D edge detection seismic attributes used to map potential conduits for water and methane in deep gold mines in the Witwatersrand basin, South Africa, *Geophysics*, **77**(5), WC133–WC147, doi: 10.1190/GEO2012–0135.1.
- Manzi, M. S. D., Gibson, M. A. S., Hein, K. A. A., King, N. & Durrheim, R. J., 2012. Application of 3D seismic techniques to evaluate ore resources in the West Wits Line goldfield and portions of the West Rand goldfield, South Africa, *Geophysics*, **77**(5), WC163–WC171, doi: 10.1190/GEO2012–0133.1.
- Maraschini, M., Ernst, F., Foti, S. & Socco, L. V., 2010. A new misfit function for multimodal inversion of surface waves, *Geophysics*, **75**(4), G31–G43, doi: 10.1190/1.3436539.
- Marchaud, F. B. T., de Villiers, G. D. & Pike, E. R., 1971. Element positioning for linear arrays using generalized Gaussian quadrature, *IEEE T. Anten. Propag.*, **6**, 1357–1363, doi: 10.1109/TAP.2003.812276.
- Mardia, K. V. & Marshall, R. J., 1984. Maximum likelihood estimation of models for residual covariance in spatial regression, *Biometrika*, **71**(1), 135–146.
- Mareschal, J.-C., 1989. Fractal reconstruction of sea-floor topography, *Pure Appl. Geophys.*, **131**(1–2), 197–210.
- Mareschal, J.-C. & Kuang, J., 1986. Intraplate stresses and seismicity: the role of topography and density heterogeneities, *Tectonophysics*, **132**(1–3), 153–162.
- Mareschal, M., Kellett, R. L., Kurtz, R. D., Ludden, J. N., Ji, S. & Bailey, R. C., 1995. Archaean cratonic roots, mantle shear zones and deep electrical anisotropy, *Nature*, **375**, 134–137.
- Margerin, L. & Nolet, G., 2003. Multiple scattering of high-frequency seismic waves in the deep Earth: PKP precursor analysis and inversion for mantle granularity, *J. Geophys. Res.*, **108**, 2514, doi: 10.1029/2003JB002455.
- Marinucci, D. & Peccati, G., 2010. Representations of $SO(3)$ and angular polyspectra, *J. Multiv. Anal.*, **191**, 77–100, doi: 10.1016/j.jmva.2009.04.017.
- Marinucci, D., Pietrobon, D., Balbi, A., Baldi, P., Cabella, P., Kerkycharian, G., Natoli, P., Picard, D. & Vittorio, N., 2008. Spherical needlets for cosmic microwave background data analysis, *Mon. Not. R. Astron. Soc.*, **383**(2), 539–545, doi: 10.1111/j.1365–2966.2007.12550.x.

- Marone, C. & Richardson, E., 2006. Do earthquakes rupture piece by piece or all together?, *Science*, **313**(5794), 1748–1749, doi: 10.1126/science.1131296.
- Marone, F. & Romanowicz, B., 2007. The depth distribution of azimuthal anisotropy in the continental upper mantle, *Nature*, **447**, 198–201, doi: 10.1038/nature05742.
- Marquardt, D. W., 1963. An algorithm for least-squares estimation of nonlinear parameters, *J. Soc. Industr. Appl. Math.*, **11**(1), 431–444.
- Marquardt, D. W., 1970. Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation, *Technom.*, **12**, 591–612.
- Marquering, H. & Snieder, R., 1995. Surface-wave mode coupling for efficient forward modelling and inversion of body-wave phases, *Geophys. J. Int.*, **120**, 186–208.
- Marquering, H. & Snieder, R., 1996. Shear-wave velocity structure beneath Europe, the Northeastern Atlantic and Western Asia from waveform inversions including surface-wave mode coupling, *Geophys. J. Int.*, **127**, 283–304.
- Marquering, H., Snieder, R. & Nolet, G., 1996. Waveform inversions and the significance of surface-wave mode coupling, *Geophys. J. Int.*, **124**, 258–278.
- Marquering, H., Nolet, G. & Dahlen, F. A., 1998. Three-dimensional waveform sensitivity kernels, *Geophys. J. Int.*, **132**, 521–534.
- Marquering, H., Dahlen, F. A. & Nolet, G., 1999. Three-dimensional sensitivity kernels for finite-frequency travel times: the banana-doughnut paradox, *Geophys. J. Int.*, **137**(3), 805–815, doi: 10.1046/j.1365-246x.1999.00837.x.
- Marra, G., Clivati, C., Lockett, R., Tampellini, A., Kronjäger, J., Wright, L., Mura, A., Levi, F., Robinson, S., Xuereb, A. et al., 2018. Ultrastable laser interferometry for earthquake detection with terrestrial and submarine cables, *Science*, **361**(6401), 486–490, doi: 10.1126/science.aat4458.
- Marshak, S., 2005. *Earth: Portrait of a Planet*, W. W. Norton, New York, 2nd edn.
- Martin, D. & Nokes, R., 1988. Crystal settling in a vigorously convecting magma chamber, *Nature*, **332**(6164), 534–536, doi: 10.1038/332534a0.
- Martin, D. & Nokes, R., 1989. A fluid-dynamical study of crystal settling in convecting magmas, *J. Petrol.*, **30**(6), 1471–1500, doi: 10.1093/petrology/30.6.1471.
- Martin, G. S., Wiley, R. & Marfurt, K. J., 2006. Marmousi2: An elastic upgrade for Marmousi, *The Leading Edge*, **25**(2), 156–166.
- Martin, J., Wilcox, L. C., Burstedde, C. & Ghattas, O., 2012. A stochastic Newton MCMC method for large-scale statistical inverse problems with application to seismic inversion, *SIAM J. Sci. Comput.*, **34**(3), A1460–A1487, doi: 10.1137/110845598.

- Martinec, Z., 2010, The forward and adjoint methods of global electromagnetic induction for CHAMP magnetic data, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 19, pp. 565–624, doi: 10.1007/978-3-642-01546-5_19, Springer, Heidelberg, Germany.
- Maruyama, S., Santosh, M. & Zhao, D., 2007. Superplume, supercontinent, and post-perovskite: Mantle dynamics and anti-plate tectonics on the Core–Mantle Boundary, *Gondwana Res.*, **11**(1–2), 7–37.
- Masoni, I., Brossier, R., Virieux, J. & Boelle, J. L., 2014, Robust full waveform inversion of surface waves, in *SEG Tech. Prog. Expanded Abstracts*, pp. 1126–1130, doi: 10.1190/segam2014-1077.1, Soc. Explor. Geophys., Denver, Col.
- Masters, G., 1997. Tracking slabs in the lower mantle, *Nature*, **386**, 558.
- Masters, G. & Richards-Dinger, K., 1998. On the efficient calculation of ordinary and generalized spherical harmonics, *Geophys. J. Int.*, **135**(1), 307–309.
- Masters, G., Jordan, T. H., Silver, P. G. & Gilbert, F., 1982. Aspherical Earth structure from fundamental spheroidal-mode data, *Nature*, **298**(5875), 609–613.
- Masters, G., Johnson, S., Laske, G. & Bolton, H., 1996. A shear-velocity model of the mantle, *Phil. Trans. R. Soc. London, Ser. A*, **354**(1711), 1385–1411.
- Masters, G., Laske, G., Bolton, H. & Dziewonski, A. M., 2000, The relative behavior of shear velocity, bulk sound speed, and compressional velocity in the mantle: implications for chemical and thermal structure, in *Earth’s Deep Interior. Mineral Physics and Tomography from the Atomic to the Global Scale*, edited by S. Karato, A. Forte, R. Liebermann, G. Masters, & L. Stixrude, vol. 117 of **Geophysical Monograph**, pp. 63–87, Amer. Geophys. Union, Washington, D. C.
- Masters, T. G., 1989. Low-frequency seismology and the three-dimensional structure of the earth, *Phil. Trans. R. Soc. London, Ser. A*, **328**(1599), 329–349.
- Matabos, M., Best, M., Blandin, J., Hoeberechts, M., Juniper, S. K., Pirenne, B., Robert, K., Ruhl, H. A., Sarrazin, J. & Vardaro, M., 2016, Seafloor observatories, in *Biological Sampling in the Deep Sea*, edited by M. Clark, M. Consalvey, & A. A. Rowden, chap. 14, pp. 306–337, doi: 10.1002/9781118332535.ch14, Wiley, Chichester, UK.
- Mather, J. C., Fixsen, D. J., Shafer, R. A., Mosier, C. & Wilkinson, D. T., 1999. Calibrator design for the *cobe* Far Infrared Absolute Spectrophotometer (FIRAS), *Astroph. J.*, **512**, 511–520.
- Matsubara, T., 2004. Correlation function in deep redshift space as a cosmological probe, *Astroph. J.*, **615**, 573–585, doi: 10.1086/424561.
- Matsuda, Y. & Yajima, Y., 2009. Fourier analysis of irregularly spaced data on r^d , *J. R. Stat. Soc., Ser. B*, **71**(1), 191–217.

- Matsumoto, H., Dziak, R. P., Mellinger, D. K., Fowler, M., Haxel, J., Lau, A., Meinig, C., Bumgardner, J. & Hannah, W., 2006. Autonomous hydrophones at NOAA/OSU and a new seafloor sentry system for real-time detection of acoustic events, *Oceans 2006*, **1–4**, 1831–1834, doi: 10.1109/OCEANS.2006.307041.
- Matsumoto, H., Jones, C., Klinck, H., Mellinger, D. K., Dziak, R. P. & Meinig, C., 2013. Tracking beaked whales with a passive acoustic profiler float, *J. Acoust. Soc. Am.*, **133**(2), 731–740, doi: 10.1121/1.4773260.
- Matsuo, K. & Heki, K., 2010. Time-variable ice loss in Asian high mountains from satellite gravimetry, *Earth Planet. Sci. Lett.*, **290**(1–2), 30–36, doi: 10.1016/j.epsl.2009.11.053.
- Matsuo, K. & Heki, K., 2011. Coseismic gravity changes of the 2011 Tohoku-Oki earthquake from satellite gravimetry, *Geophys. Res. Lett.*, **38**, L00G12, doi: 10.1029/2011GL049018.
- Matthews, M. C., Hope, V. S. & Clayton, C. R. I., 1996. The use of surface waves in the determination of ground stiffness profiles, *Proc. ICE — Geotechnical Engineering*, **119**(2), 84–95, doi: 10.1680/igeng.1996.28168.
- Matz, G. & Hlawatsch, F., 2000. Time-frequency coherence analysis of nonstationary random processes, in *Proc. IEEE-SP Workshop on Statistical Signal and Array Proc.*, pp. 554–558, IEEE, Pocono Manor, PA.
- Mauersberger, P., 1956. Das Mittel der Energiedichte des geomagnetischen Hauptfeldes an der Erdoberfläche und seine säkulare Änderung, *Gerlands Beitr. Geophys.*, **65**, 207–215.
- Maupin, V., 1985. Partial derivatives of surface wave phase velocities for flat anisotropic models, *Geophys. J. R. Astron. Soc.*, **83**, 379–398.
- Maupin, V. & Kolstrup, M. L., 2015. Insights in *P*- and *S*-wave relative traveltime tomography from analysing finite-frequency Fréchet kernels, *Geophys. J. Int.*, **202**(3), 1581–1598. doi: 10.1093/gji/ggv239.
- Maus, S., 2008. The geomagnetic power spectrum, *Geophys. J. Int.*, **174**, 135–142, doi: 10.1111/j.1365–246X.2008.03820.x.
- Maus, S., 2010. An ellipsoidal harmonic representation of Earth’s lithospheric magnetic field to degree and order 720, *Geochem. Geophys. Geosys.*, **11**(6), Q06015, doi: 10.1029/2010GC003026.
- Maus, S. & Dimri, V., 1996. Depth estimation from the scaling power spectrum of potential fields?, *Geophys. J. Int.*, **124**(1), 113–120, doi: 10.1111/j.1365–246X.1996.tb06356.x.
- Maus, S., Lühr, H. & Purucker, M., 2006. Simulation of the high-degree lithospheric field recovery for the *Swarm* constellation of satellites, *Earth Planets Space*, **58**, 397–407.
- Maus, S., Rother, M., Hemant, K., Stolle, C., Lühr, H., Kuvshinov, A. & Olsen, N., 2006. Earth’s lithospheric magnetic field determined to spherical harmonic degree 90 from CHAMP satellite measurements, *Geophys. J. Int.*, **164**, 319–330, doi: 10.1111/j.1365–246X.2005.02833.x.

- Maus, S., Rother, M., Stolle, C., Mai, W., Choi, S., Lühr, H., Cooke, D. & Roth, C., 2006. Third generation of the Potsdam Magnetic Model of the Earth (POMME), *Geochem. Geophys. Geosys.*, **7**, Q07008, doi: 10.1029/2006GC001269.
- Maus, S., Manoj, C., Rauber, J., Michaelis, I. & Lühr, H., 2010. NOAA/NGDC candidate models for the 11th generation International Geomagnetic Reference Field and the concurrent release of the 6th generation Pomme magnetic model, *Earth Planets Space*, **62**, 729–735, doi: 10.5047/eps.2010.07.006.
- Mayer, C. & Maier, T., 2006. Separating inner and outer Earth’s magnetic field from CHAMP satellite measurements by means of vector scaling functions and wavelets, *Geophys. J. Int.*, **167**, 1188–1203, doi: 10.1111/j.1365–246X.2006.03199.x.
- Mayer-Rosa, D. & Mueller, S., 1973. The gross velocity-depth distribution of *P*- and *S*-waves in the upper mantle of Europe from earthquake observations, *Z. Geophys.*, **39**, 395–410.
- McCammon, C., 2001. Deep diamond mysteries, *Science*, **293**, 813–814.
- McClellan, J. H., 1982. Multidimensional spectral estimation, *Proc. IEEE*, **70**(9), 1029–1039.
- McClusky, S., Balassanian, S., Barka, A., Demir, C., Ergintav, S., Georgiev, I., Gurkan, O., Hamburger, M., and H. Kahle, K. H., Kastens, K., Kekelidze, G., King, R., Kotzev, V., Lenk, O., Mahmoud, S., Mishin, A., Nadariya, M., Ouzounis, A., Paradissis, D., Peter, Y., Prilepin, M., Reilinger, R., Sanli, I., Seeger, H., Tealeb, A., Toksöz, M. N. & Veis, G., 2000. Global Positioning System constraints on plate kinematics and dynamics in the eastern Mediterranean and Caucasus, *J. Geophys. Res.*, **105**(B3), 5695–5719.
- McCreery, C. S. & Duennebie, F. K., 1993. Correlation of deep ocean noise (0.4–30 Hz) with wind, and the Holu Spectrum — A worldwide constant, *J. Acoust. Soc. Am.*, **93**(5), 2639–2648.
- McDonald, G. D., Collerson, K. D. & Kinny, P. D., 1997. Late Archean and Early Proterozoic crustal evolution of the Mount Isa block, northwest Queensland, Australia, *Geology*, **25**(12), 1095–1098.
- McDonald, M. A. & Hildebrand, J. A., 1995. Blue and fin whales observed on a seafloor array in the Northeast Pacific, *J. Acoust. Soc. Am.*, **98**(2), 712–712.
- McEwen, J. D. & Wiaux, Y., 2011. A novel sampling theorem on the sphere, *Signal Processing, IEEE Transactions on*, **59**(12), 5876–5887, doi: 10.1109/TSP.2011.2166394.
- McEwen, J. D., Hobson, M. P., Lasenby, A. N. & Mortlock, D. J., 2005. A high-significance detection of non-Gaussianity in the *wilkinson microwave anisotropy probe* 1-yr data using directional spherical wavelets, *Mon. Not. R. Astron. Soc.*, **359**(4), 1583–1596.
- McEwen, J. D., Hobson, M. P., Lasenby, A. N. & Mortlock, D. J., 2006. A high-significance detection of non-Gaussianity in the *wmap* 3-yr data using directional spherical wavelets, *Mon. Not. R. Astron. Soc.*, **371**(1), L50–L54.

- McEwen, J. D., Hobson, M. P., Mortlock, D. J. & Lasenby, A. N., 2007. Fast directional continuous spherical wavelet transform algorithms, *IEEE T. Signal Process.*, **55**(2), 520–529.
- McEwen, J. D., Wiaux, Y. & Eysers, D. M., 2011. Data compression on the sphere, *Astr. Astroph.*, **531**.
- McGovern, P. J., Solomon, S. C., Smith, D. E., Zuber, M. T., Simons, M., Wieczorek, M. A., Phillips, R. J., Neumann, G. A., Aharonson, O. & Head, J. W., 2002. Localized gravity/topography admittance and correlation spectra on Mars: Implications for regional and global evolution, *J. Geophys. Res.*, **107**(E12), 5136, doi: 10.1029/2002JE001854.
- McGovern, P. J., Solomon, S. C., Smith, D. E., Zuber, M. T., Simons, M., Wieczorek, M. A., Phillips, R. J., Neumann, G. A., Aharonson, O. & Head, J. W., 2004. Correction to: "localized gravity/topography admittance and correlation spectra on Mars: Implications for regional and global evolution", *J. Geophys. Res.*, **109**, E07007, doi: 10.1029/2004JE002286.
- McGuire, J. J., Boettcher, M. S. & Jordan, T. H., 2005. Foreshock sequences and short-term earthquake predictability on East Pacific Rise transform faults, *Nature*, **434**(7041), 457–461, doi: 10.1038/nature03377.
- McGuire, J. J., Simons, F. J. & Collins, J. A., 2008. Analysis of seafloor seismograms of the 2003 Tokachi-Oki earthquake sequence for earthquake early warning, *Geophys. Res. Lett.*, **35**, L14310, doi: 10.1029/2008GL033986.
- McGuire, J. J., Collins, J. A., Gou  dard, P., Roland, E., Lizarralde, D., Boettcher, M. S., Behn, M. D. & van der Hilst, R. D., 2012. Variations in earthquake rupture properties along the Gofar transform fault, East Pacific Rise, *Nature Geosci.*, **5**(5), 336–341, doi: 10.1038/ngeo1454.
- McKenzie, D., 1994. The relationship between topography and gravity on Earth and Venus, *Icarus*, **112**, 55–88.
- McKenzie, D., 2003. Estimating T_e in the presence of internal loads, *J. Geophys. Res.*, **108**(B9), 2348, doi: 10.1029/2002JB001766.
- McKenzie, D., 2010. The influence of dynamically supported topography on estimates of T_e , *Earth Planet. Sci. Lett.*, **295**(1–2), 127–138, doi: 10.1016/j.epsl.2010.03.033.
- McKenzie, D. & Prestley, K., 2008. The influence of lithospheric thickness variations on continental evolution, *Lithos*, **102**, 1–11, doi: :10.1016/j.lithos.2007.05.005.
- McKenzie, D. & Sclater, J. G., 1971. The evolution of the Indian Ocean since the Late Cretaceous, *Geophys. J. R. Astron. Soc.*, **25**, 437–528.
- McKenzie, D. P., 1967. Some remarks on heat flow and gravity anomalies, *J. Geophys. Res.*, **72**(24), 6261–6273, doi: 10.1029/JZ072i024p06261.
- McKenzie, D. P., 1979. Finite deformation during fluid flow, *Geophys. J. R. Astron. Soc.*, **58**, 689–715.

- McKenzie, D. P., 1984. A possible mechanism for epeirogenic uplift, *Nature*, **307**, 616–618.
- McKenzie, D. P. & Bowin, C., 1976. The relationship between bathymetry and gravity in the Atlantic Ocean, *J. Geophys. Res.*, **81**(11), 1903–1915.
- McKenzie, D. P. & Fairhead, J. D., 1997. Estimates of the effective elastic thickness of the continental lithosphere from Bouguer and free air gravity anomalies, *J. Geophys. Res.*, **102**(B12), 27523–27552.
- McKenzie, D. P. & Jackson, J., 1983. The relationship between strain rates, crustal thickening, palaeomagnetism, finite strain and fault movements within a deforming zone, *Earth Planet. Sci. Lett.*, **65**, 182–202.
- McKenzie, D. P. & Morgan, W. J., 1969. Evolution of triple junctions, *Nature*, **224**(5215), 125–133.
- McKenzie, D. P., Barnett, D. N. & Yuan, D.-N., 2002. The relationship between Martian gravity and topography, *Earth Planet. Sci. Lett.*, **195**, 1–16.
- McLeod, M. G., 1986. Stochastic processes on a sphere, *Phys. Earth Planet. Inter.*, **43**(4), 283–299.
- McMechan, G. A. & Yedlin, M. J., 1981. Analysis of dispersive waves by wave field transformation, *Geophysics*, **46**(6), 869–874, doi: 10.1190/1.1441225.
- McNamara, A. K., Karato, S.-I. & van Keken, P. E., 2001. Localization of dislocation creep in the lower mantle: implications for the origin of seismic anisotropy, *Earth Planet. Sci. Lett.*, **191**, 85–99.
- McNamara, A. K., van Keken, P. E. & Karato, S.-I., 2002. Development of anisotropic structure in the Earth's lower mantle by solid-state convection, *Nature*, **416**, 310–314.
- McNamara, D. E. & Boaz, R. I., 2006. Seismic noise analysis system using power spectral density probability density functions: A stand-alone software package, Open-file report 2005-1438, U. S. Dept. Interior, Geological Survey.
- McNamara, D. E. & Buland, R. P., 2004. Ambient noise levels in the continental United States, *B. Seismol. Soc. Am.*, **94**(4), 1517–1527, doi: 10.1785/012003001.
- McNutt, M. K., 1983. Influence of plate subduction on isostatic compensation in Northern California, *Tectonics*, **2**(4), 399–415.
- McNutt, M. K., 1984. Lithospheric flexure and thermal anomalies, *J. Geophys. Res.*, **89**(B13), 11180–11194.
- McNutt, M. K., 1995. Marine geodynamics: Depth-age revisited, *Rev. Geophys.*, **Suppl.**, 413–418.
- McNutt, M. K., 2006. Another nail in the plume coffin?, *Science*, **313**(5792), 1394, doi: 10.1126/science.1131298.

- McNutt, M. K. & Fischer, K. M., 1987, The South Pacific superswell, in *Seamounts, Islands, and Atolls*, edited by B. H. Keating, P. Fryer, R. Batiza, & G. W. Boehlert, vol. 43 of **Geophysical Monograph**, pp. 25–34, doi: 10.1029/GM043, Amer. Geophys. Union.
- McNutt, M. K. & Judge, A. V., 1990. The Superswell and mantle dynamics beneath the South Pacific, *Science*, **248**(4958), 969–975, doi:.
- McNutt, M. K. & Menard, H. W., 1982. Constraints on yield strength in the oceanic lithosphere derived from observations of flexure, *Geophys. J. R. Astron. Soc.*, **71**(2), 363–394.
- McNutt, M. K. & Parker, R. L., 1978. Isostasy in Australia and the evolution of the compensation mechanism, *Science*, **199**, 773–775.
- McPhee, J., 1989. *The Control of Nature*, Farrar, Straus & Giroux, New York.
- McQueen, H. W. S. & Lambeck, K., 1996. Determination of crustal structure in central Australia by inversion of traveltime residuals, *Geophys. J. Int.*, **126**, 645–662.
- Mead, J. L. & Ford, J. F., 2020. Joint inversion of compact operators, *J. Inverse Ill-Pose. P.*, **28**(1), 105–118, doi: 10.1515/jiip-2019-0068.
- Meade, C. & Jeanloz, R., 1991. Deep-focus earthquakes and recycling of water into the Earth’s mantle, *Science*, **252**, 68–72.
- Meaney, C., 1984. Localization of spherical harmonic expansions, *Mh. Math.*, **98**, 65–74.
- Medvigy, D. & Beaulieu, C., 2012. Trends in daily solar radiation and precipitation coefficients of variation since 1984, *J. Climate*, **25**, 1330–1339, doi: 10.1175/2011JCLI4115.1.
- Mégnin, C., Bunge, H.-P., Romanowicz, B. & Richards, M. A., 1997. Imaging 3-D spherical convection models: What can seismic tomography tell us about mantle dynamics?, *Geophys. Res. Lett.*, **24**(11), 1299–1302, doi: 10.1029/97GL01256.
- Meibom, A., Sleep, N. H., Chamberlain, C. P., Coleman, R. G., Frei, R., Hren, M. T. & Wooden, J. L., 2002. Re-os isotopic evidence for long-loved heterogeneity and equilibration processes in the Earth’s upper mantle, *Nature*, **419**, 705–708.
- Meier, M. F., Dyurgerov, M. B., Rick, U. K., O’Neel, S., Pfeffer, W. T., Anderson, R. S., Anderson, S. P. & Glazovsky, A. F., 2007. Glaciers dominate eustatic sea-level rise in the 21st century, *Science*, **317**(5841), 1064–1067, doi: 10.1126/science.1143906.
- Meier, T. & Malischewsky, P. G., 2000. Approximation of surface wave mode conversion at a passive continental margin by a mode-matching technique, *Geophys. J. Int.*, **141**, 12–24.
- Meissner, R., Mooney, W. D. & Artemieva, I., 2002. Seismic anisotropy and mantle creep in young orogens, *Geophys. J. Int.*, **149**, 1–14.
- Melbourne, T. I. & Webb, F. H., 2003. Slow but not quite silent, *Science*, **300**, 1886–1887.

- Mellors, R. J., Vernon, F. L. & Thomson, D. J., 1998. Detection of dispersive signals using multi-taper dual-frequency coherence, *Geophys. J. Int.*, **135**(1), 146–154.
- Melosh, H. J., 1980. Tectonic patterns on a reoriented planet: Mars, *Icarus*, **44**(3), 745–751, doi: 10.1016/0019-1035(80)90141-4.
- Melosh, H. J. & Raefsky, A., 1980. The dynamical origin of subduction zone topography, *Geophys. J. Int.*, **60**(3), 333–354, doi: 10.1111/j.1365-246X.1980.tb04812.x.
- Melton, B. S., 1981. Earthquake seismograph development: A modern history—part 1, *Eos Trans. AGU*, **62**(21), 505–510.
- Melton, B. S., 1981. Earthquake seismograph development: A modern history—part 2, *Eos Trans. AGU*, **62**(21), 545–548.
- Meltzer, A., Rudnick, R., Zeitler, P., Levander, A., Humphreys, G., Karlstrom, K., Ekstrom, E., Carlson, C., Dixon, T., Gurnis, M., Shearer, P. & van der Hilst, R. D., 1999. The USArray initiative, *GSA Today*, **9**, 8–10.
- Members, P. P., 2012. Making sense of palaeoclimate sensitivity, *Nature*, **491**, 683–691, doi: 10.1038/nature11574.
- Menke, W., 1989. *Geophysical Data Analysis: Discrete Inverse Theory*, vol. 45 of **International Geophysics Series**, Academic Press, San Diego, Calif., Rev. edn.
- Menke, W., 2. *Geophysical Data Analysis: Discrete Inverse Theory (MATLAB Edition)*, vol. 45 of **International Geophysics Series**, Academic Press, San Diego, Calif., 3rd edn.
- Menke, W., 2017. Sensitivity kernels for the cross-convolution measure, *B. Seismol. Soc. Am.*, **107**(5), 2213, doi: 10.1785/0120170045.
- Menzies, M. A., Fan, W. & Zhang, M., 1993, Palaeozoic and Cenozoic lithoprobes and the loss of >120 km of Archaean lithosphere, Sino-Korean craton, China, in *Magmatic Processes and Plate Tectonics*, edited by H. M. Prichard, T. Alabaster, N. B. W. Harris, & C. R. Neary, no. 76 in Geol. Soc. Spec. Pub., pp. 71–81, Geol. Soc., London, UK.
- Merali, Z., 2010. Computational science: Error... why scientific programming does not compute, *Nature*, **467**(7317), 775–777.
- Mercer, J., 1909. Functions of positive and negative type, and their connection with the theory of integral equations, *Phil. Trans. R. Soc. London, Ser. A*, **209**, 415–446.
- Mercerat, E. D. & Nolet, G., 2012. Comparison of ray- and adjoint-based sensitivity kernels for body-wave seismic tomography, *Geophys. Res. Lett.*, **39**(12), L12301, doi: 10.1029/2012GL052002.
- Mercerat, E. D. & Nolet, G., 2013. On the linearity of cross-correlation delay times in finite-frequency tomography, *Geophys. J. Int.*, **192**, 681–687, doi: 10.1093/gji/ggs017.

- Meredith, R. W. & Nagle, S. M., 1999. Coherence estimation for high-frequency narrowband cw pulsed signals in shallow water, *J. Acoust. Soc. Am.*, **106**(2), 828–836.
- Merrill, J., 2007, *Experimental testing of spar buoy for wave power generation*, Master's thesis, University of Rhode Island, Narragansett, RI.
- Merrill, R. T. & McFadden, P. L., 1998. Paleomagnetism and the nature of the geodynamo, *Science*, **248**, 3425–350.
- Merrill, R. T. & McFadden, P. L., 1999. Geomagnetic polarity transitions, *Rev. Geophys.*, **37**(2), 201–226.
- Merrill, R. T., McElhinny, M. W. & McFadden, P. L., 1998. *The Magnetic Field of the Earth*, Academic Press, San Diego, Calif.
- Mervis, J., 2010. Better intro courses seen as key to reducing attrition of STEM majors, *Science*, **330**(6002), 306.
- Mervis, J., 2012. Agencies rally to tackle big data, *Science*, **336**, 22.
- Messiah, A., 2000. *Quantum Mechanics*, Dover, New York.
- Metikas, G. & Olhede, S. C., 2007. Multiple multidimensional Morse wavelets, *IEEE T. Signal Process.*, **55**(2), 921–936, doi: 10.1109/TSP.2006.887562.
- Metz, D., Watts, A. B., Grevemeyer, I., Rodgers, M. & Paulatto, M., 2016. Ultra-long-range hydroacoustic observations of submarine volcanic activity at Monowai, Kermadec arc, *Geophys. Res. Lett.*, **43**(4), 1529–1536, doi: 10.1002/2015GL067259.
- Meyerholtz, K. A., Pavlis, G. L. & Szpakowsk, S. A., 1989. Convolutional quelling in seismic tomography, *Geophysics*, **54**, 570–580.
- Meza, J., 2008. Drowning in a sea of data: The need for new mathematical tools for petascale data analysis, *SIAM News*, **41**(7).
- Michel, V., 1999, *A multiscale method for the gravimetry problem — Theoretical and numerical aspects of harmonic and anharmonic modelling*, Ph.D. thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern, Shaker Verlag, Aachen.
- Michel, V., 2005. Regularized wavelet-based multiresolution recovery of the harmonic mass density distribution from data of the Earth's gravitational field at satellite height, *Inv. Probl.*, **21**, 997–1025, doi: 10.1088/0266–5611/21/3/013.
- Michel, V., 2005. Wavelets on the 3-dimensional ball, *Proc. Appl. Math. Mech.*, **5**, 775–776, doi: 10.1002/pamm.200510362.
- Michel, V., 2010, Tomography: Problems and multiscale solutions, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 32, pp. 949–972, doi: 10.1007/978–3–642–01546–5_32, Springer, Heidelberg, Germany.

- Michel, V., 2011. Optimally localized approximate identities on the 2-sphere, *Numer. Func. Anal. Optim.*, **32**(8), 877–903, doi: 10.1080/01630563.2011.587073.
- Michel, V., 2013. *Lectures on Constructive Approximation*, Springer, New York.
- Michel, V., 2015, Tomography: Problems and multiscale solutions, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 32, pp. 2087–21119, doi: 10.1007/978-3-642-54551-5_32, Springer, Heidelberg, Germany, 2nd edn.
- Michel, V. & Fokas, A. S., 2008. A unified approach to various techniques for the non-uniqueness of the inverse gravimetric problem and wavelet-based methods, *Inv. Probl.*, **24**, 045019, doi: 10.1088/0266-5611/24/4/045019.
- Michel, V. & Orzłowski, S., 2015. On the nullspace of a class of Fredholm integral equations of the first kind, *J. Inv. Ill-posed Probl.*, **24**(6), 1–24, doi: 10.1515/jiip-2015-0026.
- Michel, V. & Simons, F. J., 2017. A general approach to regularizing inverse problems with regional data using Slepian wavelets, *Inv. Probl.*, **33**(12), 12501, doi: 10.1088/1361-6420/aa9909.
- Michel, V. & Wolf, K., 2006. Numerical aspects of a spline-based multiresolution recovery of the harmonic mass density out of gravity functionals, *Schriften zur Funktionalanalysis und Geomathematik*, **28**.
- Michel, V. & Wolf, K., 2008. Numerical aspects of a spline-based multiresolution recovery of the harmonic mass density out of gravity functionals, *Geophys. J. Int.*, **173**, 1–16, doi: 10.1111/j.1365-246X.2007.03700.x.
- Mikhailov, V., Tikhotsky, S., Diamant, M., Panet, I. & Ballu, V., 2004. Can tectonic processes be recovered from new gravity satellite data?, *Earth Planet. Sci. Lett.*, **228**(3–4), 281–297, doi: 10.1016/j.epsl.2004.09.035.
- Milbury, C. & Schubert, G., 2010. Search for the global signature of the Martian dynamo, *J. Geophys. Res.*, **115**(E10), E10010, doi: 10.1029/2010JE003617.
- Milbury, C., Schubert, G., Raymond, C. A., Smrekar, S. E. & Langlais, B., 2012. The history of Mars’ dynamo as revealed by modeling magnetic anomalies near Tyrrhenus Mons and Syrtis Major, *J. Geophys. Res.*, **117**, E10007, doi: 10.1029/2012JE004099.
- Milbury, C. A. E., Smrekar, S. E., Raymond, C. A. & Schubert, G., 2007. Lithospheric structure in the eastern region of Mars’ dichotomy boundary, *Planet. Space Sci.*, **55**(3), 280–288, doi: 10.1016/j.pss.2006.03.009.
- Milkovich, S. M. & Plaut, J. J., 2008. Martian South Polar Layered Deposit stratigraphy and implications for accumulation history, *J. Geophys. Res.*, **113**, E06007, doi: 10.1029/2007JE002987.
- Milkovich, S. M., Head, J. W. & Pratt, S., 2002. Meltback of Hesperian-aged ice-rich deposits near the south pole of Mars: Evidence for drainage channels and lakes, *J. Geophys. Res.*, **107**(E6), 10–1–10–13, doi: 10.1029/2001JE001802.

- Miller, D., Oristaglio, M. & Beylkin, G., 1987. A new slant on seismic imaging: Migration and integral geometry, *Geophysics*, **52**(7), 943–964, doi: 10.1190/1.1442364.
- Miller, G. F. & Pursey, H., 1955. On the partition of energy between elastic waves in a semi-infinite solid, *Proc. R. Soc. London, Ser. A*, **233**(1192), 55–69, doi: 10.1098/rspa.1955.0245.
- Miller, K. S., 1969. Complex Gaussian processes, *SIAM Rev.*, **11**(4), 544–567.
- Miller, K. S., 1974. *Complex stochastic processes: an introduction to theory and application*, Addison-Wesley, Reading, Mass.
- Miller, M. M., Melbourne, T. I., Johnson, D. J. & Sumner, W. Q., 2002. Periodic slow earthquakes from the Cascadia subduction zone, *Science*, **295**, 2423.
- Miller, R. D., Xia, J., Park, C. B. & Ivanov, J. M., 1999. Multichannel analysis of surface waves to map bedrock, *The Leading Edge*, **18**(12), 1392–1396.
- Miller, R. G., 1974. The jackknife — A review, *Biometrika*, **61**(1), 1–15.
- Milne, G. A., Gehrels, W. R., Hughes, C. W. & Tamisiea, M. E., 2009. Identifying the causes of sea-level change, *Nature Geosci.*, **2**(7), 471–478, doi: 10.1038/ngeo544.
- Milne, J., 1886. *Earthquakes and Other Earth Movements*, vol. LV of **The International Scientific Series**, D. Appleton and Company.
- Milsom, J., 2003. *Field Geophysics*, John Wiley, 3rd edn.
- Milsom, J. & Eriksen, A., 2011. *Field Geophysics*, John Wiley, 4th edn.
- Ming, D.-J., Shin, J. & Shin, C., 2015. Application of the least-squares inversion method: Fourier series versus waveform inversion, *J. Appl. Geoph.*, **122**(189), 62–73, doi: 10.1016/j.jappgeo.2015.08.006.
- Minshull, T. A. & Goult, N. R., 1988. The influence of tidal stresses on deep moonquake activity, *Phys. Earth Planet. Inter.*, **52**, 41–55.
- Miranian, L., 2004. Slepian functions on the sphere, generalized Gaussian quadrature rule, *Inv. Probl.*, **20**, 877–892.
- Mishra, D. C. & Pedersen, L. B., 1982. Statistical analysis of potential fields from subsurface reliefs, *Geoexploration*, **19**, 247–265.
- Mitchell, B. J. & Cong, L., 1998. L_g coda Q and its relation to the structure and evolution of continents: a global perspective, *Pure Appl. Geophys.*, **153**, 655–663.
- Mitchell, B. J. & Kuen Yu, G., 1980. Surface wave dispersion, regionalized velocity models, and anisotropy of the Pacific crust and upper mantle, *Geophys. J. R. Astron. Soc.*, **63**(2), 497–514.
- Mitchell, B. J., Baqer, S., Akinci, A. & Cong, L., 1998. L_g coda Q in Australia and its relation to crustal structure and evolution, *Pure Appl. Geophys.*, **153**, 639–653.

- Mitchell, D. L., Lillis, R. J., Lin, R. P., Connerney, J. E. P. & Acuña, M. H., 2007. A global map of Mars' crustal magnetic field based on electron reflectometry, *J. Geophys. Res.*, **112**, E01002, doi: 10.1029/2005JE002564.
- Mitra, P. P. & Maniar, H., 2005. Local basis expansions for MEG source localization, *Int. J. Bioelectromagn.*, **7**(2), 30–33.
- Mitra, P. P. & Maniar, H., 2006. Concentration maximization and local basis expansions (LBEX) for linear inverse problems, *IEEE T. Biomed Eng.*, **53**(9), 1775–1782.
- Mitrovica, J. X., Gomez, N. & Clark, P. U., 2009. The sea-level fingerprint of West Antarctic collapse, *Science*, **323**(5915), 753, doi: 10.1126/science.1166510.
- Mitrovica, J. X., Gomez, N., Morrow, E., Hay, C., Latychev, K. & Tamisiea, M. E., 2011. On the robustness of predictions of sea level fingerprints, *Geophys. J. Int.*, **187**(2), 729–742, doi: 10.1111/j.1365–246X.2011.05090.x.
- Mochizuki, E., 1986. The free oscillations of an anisotropic and heterogeneous Earth, *Geophys. J. R. Astron. Soc.*, **86**(1), 167–176.
- Modrak, R. & Tromp, J., 2016. Seismic waveform inversion best practices: regional, global and exploration test cases, *Geophys. J. Int.*, **206**(3), 1864–1889, doi: 10.1093/gji/ggw202.
- Modrak, R. T., Borisov, D., Lefebvre, M. & Tromp, J., 2018. SeisFlows—Flexible waveform inversion software, *Comput. Geosci.*, **115**, 88–95, doi: 10.1016/j.cageo.2018.02.004.
- Modroo, J. & Olhoeft, G. R., 2004, Ground penetrating radar location of buried avalanche victims, in *Proc. Internat. Snow Science Workshop*, pp. 399–408, Jackson Hole, WY.
- Moholdt, G., Nuth, C., Hagen, J. O. & Kohler, J., 2010. Recent elevation changes of Svalbard glaciers derived from ICESat laser altimetry, *Remote Sens. Environ.*, **114**(11), 2756–2767, doi: 10.1016/j.rse.2010.06.008.
- Molnar, P. & Dayem, K. E., 2010. Major intracontinental strike-slip faults and contrasts in lithospheric strength, *Geosphere*, **6**(4), 444–467, doi: 10.1130/GES00519.1.
- Molnar, P., Anderson, H. J., Audoin, E., Eberhart-Phillips, D., Gledhill, K. R., Klosko, E. R., McElvilly, T. V., Okaya, D., Savage, M. K., Stern, T. & Wu, F. T., 1999. Continuous deformation versus faulting through the continental lithosphere of New Zealand, *Science*, **286**, 516–519.
- Montagner, J.-P., 1985. Seismic anisotropy of the Pacific Ocean inferred from long-period surface-waves dispersion, *Phys. Earth Planet. Inter.*, **38**(1), 28–50.
- Montagner, J.-P., 1986. Regional three-dimensional structures using long-period surface waves, *Ann. Geophys.–Germany*, **4**(B3), 283–294.
- Montagner, J.-P., 1996, Surface waves on a global scale, Influence of anisotropy and anelasticity, in *Seismic Modelling of Earth Structure*, edited by E. Boschi, G. Ekström, & A. Morelli, pp. 81–148, Editrice Compositori, Bologna, Italy.

- Montagner, J.-P., 1998. Where can seismic anisotropy be detected in the Earth's mantle? In boundary layers..., *Pure Appl. Geophys.*, **151**(2–4), 223–256, doi: 10.1007/s000240050113.
- Montagner, J.-P., 2008. Normal modes of the Earth, *J. Physics: Conf. Ser.*, **118**, 012004, doi: 10.1088/1742-6596/1181/1/012004.
- Montagner, J.-P., 32. Can seismology tell us anything about convection in the mantle?, *Rev. Geophys.*, **2**(115–137).
- Montagner, J.-P. & Anderson, D. L., 1989. Petrological constraints on seismic anisotropy, *Phys. Earth Planet. Inter.*, **54**, 82–105.
- Montagner, J.-P. & Jobert, N., 1988. Vectorial tomography — II. Application to the Indian Ocean, *Geophys. J. Int.*, **94**, 309–344.
- Montagner, J.-P. & Kennett, B. L. N., 1995. How to reconcile body-wave and normal-mode reference Earth models?, *Geophys. J. Int.*, **125**(1), 229–248.
- Montagner, J.-P. & Nataf, H.-C., 1986. A simple method for inverting the azimuthal anisotropy of surface waves, *J. Geophys. Res.*, **91**(B1), 511–520.
- Montagner, J.-P. & Nataf, H.-C., 1988. Vectorial tomography — I. Theory, *Geophys. J. Int.*, **94**, 295–307.
- Montagner, J.-P. & Ritsema, J., 2001. Interactions between ridges and plumes, *Science*, **294**, 1472–1473.
- Montagner, J.-P. & Tanimoto, T., 1990. Global anisotropy in the upper mantle inferred from the regionalization of phase velocities, *J. Geophys. Res.*, **95**(B4), 4797–4819.
- Montagner, J.-P. & Tanimoto, T., 1991. Global upper mantle tomography of seismic velocities and anisotropies, *J. Geophys. Res.*, **96**(B12), 20337–20351.
- Montagner, J.-P., Ho-Liu, P. & Kanamori, H., 1990. Reply to comment by J. Trampert, *Geophys. J. Int.*, **103**, 757–758.
- Montagner, J.-P., Lognonné, P., Beauduin, R., Roullet, G., Karczewski, J.-F. & Stutzmann, E., 1998. Towards multiscalar and multiparameter networks for the next century: the French efforts, *Phys. Earth Planet. Inter.*, **108**(2), 155–174.
- Montagner, J.-P., Griot-Pommera, D.-A. & Lavé, J., 2000. How to relate body wave and surface wave anisotropy?, *J. Geophys. Res.*, **105**(B8), 19015–19027.
- Monteiller, V., Got, J.-L., Virieux, J. & Okubo, P., 2005. An efficient algorithm for double-difference tomography and location in heterogeneous media, with an application to the Kilauea volcano, *J. Geophys. Res.*, **110**, B12306, doi: 10.1029/2004JB003466.
- Monteiller, V., Chevrot, S., Komatitsch, D. & Fuji, N., 2013. A hybrid method to compute short-period synthetic seismograms of teleseismic body waves in a 3-D regional model, *Geophys. J. Int.*, **192**(1), 230–247, doi: 10.1093/gji/ggs006.

- Monteiller, V., Chevrot, S., Komatitsch, D. & Wang, Y., 2015. Three-dimensional full waveform inversion of short-period teleseismic wavefields based upon the SEM–DSM hybrid method, *Geophys. J. Int.*, **202**(2), 811–827, doi: 10.1093/gji/ggv189.
- Montelli, R., Nolet, G., Dahlen, F. A., Masters, G., Engdahl, E. R. & Hung, S.-H., 2004. Finite-frequency tomography reveals a variety of plumes in the mantle, *Science*, **303**(5656), 338–343, doi: 10.1126/science.1092485.
- Montelli, R., Nolet, G., Dahlen, F. A., Masters, G., Engdahl, E. R. & Hung, S.-H., 2004. Global *P* and *PP* traveltimes tomography: rays versus waves, *Geophys. J. Int.*, **158**, 637–654.
- Montelli, R., Nolet, G., Dahlen, F. A. & Masters, G., 2006. A catalogue of deep mantle plumes: New results from finite-frequency tomography, *Geochem. Geophys. Geosys.*, **7**(11), Q11007, doi: 10.1029/2006GC001248.
- Montési, L. G. J., di Toro, G., Simons, F. J., Akber-Knutson, S., Becker, T. W., Billen, M., Deschamps, A. & Kellogg, J. B., 2006. Young scientists focus on the dynamics of the lithosphere, *Eos Trans. AGU*, **87**(44), 482, doi: 10.1029/2006EO440005.
- Mooney, W., Laske, G. & Masters, G., 1998. CRUST 5.1: A global crustal model at 5 degrees x 5 degrees, *J. Geophys. Res.*, **103**(B1), 727–747.
- Mooney, W. D., 1995. Continental roots go with the flow, *Nature*, **375**, 15.
- Moore, I. C. & Cada, M., 2004. Prolate spheroidal wave functions, an introduction to the Slepian series and its properties, *Appl. Comput. Harmon. Anal.*, **16**, 208–230.
- Mora, P., 1987. Nonlinear two-dimensional elastic inversion of multioffset seismic data, *Geophysics*, **52**(9), 1211–1228.
- Mora, P., 1988. Elastic wave-field inversion of reflection and transmission data, *Geophysics*, **53**(6), 750–759.
- Mora, P., 1989. Inversion = migration + tomography, *Geophysics*, **54**(12), 1575–1586.
- Mora, S. D., Boschi, L., Tackley, P. J., Nakagawa, T. & Giardini, D., 2011. Low seismic resolution cannot explain S/P decorrelation in the lower mantle, *Geophys. Res. Lett.*, **38**(12), L12303, doi: 10.1029/2011GL047559.
- Moraes, F. S. & Scales, J. A., 2000. Local Bayesian inversion: theoretical developments, *Geophys. J. Int.*, **141**, 713–723.
- Moreau, F., Gibert, D., Holschneider, M. & Saracco, G., 1997. Wavelet analysis of potential fields, *Inv. Probl.*, **13**, 165–178.
- Moreau, F., Gibert, D., Holschneider, M. & Saracco, G., 1999. Identification of sources of potential fields with the continuous wavelet transform: Basic theory, *J. Geophys. Res.*, **104**(B3), 5003–5013.

- Morelli, A. & Danesi, S., 2004. Seismological imaging of the Antarctic continental lithosphere: a review, *Global Planet. Change*, **42**(1), 155–165, doi: 10.1016/j.gloplacha.2003.12.005.
- Morelli, A. & Dziewoński, A. M., 1987. Topography of the core-mantle boundary and lateral homogeneity of the liquid core, *Nature*, **325**, 678–683.
- Morgan, W. J., 1965. Gravity anomalies and convection currents. 1. A sphere and cylinder sinking beneath surface of a viscous fluid, *J. Geophys. Res.*, **70**(24), 6175–6185, doi: 10.1029/JZ070i024p06175.
- Morgan, W. J., 1971. Convection plumes in the lower mantle, *Nature*, **230**(5288), 42–43, doi: 10.1038/230042a0.
- Morita, Y. & Hamaguchi, H., 1984. Automatic detection of onset time of seismic waves and its confidence interval using the autoregressive model fitting, *Zisin (J. Seismol. Soc. Japan)*, **37**(2), 281–293, doi: 10.4294/zisin1948.37.2_281.
- Moritz, H., 2010, Classical physical geodesy, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 6, pp. 127–158, doi: 10.1007/978-3-642-01546-5_6, Springer, Heidelberg, Germany.
- Morlet, J., Arens, G., Fournageau, E. & Giard, D., 1982. Wave propagation and sampling theory — Part I: Complex signal and scattering in multilayered media, *Geophysics*, **47**(2), 203–221.
- Morlet, J., Arens, G., Fournageau, E. & Giard, D., 1982. Wave propagation and sampling theory — Part II: Sampling theory and complex waves, *Geophysics*, **47**(2), 222–236.
- Morozova, E. A., Morozov, I. B., Smithson, S. B. & Solodilov, L. N., 1999. Heterogeneity of the uppermost mantle beneath Russian Eurasia from the ultra-long-range profile QUARTZ, *J. Geophys. Res.*, **104**(B9), 20329–20348.
- Morrison, J. A., 1962. On the commutation of finite integral operators, with difference kernels, and linear selfadjoint differential operators, *Abstract, Not. AMS*, p. 119.
- Morrison, J. A., 1963. On the eigenfunctions corresponding to the bandpass kernel, in the case of degeneracy, *Quart. Appl. Math.*, **21**, 13–19.
- Morschhauser, A., Lesur, V. & Grott, M., 2014. A spherical harmonic model of the lithospheric magnetic field of Mars, *J. Geophys. Res.*, **119**(6), 1162–1188, doi: 10.1002/2013JE004555.
- Mortlock, D. J., Challinor, A. D. & Hobson, M. P., 2002. Analysis of cosmic microwave background data on an incomplete sky, *Mon. Not. R. Astron. Soc.*, **330**, 405–420.
- Morton, K., 2011. Climate change and security at the Third Pole, *Survival: Global Politics & Strategy*, **53**(1), 121–132, doi: 10.1080/00396338.2011.555606.
- Mosegaard, K. & Tarantola, A., 1995. Monte Carlo sampling of solutions to inverse problems, *J. Geophys. Res.*, **100**(B7), 12431–12447.
- Moser, T. J., 1991. Shortest path calculation of seismic rays, *Geophysics*, **56**, 59–67.

- Moser, T. J., Nolet, G. & Snieder, R., 1992. Ray bending revisited, *B. Seismol. Soc. Am.*, **82**(1), 259–288.
- Moucha, R., Forte, A. M., Rowley, D. B., Mitrovica, J. X., Simmons, N. A. & Grand, S. P., 2009. Deep mantle forces and the uplift of the Colorado Plateau, *Geophys. Res. Lett.*, **36**(19), L19310.
- Mouginot, J., Rignot, E. & Scheuchl, B., 2014. Sustained increase in ice discharge from the Amundsen Sea Embayment, West Antarctica, from 1973 to 2013, *Geophys. Res. Lett.*, **41**(5), 1576–1584, doi: 10.1002/2013GL059069.
- Moulik, P. & Ekström, G., 2016. The relationships between large-scale variations in shear velocity, density, and compressional velocity in the Earth's mantle, *J. Geophys. Res.*, **121**, 2737–2271, doi: 10.1002/2015JB012679.
- Mount, V. S. & Suppe, J., 1992. Present-day stress orientations adjacent to active strike-slip faults: California and Sumatra, *J. Geophys. Res.*, **97**(B8), 11995–12013.
- Mouthereau, F., Watts, A. B. & Burov, E., 2013. Structure of orogenic belts controlled by lithosphere age, *Nature Geosci.*, **6**, 785–789, doi:10.1038/ngeo1902.
- Moyen, J. F. & van Hunen, J., 2012. Short-term episodicity of Archaean plate tectonics, *Geology*, p. doi:10.1130/G32894.1.
- Mulibo, G. D. & Nyblade, A. A., 2013. Mantle transition zone thinning beneath eastern Africa: Evidence for a whole-mantle superplume structure, *Geophys. Res. Lett.*, **40**(14), 3562–3566, doi: 10.1002/grl.50694.
- Müller, C., 1966. *Spherical harmonics*, Springer, Berlin, Germany.
- Müller, G., 1973. Seismic moment and long-period radiation of underground nuclear explosions, *B. Seismol. Soc. Am.*, **63**(3), 847–857.
- Müller, G., 1985. The reflectivity method: A tutorial, *J. Geophys.*, **58**, 153–174.
- Müller, R. D., Roest, W. R., Royer, J.-Y., Gahagan, L. M. & Sclater, J. G., 1997. Digital isochrons for the world's ocean floor, *J. Geophys. Res.*, **102**(B2).
- Müller, R. D., Roest, W. R. & Royer, J.-Y., 1998. Asymmetric sea-floor spreading caused by ridge-plume interactions, *Nature*, **396**, 455–459.
- Mullis, C. T. & Scharf, L. L., 1991, Quadratic estimators of the power spectrum, in *Advances in Spectrum Analysis and Array Processing*, edited by S. Haykin, vol. 1, chap. 1, pp. 1–57, Prentice-Hall, Englewood Cliffs, N. J.
- Munk, W. H., 1974. Sound channel in an exponentially stratified ocean, with application to SOFAR, *J. Acoust. Soc. Am.*, **55**(2), 220–226, doi: 10.1121/1.1914492.
- Munk, W. H. & Cartwright, D. E., 1966. Tidal spectroscopy and prediction, *Phil. Trans. R. Soc. London, Ser. A*, **259**, 533–581.

- Munk, W. H., Spindel, R. C., Baggeroer, A. & Birdsall, T. G., 1994. The Heard Island Feasibility Test, *J. Acoust. Soc. Am.*, **96**(4), 2330–2342.
- Murphy, G., Brown, V. & Vigh, D., 2020. Land FWI in the Delaware Basin, west Texas: A case study, *The Leading Edge*, **39**(5), 324–331, doi: 10.1190/tle39050324.1.
- Murphy, J. R. & McLaughlin, K. L., 1998. Comment on "empirical determination of depth-distance corrections for m_b and m_w from Global Seismograph Network stations" by guust nolet, steve krueger and robert m. clouser, *Geophys. Res. Lett.*, **25**(23), 4269–4270.
- Murphy, S. A. & van der Vaart, A. W., 2000. On profile likelihood, *J. Am. Stat. Assoc.*, **95**(450), 449–465.
- Murray, C. G., Scheibner, E. & Walker, R. N., 1989. Regional geological interpretation of a digital coloured residual Bouguer gravity image of eastern Australia with a wavelength cut-off of 250 km, *Aust. J. Earth Sci.*, **36**, 423–449.
- Murray, T., Nettles, M., Selmes, N., Cathles, L. M., Burton, J. C., James, T. D., Edwards, S., Martin, I., O'Farrell, T., Aspey, R., Rutt, I. & Baugé, T., 2015. Reverse glacier motion during iceberg calving and the cause of glacial earthquakes, *Science*, **349**(6245), 305–308, doi: 10.1126/science.aab0460.
- Muscheler, R., Kromer, B., Björck, S., Svensson, A., Friedrich, M., Kaiser, K. F. & Southon, J., 2008. Tree rings and ice cores reveal 14C calibration uncertainties during the Younger Dryas, *Nature Geosci.*, **1**(4), 263–267, doi: 10.1038/ngeo128.
- Mustafa, B., Davcev, D., Trajkovic, V. & Kalajdziski, S., 2006, 3D object matching using spherical mapping, in *IEEE IECON 2006-32nd Annual Conference on Industrial Electronics*, pp. 3450–3454, Proc. IEEE.
- Muyzert, E. & Snieder, R., 2000. An alternative parameterisation for surface waves in a transverse isotropic medium, *Phys. Earth Planet. Inter.*, **118**, 125–133.
- Myers, J. S., Shaw, R. D. & Tyler, I. M., 1996. Tectonic evolution of Proterozoic Australia, *Tectonics*, **15**(6), 1431–1446.
- nad R. Balia, G. P. D., 2001. An ultrashallow *SH*-wave seismic reflection experiment on a subsurface ground model, *Geophysics*, **66**(4), 1097–1104, doi: 10.1190/1.1487057.
- Nagel, T. J., Hoffmann, J. E. & Münker, C., 2012. Generation of Eoarchean tonalite-trondhjemitic-granodiorite series from thickened mafic arc crust, *Geology*, p. doi: 10.1130/G32729.1.
- Nahavandchi, H., Joodaki, G. & Schwarz, V., 2015. GRACE-derived ice-mass loss spread over Greenland, *J. Geod. Sci.*, **5**, 97–102.
- Nair, R. R., Majo, T. K., Mati, T., Kandpal, S. C., Kumar, R. T. R. & Shekhar, S., 2011. Multi-taper coherence method for appraising the elastic thickness of the Indonesian active continental margin, *J. Asian Earth Sci.*, **40**, 326–333, doi: 10.1016/j.jseas.2010.06.009.

- Nair, R. R., Singh, Y., Trivedi, D. & Kandpal, S. C., 2012. Anisotropy in the flexural response of the Indian Shield, *Tectonophysics*, **532–535**, doi: 10.1016/j.tecto.2012.02.006.
- Nakamura, Y., 1977. Seismic energy transmission in an intensely scattering environment, *J. Geophys. Res.*, **43**, 389–399.
- Nakamura, Y., 1978. A1 moonquakes: Source distribution and mechanisms, *Proc. Lunar Sci. Conf.*, **9**, 389–399.
- Nakamura, Y., 1983. Seismic velocity structure of the lunar mantle, *J. Geophys. Res.*, **88**(B1), 677–686.
- Nakamura, Y., 2005. Far-side deep Moonquakes and deep interior of the Moon, *J. Geophys. Res.*, **110**, doi: 10.1029/2004JE002332.
- Nakamura, Y., Latham, G., Lammlein, D., Ewing, M., Duennebier, F. & Dorman, J., 1974. Deep lunar interior inferred from recent seismic data, *Geophys. Res. Lett.*, **1**, 137–140.
- Nakamura, Y., Latham, G. V., Dorman, H. J. & Harris, J. E., 2004. Passive seismic experiment long period event catalog, in *Tech. Rep. 118, rev. ed.*, Univ. of Texas Inst. for Geophys., Austin.
- Nakata, N., Gualtieri, L. & Fichtner, A., 2019. *Seismic Ambient Noise*, Cambridge Univ. Press, Cambridge, UK.
- Narcowich, F. J. & Ward, J. D., 1996. Nonstationary wavelets on the m-sphere for scattered data, *Appl. Comput. Harmon. Anal.*, **3**, 324–336.
- Nashed, M. Z. & Wahba, G., 1974. Convergence rates of approximate least-squares solutions of linear integral and operator equations of the first kind, *Math. Comput.*, **28**(125), 69–80.
- Nashed, M. Z. & Wahba, G., 1975. Some exponentially decreasing error bounds for a numerical inversion of the Laplace transform, *J. Math. Anal. Appl.*, **52**(3), 660–668.
- Nashed, M. Z. & Walter, G. G., 1991. General sampling theorems for functions in Reproducing Kernel Hilbert Spaces, *Math. Control Signals Syst.*, **4**, 363–390.
- Nataf, H.-C., 2000. Inner core takes another turn, *Nature*, **405**, 411–412.
- Nataf, H.-C. & Ricard, Y., 1996. 3SMAC: An a priori tomographic model of the upper mantle based on geophysical modeling, *Phys. Earth Planet. Inter.*, **95**, 101–122.
- Nataf, H.-C., Nakanishi, I. & Anderson, D. L., 1986. Measurements of mantle wave velocities and inversion for lateral heterogeneities and anisotropy: 3. Inversion, *J. Geophys. Res.*, **91**(B7), 7261–7307, doi: 10.1029/JB091iB07p07261.
- Nature Editors, 2011. Devil in the details, *Nature*, **470**, 305–306.
- Naumova, V., Pereverzyev, S. V. & Tkachenko, P., 2014. Regularized collocation for spherical harmonics gravitational field modeling, *Intern. J. Geomath.*, **5**, 81–98, doi: 10.1007/s13137-013-0054-9.

- Neeser, F. D. & Massey, J. L., 1993. Proper complex random processes with applications to information theory, *IEEE T. Inform. Theory*, **39**(4), 1293–1302.
- Nemeth, T., Normark, E. & Qin, F., 1997. Dynamic smoothing in crosswell travelttime tomography, *Geophysics*, **62**(1), 168–176.
- Nerem, R. S. & Wahr, J., 2011. Recent changes in the Earth's oblateness driven by Greenland and Antarctic ice mass loss, *Geophys. Res. Lett.*, **38**(13), L13501, doi: 10.1029/2011GL047879.
- Nerem, R. S., Jekeli, C. & Kaula, W. M., 1995. Gravity field determination and characteristics: Retrospective and prospective, *J. Geophys. Res.*, **100**(B8), 15053–15074.
- Nettles, M. & Dziewoński, A. M., 2008. Radially anisotropic shear velocity structure of the upper mantle globally and beneath North America, *J. Geophys. Res.*, **113**, B02303, doi: 10.1029/2006JB004819.
- Nettles, M. & Ekström, G., 1998. Faulting mechanism of anomalous earthquakes near Bárðarbunga Volcano, Iceland, *J. Geophys. Res.*, **103**(B8), 17973–17983, doi: 10.1029/98JB01392.
- Nettles, M., Larsen, T. B., Elósegui, P., Hamilton, G. S., Stearns, L. A., Ahlstrøm, A. P., Davis, J. L., Andersen, M. L., de Juan, J., Khan, S. A., Stenseng, L., Ekström, G. & Forsberg, R., 2008. Step-wise changes in glacier flow speed coincide with calving and glacial earthquakes at Helheim Glacier, Greenland, *Geophys. Res. Lett.*, **35**, L24503, doi: 10.1029/2008GL036127.
- Neumann, N., Sandiford, M. & Foden, J., 2000. Regional geochemistry and continental heat flow: Implications for the origin of the South Australian heat flow anomaly, *Earth Planet. Sci. Lett.*, **183**, 107–120.
- Newey, W. K. & West, K. D., 1994. Automatic lag selection in covariance estimation, *Rev. Econ. Stud.*, **61**, 631–653.
- Newman, A., Bartlow, N., Schmidt, D., Charlevoix, D., Foster, J., Haines, B., Araki, E., Bürgmann, R., Chadwick, W., Gomberg, J., Melgar, D., Wallace, L., Wei, M. & Wilcock, W., 2007. Future directions in seafloor geodesy, Online, april 6–9, 2021, 2021 Community Workshop.
- Newman, W. I., 2016. *Mathematical Methods for Geophysics and Space Physics*, Princeton Univ. Press, Princeton, N.J.
- Nghiem, S. V., Hall, D. K., Mote, T. L., Tedesco, M., Albert, M. R., Keegan, K., Shuman, C. A., DiGirolamo, N. E. & Neumann, G., 2012. The extreme melt across the Greenland ice sheet in 2012, *Geophys. Res. Lett.*, **39**, L20502, doi: 10.1029/2012GL053611.
- Nguuri, T. K., Gore, J., James, D. E., Webb, S. J., Wright, C., Zengeni, T. G., Gwavava, O., Snoke, J. A. & Kaapvaal Seismic Group, 2001. Crustal structure beneath southern Africa and its implications for the formation and evolution of the Kaapvaal and Zimbabwe cratons, *Geophys. Res. Lett.*, **28**(13), 2501–2504.
- Ni, S. & Helmberger, D. V., 2003. Seismological constraints on the South African superplume; could be the oldest distinct structure on Earth, *Earth Planet. Sci. Lett.*, **206**(1–2), 119–131.

- Nichols, S. M. & Bradley, D. L., 2016. Global examination of the wind-dependence of very low frequency underwater ambient noise, *J. Acoust. Soc. Am.*, **139**(3), 1110–1123, doi: 10.1121/1.4943544.
- Nicolas, A. & Poirier, J.-P., 1976. *Crystalline plasticity and solid state flow in metamorphic rocks*, John Wiley, New York.
- Nimmo, F., 2000. Dike intrusion as a possible cause of linear Martian magnetic anomalies, *Geology*, **28**(5), 391–394.
- Nimmo, F. & Gilmore, M. S., 2001. Constraints on the depth of magnetized crust on Mars from impact craters, *J. Geophys. Res.*, **106**(E6), 12315–12323, doi: 10.1029/2000JE001325.
- Nimmo, F. & Stevenson, D. J., 2001. Estimates of Martian crustal thickness from viscous relaxation of topography, *J. Geophys. Res.*, **106**(E3), 5085–5098, doi: 10.1029/2000JE001331.
- Nimmo, F. & Tanaka, K., 2005. Early crustal evolution of Mars, *Annu. Rev. Earth Planet. Sc.*, **33**, 133–161, doi: 10.1146/annurev.earth.33.092203.122637.
- Nisbet, E. G. & Fowler, C. M. R., 1996. Some liked it hot, *Nature*, **382**, 404–405.
- Nishida, K., Kobayashi, N. & Fukao, Y., 2000. Resonant oscillations between the solid Earth and the atmosphere, *Science*, **287**(5461), 2244–2246, doi: 10.1126/science.287.5461.2244.
- Nishimura, C. E. & Conlon, D. M., 1993. IUSS dual-use: Monitoring whales and earthquakes using SOSUS, *Mar. Tech. Soc. J.*, **27**(4), 13–21.
- Nishimura, C. E. & Forsyth, D. W., 1985. Anomalous Love-wave phase velocities in the Pacific: Sequential pure-path and spherical harmonic inversion, *Geophys. J. R. Astron. Soc.*, **81**(2), 389–407.
- Nishimura, C. E. & Forsyth, D. W., 1988. Rayleigh wave phase velocities in the Pacific with implications for azimuthal anisotropy and lateral heterogeneities, *Geophys. J. Int.*, **94**, 479–501.
- Nishimura, C. E. & Forsyth, D. W., 1989. The anisotropic structure of the upper mantle in the Pacific, *Geophys. J. Int.*, **96**(2), 203–229.
- Nissen-Meyer, T., Dahlen, F. A. & Fournier, A., 2007. Spherical-earth Fréchet sensitivity kernels, *Geophys. J. Int.*, **168**(3), 1051–1066, doi: 10.1111/j.1365–246X.2006.03123.x.
- Nissen-Meyer, T., Fournier, A. & Dahlen, F. A., 2007. A two-dimensional spectral-element method for computing spherical-earth seismograms — I. Moment-tensor source, *Geophys. J. Int.*, **168**(3), 1067–1092, doi: 10.1111/j.1365–246X.2006.03121.x.
- Nissen-Meyer, T., Fournier, A. & Dahlen, F. A., 2008. A two-dimensional spectral-element method for computing spherical-earth seismograms — II. Waves in solid-fluid media, *Geophys. J. Int.*, **174**(3), 873–888, doi: 10.1111/j.1365–246X.2008.03813.x.

- Nissen-Meyer, T., van Driel, M., Stähler, S. C., Hosseini, K., Hempel, S., Auer, L., Colombi, A. & Fournier, A., 2014. AxiSEM: broadband 3-D seismic wavefields in axisymmetric media, *Solid Earth*, **5**(1), 425–445, doi: 10.5194/se-5-425-2014.
- Niu, F., 2014. Distinct compositional thin layers at mid-mantle depths beneath northeast China revealed by the USArray, *Earth Planet. Sci. Lett.*, **402**, 305–312, doi: 10.1016/j.epsl.2013.02.015.
- Niu, F. & Wen, L., 2001. Hemispherical variations in seismic velocity at the top of the Earth's core, *Nature*, **410**, 1081–1084.
- Niu, F., Kawakatsu, H. & Fukao, Y., 2003. Seismic evidence for a chemical heterogeneity in the midmantle: A strong and slightly dipping seismic reflector beneath the Mariana subduction zone, *J. Geophys. Res.*, **108**(B9), 2419, doi: 10.1029/2002JB002384.
- Nocedal, J. & Wright, S. J., 2006. *Numerical Optimization*, Operations Research and Financial Engineering, Springer, New York.
- Nocquet, J.-M. & Calais, E., 2003. Crustal velocity field of western Europe from permanent GPS array solutions, 1996–2001, *Geophys. J. Int.*, **154**(1), 72–88.
- Nolet, G., 1975. Higher Rayleigh modes in Western Europe, *Geophys. Res. Lett.*, **2**(2), 60–62.
- Nolet, G., 1985. Solving or resolving inadequate and noisy tomographic systems, *J. Comput. Phys.*, **61**, 463–482.
- Nolet, G., ed., 1987. *Seismic Tomography*, Reidel, Hingham, Mass.
- Nolet, G., 1987, Seismic wave propagation and seismic tomography, in *Seismic Tomography*, edited by G. Nolet, chap. 1, pp. 1–23, Reidel, Hingham, Mass.
- Nolet, G., 1987, Waveform tomography, in Nolet (1987a), chap. 13, pp. 301–322.
- Nolet, G., 1990. Partitioned Waveform Inversion and two-dimensional structure under the Network of Autonomously Recording Seismographs, *J. Geophys. Res.*, **95**(B6), 8499–8512.
- Nolet, G., 1996, A general view on the seismic inverse problem, in *Seismic Modelling of Earth Structure*, edited by E. Boschi, G. Ekström, & A. Morelli, pp. 1–29, Editrice Compositori,, Bologna, Italy.
- Nolet, G., 2008. *A Breviary of Seismic Tomography*, Cambridge Univ. Press, Cambridge, UK.
- Nolet, G., 2015, Transmission tomography in seismology, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, pp. 1887–1904, doi: 10.1007/978-3-642-54551-1_58, Springer, Heidelberg, Germany, 2nd edn.
- Nolet, G. & Dahlen, F. A., 2000. Wave front healing and the evolution of seismic delay times, *J. Geophys. Res.*, **105**(B8), 19043–19054, doi: 10.1029/2000JB900161.
- Nolet, G. & Dorman, L. M., 1996. Waveform analysis of Scholte modes in ocean sediment layers, *Geophys. J. Int.*, **125**(2), 385–396, doi: 10.1111/j.1365-246X.1996.tb00006.x.

- Nolet, G. & Montelli, R., 2005. Optimal parametrization of tomographic models, *Geophys. J. Int.*, **161**(2), 365–372, doi: 10.1111/j.1365-246X.2005.02596.x.
- Nolet, G. & Panza, G., 1976. Array analysis of seismic surface-waves: Limits and possibilities, *Pure Appl. Geophys.*, **114**(5), 775–790, doi: 10.1007/BF00875787.
- Nolet, G. & Zielhuis, A., 1994. Low *S*-velocities under the Tornquist-Teisseyre zone, Evidence for water injection into the transition zone by subduction, *J. Geophys. Res.*, **99**(B8), 15813–15820.
- Nolet, G., van Trier, J. & Huisman, R., 1986. A formalism for nonlinear inversion of seismic surface waves, *Geophys. Res. Lett.*, **13**(1), 26–29.
- Nolet, G., Grand, S. P. & Kennett, B. L. N., 1994. Seismic heterogeneity in the upper mantle, *J. Geophys. Res.*, **99**(B12), 23753–23766.
- Nolet, G., Clouser, R. M. & Krueger, S., 1998. Reply, *Geophys. Res. Lett.*, **25**(22), 4243–4244.
- Nolet, G., Krueger, S. & Clouser, R. M., 1998. Empirical determination of depth-distance corrections for m_b and m_w from Global Seismograph Network stations, *Geophys. Res. Lett.*, **25**(9), 1451–1454.
- Nolet, G., Krueger, S. & Clouser, R. M., 1998. Reply, *Geophys. Res. Lett.*, **25**(23), 4271–4272.
- Nolet, G., Montelli, R. & Virieux, J., 1999. Explicit, approximate expressions for the resolution and a posteriori covariance of massive tomographic systems, *Geophys. J. Int.*, **138**(1), 36–44.
- Nolet, G., Dahlen, F. A. & Montelli, R., 2005, Traveltimes and amplitudes of seismic waves: A reassessment, in *Seismic Earth: Array Analysis of Broadband Seismograms*, edited by A. Levander & G. Nolet, vol. 157 of **Geophysical Monograph**, pp. 37–47, Amer. Geophys. Union.
- Nolet, G., Karato, S.-I. & Montelli, R., 2006. Plume fluxes from seismic tomography, *Earth Planet. Sci. Lett.*, **248**(3–4), 685–699, doi: 10.1016/j.epsl.2006.06.011.
- Nolet, G., Allen, R. & Zhao, D., 2007. Mantle plume tomography, *Chemical Geology*, **241**(3–4), 248–263, doi: 10.1016/j.chemgeo.2007.01.022.
- Nolet, G., Hello, Y., van der Lee, S., Bonnieux, S., Ruiz, M. C., Pazmino, N. A., Deschamps, A., Regnier, M. M., Font, Y., Chen, Y. J. & Simons, F. J., 2019. Imaging the Galápagos mantle plume with an unconventional application of floating seismometers, *Sci. Rep.*, **9**, 1326, doi: 10.1038/s41598-018-36835-w.
- North, G. R., Wang, J. & Genton, M. G., 2011. Correlation models for temperature fields, *J. Climate*, **24**, 5850–5862, doi: 10.1175/2011JCLI4199.1.
- Novák, P., Kern, M., Schwarz, K.-P. & Heck, B., 2003. Evaluation of band-limited topographical effects in airborne gravimetry, *J. Geod.*, **76**, 597–604.
- Nutz, H., 2002, *A Unified Setup of Gravitational Field Observables*, Ph.D. thesis, Univ. Kaiserslautern, Germany.

- Nyblade, A. A., 1999. Heat flow and the structure of Precambrian lithosphere, *Lithos*, **48**(1–4), 81–91.
- Nyblade, A. A., 2001. Earth science — Hard-cored continents, *Nature*, **2001**(411), 6833.
- Nyström, E. J., 1930. Über die praktische Auflösung von Integralgleichungen mit Anwendungen auf Randwertaufgaben, *Acta Mathematica*, **54**, 185–204.
- Obara, K., 2002. Nonvolcanic deep tremor associated with subduction in Southwest Japan, *Science*, **296**, 1679–1681.
- Obermaier, J., 2003. A continuous function space with a Faber basis, *J. Approx. Theory*, **125**(2), 303–312.
- O’Brien, M. S. & Parker, R. L., 1994. Regularized geomagnetic field modelling using monopoles, *Geophys. J. Int.*, **118**(3), 566–578, doi: 10.1111/j.1365–246X.1994.tb03985.x.
- O’Connell, R. J. & Budiansky, B., 1978. Measures of dissipation in viscoelastic media, *Geophys. Res. Lett.*, **5**(1), 5–8.
- O’Dowd, R. J., 1990. Ill-conditioning and pre-whitening in seismic deconvolution, *Geophys. J. Int.*, **101**(2), 489–491, doi: 10.1111/j.1365–246X.1990.tb06582.x.
- Ogburn, D. X., Waters, C. L., Sciffer, M. D., Hogan, J. A. & Abbott, P. C., 2013. A finite difference construction of the spheroidal wave functions, *Comput. Phys. Comm.*, **185**, 244–253.
- Oh, S. P., Spergel, D. N. & Hinshaw, G., 1999. An efficient technique to determine the power spectrum from cosmic microwave background sky maps, *Astroph. J.*, **510**, 551–563.
- O’Hanlon, L., 2001. Seismic sleuths, *Nature*, **411**(6839), 734–736.
- Ohtaki, T. & Kaneshima, S., 2015. Independent estimate of velocity structure of Earth’s lowermost outer core beneath the northeast Pacific from PKiKP–PKPbc differential traveltime and dispersion in PKPbc, *J. Geophys. Res.*, **120**(11), 7572–7586, doi: 10.1002/2015JB012140.
- Oja, E., 1992. A simplified neuron model as a principal component analyzer, *JMB*, **15**, 267–273.
- Ojeda, G. Y. & Whitman, D., 2002. Effect of windowing on lithosphere elastic thickness estimates obtained via the coherence method: Results from northern South America, *J. Geophys. Res.*, **107**(B11), 2275, doi: 10.1029/2000JB000114.
- Okal, E. A., 1977. The effect of intrinsic oceanic upper-mantle heterogeneity on regionalization of long-period Rayleigh-wave phase velocities, *Geophys. J. R. Astron. Soc.*, **49**, 357–370.
- Okal, E. A., 2008. The generation of *T* waves by earthquakes, *Adv. Geophys.*, **49**, 1–65, doi: 10.1016/S0065–2687(07)49001–X.
- Okal, E. A., Talandier, J. & Reymond, D., 2007. Quantification of hydrophone records of the 2004 Sumatra tsunami, *Pure Appl. Geophys.*, **164**, 309–323, doi: 10.1007/s00024–006–0165–4.

- Oldenburg, D. W., 1974. The inversion and interpretation of gravity anomalies, *Geophysics*, **39**(4), 526–536, doi: 10.1190/1.1440444.
- O’Leary, D. P., Stewart, G. W. & Vandergraft, J. S., 1979. Estimating the largest eigenvalue of a positive definite matrix, *Math. Comput.*, **33**(148), 1289–1292.
- Olhede, S. & Walden, A. T., 2002. Generalized Morse wavelets, *IEEE T. Signal Process.*, **50**(11), 2661–2670.
- Olhede, S. & Walden, A. T., 2003. Polarization phase relationships via multiple Morse wavelets. I. Fundamentals, *Proc. R. Soc. London, Ser. A*, **459**(2030), 413–444.
- Olhede, S. & Walden, A. T., 2003. Polarization phase relationships via multiple Morse wavelets. II. Data analysis, *Proc. R. Soc. London, Ser. A*, **459**(2031), 641–657.
- Olhede, S. C., 2007. Hyperanalytic denoising, *IEEE T. Image Proc.*, **16**(6), 1522–1537, doi: 10.1109/TIP.2007.896633.
- Olhede, S. C., 2008. Localisation of geometric anisotropy, *IEEE T. Signal Process.*, **56**(5), 2133–2138, doi: 10.1109/TSP.2007.912894.
- Olhede, S. C. & Metikas, G., 2006, Multiple wavelet coherence analysis, in *Image Processing: Algorithms and Systems, Neural Networks, and Machine Learning*, edited by E. R. Dougherty, J. T. Astola, & K. O. Egiazarian, Proc. SPIE, pp. 31–42, San Jose, Calif.
- Olhede, S. C. & Metikas, G., 2009. The monogenic wavelet transform, *IEEE T. Signal Process.*, **57**(9), 3426–3441, doi: 10.1109/TSP.2009.2023397.
- Olhede, S. C., Ramíres, D. & Schreier, P. J., 2014. Detecting directionality in random fields using the monogenic signal, *IEEE T. Inform. Theory*, **60**(10), 6491–6510, doi: 10.1109/TIT.2014.2342734.
- Olive, J.-A., Behn, M. D., Ito, G., Buck, W. R., Escartin, J. & Howell, S., 2015. Sensitivity of seafloor bathymetry to climate-driven fluctuations in mid-ocean ridge magma supply, *Science*, **350**(6258), 310–313, doi: 10.1126/science.aad0715.
- Oliver, H. W., Pakiser, L. C. & Kane, M. F., 1961. Gravity anomalies in the Central Sierra Nevada, California, *J. Geophys. Res.*, **66**(12), 4265–4271, doi: 10.1029/JZ066i012p04265.
- Oliver, M. A., 2009. Special issue on applications of wavelets in the geosciences, *Math. Geosc.*, **41**(6), 609–610.
- Olsen, N., Manda, M., Sabaka, T. J. & Tøffner-Clausen, L., 2009. CHAOS-2—a geomagnetic field model derived from one decade of continuous satellite data, *Geophys. J. Int.*, **179**, 1477–1487, doi: 10.1111/j.1365–246X.2009.04386.x.
- Olsen, N., Glassmeier, K.-H. & Jia, X., 2010. Separation of the magnetic field into external and internal parts, *Space Sci. Rev.*, **152**, 135–157, doi: 10.1007/s11214–009–9563–0.

- Olsen, N., Hulot, G. & Sabaka, T. J., 2010, Sources of the geomagnetic field and the modern data that enable their investigation, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 5, pp. 105–124, doi: 10.1007/978-3-642-01546-5_5, Springer, Heidelberg, Germany.
- Olsen, N., Hulot, G. & Sabaka, T. J., 2010. Measuring the Earth’s magnetic field from space: Concepts of past, present and future missions, *Space Sci. Rev.*, **155**, 65–93, doi: 10.1007/s11214-010-9676-5.
- Olsen, N., Friis-Christensen, E., Floberghagen, R., Alken, P., Beggan, C. D., Chulliat, A., Doornbos, E., ao Teixeira da Encarnação, J., Hamilton, B., Hulot, G., van den IJssel, J., Kuvshinov, A., Lesur, V., Lühr, H., Macmillan, S., Maus, S., Noja, M., Olsen, P. E. H., Park, J., Plank, G., Püthe, C., Rauberg, J., Ritter, P., Rother, M., Sabaka, T. J., Schachtschneider, R., Sirol, O., Stolle, C., Thébaud, E., Thomson, A. W. P., Tøffner-Clausen, L., Velínský, J., Vigneron, P. & Visser, P. N., 2013. The Swarm satellite constellation application and research facility (SCARF) and Swarm data products, *Earth Planets Space*, **55**, 1–13.
- Olson, E. L. & Allen, R. M., 2005. The deterministic nature of earthquake rupture, *Nature*, **438**, 212–214, doi: 10.1038/nature04214.
- Olson, E. L. & Allen, R. M., 2006. Earth science: Is earthquake rupture deterministic? (Reply), *Nature*, **446**, E6, doi: 10.1038/nature04964.
- Olson, P., Christensen, U. & Glatzmaier, G. A., 1999. Numerical modeling of the geodynamo: Mechanisms of field generation and equilibration, *J. Geophys. Res.*, **104**(B5), 10383–10404.
- Olver, F. W. J., 1997. *Asymptotics and Special Functions*, A. K. Peters, Wellesley, Mass.
- Ombao, H. C., Raz, J. A., von Sachs, R. & Malow, B. A., 2001. Automatic statistical analysis of bivariate nonstationary time series, *J. Am. Stat. Assoc.*, **96**(454), 534–560.
- Omre, H., 2004, Lecture notes: Stochastic simulation of spatial models, Colorado School of Mines Summer School in Mathematical Geophysics and Uncertainty in Earth Models.
- O’Neill, A. & Matsuoka, T., 2005. Dominant higher surface-wave modes and possible inversion pitfalls, *J. Environ. Eng. Geophys.*, **10**(2), 185–201, doi: 10.2113/JEEG10.2.185.
- O’Neill, C., Moresi, L., Lenardic, A. & Cooper, K., 2003. Inferences on Australia’s heat flow and thermal structure from mantle convection models, *Geological Society of America and Australia Joint Publication*, **22**, 163–178.
- Oonincx, P. J., 1999. A wavelet method for detecting S-waves in seismic data, *Comput. Geosc.*, **3**(2), 111–134, doi: 10.1023/A:1011527009040.
- Operto, S., Ravaut, C., Impropa, L., Virieux, J., Herrero, A. & Aversana, P. D., 2004. Quantitative imaging of complex structures from dense wide-aperture seismic data by multiscale traveltimes and waveform inversions: a case study, *Geophys. Prospect*, **52**(6), 625–651, doi: 10.1111/j.1365-2478.2004.00452.x.

- Operto, S., Gholami, Y., Brossier, R., Métivier, L., Prioux, V., Ribodetti, A. & Virieux, J., 2013. A guided tour of multiparameter full-waveform inversion with multicomponent data: From theory to practice, *The Leading Edge*, **32**(9), 1040–1054, doi: 10.1190/tle32091040.1.
- Oppenheim, A. V. & Lim, J. S., 1981. The importance of phase in signals, *Proc. IEEE*, **69**(5), 529–541, doi: 10.1109/PROC.1981.12022.
- Oppenheimer, M., 1998. Global warming and the stability of the West Antarctic Ice Sheet, *Nature*, **393**(6683), 325–332, doi: 10.1038/30661.
- O'Reilly, S. Y., Griffin, W. L., Poudjom-Djomani, Y. H. & Morgan, P., 2001. Are lithospheres forever? Tracking changes in subcontinental lithospheric mantle through time, *GSA Today*, **11**(4), 4–10.
- Ory, J. & Pratt, R. G., 1995. Are our parameter estimators biased? The significance of finite-difference regularization operators, *Inv. Probl.*, **11**(2), 397–424.
- Osipov, A., Rokhlin, V. & Xiao, H., 2013. *Prolate spheroidal wave functions of order zero*, vol. 187 of **Applied Mathematical Sciences**, Springer, New York.
- Ould Kaber, S. M., 1996. A Legendre pseudospectral viscosity method, *J. Comput. Phys.*, **128**, 165–180.
- Overpeck, J. T., Otto-Bliesner, B. L., Miller, G. H., Muhs, D. R., Alley, R. B. & Kiehl, J. T., 2006. Paleoclimatic evidence for future ice-sheet instability and rapid sea-level rise, *Science*, **311**(5768), 1747–1750, doi: 10.1126/science.1115159.
- Owens, T. J., Crotwell, H. P., Groves, C. & Oliver-Paul, P., 2004. SOD: Standing order for data, *Seismol. Res. Lett.*, **75**(4), 515–520, doi: 10.1785/gssrl.75.4.515-a.
- Özalaybey, S. & Chen, W. P., 1999. Frequency-dependent analysis of *sk*s-*sk*s waveforms observed in Australia: Evidence for null birefringence, *Phys. Earth Planet. Inter.*, **114**(3–4), 197–210.
- Ozima, M., Seki, K., Terada, N., Miura, Y. N., Podosek, F. A. & Shinagawa, H., 2005. Terrestrial nitrogen and noble gases in lunar soils, *Nature*, **436**, 655–659, doi: 10.1038/nature03929.
- Paciorek, C. J., 2007. Bayesian smoothing with Gaussian processes using Fourier basis functions in the spectralGP package, *J. Stat. Softw.*, **19**(2), nihpa22751.
- Packham, G., 1996. Cenozoic SE Asia: Reconstructing its aggregation and reorganization, in *Tectonic Evolution of Southeast Asia*, edited by R. Hall & D. Blundell, vol. 106, pp. 153–184, Geol. Soc. Am.
- Page, R. A., Molnar, P. H. & Oliver, J., 1968. Seismicity in the vicinity of the Ramapo fault, New Jersey-New York, *B. Seismol. Soc. Am.*, **58**(2), 681–687, doi: 10.1785/BSSA0580020681.
- Paige, C. C. & Saunders, M. A., 1982. LSQR: An algorithm for sparse linear equations and sparse least squares, *ACM T. Math. Software*, **8**(1), 43–71.

- Pail, R., Plank, G. & Schuh, W.-D., 2001. Spatially restricted data distributions on the sphere: the method of orthonormalized functions and applications, *J. Geod.*, **75**, 44–56.
- Palmer, D. R., Brown, M. G., Tappert, F. D. & Bezdek, H. F., 1988. Classical chaos in nonseparable wave propagation problems, *Geophys. Res. Lett.*, **15**(6), 569–572, doi: 10.1029/GL015i006p00569.
- Pan, W. & Wang, Y., 2020. On the influence of different misfit functions for attenuation estimation in viscoelastic full-waveform inversion: synthetic study, *Geophys. J. Int.*, **221**(2), 1292–1319, doi: 10.1093/gji/ggaa089.
- Pan, Y. & Gao, L., 2020. Random objective waveform inversion of surface waves, *Geophysics*, **85**(4), EN49–EN61, doi: 10.1190/geo2019–0613.1.
- Panet, I., Chambodut, A., Diament, M., Holschneider, M. & Jamet, O., 2006. New insights on intraplate volcanism in French Polynesia from wavelet analysis of GRACE, CHAMP, and sea surface data, *J. Geophys. Res.*, **111**, B09403, doi: 10.1029/2005JB004141.
- Panet, I., Mikhailov, V., Diament, M., Pollitz, F., King, G., de Viron, O., Holschneider, M., Biancale, R. & Lemoine, J.-M., 2007. Coseismic and post-seismic signatures of the Sumatra 2004 December and 2005 March earthquakes in GRACE satellite gravity, *Geophys. J. Int.*, **171**(1), 177–190, doi: 10.1111/j.1365–246X.2007.03525.x.
- Panet, I., Pajot-Métivier, G., Greff-Lefftz, M., Métivier, L., Diament, M. & Mandea, M., 2014. Mapping the mass distribution of earth’s mantle using satellite-derived gravity gradients, *Nature Geosci.*, **7**, 131–135, doi: 10.1038/ngeo2063.
- Panning, M. & Romanowicz, B., 2006. A three-dimensional radially anisotropic model of shear velocity in the whole mantle, *Geophys. J. Int.*, **167**(1), 361–379, doi: 10.1111/j.1365–246X.2006.03100.x.
- Panning, M., Lekić, V., Manga, M., Cammarano, F. & Romanowicz, B., 2006. Long-period seismology on Europa: 2. Predicted seismic response, *J. Geophys. Res.*, **111**(E12), E12008, doi: 10.1029/2006JE002712.
- Panning, M. P. & Nolet, G., 2008. Surface wave tomography for azimuthal anisotropy in a strongly reduced parameter space, *Geophys. J. Int.*, **174**(2), 629–648, doi: 10.1111/j.1365–246X.2008.03833.x.
- Panning, M. P., Capdeville, Y. & Romanowicz, B. A., 2009. Seismic waveform modelling in a 3-D Earth using the Born approximation: potential shortcomings and a remedy, *Geophys. J. Int.*, **177**(1), 161–178, doi: 10.1111/j.1365–246X.2008.04050.x.
- Panza, G. F. & Mueller, S., 1979. The plate boundary between Eurasia and Africa in the Alpine Area., *Mem. Sc. Geol.*, **33**, 43–50.
- Papalexandrou, N., 2006. A Cypro-Archaic public building at Polis Chrysochou, 1999–2003: Preliminary Report, *Report of the Department of Antiquities, Cyprus*, pp. 223–237.

- Papalexandrou, N., 2008. A Cypro-Archaic public building at Polis Chrysochou, 2006–2007: Interim Report, *Report of the Department of Antiquities, Cyprus*, pp. 251–262.
- Papoulis, A., 1975. A new algorithm in spectral analysis and band-limited extrapolation, *IEEE-CS*, **22**(9), 735–742.
- Pari, G. & Peltier, W. R., 1995. The heat flow constraint on mantle tomography-based convection models: Towards a geodynamically self-consistent inference of mantle viscosity, *J. Geophys. Res.*, **100**(B7), 12731–12751.
- Pari, G. & Peltier, W. R., 1996. The free-air gravity constraint on subcontinental mantle dynamics, *J. Geophys. Res.*, **101**(B12), 28105–28132.
- Pari, G. & Peltier, W. R., 1998. Global surface heat-flux anomalies from seismic tomography-based models of mantle flow: Implications for mantle convection, *J. Geophys. Res.*, **103**(B10), 23743–23780.
- Pari, G. & Peltier, W. R., 2000. Subcontinental mantle dynamics: A further analysis based on the joint constraints of dynamic surface topography and free-air gravity, *J. Geophys. Res.*, **105**(B3), 5635–5662.
- Park, C. B., Miller, R. D. & Xia, J., 1999. Multichannel analysis of surface waves, *Geophysics*, **64**(3), 800–808, doi: 10.1190/1.1444590.
- Park, J. & Levin, V., 2002. Seismic anisotropy: Tracing plate dynamics in the mantle, *Science*, **296**, 485–489.
- Park, J., Lindberg, C. R. & III, F. L. V., 1987. Multitaper spectral analysis of high-frequency seismograms, *J. Geophys. Res.*, **92**(B12), 12675–12684, doi: 10.1029/JB092iB12p12675.
- Park, J., Lindberg, C. R. & Thomson, D. J., 1987. Multiple-taper spectral analysis of terrestrial free oscillations, I, *Geophys. J. R. Astron. Soc.*, **91**, 755–794.
- Park, M., Odom, R. I. & Soukup, D. J., 2001. Modal scattering: a key to understanding oceanic T-waves, *Geophys. Res. Lett.*, **28**(17), 3401–3404, doi: 10.1029/2001GL013472.
- Park, Y.-G., Oh, K.-H., Chang, K.-I. & Suk, M.-S., 2004. Intermediate level circulation of the southwestern part of the East/Japan Sea estimated from autonomous isobaric profiling floats, *Geophys. Res. Lett.*, **31**, L13213, doi: 10.1029/2004GL020424.
- Parker, R. L., 1973. The rapid calculation of potential anomalies, *Geophys. J. R. Astron. Soc.*, **31**(4), 447–455, doi: 10.1111/j.1365–246X.1973.tb06513.x.
- Parker, R. L., 1975. The theory of ideal bodies for gravity interpretation, *Geophys. J. R. Astron. Soc.*, **42**(2), 315–334.
- Parker, R. L., 1977. Understanding inverse theory, *Annu. Rev. Earth Planet. Sc.*, **5**, 35–64, doi: 10.1146/annurev.ea.05.050177.000343.

- Parker, R. L., 1977. Linear inference and underparameterized models, *Rev. Geophys. Space Phys.*, **15**(4), 446–456.
- Parker, R. L., 1994. *Geophysical Inverse Theory*, Princeton Univ. Press, Princeton, N.J.
- Parker, R. L. & McNutt, M. K., 1980. Statistics for the one-norm misfit measure, *J. Geophys. Res.*, **85**(B8), 4429–4430, doi: 10.1029/JB085iB08p04429.
- Parks, T. W. & Shenoy, R. G., 1990, Time-frequency concentrated basis functions, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, vol. 5, pp. 2459–2462, IEEE.
- Parlett, B. N. & Wu, W.-D., 1984. Eigenvector matrices of symmetric tridiagonals, *Numer. Math.*, **44**, 103–110.
- Parman, S. W., 2007. Helium isotopic evidence for episodic mantle melting and crustal growth, *Nature*, **446**, 900–903, doi: 10.1038/nature05691.
- Parmentier, E. M., Turcotte, D. L. & Torrance, K. E., 1976. Studies of finite amplitude non-Newtonian thermal convection with application to convection in the Earth's mantle, *J. Geophys. Res.*, **81**(11), 1839–1846, doi: 10.1029/JB081i011p01839.
- Parolai, S., Trojani, L., Frappiccini, M. & Monachesi, G., 2002. Seismic source classification by means of a sonogram-correlation approach: Application to data of the RSM seismic network (Central Italy), *Pure Appl. Geophys.*, **159**, 2763–2788.
- Pascal, C., van Wijk, J. W., Cloetingh, S. A. P. L. & Davies, G. R., 2002. Effect of lithospheric thickness heterogeneities in controlling rift localization: Numerical modeling of the Oslo Graben, *Geophys. Res. Lett.*, **29**(9), doi: 10.1029/2001GL014354.
- Passier, M. L. & Snieder, R. K., 1995. On the presence of intermediate-scale heterogeneities in the upper mantle, *Geophys. J. Int.*, **123**, 817–837.
- Passier, M. L. & Snieder, R. K., 1995. Using differential waveform data to retrieve local *S* velocity structure or path-averaged *S* velocity gradients, *J. Geophys. Res.*, **100**(B12), 24061–24078.
- Passier, M. L. & Snieder, R. K., 1996. Correlation between shear wave upper mantle structure and tectonic surface expressions: Application to central and southern Germany, *J. Geophys. Res.*, **101**(B11), 25293–25304.
- Passier, M. L., van der Hilst, R. D. & Snieder, R. K., 1997. Surface wave waveform inversions for local shear-wave velocities under eastern Australia, *GRL*, **24**(11), 1291–1294.
- Paul, M. K., 1978. Recurrence relations for integrals of associated Legendre functions, *Bull. Géod.*, **52**, 177–190.
- Paulson, A., Zhong, S. & Wahr, J., 2007. Inference of mantle viscosity from GRACE and relative sea level data, *Geophys. J. Int.*, **171**(2), 497–508, doi: 10.1111/j.1365–246X.2007.03556.x.

- Paulson, A., Zhong, S. & Wahr, J., 2007. Limitations on the inversion for mantle viscosity from postglacial rebound, *Geophys. J. Int.*, **168**(3), 1195–1209, doi: 10.1111/j.1365–246X.2006.03222.x.
- Pavlis, G. L. & Booker, J. R., 1980. The mixed discrete-continuous inverse problem: Application to the simultaneous determination of earthquake hypocenters and velocity structure, *J. Geophys. Res.*, **85**(B9), 4801–4810, doi: 10.1029/JB085iB09p04801.
- Pavlis, N. K., Holmes, S. A., Kenyon, S. C. & Factor, J. K., 2012. The development and evaluation of the Earth Gravitational Model 2008 (EGM2008), *J. Geophys. Res.*, **117**, B04406, doi: 10.1029/2011JB008916.
- Pavlis, N. K., Holmes, S. A., Kenyon, S. C. & Factor, J. K., 2013. Correction to “the development and evaluation of the Earth Gravitational Model 2008 (EGM2008)”, *J. Geophys. Res.*, **118**, 2633, doi: 10.1002/jgrb.50167.
- Pawitan, Y., 2001. *In All Likelihood: Statistical Modelling and Inference Using Likelihood*, Oxford Univ. Press, New York.
- Pazan, S. E. & Niiler, P. P., 2004. New global drifter data set available, *Eos Trans. AGU*, **85**(2), 17.
- Pearson, D. G., 1999. The age of continental roots, *Lithos*, **48**(1–4), 171–194.
- Pearson, D. G., Snyder, G. A., Shirey, S., Taylor, L. A., Carlson, R. W. & Sobolev, N., 1995. Archean Re-Os age for Siberian eclogites and constraints on Archean tectonics, *Nature*, **374**(6524), 711–713.
- Pearson, D. G., Parman, S. W. & Nowell, G. M., 2007. A link between large mantle melting events and continent growth seen in osmium isotopes, *Nature*, **449**(7159), 202–205, doi: 10.1038/nature06122.
- Peebles, P. J. E., 1973. Statistical analysis of catalogs of extragalactic objects. I. Theory, *Astroph. J.*, **185**, 413–440.
- Peitgen, H. O. & Saupe, D., eds., 1988. *The science of fractal images*, vol. 65, Springer, New York.
- Pekeris, C. L., 1965. Asymptotic theory of the free torsional oscillations of the earth, *Geophysics*, **53**, 1254–1261.
- Pekeris, C. L., Alterman, Z., Abramovici, F. & Jarosch, H., 1965. Propagation of a compressional pulse in a layered solid, *Rev. Geophys.*, **3**(1), 25–47, doi: 10.1029/RG003i001p00025.
- Peltier, W. R., 1976. Glacial-isostatic adjustment — II. The inverse problem, *Geophys. J. R. Astron. Soc.*, **46**(669–705).
- Peltier, W. R., 1985. Mantle convection and viscoelasticity, *Annu. Rev. Fluid Mech.*, **17**(1), 561–608, doi: 10.1146/annurev.fl.17.010185.003021.

- Peltier, W. R., 2004. Global glacial isostasy and the surface of the ice-age earth: The ICE-5G (VM2) model and GRACE, *Annu. Rev. Earth Planet. Sc.*, **32**, 111–149, doi: 10.1146/anurev.earth.32.082503.144359.
- Peltier, W. R. & Andrews, J. T., 1976. Glacial-isostatic adjustment — I. The forward problem, *Geophys. J. R. Astron. Soc.*, **46**(605–646).
- Peltier, W. R. & Jarvis, G. T., 1982. Whole mantle convection and the thermal evolution of the Earth, *Phys. Earth Planet. Inter.*, **29**(3–4), 281–304, doi: 10.1016/0031-9201(82)90018-8.
- Peltier, W. R., Forte, A. M., Mitrovica, J. X. & Dziewonski, A. M., 1992. Earth’s gravitational field: Seismic tomography resolves the enigma of the Laurentian anomaly, *Geophys. Res. Lett.*, **19**(15), 1555–1558.
- Percival, D. B., 1992. Simulating Gaussian random processes with specified spectra, *Comp. Sc. Stat.*, **24**, 534–538.
- Percival, D. B. & Walden, A. T., 1993. *Spectral Analysis for Physical Applications, Multitaper and Conventional Univariate Techniques*, Cambridge Univ. Press, New York.
- Percival, D. B. & Walden, A. T., 2006. *Wavelet methods for time series analysis*, Cambridge Univ. Press.
- Percival, D. B., Sardy, S. & Davison, A. C., 2000, Wavestrapping time series: Adaptive wavelet-based bootstrapping, in *Nonlinear and Nonstationary Signal Processing*, edited by W. J. Fitzgerald, R. L. Smith, A. T. Walden, & C. P. Young, Cambridge Univ. Press, Cambridge, UK.
- Percival, W. J., Burkey, D., Heavens, A., Taylor, A., Cole, S., Peacock, J. A., Baugh, C. M., Bland-Hawthorn, J., Bridges, T., Cannon, R., Colless, M., Collins, C., Couch, W., Dalton, G., de Propriis, R., Driver, S. P., Efstathiou, G., Ellis, R. S., Frenk, C. S., Glazebrook, K., Jackson, C., Lahav, O., Lewis, I., Lumsden, S., Maddox, S., Norberg, P., Peterson, B. A., Sutherland, W. & Taylor, K., 2004. The 2dF Galaxy Redshift Survey: spherical harmonics analysis of fluctuations in the final catalogue, *Mon. Not. R. Astron. Soc.*, pp. doi: 10.1111/j.1365-2966.2004.08146.x.
- Pereverzev, S. & Schock, E., 1999. Error estimates for band-limited spherical regularization wavelets in an inverse problem of satellite geodesy, *Inv. Probl.*, **15**(4), 881–890, doi: 10.1088/0266-5611/15/4/304.
- Pérez-Gussinyé, M. & Watts, A. B., 2005. The long-term strength of Europe and its implications for plate-forming processes, *Nature*, **436**(7049), 381–384.
- Pérez-Gussinyé, M., Lowry, A., Watts, A. B. & Velicogna, I., 2004. On the recovery of effective elastic thickness using spectral methods: Examples from synthetic data and from the Fennoscandian Shield, *J. Geophys. Res.*, **109**, B10409, doi: 10.1029/2003JB002788.
- Pérez-Gussinyé, M., Lowry, A. R. & Watts, A. B., 2007. Effective elastic thickness of South America and its implications for intracontinental deformation, *Geochem. Geophys. Geosys.*, **8**(5), Q05009, doi: 10.1029/2006GC001511.

- Pérez-Gussinyé, M., Metois, M., Fernández, M., Vergés, J., Fulla, J. & Lowry, A. R., 2009. Effective elastic thickness of Africa and its relationship to other proxies for lithospheric structure and surface tectonics, *Earth Planet. Sci. Lett.*, **287**(1), 152–167, doi: 10.1016/j.epsl.2009.08.004.
- Pérez-Gussinyé, M., Swain, C. J., Kirby, J. F. & Lowry, A. R., 2009. Spatial variations of the effective elastic thickness, T_e , using multitaper spectral estimation and wavelet methods: Examples from synthetic data and application to South America, *Geochem. Geophys. Geosys.*, **10**(4), Q04005, doi: 10.1029/2008GC002229.
- Pérez Solano, C. A., 2013, *Two-dimensional near-surface seismic imaging with surface waves: alternative methodology for waveform inversion*, Ph.D. thesis, Mines ParisTech, Fontainebleau, France.
- Pérez Solano, C. A., Donno, D. & Chauris, H., 2014. Alternative waveform inversion for surface wave analysis in 2-D media, *Geophys. J. Int.*, **198**(3), 1359–1372, doi: 10.1093/gji/ggu211.
- Perron, J. T., Mitrovica, J. X., Manga, M., Matsuyama, I. & Richards, M. A., 2007. Evidence for an ancient martian ocean in the topography of deformed shorelines, *Nature*, **447**, 840–843, doi: 10.1038/nature05873.
- Perry, H. K. C., Forte, A. M. & Eaton, D. W. S., 2003. Upper-mantle thermochemical structure below North America from seismic-geodynamic flow models, *Geophys. J. Int.*, **154**, 279–299.
- Perttula, T. K., Walker, C. P. & Schultz, T. C., 2008. A revolution in Caddo archaeology: The remote sensing and archaeological view from the Hill Farm site (41BW169) in Bowie County, Texas, *Southeastern Archaeology*, **27**, 93–107.
- Peselnick, L. & Nicolas, A., 1978. Seismic anisotropy in an ophiolite peridotite. Application to oceanic upper mantle, *J. Geophys. Res.*, **83**, 1227–1235.
- Peter, D., Tape, C., Boschi, L. & Woodhouse, J. H., 2007. Surface wave tomography: global membrane waves and adjoint methods, *Geophys. J. Int.*, **171**(3), 1098–1117, doi: 10.1111/j.1365–246X.2007.03554.x.
- Peter, D., Komatitsch, D., Luo, Y., Martin, R., Goff, N. L., Casarotti, E., Loher, P. L., Magnoni, F., Liu, Q., Blitz, C., Nissen-Meyer, T., Basini, P. & Tromp, J., 2011. Forward and adjoint simulations of seismic wave propagation on fully unstructured hexahedral meshes, *Geophys. J. Int.*, **186**(2), 721–739, doi: 10.1111/j.1365–246X.2011.05044.x.
- Petersen, N. V., 1990. Inverse kinematic problem for a random gradient medium in geometric optics approximation, *Pure Appl. Geophys.*, **132**, 417–437, doi: 10.1007/BF00874372.
- Peterson, J., 1993, Observations and modeling of seismic background noise, Open-file report 93-322, U. S. Dept. Interior, Geological Survey.
- Petitt, R. A., Harris, D. W., Wooding, B., Bailey, J., Jolly, J., Hobart, E., Chave, A. D., Duennebier, F., Butler, R., Bowen, A. & Yoerger, D., 2002. The Hawaii-2 Observatory, *IEEE-OE*, **27**(2), 245–253, doi: 10.1109/JOE.2002.1002479.

- Pettersen, Ø. & Maupin, V., 2002. Lithospheric anisotropy on the Kerguelen hotspot track inferred from Rayleigh wave polarisation anomalies, *Geophys. J. Int.*, **149**, 225–246.
- Pfeffer, W. T., Harper, J. T. & O’Neel, S., 2008. Kinematic constraints on glacier contributions to 21st-century sea-level rise, *Science*, **321**(5894), 1340–1343 and doi: 10.1126/science.1159099.
- Pfeffer, W. T., Arendt, A. A., Bliss, A., Bolch, T., Cogley, J. G., Gardner, A. S., Hagen, J. O., Hock, R., Kaser, G., Kienholz, C., Miles, E. S., Moholdt, G., Mölg, N., Paul, F., Radić, V., Rastner, P., Raup, B. H., Rich, J., Sharp, M. J. & the Randolph Consortium, 2014. The Randolph Glacier Inventory: a globally complete inventory of glaciers, *J. Glaciol.*, **60**(221), 537–552, doi: 10.3189/2014JoG13J176.
- Philander, S. G., 2007. A geological perspective on global warming, *pers. comm.*.
- Phillips, R. J. & Lambeck, K., 1980. Gravity fields of the terrestrial planets: Long-wavelength anomalies and tectonics, *Rev. Geophys. Space Phys.*, **18**(1), 27–76.
- Phillips, W. S. & Fehler, M. C., 1991. Traveltime tomography: A comparison of popular methods, *Geophysics*, **56**(10), 1639–1649, doi: 10.1190/1.1442974.
- Phinney, R. A., 1964. Structure of the Earth’s crust from spectral behavior of long-period body waves, *J. Geophys. Res.*, **69**(14), 2997–3017.
- Phinney, R. A., 2002. Retrospective on the PEPP experience, *Eos Trans. AGU*, **83**(47), Fall Meet. Suppl., Abstract ED71C–13.
- Phinney, R. A. & Burridge, R., 1973. Representation of the elastic-gravitational excitation of a spherical Earth model by generalized spherical harmonics, *Geophys. J. R. Astron. Soc.*, **34**(4), 451–487, doi: 10.1029/JZ069i014p02997.
- Phipps Morgan and Walter H. F. Smith, J., 1994. Correction *flattening of the sea-floor depth-age curve as a response to asthenospheric flow*, *Nature*, **371**, 83, doi: 10.1038/371083a0.
- Piao, S., Ciais, P., Huang, Y., Shen, Z., Peng, S., Li, J., Zhou, L., Liu, H., Ma, Y., Ding, Y., Friedlingstein, P., Liu, C., Tan, K., Yu, Y., Zhang, T. & Fang, J., 2010. The impacts of climate change on water resources and agriculture in China, *Nature*, **467**(7311), 43–51, doi: 10.1038/nature09364.
- Piazzoni, A. S., Steinle-Neumann, G., Bunge, H.-P. & Dolejš, D., 2007. A mineralogical model for density and elasticity of the Earth’s mantle, *Geochem. Geophys. Geosys.*, **8**, Q11010, doi: 10.1029/2007GC001697.
- Pica, A., Diet, J. P. & Tarantola, A., 1990. Nonlinear inversion of seismic reflection data in a laterally invariant medium, *Geophysics*, **55**(3), 284–292.
- Picinbono, B., 1996. Second-order complex random vectors and normal distributions, *IEEE T. Signal Process.*, **44**(10), 1072–1081.
- Picinbono, B., 1997. Ergodicity and fourth-order spectral moments, *IEEE T. Inform. Theory*, **43**(4), 1273–1276.

- Pierce, D. A., 1972. Least squares estimation in dynamic-disturbance time series models, *Biometrika*, **59**(1), 73–78.
- Pierce, D. A., 1972. Residual correlations and diagnostic checking in dynamic-disturbance time series models, *J. Am. Stat. Assoc.*, **67**(339), 636–640, doi: 10.1080/01621459.1972.10481266.
- Pilkington, M., 1991. Mapping elastic lithospheric thickness variations in Canada, *Tectonophysics*, **190**, 283–297.
- Pillet, R., Rouland, D., Roult, G. & Wiens, D. A., 1999. Crust and upper mantle heterogeneities in the southwest Pacific from surface wave phase velocity analysis, *Phys. Earth Planet. Inter.*, **110**, 211–234.
- Pinder, G. F. & Celia, M. A., 2006. *Subsurface hydrology*, John Wiley, Hoboken, New Jersey.
- Pipatprathanporn, S. & Simons, F. J., 2022. One year of sound recorded by a MERMAID float in the Pacific: hydroacoustic earthquake signals and infrasonic ambient noise, *Geophys. J. Int.*, **228**(1), 193–212, doi: 10.1093/gji/ggab296.
- Piromallo, C., Vincent, A. P., Yuen, D. A. & Morelli, A., 2001. Dynamics of the transition zone under Europe inferred from wavelet cross-spectra of seismic tomography, *Phys. Earth Planet. Inter.*, **125**, 125–139.
- Plattner, A. & Simons, F. J., 2012. Vector-valued spherical Slepian functions and for lithospheric-field analysis, *Geophys. Res. Abstr.*, **14**, 6809.
- Plattner, A. & Simons, F. J., 2013. A spatio-spectral localization approach for analyzing and representing vector-valued functions on spherical surfaces, in *Wavelets and Sparsity XV*, edited by D. Van de Ville, V. K. Goyal, & M. Papadakis, vol. 8858, pp. 88580N, doi: 10.1117/12.2024703, SPIE.
- Plattner, A. & Simons, F. J., 2013. Vectorial Slepian functions and the estimation of the crustal magnetic field, *Geophys. Res. Abstr.*, **15**, 5901.
- Plattner, A. & Simons, F. J., 2014. Spatio-spectral concentration of vector fields on a sphere, *Appl. Comput. Harmon. Anal.*, **36**, 1–22, doi: 10.1016/j.acha.2012.12.001.
- Plattner, A. & Simons, F. J., 2015. High-resolution local magnetic field models for the Martian South Pole from Mars Global Surveyor data, *J. Geophys. Res.*, **120**, 1543–1566, doi: 10.1002/2015JE004869.
- Plattner, A. & Simons, F. J., 2015. Mars’ heterogeneous south polar magnetic field revealed using altitude vector Slepian functions, in *46th Lunar Planetary Science Conference*, p. 1794.
- Plattner, A. & Simons, F. J., 2015. Potential-field estimation using scalar and vector Slepian functions at satellite altitude, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, pp. 2003–2055, doi: 10.1007/978-3-642-54551-1_64, Springer, Heidelberg, Germany, 2nd edn.

- Plattner, A. & Simons, F. J., 2016. Local high-resolution crustal magnetic field analysis from satellite data, *Geophys. Res. Abstr.*, **18**, 9560.
- Plattner, A. & Simons, F. J., 2017. Internal and external potential field estimation from regional vector data at varying satellite altitude, *Geophys. J. Int.*, **211**(1), 207–238, doi: 10.1093/gji/ggx244.
- Plattner, A., Maurer, H.-R., Vorloeper, J. & Blome, M., 2012. 3-D electrical resistivity tomography using adaptive wavelet parameter grids, *Geophys. J. Int.*, **189**(1), 317–330, doi: 10.1111/j.1365–246X.2012.05374.x.
- Plattner, A., Simons, F. J., Maloof, A. C. & Husson, J., 2012. Geophysical survey of the Peristeries Plateau in Polis Chrysochous, Cyprus, *ASOR Annual Meeting*, pp. City of Gold: Archaeological excavations at Polis Chrysochous, Cyprus.
- Plattner, A., Simons, F. J. & Wei, L., 2012, Analysis of real vector fields on the sphere using Slepian functions, in *2012 IEEE Statistical Signal Processing Workshop (SSP'12)*, p. doi: 10.1109/SSP.2012.6319659, IEEE, Ann Arbor, Mich.
- Plattner, A., Golabek, G. J. & Simons, F. J., 2017, A spectral view of the Terra Sirenum / Cimmeria crustal magnetic field, in *48th Lunar Planetary Science Conference*, p. 1627.
- Plattner, A. M., 2020. GPRPy: Open-source ground-penetrating radar processing and visualization software, *The Leading Edge*, **39**(5), 332–337, doi: 10.1190/tle39050332.1.
- Plessix, C. P., 2019. Velocity-model building with enhanced shallow resolution using elastic waveform inversion—an example from onshore Oman, *Geophysics*, **84**(6), R977–R988, 10.1190/geo2018–0736.1.
- Plessix, R.-E., 2006. A review of the adjoint-state method for computing the gradient of a functional with geophysical applications, *Geophys. J. Int.*, **167**(2), 495–503, doi: 10.1111/j.1365–246X.2006.02978.x.
- Plomerová, J., Liebermann, R. C. & Babuška, V., eds., 1998. *Geodynamics of Lithosphere and Earth's Mantle*, vol. 151 of **Pure Appl. Geophys.**, Birkhäuser, Boston, Mass.
- Plumb, K. A., 1979. The tectonic evolution of Australia, *Earth Sci. Rev.*, **14**, 205–249.
- Podosekl, F. A., 1999. Origin of Earth and moon - A couple of uncertain age, *Science*, **283**(5409), 1863–1864.
- Poirier, J.-P., 1994. Light elements in the Earth's outer core: A critical review, *Phys. Earth Planet. Inter.*, **85**, 319–337.
- Pol, K., Masson-Delmotte, V., Cattani, O., Debret, M., Falourd, S., Jouzel, J., Landais, A., Minster, B., Mudelsee, M., Schulz, M. & Stenni, B., 2014. Climate variability features of the last interglacial in the East Antarctic EPICA Dome C ice core, *Geophys. Res. Lett.*, **41**, 4004–4012, doi: 10.1002/2014GL059561.

- Polet, J. & Anderson, D. L., 1995. Depth extent of cratons as inferred from tomographic studies, *Geology*, **23**(3), 205–208.
- Pollack, H. N., Hurter, S. J. & Johnson, J. R., 1993. Heat flow from the Earth's interior: Analysis of the global data set, *Rev. Geophys.*, **31**, 267–280.
- Pollitz, F. F., 2006. A new class of earthquake observations, *Science*, **313**(5787), 619, doi: 10.1126/science.1131208.
- Pollitz, F. F., Bürgmann, R. & Romanowicz, B., 1998. Viscosity of oceanic asthenosphere inferred from remote triggering of earthquakes, *Science*, **280**, 1245–1249.
- Polyakov, A. S., 2002, *Local basis expansions for linear inverse problem*, Ph.D. thesis, New York University.
- Porter, D. L. & Keller, K. H., 2012, IBuoy: Expendable short time duration wave buoy with satellite data telemetry, in *Oceans 2012, Hampton Roads VA*, pp. 1–4, doi: 10.1109/OCEANS.2012.6404838, IEEE.
- Portilla-Yandún, J., 2018. The global signature of ocean wave spectra, *Geophys. Res. Lett.*, **45**, 267–276, doi: 10.1002/2017GL076431.
- Portnoy, S., 1977. Asymptotic efficiency of minimum variance unbiased estimators, *Ann. Stat.*, **5**(3), 522–529.
- Poudjom Djomani, Y. H., Fairhead, J. D. & Griffin, W. L., 1999. The flexural rigidity of Fennoscandia: Reflection of the tectonothermal age of the lithospheric mantle, *Earth Planet. Sci. Lett.*, **174**, 139–154.
- Poudjom Djomani, Y. H., O'Reilly, S. Y., Griffin, W. L. & Morgan, P., 2001. The density structure of subcontinental lithosphere through time, *Earth Planet. Sci. Lett.*, **184**, 605–621.
- Poupinet, G. & Kennett, B. L. N., 2004. On the observation of high frequency PKiKP and its coda in Australia, *Phys. Earth Planet. Inter.*, **146**, 497–511, doi: 10.1016/j.pepi.2004.05.003.
- Poupinet, G., Pillet, R. & Souriau, A., 1983. Possible heterogeneity of the Earth's core deduced from PKiKP travel times, *Nature*, **305**, 204–206, doi: 10.1038/305204a0.
- Poupinet, G., Ellsworth, W. L. & Fréchet, J., 1984. Monitoring velocity variations in the crust using earthquake doublets: An application to the Calaveras fault, California, *J. Geophys. Res.*, **89**(B7), 5719–5731, doi: 10.1029/JB089iB07p05719.
- Poupinet, G., Pasquier, M., Vadell, M. & Martel, L., 1989. A seismological platform transmitting via Meteosat, *B. Seismol. Soc. Am.*, **79**(5), 1651–1661.
- Powell, C., 1998, Break-up of Rodinia in Australia; Implications for the western margin of Laurentia, in *Abstracts with Programs, Geological Society of America, 1998 annual meeting*, vol. 30, p. 47, Geological Society of America.

- Powell, M. J. D., 1964. An efficient method for finding the minimum of a function of several variables without calculating derivatives, *Comp. J.*, **72**(2), 155–162.
- Pratt, R. G., 1999. Seismic waveform inversion in the frequency domain, Part 1: Theory and verification in a physical scale model, *Geophysics*, **64**(3), 888–901, doi: 10.1190/1.1444597.
- Pratt, R. G. & Shipp, R. M., 1999. Seismic waveform inversion in the frequency domain, Part 2: Fault delineation in sediments using crosshole data, *Geophysics*, **64**(3), 902–914, doi: 10.1190/1.1444598.
- Pratt, R. G., Song, Z.-M., Williamson, P. & Warner, M., 1996. Two-dimensional velocity models from wide-angle seismic data by wavefield inversion, *Geophys. J. Int.*, **124**(2), 323–340, doi: 10.1111/j.1365-246X.1996.tb07023.x.
- Press, F., 1965. Resonant vibrations of the earth, *Sci. Am.*, **213**(5), 28–37, doi: 10.1038/scientificamerican1165-28.
- Press, W. H., Teukolsky, S. A., Vetterling, W. T. & Flannery, B. P., 1992. *Numerical Recipes in FORTRAN: The Art of Scientific Computing*, Cambridge Univ. Press, New York, 2nd edn.
- Priestley, K., 1999. Velocity structure of the continental upper mantle: Evidence from South Africa, *Lithos*, **48**(1–4), 45–56.
- Priestley, K. & Brune, J., 1978. Surface waves and the structure of the Great Basin of Nevada and Western Utah, *J. Geophys. Res.*, **83**(B5), 2265–2272.
- Priestley, M., 1981. *Spectral Analysis and Time Series*, Academic Press, San Diego, Calif.
- Prieux, V., Brossier, R., Operto, S. & Virieux, J., 2013. Multiparameter full waveform inversion of multicomponent ocean-bottom-cable data from the Valhall field. Part 1: imaging compressional wave speed, density and attenuation, *Geophys. J. Int.*, **194**(3), 1640–1664, doi: 10.1093/gji/ggt177.
- Prieux, V., Brossier, R., Operto, S. & Virieux, J., 2013. Multiparameter full waveform inversion of multicomponent ocean-bottom-cable data from the Valhall field. Part 2: imaging compressive-wave and shear-wave velocities, *Geophys. J. Int.*, **194**(3), 1665–1681, doi: 10.1093/gji/ggt178.
- Pritchard, H. D. & Vaughan, D. G., 2007. Widespread acceleration of tidewater glaciers on the Antarctic Peninsula, *J. Geophys. Res.*, **112**(F3), F03S29, doi: 10.1029/2006JF000597.
- Pritchard, H. D., Arthern, R. J., Vaughan, D. G. & Edwards, L. A., 2009. Extensive dynamic thinning on the margins of the Greenland and Antarctic ice sheets, *Nature*, **461**, 971–975, doi: 10.1038/nature08471.
- Pritchard, H. D., Ligtenberg, S. R. M., Fricker, H. A., Vaughan, D. G., den Broeke, M. R. V. & Padman, L., 2012. Antarctic ice-sheet loss driven by basal melting of ice shelves, *Nature*, **484**(7395), 502–505, doi: 10.1038/nature10968.

- Pritchard, M. E., Allen, R. M., Becker, T. W., Behn, M. D., Brodsky, E. E., Bürgmann, R., Ebinger, C., Freymueller, J. T., Gerstenberger, M., Haines, B., Kaneko, Y., Jacobsen, S. D., Lindsey, N., McGuire, J. J., Page, M., Ruiz, S., Tolstoy, M., Wallace, L., Walter, W. R., Wilcock, W. & Vincent, H., 2020. New opportunities to study earthquake precursors, *Seismol. Res. Lett.*, **91**(5), 2444–2447, doi: 10.1785/02202000089.
- Pritt, M. D. & Ghiglia, D. C., 1998. *Two-dimensional phase unwrapping. Theory, algorithms, and software*, John Wiley, New York, NY.
- propagation theory, W. & synthetic seismograms, 1991. *Rev. geophys.*, **29**, **29**, 662–670.
- Pujol, J., 1992. Joint hypocentral location in media with lateral velocity variations and interpretation of the station corrections, *Phys. Earth Planet. Inter.*, **75**, 7–24.
- Pulliam, R. J., Vasco, D. W. & Johnson, L. R., 1993. Tomographic inversions for mantle *P* wave velocity structure based on the minimization of l^2 and l^1 norms of International Seismological Centre travel time residuals, *J. Geophys. Res.*, **98**(B1), 699–734.
- Purucker, M., Ravat, D., Frey, H., Voorhies, C., Sabaka, T. & Acuña, M., 2000. An altitude-normalized magnetic map of Mars and its interpretation, *Geophys. Res. Lett.*, **27**(16), 2449–2452, doi: 10.1029/2000GL000072.
- Purucker, M. E., Head, J. W. & Wilson, L., 2012. Magnetic signature of the lunar South Pole-Aitken basin: Character, origin, and age, *J. Geophys. Res.*, **117**(E5), E05001, doi: 10.1029/2011JE003922.
- Puster, P., Jordan, T. H. & Hager, B. H., 1995. Characterization of mantle convection experiments using two-point correlation functions, *J. Geophys. Res.*, **100**(B4), 6351–6365.
- Pysklywec, R. N., Beaumont, C. & Fullsack, P., 2000. Modeling the behavior of the continental mantle lithosphere during plate convergence, *Geology*, **28**(7), 655–658.
- Qin, Y., Capdeville, Y., Montagner, J. P., Boschi, L. & Becker, T. W., 2009. Reliability of mantle tomography models assessed by spectral element simulation, *Geophys. J. Int.*, **177**(1), 125–144.
- Qiu, J., 2012. Glaciologists to target third pole, *Nature*, **484**(7392), 19.
- Quenouille, M. H., 1956. Notes on bias in estimation, *Biometrika*, **43**(3–4), 353–360.
- Quesnel, Y., Langlais, B. & Sotin, C., 2007. Local inversion of magnetic anomalies: Implication for Mars’ crustal evolution, *Planet. Space Sci.*, **55**, 258–269, doi: 10.1016/j.pss.2006.02.004.
- Quesnel, Y., Sotin, C., Langlais, B., Costin, S., Manda, M., Gottschalk, M. & Dymant, J., 2009. Serpentinization of the Martian crust during Noachian, *Earth Planet. Sci. Lett.*, **277**(1–2), 184–193.
- Radon, J., 1917. Über die Bestimmung von Funktionen durch ihre Integralwerte längs gewisser Mannigfaltigkeiten, *Berichte Sächsische Akademie der Wissenschaften*, **29**, 262–277.

- Rae, K. H. & von Frese, R. R. B., 2013. Localized analysis of polar geomagnetic jerks, *Tectonophysics*, **585**, 26–33, doi: 10.1016/j.tecto.2012.06.038.
- Rajesh, R. S. & Mishra, D. C., 2004. Lithospheric thickness and mechanical strength of the Indian Shield, *Earth Planet. Sci. Lett.*, **225**, 319–328.
- Rajesh, R. S., Stephen, J. & Mishra, D. C., 2003. Isostatic response and anisotropy of the Eastern Himalayan-Tibetan Plateau: A reappraisal using multitaper spectral analysis, *Geophys. Res. Lett.*, **30**(2), 1060, doi: 10.1029/2002GL016104.
- Rajesh, R. S., Stephen, J. & Mishra, D. C., 2003. Correction to "Isostatic response and anisotropy of the Eastern Himalayan-Tibetan Plateau: A reappraisal using multitaper spectral analysis", *Geophys. Res. Lett.*, **30**(7), 1352, doi: 10.1029/2003GL017201.
- Ram, M., Stolz, M. R. & Tinsley, B. A., 2009. The terrestrial cosmic ray flux: Its importance for climate, *Eos Trans. AGU*, **90**(44), 397–398.
- Ramesh, P. S. & Lean, M. H., 1991. Accurate integration of singular kernels in boundary integral formulations for Helmholtz equation, *Int. J. Num. Meth. Eng.*, **31**, 1055–1068.
- Ranalli, G., 1995. *Rheology of the Earth*, Chapman and Hall, London, UK, 2nd edn.
- Randall, M. J., 1973. The spectral theory of seismic sources, *B. Seismol. Soc. Am.*, **63**(3), 1133–1144.
- Rapp, R. H., 1997. Use of potential coefficient models for geoid undulation determinations using a spherical harmonic representation of the height anomaly/geoid undulation difference, *J. Geod.*, **71**(5), 282–289, doi: 10.1007/s001900050096.
- Rappaport, N. J., Konopliv, A. S., Kucinskis, A. B. & Ford, P. G., 1999. An improved 360 degree and order model of Venus topography, *Icarus*, **139**, 19–31.
- Rasch, J. & Yu, A. C. H., 2003. Efficient storage scheme for precalculated Wigner $3j$, $6j$, and Gaunt coefficients, *SIAM J. Sci. Comput.*, **25**(4), 1416–1428.
- Rasmussen, C. E. & Williams, C. K. I., 2006. *Gaussian Processes for Machine Learning*, The MIT Press, Cambridge, Mass.
- Rasmussen, J. & Eugene Humphreys, 1988. Tomographic image of the Juan de Fuca plate beneath Washington and western Oregon using teleseismic P-wave travel times, *Geophys. Res. Lett.*, **15**(12), 1417–1420.
- Rastin, S. J., Unsworth, C. P., Benites, R. & Gledhill, K. R., 2013. Using real and synthetic waveforms of the Matata Swarm to assess the performance of New Zealand GeoNet phase pickers, *B. Seismol. Soc. Am.*, **103**(4), 2173–2187, doi: 10.1785/0120120059.
- Ratnaswamy, V., Stadler, G. & Gurnis, M., 2015. Adjoint-based estimation of plate coupling in a non-linear mantle flow model: theory and examples, *Geophys. J. Int.*, **202**(2), 768–786, doi: 10.1093/gji/ggv166.

- Rawlinson, N. & Sambridge, M., 2003. Seismic traveltime tomography of the crust and lithosphere, *Adv. Geophys.*, **46**, 81–198, doi: 10.1016/S0065–2687(03)46002–0.
- Rawlinson, N., Pozgay, S. & Fishwick, S., 2010. Seismic tomography: A window into deep Earth, *Phys. Earth Planet. Inter.*, **178**, 101–135, doi: 10.1016/j.pepi.2009.10.002.
- Rawlinson, N., Fichtner, A., Sambridge, M. & Young, M. K., 2014. Seismic tomography and the assessment of uncertainty, *Adv. Geophys.*, **55**, 1–76, doi: 10.1016/bs.agph.2014.08.001.
- Ray, R. D., Rowlands, D. D. & Egbert, G. D., 2003. Tidal models in a new era of satellite gravimetry, *Space Sci. Rev.*, **108**(1–2), 271–282, doi: 10.1023/A:1026223308107.
- Rayleigh, J. W. S., 1885. On waves propagated along the plane surface of an elastic solid, *Proc. London Math. Soc.*, **17**(4–11).
- Raymo, M. E. & Mitrovica, J. X., 2012. Collapse of polar ice sheets during the stage 11 interglacial, *Nature*, **483**, 453–456, doi: 10.1038/nature10891.
- Raymond, M. J. & Gudmundsson, G. H., 2005. On the relationship between surface and basal properties on glaciers, ice sheets, and ice streams, *J. Geophys. Res.*, **110**, B08411, doi: 10.1029/2005JB003681.
- Reager, J. T., Gardner, A. S., Famiglietti, J. S., Wiese, D. N., Eicker, A. & Lo, M.-H., 2016. A decade of sea level rise slowed by climate-driven hydrology, *Science*, **351**(6274), 699–703, doi: 10.1126/science.aad8386.
- Reasenber, P. A., 1985, FPFIT, FPPLLOT, and FPPAGE: Fortran computer programs for calculating and displaying earthquake fault-plane solutions, Open-file report 85–739, U. S. Dept. Interior, Geological Survey.
- Reches, Z. & Fink, J., 1988. The mechanism of intrusion of the Inyo Dike, Long Valley Caldera, California, *J. Geophys. Res.*, **93**(B5), 4321–4334.
- Rees, B. A. & Okal, E. A., 1987. The depth of the deepest historical earthquakes, *Pure Appl. Geophys.*, **125**, 699–715.
- Reese, D. S., 1975. Men, saints, or dragons?, *Expedition*, **17**, 26–30.
- Reese, D. S., 1995. *The Pleistocene vertebrate sites and fauna of Cyprus*, Ministry of Agriculture, Natural Resources and Environment, Geological Survey Department, Nicosia, Cyprus.
- Regge, T., 1958. Symmetry properties of Clebsch-Gordon’s coefficients, *Nuov. Cimen.*, **10**(3), 544–545.
- Rehmeyer, J., 2011. How GPS bends time, *Wired*, p. 48.
- Reichle, M. S., Sharman, G. F. & Brune, J. N., 1976. Sonobuoy and teleseismic study of Gulf of California transform fault earthquake sequences, *B. Seismol. Soc. Am.*, **66**(5), 1623–1641.

- Reid, I., Reichle, M., Brune, J. & Bradner, H., 1973. Microearthquake studies using sonobuoys: Preliminary results from the Gulf of California, *Geophys. J. R. Astron. Soc.*, **34**(3), 365–379.
- Reimer, P. J. & Hughen, K. A., 2008. Palaeoclimate: Tree rings floating on ice cores, *Nature Geosci.*, **1**(4), 218–219, doi: 10.1038/ngeo167.
- Replumaz, A., Káráson, H., van der Hilst, R. D., Besse, J. & Tapponnier, P., 2004. 4-D evolution of SE Asia’s mantle from geological reconstructions and seismic tomography, *Earth Planet. Sci. Lett.*, **221**(1–4), 103–115.
- Reuber, G. S. & Simons, F. J., 2020. Multi-physics adjoint modeling of earth structure: combining gravimetric, seismic, and geodynamic inversions, *Intern. J. Geomath.*, **11**(30), 1–38, doi: 10.1007/s13137-020-00166-8.
- Reuber, G. S., Kaus, B. J. P., Popov, A. A. & Baumann, T. S., 2018. Unraveling the physics of the Yellowstone magmatic system using geodynamic simulations, *Front. Earth Sci.*, **6**, 117, doi: 10.3389/feart.2018.00117.
- Revenaugh, J. & Jordan, T. H., 1991. Mantle layering from *scs* reverberations. 3. The upper mantle, *J. Geophys. Res.*, **96**(B12), 19781–19810.
- Reymond, D., Hyvernaud, O., Talandier, J. & Okal, E. A., 2003. *T*-wave detection of two underwater explosions off Hawaii on 13 april 2000, *B. Seismol. Soc. Am.*, **93**(2), 804–816, doi: 10.1785/0120010296.
- Reynolds, S. D., Coblenz, D. D. & Hillis, R. R., 2002. Tectonic forces controlling the regional intraplate stree field in continental Australia: Rresults from new finite element modeling, *J. Geophys. Res.*, **107**(B7), 2131, doi: 10.1029/2001JB000408.
- Rhein, M., 2000. Drifters reveal deep circulation, *Nature*, **407**(6800), 30–31, doi: 10.1038/35024186.
- Rhie, J. & Romanowicz, B., 2004. Excitation of Earth’s continuous free oscillations by atmosphere-ocean-seafloor coupling, *Nature*, **431**, 552–556, doi: 10.1038/nature02942.
- Ribe, N. & Steinle, F., 2002. Exploratory experimentation: Goethe, Land, and color theory, *Physics Today*, **55**(7), 43–49.
- Ribe, N. M., 1982. On the interpretation of frequency response functions for oceanic gravity and bathymetry, *Geophys. J. R. Astron. Soc.*, **70**, 273–294.
- Ribe, N. M., 1992. On the relation between seismic anisotropy and finite strain, *J. Geophys. Res.*, **97**(B6), 8737–8747.
- Ribeiro, E. & Hancock, E. R., 2002. Estimating the perspective pose of texture planes using spectral analysis on the unit sphere, *Pattern Recognition*, **35**, 2141–2163.
- Ricard, Y. & Vigny, C., 1989. Mantle dynamics with induced plate tectonics, *J. Geophys. Res.*, **94**(B12), 17543–17559.

- Ricard, Y., Doglioni, C. & Sabadini, R., 1991. Differential rotation between lithosphere and mantle: A consequence of lateral mantle viscosity variations, *J. Geophys. Res.*, **96**(B5), 8407–8415.
- Ricard, Y., Nataf, H.-C. & Montagner, J.-P., 1996. The three-dimensional Seismological Model A priori Constrained: Confrontation with seismic data, *J. Geophys. Res.*, **101**(B4), 8457–8472.
- Richards, M. A. & Hager, B. H., 1984. Geoid anomalies in a dynamic Earth, *J. Geophys. Res.*, **89**(NB7), 5987–6002.
- Richards, P. G., 1990, Theoretical seismology, in *Oceanographic and Geophysical Tomography*, edited by Y. Desaubies, A. Tarantola, & J. Zinn-Justin, chap. 2, pp. 29–134, Elsevier, Amsterdam, Neth.
- Richards-Dinger, K. B. & Shearer, P. M., 2000. Earthquake locations in southern California obtained using source-specific station terms, *J. Geophys. Res.*, **105**(B5), 10939–10960.
- Richardson, A. M. & Hodgkiss, W. S., 1994. Bispectral analysis of underwater acoustic data, *J. Acoust. Soc. Am.*, **96**(2), 828–837.
- Richardson, S. H., Gurney, J. J., Erlank, A. J. & Harris, J. W., 1984. Origin of diamonds in old enriched mantle, *Nature*, **310**, 198–202.
- Richart, F. E., Hall, J. R. & Woods, R. D., 1970. *Vibrations of Soils and Foundations*, Theoretical and Applied Mechanics, Prentice-Hall, Englewood Cliffs, New Jersey.
- Richter, F. M., 1973. Convection and large-scale circulation in the mantle, *J. Geophys. Res.*, **84**, 6,783–6,795.
- Richter, F. M., 1981. On some consequences and possible causes of layered mantle convection, *J. Geophys. Res.*, **86**(B7), 6133–6142.
- Richter, F. M., 1984. Regionalized models for the thermal evolution of the Earth, *Earth Planet. Sci. Lett.*, **68**, 471–484.
- Richter, F. M., 1985. Models for the Archean thermal regime, *Earth Planet. Sci. Lett.*, **73**, 350–360.
- Richter, F. M., 1988. A major change in the thermal state of the Earth at the Archean-Proterozoic boundary: Consequences for the nature and preservation of continental lithosphere, *J. Petrol.*, **Special Lithosphere Issue**, 39–52.
- Rickers, F., Fichtner, A. & Trampert, J., 2012. Imaging mantle plumes with instantaneous phase measurements of diffracted waves, *Geophys. J. Int.*, **190**(1), 650–664, doi: 10.1111/j.1365–246X.2012.05515.x.
- Riedel, K. S. & Sidorenko, A., 1995. Minimum bias multiple taper spectral estimation, *IEEE T. Signal Process.*, **43**(1), 188–195.
- Rietbrock, A. & Waldhauser, F., 2004. A narrowly spaced double-seismic zone in the subducting Nazca plate, *Geophys. Res. Lett.*, **31**, L10608, doi: 10.1029/2004GL019610.

- Rignot, E., 2006. Changes in ice dynamics and mass balance of the Antarctic ice sheet, *Phil. Trans. R. Soc. London, Ser. A*, **364**, 1637–1655, doi: 10.1098/rsta.2006.1793.
- Rignot, E., 2008. Changes in West Antarctic ice stream dynamics observed with ALOS PALSAR data, *Geophys. Res. Lett.*, **35**, L12505, doi: 10.1029/2008GL033365.
- Rignot, E. & Kanagaratnam, P., 2006. Changes in the velocity structure of the Greenland ice sheet, *Science*, **311**(5763), 986–990, doi: 10.1126/science.1121381.
- Rignot, E. & Mouginot, J., 2012. Ice flow in Greenland for the International Polar Year 2008-2009, *Geophys. Res. Lett.*, **39**, L11501, doi:10.1029/2012GL051634.
- Rignot, E., Casassa, G., Gogineni, P., Krabill, W., Rivera, A. & Thomas, R., 2004. Accelerated ice discharge from the Antarctic Peninsula following the collapse of Larsen B ice shelf, *Geophys. Res. Lett.*, **31**, L18401, doi: 10.1029/2004GL020697.
- Rignot, E., Bamber, J. L., van den Broeke, M. R., Davis, C., Li, Y., van de Berg, W. J. & van Meijgaard, E., 2008. Recent Antarctic ice mass loss from radar interferometry and regional climate modelling, *Nature Geosci.*, **1**(2), 106–110, doi: 10.1038/ngeo102.
- Rignot, E., Box, J. E., Burgess, E. & Hanna, E., 2008. Mass balance of the Greenland ice sheet from 1958 to 2007, *Geophys. Res. Lett.*, **35**(20), L20502, doi: 10.1029/2008GL035417.
- Rignot, E., Koppes, M. & Velicogna, I., 2010. Rapid submarine melting of the calving faces of West Greenland glaciers, *Nature Geosci.*, **3**(3), 187–191.
- Rignot, E., Mouginot, J. & Scheuchl, B., 2011. Ice flow of the Antarctic ice sheet, *Science*, **333**, 1427–1430, doi: 10.1126/science.1208336.
- Rignot, E., Velicogna, I., van den Broeke, M. R., Monaghan, A. & Lenaerts, J., 2011. Acceleration of the contribution of the Greenland and Antarctic ice sheets to sea level rise, *Geophys. Res. Lett.*, **38**(5), L05503, doi: 10.1029/2011GL046583.
- Rignot, E., Jacobs, S., Mouginot, J. & Scheuchl, B., 2013. Ice-shelf melting around Antarctica, *Science*, **341**(6143), 266–270, doi: 10.1126/science.1235798.
- Rignot, E., Mouginot, J., Morlighem, M., Seroussi, H. & Scheuchl, B., 2014. Widespread, rapid grounding line retreat of Pine Island, Thwaites, Smith, and Kohler glaciers, West Antarctica, from 1992 to 2011, *Geophys. Res. Lett.*, **41**(10), 3502–3509, doi: 10.1002/2014GL060140.
- Rinard Hinga, B., 2015. *Ring of Fire: An Encyclopedia of the Pacific Rim's earthquakes, tsunamis, and volcanoes*, ABC-CLIO, Santa Barbara, Calif.
- Ringdal, F., 1977. P-wave amplitudes and sources of scattering in m_b -observations, *J. Geophys.*, **43**, 611–622.
- Ringwood, A. E., 1975. *Composition and Petrology of the Earth's Mantle*, MacGraw-Hill, New York, NY.

- Rioul, O. & Flandrin, P., 1992. Time-scale energy distributions: A general class extending wavelet transforms, *IEEE T. Signal Process.*, **40**(7), 1746–1757.
- Rioul, O. & Vetterli, M., 1991. Wavelets and signal processing, *IEEE Signal Process. Mag.*, **8**(4), 14–38.
- Risbo, T., 1996. Fourier transform summation of Legendre series and D-functions, *J. Geod.*, **70**(7), 383–396.
- Riser, S. C., Nystuen, J. & Rogers, A., 2008. Monsoon effects in the Bay of Bengal inferred from profiling float-based measurements of wind speed and rainfall, *Limnol. Oceanogr.*, **53**(5, part 2), 2080–2093, doi: 10.4319/lo.2008.53.5_part_2.2080.
- Riser, S. C., Swift, D. & Drucker, R., 2018. Profiling floats in SOCCOM: Technical capabilities for studying the Southern Ocean, *J. Geophys. Res.*, **123**(6), 4055–4073, doi: 10.1002/2017JC013419.
- Ritchie, D. W. & Kemp, G. J. L., 2000. Fast computation, rotation and comparison of low resolution spherical harmonic molecular surfaces, *J. Comput. Chem.*.
- Ritsema, J., 2005. Global seismic structure maps, *Geol. Soc. Am. Spec. Paper*, **388**, 11–18, doi: 10.1130/2005.2388(02).
- Ritsema, J. & Lekić, V., 2020. Heterogeneity of seismic wave velocity in Earth’s mantle, *Annu. Rev. Earth Planet. Sc.*, **48**, 377–401, doi: 10.1146/annurev-earth-082119-065909.
- Ritsema, J. & van Heijst, H.-J., 2002. Constraints on the correlation of *p*- and *s*-wave velocity heterogeneity in the mantle from *p*, *PP*, *PPP* and *PKPab* traveltimes, *Geophys. J. Int.*, **149**(2), 482–489, doi: 10.1046/j.1365-246X.2002.01631.x.
- Ritsema, J., van Heijst, H.-J. & Woodhouse, J. H., 1999. Complex shear wave velocity structure imaged beneath Africa and Iceland, *Science*, **286**(5446), 1925–1928, doi: 10.1126/science.286.5446.1925.
- Ritsema, J., Rivera, L. A., Komatitsch, D., Tromp, J. & van Heijst, H.-J., 2002. Effects of crust and mantle heterogeneity on *PP/P* and *SS/S* amplitude ratios, *Geophys. Res. Lett.*, **29**(10), 1430, doi: 10.1029/2001GL013831.
- Ritsema, J., van Heijst, H. J. & Woodhouse, J. H., 2004. Global transition zone tomography, *J. Geophys. Res.*, **109**(B2), B02302, doi: 10.1029/2003JB002610.
- Ritsema, J., McNamara, A. K. & Bull, A. L., 2007. Tomographic filtering of geodynamic models: Implications for model interpretation and large-scale mantle structure, *J. Geophys. Res.*, **112**, B01303, doi: 10.1029/2006JB004566.
- Ritsema, J., A. Deuss, A., van Heijst, H. J. & Woodhouse, J. H., 2011. S40RTS: a degree-40 shear-velocity model for the mantle from new Rayleigh wave dispersion, teleseismic travel-time and normal-mode splitting function measurements, *Geophys. J. Int.*, **184**, 1223–1236, doi: 10.1111/j.1365-246X.2010.04884.x.

- Ritsema, J., Kaneshima, S. & Haugland, S. M., 2020. The dimensions of scatterers in the lower mantle using USArray recordings of *S*-wave to *P*-wave conversions, *Phys. Earth Planet. Inter.*, **306**, 106541, doi: 10.1016/j.pepi.2020.106541.
- Ritzer, J. A. & Steven A. Hauck, I., 2009. Lithospheric structure and tectonics at Isidis Planitia, Mars, *Icarus*, **201**(2), 528–539.
- Riva, R. E. M., Gunter, B. C., Urban, T. J., Vermeersen, B. L. A., Lindenbergh, R. C., Helsen, M. M., Bamber, J. L., van de Wal, R. S. W., van den Broeke, M. R. & Scutz, B. E., 2009. Glacial isostatic adjustment over Antarctica from combined ICESat and GRACE satellite data, *Earth Planet. Sci. Lett.*, **288**, 516–523, doi: 10.1016/j.epsl.2009.10.013.
- Riva, R. E. M., Bamber, J. L., Lavallée, D. A. & Wouters, B., 2010. Sea-level fingerprint of continental water and ice mass change from GRACE, *Geophys. Res. Lett.*, **37**, L19605, doi: 10.1029/2010GL044770.
- Rix, G. J., Lai, C. G. & Jr., A. W. S., 2000. In situ measurement of damping ratio using surface waves, *J. Geotech. Geoenviron. Eng.*, **126**(5), 472–480.
- Rix, G. J., Lai, C. G., Orozco, M. C., Hebel, G. L. & Roma, V., 2001, Recent advances in surface wave methods for geotechnical site characterization, in *Proc. XV Int. Conf. Soil Mechanics Geotechn. Eng.*, pp. 499–502, Balkema, Rotterdam.
- Robbins, A. R. & Plattner, A., 2018. Offset-electrode profile acquisition strategy for electrical resistivity tomography, *J. Appl. Geoph.*, **151**, 66–72, doi: 10.1016/j.jappgeo.2018.01.027.
- Roberts, D. H., Lehár, J. & Dreher, J. W., 1987. Time series analysis with CLEAN. I. derivation of a spectrum, *Astroph. J.*, **93**(4), 968–989.
- Robertsson, J. O. A., 1996. A numerical free-surface condition for elastic/viscoelastic finite-difference modeling in the presence of topography, *Geophysics*, **61**, 1921–1934.
- Robin, M. J. L., Gutjahr, A. L., Sudicky, E. A. & Wilson, J. L., 1993. Cross-correlated random field generation with the direct Fourier transform method, *Water Resources Res.*, **29**(7), 2385–2397.
- Robinson, P. M. & Sanz, J. V., 2006. Modified Whittle estimation of multilateral models on a lattice, *J. Multivar. Anal.*, **97**, 1090–1120.
- Rocha, D., Tanushev, N. & Sava, P., 2017. Anisotropic elastic wavefield imaging using the energy norm, *Geophysics*, **82**(3), S225–S234, doi: 10.1190/geo2016-0424.1.
- Rodell, M., Chen, J., Kato, H., Famiglietti, J. S., Nigro, J. & Wilson, C. R., 2007. Estimating groundwater storage changes in the Mississippi River basin (USA) using GRACE, *Hydrogeol. J.*, **15**, 159–166, doi: 10.1007/s10040-006-0103-7.
- Rodell, M., Velicogna, I. & Famiglietti, J. S., 2009. Satellite-based estimates of groundwater depletion in India, *Nature*, **460**, 999–1002.

- Roemmich, D., Johnson, G. C., Riser, S., Davis, R., Gilson, J., Owens, W. B., Garzoli, S. L., Schmid, C. & Ignaszewski, M., 2009. The Argo program: Observing the global ocean with profiling floats, *Oceanography*, **22**(2), 34–43, doi: 10.5670/oceanog.2009.36.
- Rogers, G. & Dragert, H., 2003. Episodic tremor and slip on the Cascadia subduction zone: The chatter of silent slip, *Science*, **300**, 1942–1943.
- Röhm, A. H. E., Snieder, R., Goes, S. & Trampert, J., 2000. Thermal structure of continental upper mantle inferred from *S*-wave velocity and surface heat flow, *Earth Planet. Sci. Lett.*, **181**(3), 395–407.
- Rokhlin, V. & Tygert, M., 2006. Fast algorithms for spherical harmonic expansions, *SIAM J. Sci. Comput.*, **27**, 1903–1928.
- Romanowicz, B., 1991. Seismic tomography of the Earth’s mantle, *Annu. Rev. Earth Planet. Sc.*, **19**, 77–99.
- Romanowicz, B., 2003. Global mantle tomography: Progress status in the last 10 years, *Annu. Rev. Geoph. Space Phys.*, **31**, 303–328, doi: 10.1146/annurev.earth.31.091602.113555.
- Romanowicz, B., 2008. Using seismic waves to image Earth’s structure, *Nature*, **451**(7176), 266–268, doi: 10.1038/nature06583.
- Romanowicz, B., 2009. The thickness of tectonic plates, *Science*, **324**, 474–476, doi: 10.1126/science.1172879.
- Romanowicz, B. & Giardini, D., 2001. The future of permanent seismic networks, *Science*, **293**(5537), 2000–2001, doi: 10.1126/science.1061771.
- Romanowicz, B. & Gung, Y., 2002. Superplumes from the core-mantle boundary to the lithosphere: Implications for heat flux, *Science*, **296**, 513–516.
- Romanowicz, B., Stakes, D., Uhrhammer, R., McGill, P., Neuhauser, D., Ramirez, T. & Dolenc, D., 2003. The MOBB experiment: A prototype permanent off-shore ocean bottom broadband station, *Eos Trans. AGU*, **84**(34), 325,331–332, doi: 10.1029/2003EO340002.
- Romanowicz, B., Stakes, D., Dolenc, D., Neuhauser, D., McGill, P., Uhrhammer, R. & Ramirez, T., 2006. The Monterey Bay broadband ocean bottom seismic observatory, *Ann. Geophys.–Italy*, **49**(2–3), 607–623, doi: 10.4401/ag–3132.
- Romanowicz, B. A. & Mitchell, B. J., 2015, Deep Earth structure: Q of the Earth from crust to core, in *Treatise on Geophysics*, edited by B. Romanowicz & A. M. Dziewoński, vol. 1, pp. 789–827, doi: 10.1016/B978-0-444-53802-4.00021-X, Elsevier, Amsterdam, Neth.
- Romero, L. A., Ghiglia, D. C., Ober, C. C. & Morton, S. A., 2000. Phase encoding of shot records in prestack migration, *Geophysics*, **65**(2), 426–436, doi: 10.1190/1.1444737.
- Ronchi, C., Iacono, R. & Paolucci, P. S., 1996. The “Cubed Sphere”: A new method for the solution of partial differential equations in spherical geometry, *J. Comput. Phys.*, **124**, 93–114, doi: 10.1006/jcph.1996.0047.

- Rondenay, S., Bostock, M. G., Hearn, T. M., White, D. J. & Ellis, R. M., 2000. Lithospheric assembly and modification of the SE Canadian Shield: Abitibi-Grenville teleseismic experiment, *J. Geophys. Res.*, **105**(B6), 13735–13754.
- Rosenburg, M. A., Aharonson, O., Head, J. W., Kreslavsky, M. A., Mazarico, E., Neumann, G. A., Smith, D. E., Torrence, M. H. & Zuber, M. T., 2011. Global surface slopes and roughness of the Moon from the Lunar Orbiter Laser Altimeter, *J. Geophys. Res.*, **116**, E02001, doi: 10.1029/2010JE003716.
- Rösler, M. & Voit, M., 1997. An uncertainty principle for ultraspherical expansions, *J. Math. Anal. Appl.*, **209**, 624–634.
- Rossby, T. & Webb, D., 1970. Observing abyssal motions by tracking Swallow floats in the SOFAR channel, *Deep-Sea Res.*, **17**(2), 359–365.
- Rossby, T., Dorson, D. & Fontaine, J., 1986. The RAFOS system, *J. Atmos. Ocean Tech.*, **3**(4), 672–679, doi: 10.1175/1520-0426(1986)003<0672:TRS>2.0.CO;2.
- Rost, S. & Thomas, C., 2002. Array seismology: Methods and applications, *Rev. Geophys.*, **40**(3), 1008, doi: 10.1029/2000RG000100.
- Rost, S., Garnero, E. J., Williams, Q. & Manga, M., 2005. Seismological constraints on a possible plume root at the core-mantle boundary, *Nature*, **435**, 666–669, doi: 10.1038/nature03620.
- Roth, E. G. & Wiens, D. A., 1999. Depression of the 660 km discontinuity beneath the Tonga slab determined from near-vertical *ScS* reverberations, *Geophys. Res. Lett.*, **26**(9), 1223–1226.
- Rott, H., Floricioiu, D., Wuite, J., Scheiblauer, S., Nagler, T. & Kern, M., 2014. Mass changes of outlet glaciers along the Nordenskjöld Coast, northern Antarctic Peninsula, based on TanDEM-X satellite measurements, *Geophys. Res. Lett.*, **41**(22), 8123–8129, doi: 10.1002/2014GL061613.
- Rousseeuw, P. J., 1984. Least median of squares regression, *J. Am. Stat. Assoc.*, **79**(388), 871–880.
- Rowlands, D. D., Luthcke, S. B., Klosko, S. M., Lemoine, F. G. R., Chinn, D. S., McCarthy, J. J., Cox, C. M. & Anderson, O. B., 2005. Resolving mass flux at high spatial and temporal resolution using GRACE intersatellite measurements, *Geophys. Res. Lett.*, **32**, L04310, doi: 10.1029/2004GL021908.
- Rowlands, D. D., Luthcke, S. B., McCarthy, J. J., Klosko, S. M., Chinn, D. S., Lemoine, F. G., Boy, J.-P. & Sabaka, T. J., 2010. Global mass flux solutions from GRACE: A comparison of parameter estimation strategies — Mass concentrations versus Stokes coefficients, *J. Geophys. Res.*, **115**(B1), B01403, doi: 10.1029/2009JB006546.
- Rowley, D. B., Forte, A. M., Moucha, R., Mitrovica, J. X., Simmons, N. A. & Grand, S. P., 2013. Dynamic topography change of the eastern United States since 3 million years ago, *Science*, **340**(6140), 1560–1563, doi: 10.1126/science.1229180.

- Roy, B., 1971. Problems and methods with multiple objective functions, *Math. Prog.*, **1**(1), 239–266, doi: 10.1007/BF01584088.
- Roy, M., Jordan, T. H. & Pederson, J., 2009. Colorado Plateau magmatism and uplift by warming of heterogeneous lithosphere, *Nature*, **459**(7249), 978–982.
- Roy, R., 1973. Estimation of the covariance function of a homogeneous process on the sphere, *Ann. Stat.*, **1**(4), 780–785.
- Roy, R., 1976. Spectral analysis for a random process on the sphere, *Ann. Inst. Stat. Math.*, **28**(1), 91–97.
- Royer, J.-Y. & Gordon, R. G., 1997. The motion and boundary between the Capricorn and Australian plates, *Science*, **277**, 1268–1274.
- Ruan, Y., Lei, W., Modrak, R., Örsvuran, R., Bozdağ, E. & Tromp, J., 2019. Balancing unevenly distributed data in seismic tomography: a global adjoint tomography example, *Geophys. J. Int.*, **219**(2), 1225–1236, doi: 10.1093/gji/ggz356.
- Rubin, A. M., 1993. Dikes vs. diapirs in viscoelastic rock, *Earth Planet. Sci. Lett.*, **119**, 641–659.
- Rubin, A. M., Gillard, D. & Got, J.-L., 1999. Streaks of microearthquakes along creeping faults, *Nature*, **400**, 635–641.
- Ruddiman, W. F., 2005. How did humans first alter global climate?, *Sc. Am.*, pp. 46–53.
- Rudin, L. I., Osher, S. & Fatemi, E., 1992. Nonlinear total variation based noise removal algorithms, *Physica D*, **60**(1–4), 259–268, doi: 10.1016/0167-2789(92)90242-F.
- Rudnick, R. L., 1995. Making continental crust, *Nature*, **378**, 571–578.
- Rudnick, R. L. & Walker, R. J., 2009. Interpreting ages from re-os isotopes in peridotites, *Lithos*, **112**, 1083–1095, doi: 10.1016/j.lithos.2009.04.042.
- Rudnick, R. L., McDonough, W. F. & O’Connell, R. J., 1998. Thermal structure, thickness and composition of continental lithosphere, *Chemical Geology*, **145**, 395–411.
- Rudolph, M. L., Lekić, V. & Lithgow-Bertelloni, C., 2015. Viscosity jump in Earth’s mid-mantle, *Science*, **350**(6266), 1349–1352, doi: 10.1126/science.aad1929.
- Ruff, L. J., 1989. Multi-trace deconvolution with unknown trace scale factors: Omnilinear inversion of *P* and *S* waves for source time functions, *Geophys. Res. Lett.*, **16**(9), 1043–1046, doi: 10.1029/GL016i009p01043.
- Ruff, L. J. & Miller, A. D., 1994. Rupture process of large earthquakes in the northern Mexico subduction zone, *Pure Appl. Geophys.*, **142**(1), 101–172.
- Rummel, R., 1975, Downward continuation of gravity information from satellite to satellite tracking or satellite gradiometry in local areas, Tech. rep., Department of Geodetic Science and Surveying, The Ohio State University.

- Rummel, R. & van Gelderen, M., 1995. Meissl scheme — spectral characteristics of physical geodesy, *Manuscr. Geod.*, **20**(5), 379–385.
- Rümpker, G. & Silver, P. G., 1998. Apparent shear-wave splitting parameters in the presence of vertically varying anisotropy, *Geophys. J. Int.*, **135**(3), 790–800.
- Runcorn, S. K., 1975. On the interpretation of lunar magnetism, *Phys. Earth Planet. Inter.*, **10**, 327–335.
- Runcorn, S. K., 1975. An ancient lunar magnetic dipole field, *Nature*, **253**, 701–703.
- Rutland, R. W. R., 1976. Orogenic evolution of Australia, *Earth Sci. Rev.*, **12**, 161–196.
- Ryan, K. M., 2014, *Precision and accuracy of Global Positioning Augmentation Systems and their application to geoarchaeology*, A. B. Thesis, Princeton University.
- Rychert, C. A. & Shearer, P. M., 2009. A global view of the lithosphere-asthenosphere boundary, *Science*, **324**(5926), 495–498, doi: 10.1126/science.1169754.
- Rydelek, P. & Horiuchi, S., 2006. Earth science: Is earthquake rupture deterministic?, *Nature*, **442**, E5–E6, doi: 10.1038/nature04963.
- Rye, C. D., Garabato, A. C. N., Holland, P. R., Meredith, M. P., Nurser, A. J. G., Hughes, C. W., Coward, A. C. & Webb, D. J., 2014. Rapid sea-level rise along the Antarctic margins in response to increased glacial discharge, *Nature Geosci.*, **7**(10), 732–735, doi: 10.1038/ngeo2230.
- Sabadini, R., Lambeck, K. & Boschi, E., eds., 1991. *Glacial Isostasy, Sea-level and Mantle Rheology*, Kluwer.
- Sabaka, T. J., Hulot, G. & Olsen, N., 2010, Mathematical properties relevant to geomagnetic field modeling, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 17, pp. 503–538, doi: 10.1007/978-3-642-01546-5_17, Springer, Heidelberg, Germany.
- Sabaka, T. J., Rowlands, D. D., Luthcke, S. B. & Boy, J.-P., 2010. Improving global mass flux solutions from Gravity Recovery and Climate Experiment (GRACE) through forward modeling and continuous time correlation, *J. Geophys. Res.*, **115**, B11403, doi: 10.1029/2010JB007533.
- Sabaka, T. J., Hulot, G. & Olsen, N., 2015, Mathematical properties relevant to geomagnetic field modeling, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 17, pp. 835–877, doi: 10.1007/978-3-642-54551-1_17, Springer, Heidelberg, Germany.
- Sabra, K. G., Gerstoft, P., Roux, P., Kuperman, W. A. & Fehler, M. C., 2005. Extracting time-domain green's function estimates from ambient seismic noise, *Geophys. Res. Lett.*, **32**(3), doi: 10.1029/2004GL021862.
- Sabri, E. H. & Beamon, B. M., 2000. A multi-objective approach to simultaneous strategic and operational planning in supply chain design, *Omega*, **28**(5), 581–598, doi: 10.1016/S0305-0483(99)00080-8.

- Sadeghi, P., Kennedy, R. A. & Khalid, Z., 2012. Commutative anisotropic convolution on the 2-sphere, *IEEE T. Signal Process.*, **60**(12), 6697–6703, doi: 10.1109/TSP.2012.2217337.
- Sáez, M., Barceló, M. A., Tobias, A., Varga, D., Ocaña-Riola, R., Juan, P. & Mateu, J., 2012. Space-time interpolation of daily air temperatures, *J. Environ. Stat.*, **3**(5).
- Sagy, A., Brodsky, E. E. & Axen, G. J., 2007. Evolution of fault-surface roughness with slip, *Geology*, **35**(3), 283–286, doi: 10.1130/G23235A.1.
- Sailhac, P. & Gibert, D., 2003. Identification of sources of potential fields with the continuous wavelet transform: Two-dimensional wavelets and multipolar approximations, *J. Geophys. Res.*, **108**(B5), 2262, doi: 10.1029/2002JB002021.
- Saito, M., 1967. Excitation of free oscillations and surface waves by a point source in a vertically heterogeneous Earth, *J. Geophys. Res.*, **72**(14), 3689–3699, doi: 10.1029/JZ072i014p03689.
- Saito, N., 2007. Data analysis and representation on a general domain using eigenfunctions of Laplacian, *Appl. Comput. Harmon. Anal.*, **25**, 68–97, doi: 10.1016/j.acha.2007.09.005.
- Saitoh, S., 2005. Best approximation, Tikhonov regularization and reproducing kernels, *Kodai Math. J.*, **28**(2), 359–367.
- Saitoh, S., Matsuura, T. & Asaduzzaman, M., 2003. Operator equations and best approximation problems in reproducing kernel Hilbert spaces, *J. Anal. Appl.*, **1**(3), 131–142.
- Saki, M., Thomas, C. & Abreu, R., 2022. Detection and modelling of strong topography of mid-mantle structures beneath the North Atlantic, *Geophys. J. Int.*, **229**(1), 219–234, doi: 10.1093/gji/ggab465.
- Sakic, P., Ballu, V. & Royer, J.-Y., 2020. A multi-observation least-squares inversion for GNSS-Acoustic seafloor positioning, *Remote Sens.*, **12**(3), 448–448, doi: 10.3390/rs12030448.
- Sallarès, V., Charvis, P., Flueh, E. R., Bialas, J. & the SALIERI Scientific Party, 2005. Seismic structure of the Carnegie ridge and the nature of the Galápagos hotspot, *Geophys. J. Int.*, **161**(3), 763–788, doi: 10.1111/j.1365-246X.2005.02592.x.
- Saltus, R. W. & Blakely, R. J., 2011. Unique geological insights from "non-unique" gravity and magnetic interpretation, *GSA Today*, **21**(12), 4–11, doi: 10.1130/G136A.1.
- Saltzer, R., Leahey, G., Schmedes, J., Roth, J. & Rumpfhuber, E., 2011, Earthquakes—a naturally occurring source of low-frequency data, in *SEG Tech. Prog. Expanded Abstracts*, pp. 3689–3692, Soc. Explor. Geophys., Denver, Col.
- Saltzer, R. L., 2002. Upper mantle structure of the Kaapvaal craton from surface wave analysis — A second look, *Geophys. Res. Lett.*, **29**(6), 1093, doi: 10.1029/2001GL013702.
- Saltzer, R. L., Gaherty, J. B. & Jordan, T. H., 2000. How are vertical shear-wave splitting measurements affected by variations in the orientation of azimuthal anisotropy with depth?, *Geophys. J. Int.*, **141**, 374–390.

- Saltzer, R. L., van der Hilst, R. D. & Káráson, H., 2001. Comparing *P* and *S* wave heterogeneity in the mantle, *Geophys. Res. Lett.*, **28**(7), 1335–1338.
- Sambridge, M. & Guðmundsson, Ó., 1998. Tomographic systems of equations with irregular cells, *J. Geophys. Res.*, **103**(B1), 773–781.
- Sambridge, M. & Rawlinson, N., 2005. Seismic tomography with irregular meshes, in *Seismic Earth: Array Analysis of Broadband Seismograms*, edited by A. Levander & G. Nolet, vol. 157 of **Geophysical Monograph**, pp. 49–65, Amer. Geophys. Union.
- Sambridge, M., Beghein, C., Simons, F. J. & Snieder, R., 2006. How do we understand and visualize uncertainty?, *The Leading Edge*, **25**(5), 542–546, doi: 10.1190/1.2202654.
- Sandiford, M., 2007. The tilting continent: A new constraint on the dynamic topographic field from Australia, *Earth Planet. Sci. Lett.*, **261**(1-2), 152–163.
- Sandiford, M. & Hand, M., 1998. Controls on the locus of intraplate deformation in central Australia, *Earth Planet. Sci. Lett.*, **162**, 97–110.
- Sandwell, D. & Fialko, Y., 2004. Warping and cracking of the Pacific plate by thermal contraction, *J. Geophys. Res.*, **109**, B10411, doi: 10.1029/2004JB003091.
- Sandwell, D. T. & Renkin, M. L., 1988. Compensation of swells and plateaus in the North Pacific: No direct evidence for mantle convection, *J. Geophys. Res.*, **93**(B4), 2775–2783.
- Sandwell, D. T. & Smith, W. H. F., 1997. Marine gravity anomaly from Geosat and ERS 1 satellite altimetry, *J. Geophys. Res.*, **102**(B5), 10039–10054.
- Sandwell, D. T., Johnson, C. L., Bilotti, F. & Suppe, J., 1997. Driving forces for limited tectonics on Venus, *Icarus*, **129**, 232–244.
- Sansone, G., 1959. *Orthogonal functions*, Interscience, New York, rev. english. ed. edn.
- Santo, A. G., Gold, R. E., McNutt, Jr., R. L., Solomon, S. C., Ercol, C. J., Farquhar, R. W., Hartka, T. J., Jenkins, J. E., McAdams, J. V., Mosher, L. E., Persons, D. F., Artis, D. A., Bokulic, R. S., Conde, R. F., Dakermanji, G., Goss, Jr., M. E., Haley, D. R., Heeres, K. J., Maurer, R. H., Moore, R. C., Rodberg, E. H., Stern, T. G., Wiley, S. R., Williams, B. G., wan L. Yen, C. & Peterson, M. R., 2001. The MESSENGER mission to Mercury: spacecraft and mission design, *Planet. Space Sci.*, **49**(14–15), 1481–1500, doi: 10.1016/S0032-0633(01)00087-3.
- Santoso, S., Powers, E. J., Bengston, R. D. & Ouroua, A., 1997. Time-series analysis of nonstationary plasma fluctuations using wavelet transforms, *Rev. Sci. Instrum.*, **68**(1), 898–901.
- Sapin, M. & Hirn, A., 1974. Results of explosion seismology in the Southern Rhône Valley, *Ann. Geophys.–Germany*, **30**, 181–202.
- Sapin, M. & Prodehl, C., 1973. Long range profiles in western Europe. I. Crustal structure between the Bretagne and the Central Massif of France, *Ann. Geophys.–Germany*, **29**(1), 127–145.

- Saragiotis, C. D., Hadjileontiadis, L. J. & Panas, S. M., 2002. PAI-S/K: A robust automatic seismic *P* phase arrival identification scheme, *IEEE T. Geosci. Remote*, **40**(6), 1395–1404, doi: 10.1109/TGRS.2002.800438.
- Sasgen, I., Martinec, Z. & Fleming, K., 2007. Wiener optimal combination and evaluation of the Gravity Recovery and Climate Experiment (GRACE) gravity fields over Antarctica, *J. Geophys. Res.*, **112**, B04401, doi: 10.1029/2006JB004605.
- Sasgen, I., Martinec, Z. & Bamber, J. L., 2010. Combined GRACE and InSAR estimate of West Antarctic ice mass loss, *J. Geophys. Res.*, **115**, F04010, doi: 10.1029/2009JF001525.
- Sasgen, I., van den Broeke, M., Bamber, J. L., Rignot, E., Sørensen, L. S., Wouters, B., Martinec, Z., Velicogna, I. & Simonsen, S. B., 2012. Timing and origin of recent regional ice-mass loss in Greenland, *Earth Planet. Sci. Lett.*, **333–334**, 293–303, doi: 10.1016/j.epsl.2012.03.033.
- Sasgen, I., Konrad, H., Ivins, E. R., den Broeke, M. R. V., Bamber, J. L., Martinec, Z. & Klemann, V., 2013. Antarctic ice-mass balance 2003 to 2012: regional reanalysis of GRACE satellite gravimetry measurements with improved estimate of glacial-isostatic adjustment based on GPS uplift rates, *The Cryosphere*, **7**, 1499–1512, doi: 10.5194/tc-7-1499-2013.
- Saunders, P. M., 1981. Practical conversion of pressure to depth, *J. Phys. Oceanog.*, **11**(4), 573–574, doi: 10.1175/1520-0485(1981)011<0573:PCOPTD>2.0.CO;2.
- Saunders, R. S. & Pettengill, G. H., 1990. The Magellan Venus radar mapping mission, *J. Geophys. Res.*, **95**(B6), 8339–8355, doi: 10.1029/JB095iB06p08339.
- Savage, M. K., 1999. Seismic anisotropy and mantle deformation: What have we learned from shear wave splitting?, *Rev. Geophys.*, **37**(1), 65–106.
- Savage, M. K. & Sheehan, A. F., 2000. Seismic anisotropy and mantle flow from the Great Basin to the Great Plains, western United States, *J. Geophys. Res.*, **105**(B6), 13715–13734.
- Sawade, L., Beller, S., Lei, W. & Tromp, J., 2022. A database of global centroid moment tensors using 3D Green’s functions from model GLAD-M25, *Geophys. J. Int.*, **231**(3), 1727–1738, doi: 10.1093/gji/ggac280.
- Sayeed, A. M. & Jones, D. L., 1995. Optimal kernels for nonstationary spectral estimation, *IEEE T. Signal Process.*, **43**(2), 478–491.
- Scales, J. A. & Snieder, R., 1997. To Bayes or not to Bayes?, *Geophysics*, **62**(4), 1045–1046.
- Scales, J. A. & Snieder, R., 1998. What is noise?, *Geophysics*, **63**(4), 1122–1124.
- Scargle, J. D., Way, M. J. & Gazis, P. R., 2017. Structure in the 3D galaxy distribution. III. Fourier transforming the Universe: Phase and power spectra, *Astroph. J.*, **839**, 40, doi: 10.3847/1538-4357/aa692d.
- Schachtschneider, R., Holschneider, M. & Mandea, M., 2010. Error distribution in regional inversion of potential field data, *Geophys. J. Int.*, **181**, 1428–1440, doi: 10.1111/j.1365-246X.2010.04598.x.

- Schachtschneider, R., Holschneider, M. & Mandea, M., 2012. Error distribution in regional modelling of the geomagnetic field, *Geophys. J. Int.*, **191**, 1015–1024, doi: 10.1111/j.1365–246X.2012.05675.x.
- Schaeffer, A. J. & Lebedev, S., 2013. Global shear speed structure of the upper mantle and transition zone, *Geophys. J. Int.*, **194**(1), 441–449, doi: 10.1093/gji/ggt095.
- Schaff, D. P. & Richards, P. G., 2004. Repeating seismic events in China, *Science*, **303**(5661), 1176–1178, doi: 10.1126/science.1093422.
- Schaff, D. P., Bokelmann, G. H. R., Beroza, G. C., Waldhauser, F. & Ellsworth, W. L., 2002. High-resolution image of Calaveras Fault seismicity, *J. Geophys. Res.*, **107**(B9), 2186, doi: 10.1029/2001JB000633.
- Schaff, D. P., Bokelmann, G. H. R., Ellsworth, W. L., Zanker, E., Waldhauser, F. & Beroza, G. C., 2004. Optimizing correlation techniques for improved earthquake location, *B. Seismol. Soc. Am.*, **94**(2), 705–721.
- Schastok, J., 1997. A new nutation series for a more realistic model Earth, *Geophys. J. Int.*, **130**, 137–150.
- Scheirer, D., Forsyth, D. W. & Hosford, A., 1995. Multitaper estimates of the lithospheric strength of the Basin and Range province (abstract), *Eos Trans. AGU*, **76**(17), Spring Meet. Suppl., S282.
- Scheirer, D. S., Forsyth, D. W., Conder, J. A., Eberle, M. A., Hung, S.-H., Johnson, K. T. M. & Graham, D. W., 2000. Anomalous seafloor spreading of the Southeast Indian Ridge near the Amsterdam-St. Paul Plateau, *J. Geophys. Res.*, **105**(B4), 8243–8262.
- Schelkens, P., Decroos, F., Cornelis, J., Lafruit, G. & Catthoor, F., 1999. Implementation of an integer wavelet transform on a parallel TI TMS320C40 platform, in *Signal Processing Systems*, pp. 81–89, IEEE.
- Scherbaum, F., 1997. Zero-phase FIR filters: Blessing or curse?, *Eos Trans. AGU*, **78**(33), 343–344.
- Scherbaum, F., 2001. *Of Poles and Zeros: Fundamentals of Digital Seismology*, Kluwer, Norwell, Mass, 2nd edn.
- Scherwath, M., Stern, T., Melhuish, A. & Molnar, P., 2002. Pn anisotropy and distributed upper mantle deformation associated with a continental transform fault, *Geophys. Res. Lett.*, **29**(8), 1175, doi: 10.1029/2001GL014179.
- Scherwath, M., Spence, G., Obana, K., Kodaira, S., Wang, K., Riedel, M., McGuire, J. & Collins, J., 2011. Seafloor seismometers monitor northern Cascadia earthquakes, *Eos Trans. AGU*, **92**(47), 421–422, doi: 10.1029/2011EO470001.
- Scherzer, O. & Weickert, J., 2000. Relations between regularization and diffusion filtering, *J. Math. Imaging Vis.*, **12**(1), 43–63, doi: 10.1023/A:1008344608808.

- Schey, H. M., 2005. *Div, grad, curl, and all that*, W. W. Norton, New York, 4th edn.
- Schmeling, H., Monza, R. & Rubie, D. C., 1999. The influence of olivine metastability on the dynamics of subduction, *Earth Planet. Sci. Lett.*, **165**(1), 55–66.
- Schmerr, N., 2012. The Gutenberg discontinuity: Melt at the lithosphere-asthenosphere boundary, *Science*, **335**(6075), 1480–1483, doi: 10.1126/science.1215433.
- Schmidt, M., Han, S.-C., Kusche, J., Sanchez, L. & Shum, C. K., 2006. Regional high-resolution spatiotemporal gravity modeling from GRACE data using spherical wavelets, *Geophys. Res. Lett.*, **33**(8), L0840, doi: 10.1029/2005GL025509.
- Schmidt, M., Fengler, M., Mayer-Gürr, T., Eicker, A., Kusche, J., Sánchez, L. & Han, S.-C., 2007. Regional gravity modeling in terms of spherical base functions, *J. Geod.*, **81**(1), 17–38, doi: 10.1007/s00190-006-0101-5.
- Schmidt, V., ed., 2015. *Stochastic geometry, spatial statistics and random fields*, Springer, Heidelberg, Germany.
- Schoene, B. & Bowring, S. A., 2007. Determining accurate temperature-time paths from U–Pb thermochronology: An example from the Kaapvaal craton, southern Africa, *Geochim. Cosmochim. Acta*, **71**, 165–185, doi: 10.1016/j.gca.2006.08.029.
- Schoene, B. & Bowring, S. A., 2010. Rates and mechanisms of Mesoarchean magmatic arc construction, eastern Kaapvaal craton, Swaziland, *Geol. Soc. Amer. Bull.*, **122**(3–4), 408–429, doi: 10.1130/B26501.1.
- Schofield, O. & Tivey, M. K., 2004, A report of the workshop held January 4–8, 2004, San Juan, Puerto Rico, Tech. rep., ORION: Ocean Research Interactive Observatory Networks.
- Scholte, J. G., 1942. On surface waves in a stratified medium, I, *Proc. Acad. Sci. Amst.*, **45**, 380–386.
- Scholte, J. G., 1942. On surface waves in a stratified medium, II, *Proc. Acad. Sci. Amst.*, **45**, 449–456.
- Scholte, J. G., 1942. On surface waves in a stratified medium, III, *Proc. Acad. Sci. Amst.*, **45**, 516–523.
- Scholte, J. G., 1942. On the Stoneley-wave equation, I, *Proc. Acad. Sci. Amst.*, **45**, 20–25.
- Scholte, J. G., 1942. On the Stoneley-wave equation, II, *Proc. Acad. Sci. Amst.*, **45**, 159–164.
- Scholte, J. G., Mon. Not. R. Astron. Soc. The range of existence of Rayleigh and Stoneley waves, *Proc. Acad. Sci. Amst.*, **5**(Geophys. Suppl. 5), 120–126, doi: 10.1111/j.1365-246X.1947.tb00347.x.
- Scholz, C. H., 1998. Earthquakes and friction laws, *Nature*, **391**, 37–42.

- Schott, J.-J. & Thébault, E., 2011, Modelling the earth's magnetic field from global to regional scales, in *Geomagnetic Observations and Models*, edited by M. Manda & M. Korte, vol. 5 of **IAGA Special Sopron Book Ser.**, pp. 229–264, Springer.
- Schou, J. & Brown, T. M., 1994. Generation of artificial helioseismic time-series, *Astron. Astroph. Suppl. Ser.*, **107**, 541–550.
- Schrama, E. J. O., Wouters, B. & Lavallée, D. A., 2007. Signal and noise in Gravity Recovery and Climate Experiment (GRACE) observed surface mass variations, *J. Geophys. Res.*, **112**, B08407, doi: 10.1029/2006JB004882.
- Schrama, E. J. O., Wouters, B. & Rietbroek, R., 2014. A mascon approach to assess ice sheet and glacier mass balances and their uncertainties from GRACE data, *J. Geophys. Res.*, **119**(7), 6048–6066, doi: 10.1002/2013JB010923.
- Schreier, P. & Scharf, L. L., 2010. *Statistical Signal Processing of Complex-Valued Data*, Cambridge Univ. Press.
- Schreiner, A. E., Fox, C. G. & Dziak, R. P., 1995. Spectra and magnitudes of T-waves from the 1993 earthquake swarm on the Juan de Fuca Ridge, *Geophys. Res. Lett.*, **22**(2), 139–142.
- Schreiner, M., 1997. Locally supported kernels for spherical spline interpolation, *J. Approx. Theory*, **89**, 172–194.
- Schreiner, M., 1997. On a new condition of strictly positive definite functions on spheres, *Proc. Am. Math. Soc.*, **125**(2), 531–539.
- Schröder, C. T. & Waymond R. Scott, J., 2001. On the complex conjugate roots of the Rayleigh equation: The leaky surface wave, *J. Acoust. Soc. Am.*, **110**(6), 2867–2877, doi: 10.1121/1.1419085.
- Schröder, P. & Sweldens, W., 1995. Spherical wavelets: Efficiently representing functions on the sphere, *Computer Graphics Proceedings (SIGGRAPH 95)*, **22**, 161–172, doi: 10.1145/218380.218439.
- Schubert, G., Turcotte, D. L. & Olson, P., 2001. *Mantle convection in the Earth and planets*, Cambridge Univ. Press, Cambridge, UK.
- Schuberth, B. S. A., Bunge, H.-P. & Ritsema, J., 2009. Tomographic filtering of high-resolution mantle circulation models: Can seismic heterogeneity be explained by temperature alone?, *Geochem. Geophys. Geosys.*, **10**(5), Q05W03, doi: 10.1029/2009GC002401.
- Schulte-Pelkum, V., Masters, G. & Shearer, P. M., 2001. Upper mantle anisotropy from long-period P polarization, *J. Geophys. Res.*, **106**(B10), 21917–21934.
- Schulten, K. & Gordon, R. G., 1975. Exact recursive evaluation of $3j$ -coefficients and $6j$ -coefficients for quantum-mechanical coupling of angular momenta, *J. Math. Phys.*, **16**(10), 1961–1970.

- Schulten, K. & Gordon, R. G., 1976. Recursive evaluation of $3j$ and $6j$ coefficients, *Comput. Phys. Comm.*, **11**(2), 269–278.
- Schultz, P., 2008. Structural geology: The buried record of Chicxulub, *Nature Geosci.*, **1**(2), 90–91, doi: 10.1038/ngeo120.
- Schumacher, F., Friederich, W. & Lamara, S., 2016. A flexible, extendable, modular and computationally efficient approach to scattering-integral-based seismic full waveform inversion, *Geophys. J. Int.*, **204**(2), 1100–1119, doi: 10.1093/gji/ggv505.
- Schuster, A., 1898. An investigation of hidden periodicities with application to a supposed 26-day period of meteorological phenomena, *Terr. Magn.*, **3**, 13–41.
- Schuster, G. T., 2017. *Seismic Inversion*, Soc. Explor. Geophys., Tulsa, OK.
- Schuster, G. T., Wang, X., Huang, Y., Dai, W. & Boonyasiriwat, C., 2011. Theory of multi-source crosstalk reduction by phase-encoded statics, *Geophys. J. Int.*, **184**(3), 1289–1303, doi: 10.1111/j.1365-246X.2010.04906.x.
- Schutt, D. L. & Humphreys, E. D., 2001. Evidence for a deep asthenosphere beneath North America from western United States SKS splits, *Geology*, **29**(4), 291–294.
- Schwab, M., Karrenbach, M. & Claerbout, J., 2000. Making scientific computations reproducible, *Comput. Sci. Eng.*, **2**, 61–67, doi: 10.1109/5992.881708.
- Schwarz, U. J., 1978. Mathematical-statistical description of the iterative beam removing technique (method CLEAN), *Astron. Astroph.*, **65**, 345–356.
- Schwarzschild, B., 2007. Sonar mapping suggests that the English Channel was created by two megafloods, *Physics Today*, **60**(9), 24–27.
- Sclater, J. G., Jaupart, C. & Galson, D., 1980. The heat flow through oceanic and continental crust and the heat loss of the Earth, *Rev. Geophys. Space Phys.*, **18**(1), 269–311.
- Sclater, J. G., Parsons, B. & Jaupart, C., 1981. Oceans and continents: Similarities and differences in the mechanisms of heat loss, *J. Geophys. Res.*, **86**(B12), 11535–11552.
- Searle, M. P., 1999. Extensional and compressional faults in the Everest-Lhotse massif, Khumbu Himalaya, Nepal, *J. Geol. Soc. London*, **156**, 227–240.
- Searle, M. P., Simpson, R. L., Law, R. D., Parrish, R. R. & Waters, D. J., 2003. The structural geometry, metamorphic and magmatic evolution of the Everest massif, High Himalaya of Nepal — South Tibet, *J. Geol. Soc. London*, **160**, 345–366.
- Sébilleau, D., 1998. On the computation of the integrated products of three spherical harmonics, *J. Phys. A: Math. Gen.*, pp. 7157–7168.
- Seeley, R. T., 1966. Spherical harmonics, *Amer. Math. Monthly*, **73**(4), 115–121.

- Seibert, K., Michel, V., Simons, F. J. & Plattner, A., 2016. Spherical tensor Slepian functions for satellite gravity gradiometry, *Geophys. Res. Abstr.*, **18**, 2586.
- Seibert, K., Plattner, A., Simons, F. J. & Michel, V., 2017. Regional analysis of tensor fields on the sphere by Slepian functions, *Geophys. Res. Abstr.*, **18**, 2187.
- Seidl, D., 1980. The simulation problem for broad-band seismograms, *J. Geophys.*, **48**, 84–93.
- Seidl, D. & Stammer, W., 1984. Restoration of broad-band seismograms (Part I), *J. Geophys.*, **54**, 114–122.
- Selby, N. D. & Woodhouse, J. H., 2000. Controls on Rayleigh wave amplitudes: attenuation and focusing, *Geophys. J. Int.*, **142**(3), 933–940, doi: 10.1046/j.1365–246x.2000.00209.x.
- Seljak, U. & Zaldarriaga, M., 1996. A line-of-sight integration approach to cosmic microwave background anisotropies, *Astroph. J.*, **469**(2), 437–444.
- Semken, S., 2012. Sense of place and place-based introductory geoscience teaching for American Indian and Alaska Native undergraduates, *J. Geosc. Educ.*, **53**(2), 149–157.
- Sen, M. K. & Stoffa, P. L., 1990. Nonlinear seismic waveform inversion in one dimension using simulated annealing, *Geophysics*, **56**(10), 1119–1122, doi: 10.1190/1.1889926.
- SenGupta, I., 2011. Spectral analysis for a three-dimensional superradiance problem, *J. Math. Anal. Appl.*, **375**, 762–776, doi: 10.1016/j.jmaa.2010.10.003.
- SenGupta, I., Sun, B., Jiang, W., Chen, G. & Mariani, M. C., 2012. Concentration problems for bandpass filters in communication theory over disjoint frequency intervals and numerical solutions, *J. Fourier Anal. Appl.*, **18**, 182–210, doi: 10.1007/s00041–011–9197–y.
- Seno, T. & Yamasaki, T., 2003. Low-frequency tremors, intraslab and interplate earthquakes in Southwest Japan — from a viewpoint of slab dehydration, *Geophys. Res. Lett.*, **30**(22), 2171, doi: 10.1029/2003GL018349.
- Sens-Schönfelder, C., 2008. Synchronizing seismic networks with ambient noise, *Geophys. J. Int.*, **174**(3), 966–970, doi: 10.1111/j.1365–246X.2008.03842.x.
- Severini, T. A., 2001. *Likelihood Methods in Statistics*, Oxford Univ. Press, Oxford, UK.
- Seymour, M. S. & Cumming, I. G., 1994, Maximum likelihood estimation for SAR interferometry, in *Proc. IEEE Int. Geosci. Remote Sens. Symp.*, vol. 4, pp. 2272–2275, IEEE.
- Sguazzero, P., Vesnaver, A. & Kindelan, M., 1987, Stacking velocity analysis on complex traces, in *SEG Tech. Prog. Expanded Abstracts*, pp. 420–422, doi: 10.1190/1.1891980, Soc. Explor. Geophys., New Orleans, La.
- Shapiro, N. M., Campillo, M., Stehly, L. & Ritzwoller, M. H., 2005. High-resolution surface-wave tomography from ambient seismic noise, *Science*, **307**(5715), 1615–1618.

- Shapiro, S. S., Hager, B. H. & Jordan, T. H., 1999. Stability and dynamics of the continental tectosphere, *Lithos*, **48**(1–4), 115–133.
- Shapiro, S. S., Hager, B. H. & Jordan, T. H., 1999. The continental tectosphere and Earth's long-wavelength gravity field, *Lithos*, **48**(1–4), 135–152.
- Sharifi, M. A. & Farzaneh, S., 2014. The spatio-spectral localization approach to modeling VTEC over the western part of the USA using GPS observations, *Adv. Space Res.*, **54**(6), 908–916, doi: 10.1016/j.asr.2014.05.005.
- Sharp, R. P. & Glazner, A. F., 1993. *Geology Underfoot in Southern California*, Mountain Press, Missoula, Mont.
- Sharp, R. P. & Glazner, A. F., 1997. *Geology Underfoot in Death Valley and Owens Valley*, Mountain Press, Missoula, Mont.
- Sharpton, V. L. & Head, J. W., 1985. Analysis of regional slope characteristics on Venus and Earth, *J. Geophys. Res.*, **90**(B5), 3733–3740.
- Shaw, B. E. & Dieterich, J., 2007. Probabilities for jumping fault segment stepovers, *Geophys. Res. Lett.*, **34**, L01307, doi: 10.1029/2006GL027980.
- Shaw, R. D., Wellman, P., Gunn, P., Whitaker, A. J., Tarlowski, C. & Morse, M. P., 1995. Australian crustal elements map, *AGSO Res. Newslett.*, **23**, 1–3.
- Shearer, P., Hauksson, E. & Lin, G., 2005. Southern California hypocenter relocation with waveform cross-correlation, Part 2: Results using source-specific station terms and cluster analysis, *B. Seismol. Soc. Am.*, **95**(3), 904–915, doi: 10.1785/0120040168.
- Shearer, P. M., 1990. Seismic imaging of upper-mantle structure with new evidence for a 520-km discontinuity, *Nature*, **344**(6262), 121–126, doi:10.1038/344121a0.
- Shearer, P. M., 1999. *Introduction to Seismology*, Cambridge Univ. Press, Cambridge, UK.
- Shearer, P. M. & Earle, P. S., 2004. The global short-period wavefield modelled with a Monte Carlo seismic phonon method, *Geophys. J. Int.*, **158**(3), 1103–1117.
- Shearer, P. M. & Flanagan, M. P., 1999. Seismic velocity and density jumps across the 410- and 660-kilometer discontinuities, *Science*, **285**, 1545–1548.
- Shearer, P. M., Toy, K. M. & Orcutt, J. A., 1988. Axi-symmetric Earth models and inner-core anisotropy, *Nature*, **333**(6170), 228–232.
- Shen, Y., Sheehan, A. F., Dueker, K. G., de Groot-Hedlin, C. & Gilbert, H., 1998. Mantle discontinuity structure beneath the southern East Pacific Rise from P-to-S converted phases, *Science*, **280**, 1232–1235.
- Shen, Y., Solomon, S. C., Bjarnason, I. T. & Wolfe, C. J., 1998. Seismic evidence for a lower-mantle origin of the Iceland plume, *Nature*, **395**, 62–65, doi: 10.1038/25714.

- Shen, Y., Wolfe, C. J. & Solomon, S. C., 2003. Seismological evidence for a mid-mantle discontinuity beneath Hawaii and Iceland, *Earth Planet. Sci. Lett.*, **214**(1–2), 143–151, doi: 10.1016/S0012-821X(03)00349-2.
- Sheng, J., Leeds, A., Buddensiek, M. & Schuster, G. T., 2006. Early arrival waveform tomography on near-surface refraction data, *Geophysics*, **71**(1), U47–U57, doi: 10.1190/1.2210969.
- Shepard, M. K., Campbell, B. A., Bulmer, M. H., Farr, T. G., Gaddis, L. R. & Plaut, J. J., 2001. The roughness of natural terrain: A planetary and remote sensing perspective, *J. Geophys. Res.*, **106**(E12).
- Shepherd, A. & Wingham, D. J., 2007. Recent sea-level contributions of the Antarctic and Greenland ice sheets, *Science*, **315**(5818), 1529–1532, doi: 10.1126/science.1136776.
- Shepherd, A., Ivins, E. R., A, G., Barletta, V. R., Bentley, M. J., Bettadpur, S., Briggs, K. H., Bromwich, D. H., Forsberg, R., Galin, N., Horwath, M., Jacobs, S., Joughin, I., King, M. A., Lenaerts, J. T. M., Li, J., Ligtenberg, S. R. M., Luckman, A., Luthcke, S. B., McMillan, M., Meister, R., Milne, G., Mouginot, J., Muir, A., Nicolas, J. P., Paden, J., Payne, A. J., Pritchard, H., Rignot, E., Rott, H., Sørensen, L. S., Scambos, A., Scheuchl, B., Schrama, E. J. O., Smith, B., Sundal, A. V., van Angelen, J. H., van de Berg, W. J., van den Broeke, M. R., Vaughan, D. G., Velicogna, I., Wahr, J., Whitehouse, P. L., Wingham, D. J., Yi, D., Young, D. & Zwally, H. J., 2012. A reconciled estimate of ice-sheet mass balance, *Science*, **338**(6111), 1183–1189, doi: 10.1126/science.1228102.
- Shepp, L. & Zhang, C.-H., 2000. Fast functional magnetic resonance imaging via prolate wavelets, *Appl. Comput. Harmon. Anal.*, **9**(2), 99–119, doi: 10.1006/acha.2000.0302.
- Sheppard, C. J. R. & Török, P., 1997. Efficient calculation of electromagnetic diffraction in optical systems using a multipole expansion, *J. Mod. Optics*, **44**(4), 803–818, doi: 10.1080/09500349708230696.
- Sherif, S. S. & Török, P., 2005. Eigenfunction representation of the integrals of the Debye-Wolf diffraction formula, *J. Mod. Optics*, **52**(6), 857–876, doi: 10.1080/09500340512331309084.
- Sheriff, R. E. & Geldart, L. P., 1995. *Exploration Seismology*, Cambridge Univ. Press, Cambridge, UK.
- Shibutani, T., Sambridge, M. & Kennett, B. L. N., 1996. Genetic algorithm inversion for receiver functions with application to crust and uppermost mantle structure beneath eastern Australia, *Geophys. Res. Lett.*, **23**(14), 1829–1832.
- Shields, G. & Bowman, J. R., 2008. Seismic signals from tsunamis in the Pacific Ocean, *Geophys. Res. Lett.*, **35**(L03305), doi: 10.1029/2007GL032601.
- Shin, C. & Cha, Y. H., 2008. Waveform inversion in the Laplace domain, *Geophys. J. Int.*, **173**(3), 922–931, doi: 10.1111/j.1365-246X.2008.03768.x.
- Shin, C. & Cha, Y. H., 2009. Waveform inversion in the Laplace-Fourier domain, *Geophys. J. Int.*, **177**(3), 1067–1079, doi: 10.1111/j.1365-246X.2009.04102.x.

- Shin, C. & Cha, Y. H., 2009. Waveform inversion in the Laplace-Fourier domain, *Geophys. J. Int.*, **177**(3), 1067–1079, doi: 10.1111/j.1365–246X.2009.04102.x.
- Shin, C., Ko, S., Kim, W., Min, D.-J., Yang, D., Marfurt, K. J., Shin, S., Yoon, K. & Yoon, C. H., 2003. Traveltime calculations from frequency-domain downward-continuation algorithms, *Geophysics*, **68**(4), 1380–1388, doi: 10.1190/1.1598131.
- Shin, Y. H., Xu, H., Braitenberg, C., Fang, J. & Wang, Y., 2007. Moho undulations beneath Tibet from GRACE-integrated gravity data, *Geophys. J. Int.*, **170**, 971–985, doi: 10.1111/j.1365–246X.2007.03457.x.
- Shin, Y. H., Shum, C. K., Braitenberg, C., Lee, S. M., Xu, H., Choi, K. S., Baek, J. H. & Park, J. U., 2009. Three-dimensional fold structure of the Tibetan Moho from GRACE gravity data, *Geophys. Res. Lett.*, **36**, L01302, doi: 10.1029/2008GL036068.
- Shine, K. P., Fuglestedt, J. S., Hailemariam, K. & Stuber, N., 2005. Alternatives to the global warming potential for comparing climate impacts of emissions of greenhouse gases, *Climatic Change*, **68**(3), 281–302.
- Shinohara, M., Kanazawa, T., Yamada, T., Machida, Y., Shinbo, T. & Sakai, S., 2014. New compact ocean bottom cabled seismometer system deployed in the Japan Sea, *Mar. Geophys. Res.*, **35**, 231–242, doi: 10.1007/s11001–013–9197–1.
- Shirey, S. B. & Richardson, S. H., 2011. Start of the Wilson cycle at 3 Ga shown by diamonds from subcontinental mantle, *Science*, **333**(6041), 434–436, doi: 10.1126/science.1206275.
- Shkolnisky, Y., 2007. Prolate spheroidal wave functions on a disc — Integration and approximation of two-dimensional bandlimited functions, *Appl. Comput. Harmon. Anal.*, **22**, 235–256, doi: 10.1016/j.acha.2006.07.002.
- Shkolnisky, Y., Tygert, M. & Rokhlin, V., 2006. Approximation of bandlimited functions, *Appl. Comput. Harmon. Anal.*, **21**, 413–420, doi: 10.1016/j.acha.2006.05.001.
- Shulgin, A., Kopp, H., Mueller, C., Lueschen, E., Planert, L., Engels, M., Flueh, E. R., Krabbenhoft, A. & Djajadihardja, Y., 2009. Sunda-Banda arc transition: Incipient continent-island arc collision (northwest Australia), *Geophys. Res. Lett.*, **36**(10), L10304.
- Shum, C. K., Guo, J.-Y., Hossain, F., Duan, J., Douglas E. Alsdorf, X.-J. D., Kuo, C.-Y., Lee, H., Schmidt, M. & Wang, L., 2011, Inter-annual water storage changes in Asia from GRACE data, in *Climate Change and Food Security in Asia*, edited by R. Lal, V. K. M. Sivakumar, S. M. A. Faiz, A. H. M. M. Rahman, & R. K. Islam, chap. 6, pp. 69–63, doi: 10.1007/978–90–481–9516–9_6, Springer, Dordrecht, Neth.
- Shure, L., Parker, R. L. & Backus, G. E., 1982. Harmonic splines for geomagnetic modeling, *Phys. Earth Planet. Inter.*, **28**, 215–229.
- Sigloch, K., 2008, *Multiple-Frequency Body-Wave Tomography*, Ph.D. thesis, Princeton University, Princeton, N.J.

- Sigloch, K., 2011. Mantle provinces under North America from multifrequency *P* wave tomography, *Geochem. Geophys. Geosys.*, **12**(2), Q02W08, doi: 10.1029/2010GC003421.
- Sigloch, K. & Mihalynuk, M. G., 2013. Intra-oceanic subduction shaped the assembly of Cordilleran North America, *Nature*, **496**(7443), doi: 10.1038/nature12019.
- Sigloch, K. & Nolet, G., 2006. Measuring finite-frequency body-wave amplitudes and traveltimes, *Geophys. J. Int.*, **167**(1), 271–287, doi: 10.1111/j.1365–246X.2006.03116.x.
- Silveira, G., Stutzmann, E., Griot, D.-A., Montagner, J.-P. & Victor, L. M., 1998. Anisotropic tomography of the Atlantic Ocean from Rayleigh surface waves, *Phys. Earth Planet. Inter.*, **106**, 257–273.
- Silver, P. G., 1996. Seismic anisotropy beneath the continents: Probing the depths of geology, *Annu. Rev. Earth Planet. Sc.*, **24**, 385–432.
- Silver, P. G. & Chan, W. W., 1988. Implications for continental structure and evolution from seismic anisotropy, *Nature*, **335**(6185), 34–39.
- Silver, P. G. & Chan, W. W., 1991. Shear-wave splitting and subcontinental mantle deformation, *J. Geophys. Res.*, **96**(B10), 16429–16454.
- Silver, P. G. & Holt, W. E., 2002. The mantle flow field beneath Western North America, *Science*, **295**, 1054–1057.
- Silver, P. G. & Savage, M. K., 1994. The interpretation of shear-wave splitting parameters in the presence of two anisotropic layers, *Geophys. J. Int.*, **119**, 949–963.
- Silver, P. G., Russo, R. M. & Lithgow-Bertelloni, C., 1998. Coupling of South American and African plate motion and plate deformation, *Science*, **279**, 60–64.
- Silver, P. G., Gao, S. S., Liu, K. H. & Kaapvaal Seismic Group, 2001. Mantle deformation beneath southern Africa, *Geophys. Res. Lett.*, **28**(13), 2493–2496.
- Simmons, A. H., 1999. *Faunal extinction in an island society: Pygmy hippopotamus hunters of Cyprus*, Kluwer, New York.
- Simmons, A. H., 2008. American researchers and the earliest Cypriots, *Near Eastern Archaeology*, **71**(1–2), 21–29.
- Simmons, N. A. & Gurrola, H., 2000. Multiple seismic discontinuities near the base of the transition zone in the Earth's mantle, *Nature*, **405**(6786), 559–562, doi: 10.1038/35014589.
- Simmons, N. A., Forte, A. M., Boschi, L. & Grand, S. P., 2010. GyPSuM: A joint tomographic model of mantle density and seismic wave speeds, *J. Geophys. Res.*, **115**, B12310, doi: 10.1029/2010JB007631.
- Simmons, N. A., Myers, S. C., Johannesson, G. & Matzel, E., 2012. LLNL-G3Dv3: Global *P* wave tomography model for improved regional and teleseismic travel time prediction, *J. Geophys. Res.*, **117**, B10302, doi: 10.1029/2012JB009525.

- Simon, J. D., Simons, F. J. & Nolet, G., 2017. Estimating arrival times and their associated uncertainties in the MERMAID catalog, *Eos Trans. AGU*, pp. Fall Meet. Suppl., Abstract S13B–0651.
- Simon, J. D., Simons, F. J. & Nolet, G., 2020. Multiscale estimation of event arrival times and their uncertainties in hydroacoustic records from autonomous oceanic floats, *B. Seismol. Soc. Am.*, **110**(3), 970–997, doi: 10.1785/0120190173.
- Simon, J. D., Simons, F. J. & Irving, J. C. E., 2021. A MERMAID miscellany: Seismoacoustic signals beyond the *P* wave, *Seismol. Res. Lett.*, **92**(6), 3657–3667, doi: 10.1785/0220210052.
- Simon, J. D., Simons, F. J. & Irving, J. C. E., 2022. Recording earthquakes for tomographic imaging of the mantle beneath the South Pacific by autonomous MERMAID floats, *Geophys. J. Int.*, **228**, 147–170, doi: 10.1093/gji/ggab271.
- Simons, F. J., 2002, *Structure and Evolution of the Australian Continent: Insights from seismic and mechanical heterogeneity and anisotropy*, Ph.D. thesis, M. I. T., Cambridge, Mass.
- Simons, F. J., 2005. Time-frequency and wavelet methods to detect and classify earthquake signals in noisy environments, *Geophys. Res. Abstr.*, **7**, 06768.
- Simons, F. J., 2009. Afloat on a sea of noise, *Planet Earth Magazine*, pp. 28–29.
- Simons, F. J., 2010. Turning freshmen into scientists with field research and quantitative analysis of geoscientific data, *MATLAB Digest Academic Edition*, pp. October, 1–3.
- Simons, F. J., 2010, Slepian functions and their use in signal estimation and spectral analysis, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 30, pp. 891–923, doi: 10.1007/978–3–642–01546–5_30, Springer, Heidelberg, Germany.
- Simons, F. J., 2018. On Foundations of Seismology: Bringing Idealizations Down to Earth, by James R. Brown and M. A. Slawinski, *The Leading Edge*, **37**(3), 232, doi: 10.1190/tle37030232.1.
- Simons, F. J., 2019. Waves and Rays in Seismology: Answers to Unasked Questions, by Michael A. Slawinski, *The Leading Edge*, **38**(5), 406–407, doi: 10.1190/tle38050406.1.
- Simons, F. J., 2021. Waarde redactie | open brief, *Alumni for Alumni*, **2**(3), 73–76.
- Simons, F. J. & Dahlen, F. A., 2006. A localization approach to estimating potential fields from noisy, incomplete data at satellite altitude, *Geophys. Res. Abstr.*, **8**, 05287.
- Simons, F. J. & Dahlen, F. A., 2006. Spherical Slepian functions and the polar gap in geodesy, *Geophys. J. Int.*, **166**(3), 1039–1061, doi: 10.1111/j.1365–246X.2006.03065.x.
- Simons, F. J. & Dahlen, F. A., 2007, A spatospectral localization approach to estimating potential fields on the surface of a sphere from noisy, incomplete data taken at satellite altitudes, in *Wavelets XII*, edited by D. Van de Ville, V. K. Goyal, & M. Papadakis, vol. 6701, pp. 670117, doi: 10.1117/12.732406, SPIE.

- Simons, F. J. & Olhede, S. C., 2010. How to measure the strength of the lithosphere *without* using the admittance or coherence between gravity and topography, *Geophys. Res. Abstr.*, **12**, 5922.
- Simons, F. J. & Olhede, S. C., 2013. Maximum-likelihood estimation of lithospheric flexural rigidity, initial-loading fraction, and load correlation, under isotropy, *Geophys. J. Int.*, **193**(3), 1300–1342, doi: 10.1093/gji/ggt056.
- Simons, F. J. & Plattner, A., 2015, Scalar and vector Slepian functions, spherical signal estimation and spectral analysis, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, pp. 2563–2608, doi: 10.1007/978-3-642-54551-1_30, Springer, Heidelberg, Germany, 2nd edn.
- Simons, F. J. & van der Hilst, R. D., 2002. Age-dependent seismic thickness and mechanical strength of the Australian lithosphere, *Geophys. Res. Lett.*, **29**(11), 1529, doi: 10.1029/2002GL014962.
- Simons, F. J. & van der Hilst, R. D., 2003. Seismic and mechanical anisotropy and the past and present deformation of the Australian lithosphere, *Earth Planet. Sci. Lett.*, **211**(3–4), 271–286, doi: 10.1016/S0012-821X(03)00198-5.
- Simons, F. J. & Vincent, H. T., 2013. Son-O-Mermaid: Marine instrumentation for geophysical measurements in the oceans, *United States Provisional Patent Application*, **61911637**.
- Simons, F. J. & Wang, D. V., 2011. Spatospectral concentration in the Cartesian plane, *Intern. J. Geomath.*, **2**(1), 1–36, doi: 10.1007/s13137-011-0016-z.
- Simons, F. J., Verhelst, F. & Swennen, R., 1997. Quantitative characterization of coal by means of microfocal X-ray computed microtomography (CMT) and color image analysis (CIA), *Intern. J. Coal Geol.*, **34**(1–2), 69–88, doi: 10.1016/S0166-5162(97)00011-6.
- Simons, F. J., Zielhuis, A. & van der Hilst, R. D., 1999. The deep structure of the Australian continent from surface-wave tomography, *Lithos*, **48**, 17–43, doi: 10.1016/S0024-4937(99)00041-9.
- Simons, F. J., Zuber, M. T. & Korenaga, J., 2000. Isostatic response of the Australian lithosphere: Estimation of effective elastic thickness and anisotropy using multitaper spectral analysis, *J. Geophys. Res.*, **105**(B8), 19163–19184, doi: 10.1029/2000JB900157.
- Simons, F. J., van der Hilst, R. D., Montagner, J.-P. & Zielhuis, A., 2002. Multimode Rayleigh wave inversion for heterogeneity and azimuthal anisotropy of the Australian upper mantle, *Geophys. J. Int.*, **151**(3), 738–754, doi: 10.1046/j.1365-246X.2002.01787.x.
- Simons, F. J., Nolet, G. & Babcock, J. M., 2003. Next-generation marine instruments to join plume debate, *Eos Trans. AGU*, **84**(46), Fall Meet. Suppl., Abstract S21E-0342.
- Simons, F. J., Nolet, G. & Bohnenstiehl, D., 2003. Scrap the cable: Identification and discrimination of seismic phases by autonomous floats, *Geophys. Res. Abstr.*, **5**, 08035.
- Simons, F. J., van der Hilst, R. D. & Zuber, M. T., 2003. Spatospectral localization of isostatic coherence anisotropy in Australia and its relation to seismic anisotropy: Implications for lithospheric deformation, *J. Geophys. Res.*, **108**(B5), 2250, doi: 10.1029/2001JB000704.

- Simons, F. J., Becker, T. W., Kellogg, J. B., Billen, M., Hardebeck, J., Lee, C.-T. A., Montési, L. G. J., Panero, W. & Zhong, S., 2004. Young solid Earth researchers of the world unite!, *Eos Trans. AGU*, **85**(16), 160–161, doi: 10.1029/2004EO160011.
- Simons, F. J., Bunge, H.-P. & Becker, T. W., 2004. The seismic expression of deformation in the Australian lithosphere, *Eos Trans. AGU*, **85**(47), Fall Meet. Suppl., Abstract T33E–03.
- Simons, F. J., Nolet, G. & Babcock, J. M., 2004. Listening to distant earthquakes with autonomous oceanic floats, *Geophys. Res. Abstr.*, **6**, 04501.
- Simons, F. J., Becker, T. W., Kellogg, J. B., Billen, M., Lee, C.-T. A., Montési, L. G. J., Panero, W. & Zhong, S., 2005. MYRES: A program to unite young solid Earth researchers, *Eos Trans. AGU*, **86**(5), 48–49, doi: 10.1029/2005EO050005.
- Simons, F. J., Wiecek, M. A. & Dahlen, F. A., 2005. Spatiospectral concentration and analysis on the sphere, *Geophys. Res. Abstr.*, **7**, 00467.
- Simons, F. J., Dahlen, F. A. & Wiecek, M. A., 2006. Spatiospectral concentration on a sphere, *SIAM Rev.*, **48**(3), 504–536, doi: 10.1137/S0036144504445765.
- Simons, F. J., Dando, B. D. E. & Allen, R. M., 2006. Automatic detection and rapid determination of earthquake magnitude by wavelet multiscale analysis of the primary arrival, *Earth Planet. Sci. Lett.*, **250**(1–2), 214–223, doi: 10.1016/j.epsl.2006.07.039.
- Simons, F. J., Nolet, G., Babcock, J. M., Davis, R. E. & Orcutt, J. A., 2006. A future for drifting seismic networks, *Eos Trans. AGU*, **87**(31), 305 & 307, doi: 10.1029/2006EO310002.
- Simons, F. J., Hawthorne, J. C. & Beggan, C. D., 2009, Efficient analysis and representation of geophysical processes using localized spherical basis functions, in *Wavelets XIII*, edited by V. K. Goyal, M. Papadakis, & D. Van de Ville, vol. 7446, pp. 74460G, doi: 10.1117/12.825730, SPIE.
- Simons, F. J., Nolet, G., Georgief, P., Babcock, J. M., Regier, L. A. & Davis, R. E., 2009. On the potential of recording earthquakes for global seismic tomography by low-cost autonomous instruments in the oceans, *J. Geophys. Res.*, **114**, B05307, doi: 10.1029/2008JB006088.
- Simons, F. J., Loris, I., Brevdo, E. & Daubechies, I. C., 2011, Wavelets and wavelet-like transforms on the sphere and their application to geophysical data inversion, in *Wavelets and Sparsity XIV*, edited by M. Papadakis, D. Van de Ville, & V. K. Goyal, vol. 81380, pp. 81380X, doi: 10.1117/12.892285, SPIE.
- Simons, F. J., Loris, I., Nolet, G., Daubechies, I. C., Voronin, S., Judd, J. S., Vetter, P. A., Charléty, J. & Vonesch, C., 2011. Solving or resolving global tomographic models with spherical wavelets, and the scale and sparsity of seismic heterogeneity, *Geophys. J. Int.*, **187**(2), 969–988, doi: 10.1111/j.1365–246X.2011.05190.x.
- Simons, F. J., Olhede, S. C. & Wang, D. V., 2011. Mechanical thickness of the continents worldwide: A re-analysis, *Geophys. Res. Abstr.*, **13**, 12700.

- Simons, F. J., Olhede, S. C., Eggers, G. L. & Lewis, K. W., 2014. Characterizing the statistical structure of bathymetry and topography as a Matérn process, *Geophys. Res. Abstr.*, **16**, 14572.
- Simons, F. J., Simon, J. D. & Pipatprathanporn, S., 2021. Twenty-thousand leagues under the sea: Recording earthquakes with autonomous floats, *Acoustics Today*, **17**(2), 42–51, doi: 10.1121/AT.2021.17.2.42.
- Simons, M. & Hager, B. H., 1997. Localization of the gravity field and the signature of glacial rebound, *Nature*, **390**(6659), 500–504, doi: 10.1038/37339.
- Simons, M., Solomon, S. C. & Hager, B. H., 1997. Localization of gravity and topography: constraints on the tectonics and mantle dynamics of Venus, *Geophys. J. Int.*, **131**, 24–44.
- Simpson, F., 2001. Resistance to mantle flow inferred from the electromagnetic strike of the Australian upper mantle, *Nature*, **412**, 632–635.
- Simpson, F., 2002. Intensity and direction of lattice-preferred orientation of olivine: are electrical and seismic anisotropies of the Atralian mantle reconcilable?, *Earth Planet. Sci. Lett.*, **203**, 535–547.
- Simpson, R. W., Jachens, R. C., Blakely, R. J. & Saltus, R. W., 1986. A new isostatic residual gravity map of the conterminous United States with a discussion on the significance of isostatic residual anomalies, *J. Geophys. Res.*, **91**(B8), 8348–8372.
- Singer, A. & Coifman, R. R., 2008. Non-linear independent component analysis with diffusion maps, *Appl. Comput. Harmon. Anal.*, **25**(2), 226–239, doi: 10.1016/j.acha.2007.11.001.
- Singer, S. R., Nielsen, N. R. & Schweingruber, H. A., eds., 2012. *Discipline-Based Education Research: Understanding and Improving Learning in Undergraduate Science and Engineering*, doi: 10.17226/13362, National Research Council, Washington, DC.
- Singh, P. & Singh, V. P., 2001. *Snow and Glacier Hydrology*, Water Science and Technology Library, Kluwer, Dordrecht, Neth.
- Singh, S. P. & Thadani, R., 2015. Complexities and controversies in Himalayan research: A call for collaboration and rigor for better data, *Mountain Research and Development*, **35**(4), 401–409, doi: 10.1659/MRD-JOURNAL-D-15-00045.
- Sipkin, S. A., 1994. Rapid determination of global moment-tensor solutions, *Geophys. Res. Lett.*, **21**(16), 1667–1670.
- Sipkin, S. A. & Jordan, T. H., 1975. Lateral heterogeneity of the upper mantle determined from the travel times of *ScS*, *J. Geophys. Res.*, **80**, 1474–1484.
- Sipkin, S. A. & Jordan, T. H., 1976. Lateral heterogeneity of the upper mantle determined from the travel times of multiple *ScS*, *J. Geophys. Res.*, **81**, 6307–6320.
- Sirgue, L. & Pratt, R. G., 2004. Efficient waveform inversion and imaging: A strategy for selecting temporal frequencies, *Geophysics*, **69**(1), 231–248.

- Skodras, A., Christopoulos, C. & Ebrahimi, T., 2001. The JPEG 2000 still image compression standard, *IEEE Signal Process. Mag.*, **5**, 36–58, doi: 10.1109/79.952804.
- Skrondal, A. & Rabe-Hesketh, S., 2004. *Generalized latent variable modeling: Multilevel, longitudinal, and structural equation models*, Chapman and Hall/CRC Press, New York.
- Slack, P. D., Fox, C. G. & Dziak, R. P., 1999. P wave detection thresholds, P_n velocity estimates, and T wave location uncertainty from oceanic hydrophones, *J. Geophys. Res.*, **104**(B6), 13061–13072, doi: 10.1029/1999JB900112.
- Sladen, A., Rivet, D., Ampuero, J. P., Barros, L. D., Hello, Y., Calbris, G. & Lamare, P., 2019. Distributed sensing of earthquakes and ocean-solid Earth interactions on seafloor telecom cables, *Nat. Commun.*, **10**, 5777, doi: 10.1038/s41467-019-13793-z.
- Sleeman, R. & van Eck, T., 1999. Robust automatic P-phase picking: an on-line implementation in the analysis of broadband seismogram recordings, *Phys. Earth Planet. Inter.*, **113**(1–4), 265–275, doi: 10.1016/S0031-9201(99)00007-2.
- Sleep, N. H., 1975. Stress and flow beneath island arcs, *Geophys. J. Int.*, **42**(3), 827–857, doi: 10.1111/j.1365-246X.1975.tb06454.x.
- Sleep, N. H., 1990. Hotspots and mantle plumes: Some phenomenology, *J. Geophys. Res.*, **95**(B5), 6715–6736, doi: 10.1029/JB095iB05p06715.
- Sleep, N. H., 2003. Survival of Archean cratonic lithosphere, *J. Geophys. Res.*, **108**(B6), 2302, doi: 10.1029/2001JB000169.
- Sleep, N. H. & Fujita, K., 1997. *Principles of Geophysics*, Blackwell, Boston, Mass.
- Slepian, D., 1954. Estimation of signal parameters in the presence of noise, *Trans. IRE Prof. Gr. Inform. Th.*, **3**, 68–89.
- Slepian, D., 1964. Prolate spheroidal wave functions, Fourier analysis and uncertainty — IV: Extensions to many dimensions; generalized prolate spheroidal functions, *Bell Syst. Tech. J.*, **43**(6), 3009–3057, doi: 10.1002/j.1538-7305.1964.tb01037.x.
- Slepian, D., 1968. A numerical method for determining the eigenvalues and eigenfunctions of analytic kernels, *SIAM J. Numer. Anal.*, **5**(3), 586–600.
- Slepian, D., 1976. On bandwidth, *Proc. IEEE*, **64**(3), 292–300.
- Slepian, D., 1978. Prolate spheroidal wave functions, Fourier analysis and uncertainty — V: The discrete case, *Bell Syst. Tech. J.*, **57**, 1371–1429, doi: 10.1002/j.1538-7305.1978.tb02104.x.
- Slepian, D., 1983. Some comments on Fourier analysis, uncertainty and modeling, *SIAM Rev.*, **25**(3), 379–393.
- Slepian, D. & Pollak, H. O., 1961. Prolate spheroidal wave functions, Fourier analysis and uncertainty — I, *Bell Syst. Tech. J.*, **40**(1), 43–63.

- Slepian, D. & Sonnenblick, E., 1965. Eigenvalues associated with prolate spheroidal wave functions of zero order, *Bell Syst. Tech. J.*, **44**(8), 1745–1759.
- Slichter, L. B., 1932. The theory of the interpretation of seismic travel-time curves in horizontal structures, *Physics*, **3**(6), 273–295.
- Slichter, L. B., 1961. The fundamental free mode of the Earth's inner core, *Proc. Natl. Acad. Sc.*, **47**(2), 186–190.
- Slobbe, D. C., Simons, F. J. & Klees, R., 2012. The spherical Slepian basis as a means to obtain spectral consistency between mean sea level and the geoid, *J. Geod.*, **86**(8), 609–628, doi: 10.1007/s00190-012-0543-x.
- Small, E., 1999. Does global cooling reduce relief?, *Nature*, **401**, 31–33.
- Smith, D. A., 1998. There is no such thing as "The" EGM96 geoid: Subtle points on the use of a global geopotential model, *IGeS Bulletin*, **8**, 17–28.
- Smith, D. A., Holmes, S. A., Li, X., Guillaume, S., Wang, Y. M., Bürki, B., Roman, D. R. & Damiani, T. M., 2013. Confirming regional 1 cm differential geoid accuracy from airborne gravimetry: the Geoid Slope Validation Survey of 2011, *J. Geod.*, **87**(10-012), 885–907, doi: 10.1007/s00190-013-0653-0.
- Smith, D. E. & Zuber, M. T., 1996. The shape of Mars and the topographic signature of the hemispheric dichotomy, *Science*, **271**, 184–188.
- Smith, D. E., Zuber, M. T., Frey, H. V., Garvin, J. B., Head, J. W., Muhleman, D. O., Pettengill, G. H., Phillips, R. J., Solomon, S. C., Zwally, H. J., Banerdt, W. B. & Duxbury, T. C., 1998. Topography of the northern hemisphere of Mars from the Mars Orbiter Laser Altimeter, *Science*, **279**, 1686–1692.
- Smith, D. E., Sjogren, W. L., Tyler, G. L., Balmino, G., Lemoine, F. G. & Konopliv, A. S., 1999. The gravity field of Mars: Results from Mars Global Surveyor, *Science*, **286**(5437), 94–97.
- Smith, D. E., Zuber, M. T., Solomon, S. C., Phillips, R. J., Head, J. W., Garvin, J. B., Banerdt, W. B., Muhleman, D. O., Pettengill, G. H., Neumann, G. A., Lemoine, F. G., Abshire, J. B., Aharonson, O., Brown, C. D., Hauck, S. A., Ivanov, A. B., McGovern, P. J., Zwally, H. J. & Duxbury, T. C., 1999. The global topography of Mars and implications for surface evolution, *Science*, **284**(5419), 1495–1503.
- Smith, D. E., Zuber, M. T., Frey, H. V., Garvin, J. B., Head, J. W., Muhleman, D. O., Pettengill, G. H., Phillips, R. J., Solomon, S. C., Zwally, H. J., Banerdt, W. B., Duxbury, T. C., Golombek, M. P., Lemoine, F. G., Neumann, G. A., Rowlands, D. D., Aharonson, O., Ford, P. G., Ivanov, A. B., Johnson, C. L., McGovern, P. J., Abshire, J. B., Afzal, R. S. & Sun, X., 2001. Mars Orbiter Laser Altimeter: Experiment summary after the first year of global mapping of Mars, *J. Geophys. Res.*, **106**(E10), 23689–23722.
- Smith, D. E., Zuber, M. T. & Neumann, G. A., 2001. Seasonal variations of snow depth on Mars, *Science*, **294**, 2141–2146.

- Smith, D. K., Tolstoy, M., Fox, C. G., Bohnenstiehl, D. R., Matsumoto, H. & Fowler, M. J., 2002. Hydroacoustic monitoring of seismicity at the slow spreading Mid-Atlantic Ridge, *Geophys. Res. Lett.*, **29**(11), 1518, doi: 10.1029/2001GL013912.
- Smith, D. K., Dziak, R. P., Matsumoto, H., Fox, C. G. & Tolstoy, M., 2004. Autonomous hydrophone array monitors seismic activity at northern Mid-Atlantic Ridge, *Eos Trans. AGU*, **85**(1), 1 & 5, doi: 10.1029/2004EO010001.
- Smith, G. A. & Pun, A., 2006. *How Does Earth Work?*, Pearson Prentice Hall, Upper Saddle River, N. J.
- Smith, G. P. & Ekström, G., 1999. A global study of *Pn* anisotropy, *J. Geophys. Res.*, **104**(B1), 963–980.
- Smith, G. P., Wiens, D. A., Fischer, K. M., Dorman, L. M., Webb, S. C. & Hildebrand, J. A., 2001. A complex pattern of mantle flow in the Lau backarc, *Science*, **292**(5517), 713–716, doi: 10.1126/science.1058763.
- Smith, J. S., 1997. Preliminary comments on a rural Cypro-Achaic sanctuary in Polis-Peristeries, *B. Am. Sch. Oriental Re.*, **308**, 77–98.
- Smith, J. S., 2008. Bringing old excavations to life, *Near Eastern Archaeology*, **71**(1–2), 30–40.
- Smith, K. M. & Zalzarriaga, M., 2007. General solution to the *e-b* mixing problem, *Phys. Rev. D*, **76**, 043001, doi: 10.1103/PhysRevD.76.043001.
- Smith, M. F. & Masters, G., 1989. Aspherical structure constraints from free oscillation frequency and attenuation measurements, *J. Geophys. Res.*, **94**(B2), 1953–1976.
- Smith, M. L. & Dahlen, F. A., 1973. The azimuthal dependence of Love and Rayleigh wave propagation in a slightly anisotropic medium, *J. Geophys. Res.*, **78**(17), 3321–3333.
- Smith, M. L. & Dahlen, F. A., 1975. Correction, *J. Geophys. Res.*, **80**(14), 1923.
- Smith, M. L. & Franklin, J. N., 1969. Geophysical application of generalized inverse theory, *J. Geophys. Res.*, **74**(10), 2783–2785.
- Smith, W. H. F. & Sandwell, D. T., 1997. Global sea floor topography from satellite altimetry and ship depth soundings, *Science*, **277**(5334), 1956–1962, doi: 10.1126/science.277.5334.1956.
- Smrekar, S. E. & Stofan, E. R., 2003. Effects of lithospheric properties on the formation of Type 2 coronae on Venus, *J. Geophys. Res.*, **108**(E8), 5091, doi: 10.1029/2002JE001930.
- Smrekar, S. E., Comstock, R. & Anderson, F. S., 2003. A gravity survey of Type 2 coronae on Venus, *J. Geophys. Res.*, **108**(E8), 5090, doi: 10.1029/2002JE001935.
- Sneeuw, N., 1994. Global spherical harmonic-analysis by least-squares and numerical quadrature methods in historical perspective, *Geophys. J. Int.*, **118**(3), 707–716.

- Sneeuw, N. & Bun, R., 1006. Global spherical harmonic computation by two-dimensional Fourier methods, *J. Geod.*, **70**(4), 224–242.
- Sneeuw, N. & van Gelderen, M., 1997, The polar gap, in *Geodetic boundary value problems in view of the one centimeter geoid*, edited by F. Sansò & R. Rummel, vol. 65 of **Lecture Notes in Earth Sciences**, pp. 559–568, Springer, Berlin, Germany.
- Snieder, R., 1986. 3-D linearized scattering of surface waves and a formalism for surface wave holography, *Geophys. J. Int.*, **84**(3), 581–605, doi: 10.1111/j.1365–246X.1986.tb04372.x.
- Snieder, R., 1988. Large-scale waveform inversions of surface waves for lateral heterogeneity: 1. Theory and numerical examples, *J. Geophys. Res.*, **93**(B10), 12055–12065, doi: 10.1029/JB093iB10p12055.
- Snieder, R., 1988. Large-scale waveform inversions of surface waves for lateral heterogeneity: 2. Application to surface waves in Europe and the Mediterranean, *J. Geophys. Res.*, **93**(B10), 12067–12080, doi: 10.1029/JB093iB10p12067.
- Snieder, R., 2004. *A Guided Tour of Mathematical Methods for the Physical Sciences*, Cambridge Univ. Press, Cambridge, UK, 1st edn.
- Snieder, R., 2004. *A Guided Tour of Mathematical Methods for the Physical Sciences*, Cambridge Univ. Press, Cambridge, UK, 2nd edn.
- Snieder, R. & Aldridge, D. F., 1995. Perturbation theory for travel times, *J. Acoust. Soc. Am.*, **98**(3), 1565–1569.
- Snieder, R. & Nolet, G., 1987. Linearized scattering of surface waves on a spherical Earth, *Geophys. J. Int.*, **61**, 55–63.
- Snieder, R., Grêt, A., Douma, H. & Scales, J., 2002. Coda wave interferometry for estimating nonlinear behavior in seismic velocity, *Science*, **295**, 2253–2255.
- Snieder, R. K. & Scales, J. A., 1998. Time-reversed imaging as a diagnostic of wave and particle chaos, *Phys. Rev. E*, **58**, 5668–5675, doi: 10.1103/PhysRevE.58.5668.
- Snoke, J. A. & Sambridge, M., 2002. Constraints on the s wave velocity structure in a continental shield from surface wave data: Comparing linearized least squares inversion and the direct search Neighbourhood Algorithm, *J. Geophys. Res.*, **107**(B5), 2094, doi: 10.1029/2001JB000498.
- Sobolev, S. V., Grésillaud, A. & Cara, M., 1999. How robust is isotropic delay time tomography for anisotropic mantle?, *Geophys. Res. Lett.*, **26**(4), 509–512.
- Socco, L. V. & Strobbia, C., 2004. Surface-wave method for near-surface characterization: a tutorial, *Near Surface Geophys.*, **2**(4), 165–185, doi: 10.3997/1873–0604.2004015.
- Socco, L. V., Foti, S. & Boiero, D., 2010. Surface-wave analysis for building near-surface velocity models — Established approaches and new perspectives, *Geophysics*, **75**(5), 75A83–75A102, doi: 10.1190/1.3479491.

- Soeder, D. J., 2010. The Marcellus Shale: Resources and reservations, *Eos Trans. AGU*, **91**(32), 277–278.
- Sohn, R. A. & Hildebrand, J. A., 2001. Hydroacoustic earthquake detection in the Arctic Basin with the Spinnaker array, *B. Seismol. Soc. Am.*, **91**(3), 572–579.
- Sokos, E. N. & Zahradnik, J., 2008. ISOLA: a Fortran code and a Matlab GUI to perform multiple-point source inversion of seismic data, *Comput. Geosci.*, **34**(8), 967–977, doi: 10.1016/j.cageo.2007.07.005.
- Solomatov, V. S. & Moresi, L.-N., 2000. Scaling of time-dependent stagnant lid convection: Application to small convection on Earth and other terrestrial planets, *J. Geophys. Res.*, **105**(B9), 21795–21817.
- Solomon, S. C. & Chaikin, J., 1976, Thermal expansion and thermal stress in the Moon and terrestrial planets: Clues to early thermal history, in *Proc. Lunar Sci. Conf.*, vol. 7, pp. 3229–3243.
- Solomon, S. C. & Sleep, N. H., 1974. Some simple physical models for absolute plate motions, *J. Geophys. Res.*, **79**(17), 2557–2567.
- Solomon, S. C., McNutt Jr, R. L., Gold, R. E., Acuña, M. H., Baker, D. N., Boynton, W. V., Chapman, C. R., Cheng, A. F., Gloeckler, G., III, J. W. H., Krimigis, S. M., McClintock, W. E., Murchie, S. L., Peale, S. J., Phillips, R. J., Robinson, M. S., Slavin, J. A., Smith, D. E., Strom, R. G., Trombka, J. I. & Zuber, M. T., 2001. The MESSENGER mission to Mercury: scientific objectives and implementation, *Planet. Space Sci.*, **49**(14–15), 1445–1465, doi: 10.1016/S0032-0633(01)00085-X.
- Solomon, S. C., Baker, V. R., Bloxham, J., Booth, J., Donnellan, A., Elachi, C., Evans, D., Rignot, E., Burbank, D., Chao, B. F., Chave, A., Gillespie, A., Herring, T., Jeanloz, R., LaBrecque, J., Minster, B., Pittman, W. C., Simons, M., Turcotte, D. L. & Zoback, M. L. C., 2003. Plan for Living on a Restless Planet sets NASA's solid Earth agenda, *Eos Trans. AGU*, **84**(45), 485.
- Solomon, S. C., McNutt Jr, R. L., Gold, R. E. & Domingue, D. L., 2007. MESSENGER mission overview, *Space Sci. Rev.*, **131**(1), 3–39, doi: 10.1007/s11214-007-9247-6.
- Sondaar, P. Y. & van der Geer, A. A. E., 2002, Plio-pleistocene terrestrial vertebrate faunal evolution on Mediterranean islands, compared to that of the Palearctic mainland, in *Annales Géologiques des Pays Helléniques 1e Série*, vol. 39, pp. 165–180.
- Song, T.-R. A. & Simons, M., 2003. Large trench-parallel gravity variations predict seismogenic behavior in subduction zones, *Nature*, **301**, 630–633, doi: 10.1126/science.1085557.
- Song, X. & Richards, P. G., 1996. Seismological evidence for differential rotation of the Earth's inner core, *Nature*, **382**, 221–224, doi: 10.1038/382221a0.
- Sørensen, L. S., Simonsen, S. B., Nielsen, K., Lucas-Picher, P., Spada, G., Adalgeirsdottir, G., Forsberg, R. & Hvidberg, C. S., 2011. Mass balance of the Greenland ice sheet (2003–2008) from ICESat data — the impact of interpolation, sampling and firn density, *The Cryosphere*, **5**(1), 173–186, doi: 10.5194/tc-5-173-2011.

- Sorg, A., Bolch, T., Stoffel, M., Solomina, O. & Beniston, M., 2012. Climate change impacts on glaciers and runoff in Tien Shan (Central Asia), *Nat. Clim. Change*, **2**(10), 725–731, doi: 10.1038/nclimate1592.
- Sornette, D. & Virieux, J., 1992. Linking short-timescale deformation to long-timescale tectonics, *Nature*, **357**, 401–404, doi: 10.1038/357401a0.
- Souriau, A., 1985. On the retrieval of pure path velocities from great circle data, *Geophys. J. R. Astron. Soc.*, **80**, 783–790.
- Souriau, A., 1998. New seismological constraints on differential rotation of the inner core from Novaya Zemlya events recorded at DRV, Antarctica, *Geophys. J. Int.*, **134**, F1–F5.
- Souriau, A. & Pauchet, H., 1998. A new synthesis of Pyrenean seismicity and its tectonic implications, *Tectonophysics*, **390**(3–4), 221–244.
- Souriau, A., Sylvander, M., Rigo, A., Fels, J. F., Douchain, J. M. & Ponsolles, C., 2001. Pyrenean tectonics: main seismological constraints, *Bull. Soc. Géol. France*, **172**(1), 25–39.
- Spada, G. & Stocchi, P., 2007. SELEN: A Fortran 90 program for solving the "sea-level equation", *Comput. Geosci.*, **33**, 538–562.
- Spakman, W. & Bijwaard, H., 2001. Optimization of cell parameterization for tomographic inverse problems, *Pure Appl. Geophys.*, **158**(8), 1401–1423.
- Spakman, W. & Nolet, G., 1988, Imaging algorithms, accuracy and resolution in delay time tomography, in *Mathematical Geophysics: A Survey of Recent Developments in Seismology and Geodynamics*, edited by N. J. Vlaar, G. Nolet, M. J. R. Wortel, & S. A. P. L. Cloetingh, pp. 155–187, Reidel, Dordrecht, Neth.
- Spallarossa, D., Ferretti, G., Scafifi, D., Turino, C. & Pasta, M., 2014. Performance of the RSNI-picker, *Seismol. Res. Lett.*, **85**(6), 1243–1254, doi: 10.1785/0220130136.
- Spasov, E., 1998. The stress field in Australia from composite fault plane solutions of the strongest earthquakes in the continent, *J. Seismol.*, **2**, 173–178.
- Spasov, E. & Kennett, B. L. N., 2000. Stress and faulting in southeast Australia as derived from the strongest earthquakes in the region, *J. Asian Earth Sci.*, **18**, 17–23.
- Spaulding, M. L., Grilli, A. R., Grilli, S. T. & Merrill, J., 2007, Design and evaluation of wave energy conversion device to power ocean surveillance systems, Tech. rep., Department of Ocean Engineering, University of Rhode Island, Narragansett, RI.
- Spencer, C., 1985. The use of partitioned matrices in geophysical inversion problems, *Geophys. J. R. Astron. Soc.*, **80**(3), 619–629.
- Spencer, C. & Gubbins, D., 1980. Travel-time inversion for simultaneous earthquake location and velocity structure determination in laterally varying media, *Geophys. J. R. Astron. Soc.*, **63**(1), 95–116, doi: 10.1111/j.1365-246X.1980.tb02612.x.

- Spergel, D. N., 2015. The dark side of cosmology: Dark matter and dark energy, *Science*, **347**(6226), 1100–1102, doi: 10.1126/science.aaa0980.
- Spetzler, J., Trampert, J. & Snieder, R., 2001. Are we exceeding the limits of the great-circle approximation in global surface wave tomography, *Geophys. Res. Lett.*, **28**(12), 2341–2344.
- Spetzler, J., Trampert, J. & Snieder, R., 2002. The effect of scattering in surface wave tomography, *Geophys. J. Int.*, **149**, 755–767.
- Spies, F. N., 1985. Suboceanic geodetic measurements, *IEEE T. Geosci. Remote*, **GE-23**(4), 502–510.
- Spohn, T. & Schubert, G., 1982. Convective thinning of the lithosphere: A mechanism for the initiation of continental rifting, *J. Geophys. Res.*, **87**(B6), 4669–4681.
- Sprenke, K. F. & Baker, L. L., 2000. Magnetization, paleomagnetic poles, and polar wander on Mars, *Icarus*, **147**(1), 26–34, doi: 10.1006/icar.2000.6439.
- Stacey, F. D., 1977. Applications of thermodynamics to fundamental Earth physics, *Surv. Geophys.*, **3**, 219–229, doi: 10.1007/BF01449192.
- Stacey, F. D., 1992. *Physics of the Earth*, Brookfield Press, Brisbane, Australia, 3rd edn.
- Stacey, F. D. & Davis, P. M., 2008. *Physics of the Earth*, Cambridge Univ. Press, New York, 4th edn.
- Stadler, G., Gurnis, M., Burstedde, C., Wilcox, L. C., Alisic, L. & Ghattas, O., 2010. The dynamics of plate tectonics and mantle flow: from local to global scales, *Science*, **329**, 1033–1038, doi: 10.1126/science.1191223.
- Stafford, K. M., Nieukirk, S. L. & Fox, C. G., 2001. Geographic and seasonal variation of blue whale calls in the North Pacific, *J. Cetacean Res. Manage.*, **3**(1), 65–76.
- Stähler, S. C., Sigloch, K., Hosseini, K., Crawford, W. C., Barruol, G., Schmidt-Aursch, M., Tsekhmistrenko, M., Scholz, J.-R., Mazzullo, A. & Deen, M., 2016. Preliminary performance report of the RHUM-RUM ocean bottom seismometer network around La Réunion, western Indian Ocean, *Adv. Geophys.*, **41**, 43–63, doi: 10.5194/adgeo-41-43-2016.
- Stähler, S. C., Khan, A., Banerdt, W. B., Lognonné, P., Giardini, D., Ceylan, S., Drilleau, M., Durán, A. C., Garcia, R. F., Huang, Q., Kim, D., Lekić, V., Samuel, H., Schimmel, M., Schmerr, N., Sollberger, D., Stutzmann, E., Xu, Z., Antonangeli, D., Charalambous, C., Davis, P. M., **J. C. E. Irving**, Kawamura, T., Knapmeyer, M., Maguire, R., Marusiak, A. G., Panning, M. P., Perrin, C., Plesa, A.-C., Rivoldini, A., Schmelzbach, C., Zenhäusern, G., Beucler, E., Clinton, J., Dahmen, N., van Driel, M., Gudkova, T., Horleston, A., Pike, W. T., Plasman, M. & Smrekar, S. E., 2021. Seismic detection of the martian core, *Science*, **373**(6553), 443–448, doi: 10.1126/science.abi7730.
- Stanley, R. H. R., Kirkpatrick, J. B., Cassar, N., Barnett, B. A. & Bender, M. L., 2010. Net community production and gross primary production rates in the western equatorial Pacific, *Global Biogeochem. Cycles*, **24**(4), GB4001, doi: 10.1029/2009GB003651.

- Stanley, S. & Bloxham, J., 2004. Convective-region geometry as the cause of Uranus' and Neptune's unusual magnetic fields, *Nature*, **428**, 151–153, doi: 10.1038/nature02376.
- Stanley, S., Elkins-Tanton, L., Zuber, M. T. & Parmentier, E. M., 2008. Mars paleomagnetic field as the result of a single-hemisphere dynamo, *Science*, **321**, 1822–1825.
- Starck, J. L. & Murtagh, F., 2002. *Astronomical Image and Data Analysis*, Springer, Berlin, Germany.
- Starck, J. L., Moudden, Y., Abrial, P. & Nguyen, M., 2006. Wavelets, ridgelets and curvelets on the sphere, *Astron. Astroph.*, **446**, 1191–1204.
- Starck, J. L., Murtagh, F. & Fadili, J., 2010. *Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity*, Cambridge Univ. Press, Cambridge, UK.
- Stark, C. P., Stewart, J. & Ebinger, C. J., 2003. Wavelet transform mapping of effective elastic thickness and plate loading: Validation using synthetic data and application to the study of southern African tectonics, *J. Geophys. Res.*, **108**(B12), 2558, doi: 10.1029/2001JB000609.
- Staudigel, H. & King, S. D., 1992. Ultrafast subduction: the key to slab recycling efficiency and mantle differentiation ?, *Earth Planet. Sci. Lett.*, **109**, 517–529, doi: 10.1016/0012-821X(92)90111-8.
- Steeghs, P., 1998, Wigner-Radon representations for 3-D seismic data analysis, in *Proc. IEEE-SP Int. Symp. Time-Frequency Time-Scale Anal.*, pp. 433–436, IEEE.
- Steeghs, P. & Drikkoningen, G., 1996, Time-frequency analysis of seismic reflection signals, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, vol. 5, pp. 2972–2975, IEEE.
- Stefanov, P., Uhlmann, G., Vasy, A. & Zhou, H., 2019. Travel time tomography, *Acta Math. Sin.*, **35**(6), 1085–1114, doi: 10.1007/s10114-019-8338-0.
- Stegel, G., 2000. An uncertainty principle for convolution operators on discrete groups, *Proc. Am. Math. Soc.*, **128**(6), 1807–1812.
- Stegman, D. R., Jellinek, A. M., Zatman, S. A., Baumgardner, J. R. & Richards, M. A., 2002. An early lunar core dynamo driven by thermochemical mantle convection, *Nature*, **421**(6919), 143–146.
- Stein, C. A. & Stein, S., 1992. A model for the global variation in oceanic depth and heat flow with lithospheric age, *Nature*, **359**, 123–129.
- Stein, J. L. & Stein, S., 2012. Formulating natural hazard policies under uncertainty, *SIAM News*, **45**(10).
- Stein, M. L., 1999. *Interpolation of Spatial Data: Some Theory for Kriging*, Springer Series in Statistics, Springer, New York.
- Stein, S. & Geller, R. J., 2012. Communicating uncertainties in natural hazard forecasts, *Eos Trans. AGU*, **93**(38), 361–362.

- Stein, S. & Stein, J. L., 2013. Shallow versus deep uncertainties in natural hazard assessments, *Eos Trans. AGU*, **94**(14), 133–134.
- Steinbach, V., Yuen, D. A. & Zhao, W., 1993. Instabilities from phase transitions and the timescales of mantle thermal evolution, *Geophys. Res. Lett.*, **20**(12), 1119–1122.
- Steinberger, B., 2000. Plumes in a convecting mantle: Models and observations for individual hotspots, *J. Geophys. Res.*, **105**(B5), 11127–11152, doi: 10.1029/1999JB900398.
- Steinberger, B. & Holme, R., 2002. An explanation for the shape of Earth's gravity spectrum based on viscous mantle flow models, *Geophys. Res. Lett.*, **29**(21), 2019, doi: 10.1029/2002GL015476.
- Steinberger, B., Schmeling, H. & Marquart, G., 2001. Large-scale lithospheric stress field and topography induced by global mantle circulation, *Earth Planet. Sci. Lett.*, **186**(1), 75–91.
- Steinberger, B., Sutherland, R. & O'Connell, R. J., 2004. Prediction of Emperor-hawaii seamount locations from a revised model of global plate motion and mantle flow, *Nature*, **430**, 167–173, doi: 10.1038/nature02660.
- Steinfeld, H., Gerber, P., Wassenaar, T., Castel, V., Rosales, M. & de Haan, C., 2006. *Livestock's Long Shadow. Environmental Issues and Options*, Food and Agriculture Organization of the United Nations, Rome.
- Steinmetz, L., Hirn, A. & Perrier, G., 1974. Réflexions sismiques à la base de l'asthénosphère, *Annales de Géophysique*, **30**(2), 173–180.
- Stephen, J., Singh, S. B. & Yedekar, D. B., 2003. Elastic thickness and isostatic coherence anisotropy in the South Indian Peninsular Shield and its implications, *Geophys. Res. Lett.*, **30**(16), 1853, doi: 10.1029/2003GL017686.
- Stephen, R. A., 1988. A review of finite difference methods for seismo-acoustics problems at the seafloor, *Rev. Geophys.*, **26**(3), 445–458, doi: 10.1029/RG026i003p00445.
- Stephen, R. A., Spiess, F. N., Collins, J. A., Hildebrand, J. A., Orcutt, J. A., Peal, K. R., Vernon, F. L. & Wooding, F. B., 2003. Ocean Seismic Network Pilot Experiment, *Geochem. Geophys. Geosys.*, **4**(10), 1092, doi: 10.1029/2002GC000485.
- Stephenson, R., 1984. Flexural models of continental lithosphere based on the long-term erosional decay of topography, *Geophys. J. R. Astron. Soc.*, **77**, 385–413.
- Stephenson, R. & Beaumont, C., 1980, Small-scale convection in the upper mantle and the isostatic response of the Canadian shield, in *Mechanisms of Continental Drift and Plate Tectonics*, edited by P. A. Davies & S. K. Runcorn, pp. 111–122, Academic Press, San Diego, Calif.
- Stephenson, R. & Lambeck, K., 1985. Isostatic response of the lithosphere with in-plane stress: Application to central Australia, *J. Geophys. Res.*, **90**(B10), 8581–8588, doi: 10.1029/JB090iB10p08581.

- Stephenson, R. & Lambeck, K., 1985. Erosion-isostatic rebound models for uplift: An application to south-eastern Australia, *Geophys. J. R. Astron. Soc.*, **82**, 31–55.
- Stephenson, R. A. & Cloetingh, S. A. P. L., 1991. Some examples and mechanical aspects of continental lithospheric folding, *Tectonophysics*, **188**, 27–37.
- Sterenborg, M. G. & Bloxham, J., 2007. Application of Slepian basis functions to magnetic field analysis of Saturn, *Eos Trans. AGU*, pp. Fall Meet. Suppl., Abstract GOP33A–0928.
- Sterenborg, M. G. & Bloxham, J., 2008. A new model of Saturn’s magnetic field, *Eos Trans. AGU*, pp. Fall Meet. Suppl., Abstract P11C–1288.
- Sterenborg, M. G., Morrow, E. & Mitrovica, J. X., 2013. Bias in GRACE estimates of ice mass change due to accompanying sea-level change, *J. Geod.*, **87**(4), 387–392, doi: 10.1007/s00190–012–0608–x.
- Stergioulas, L. K. & Vourdas, A., 2002, The Bargmann analytic representation in time-frequency signal analysis, in *Third Int. Sympos. on Communication Systems Networks and Digital Signal Processing (CSNDSP)*, p. G2/G2.4, School of Computing, Staffordshire University, UK.
- Stern, R. J., 2002. Subduction zones, *Rev. Geophys.*, **40**(4), 3–1–3–38, doi: 10.1029/2001RG000108.
- Stevenson, D. J., 2001. Mars’ core and magnetism, *Nature*, **412**, 214–219, doi: 10.1038/35084155.
- Stewart, J. & Watts, A. B., 1997. Gravity anomalies and spatial variations of flexural rigidity at mountain ranges, *J. Geophys. Res.*, **102**(B3), 5327–5352.
- Stewart, R. C., 1984. Q and the rise and fall of a seismic pulse, *Geophys. J. R. Astron. Soc.*, **76**, 793–805.
- Stocker, T. F., Qin, D., Plattner, G.-K., Tignor, M. M. B., Allen, S. K., Boschung, J., Nauels, A., Xia, Y., Bex, V. & (eds.), P. M. M., 2013, Climate Change 2013: The physical science basis. Working Group I Contribution to the Fifth Assessment Report, Tech. rep., Intergovernmental Panel on Climate Change, Cambridge, UK.
- Stockmann, R., Finlay, C. C. & Jackson, A., 2009. Imaging Earth’s crustal magnetic field with satellite data: a regularized spherical triangle tessellation approach, *Geophys. J. Int.*, **179**(2), 929–944, doi: 10.1111/j.1365–246X.2009.04345.x.
- Stockwell, J. W., 1999. The CWP/SU: Seismic Un*x package, *Comput. Geosci.*, **25**(4), 415–419.
- Stockwell, R. G., Mansinha, L. & Lowe, R. P., 1996. Localization of the complex spectrum: The S transform, *IEEE T. Signal Process.*, **44**(4), 998–1001.
- Stoddard, P. R. & Jurdy, D. M., 2012. Topographic comparisons of uplift features on Venus and Earth: Implications for Venus tectonics, *Icarus*, **217**(2), 524–533, doi: 10.1016/j.icarus.2011.09.003.

- Stoica, P. & Sundin, T., 1999. On nonparametric spectral estimation, *Circuits, Systems, and Signal Processing*, **18**(2), 169–181, doi: 10.1007/BF01206681.
- Stokes, C. R., Margold, M., Clark, C. D. & Tarasov, L., 2016. Ice stream activity scaled to ice sheet volume during Laurentide Ice Sheet deglaciation, *Nature*, **530**, 322–326, doi: 10.1038/nature16947.
- Stokoe, K. H., Sung-Ho, J. & Woods, R. D., 2004. Some contributions of in situ geophysical measurements to solving geotechnical engineering problems, in *Geotechnical and Geophysical Site Characterization: Proceedings of the 2nd International Conference on Site Characterization*, edited by A. V. da Fonseca & P. W. Mayne, pp. 97–132, Int. Soc. Soil Mechanics Geotech. Eng.
- Stone, A. J. & Wood, C. P., 1980. Root-rational-fraction package for exact calculation of vector-coupling coefficients, *Comput. Phys. Comm.*, **21**(2), 195–205.
- Stoneley, R., 1924. Elastic waves at the surface of separation of two solids, *Proc. R. Soc. London, Ser. A*, **106**, 416–428.
- Storey, B. C., 1995. The role of mantle plumes in continental breakup: Case histories from Gondwanaland, *Nature*, **377**, 301–308.
- Storey, J. D. & Tibshirani, R., 2003. Statistical significance for genomewide studies, *PNAS*, **100**(16), 9440–9445, doi: 10.1073/pnas.1530509100.
- Stork, D. G. & Wilson, H. R., 1990. Do Gabor functions provide appropriate descriptions of visual cortical receptive fields?, *J. Opt. Soc. Amer. A*, **7**(8), 1362–1373.
- Strang, G., 1986. *Introduction to Applied Mathematics*, Wellesley-Cambridge, Wellesley, Mass.
- Strang, G., 1991. Inverse problems and derivatives of determinants, *Arch. Rational Mech. Anal.*, **114**(3), 255–265.
- Strang, G., 1998. *Linear Algebra and its Applications*, Harcourt Brace Jovanovich, San Diego, Calif., 3rd edn.
- Strang, G. & Nguyen, T., 1997. *Wavelets and Filter Banks*, Wellesley-Cambridge Press, Wellesley, Mass., 2nd edn.
- Strong, D. & Stevens, R. K., 1974. Possible thermal explanation of contrasting Archean and Proterozoic geological regimes, *Nature*, **249**, 545–546.
- Stroud, J. R., Stein, M. L. & Lysen, S., 2017. Bayesian and maximum likelihood estimation for Gaussian processes on an incomplete lattice, *J. Comput. Graph. Stat.*, **26**(1), 108–120, doi: 10.1080/10618600.1152970.
- Stutzmann, E. & Montagner, J.-P., 1993. An inverse technique for retrieving higher mode phase velocity and mantle structure, *Geophys. J. Int.*, **113**, 669–683.
- Stutzmann, E. & Montagner, J.-P., 1994. Tomography of the transition zone from the inversion of higher-mode surface-waves, *Phys. Earth Planet. Inter.*, **86**(1–3), 99–115.

- Su, W.-j. & Dziewoński, A. M., 1991. Predominance of long-wavelength heterogeneity in the mantle, *Nature*, **352**, 121–125.
- Su, W.-j., Woodward, R. L. & Dziewoński, A. M., 1994. Degree-12 model of shear velocity heterogeneity in the mantle, *J. Geophys. Res.*, **99**(B4), 6945–6980.
- Su, W.-j., Dziewoński, A. M. & Jeanloz, R., 1996. Planet within a planet: Rotation of the inner core of the Earth, *Science*, **274**(5294), 1883–1887.
- Subedi, S., Hetényi, G., Denton, P. & Sauron, A., 2020. Seismology at school in Nepal: A program for educational and citizen seismology through a low-cost seismic network, *Front. Earth Sci.*, **8**, 73, doi: 10.3389/feart.2020.00073.
- Suetsugu, D. & Nakanishi, I., 1987. Three-dimensional velocity map of the upper mantle beneath the Pacific Ocean as determined from Rayleigh wave dispersion, *Phys. Earth Planet. Inter.*, **47**, 205–229.
- Suetsugu, D. & Nakanishi, I., 1987. Regional and azimuthal dependence of phase velocities of mantle Rayleigh waves in the Pacific Ocean, *Phys. Earth Planet. Inter.*, **47**, 230–245, doi: 10.1016/0031-9201(87)90079-3.
- Suetsugu, D. & Shiobara, H., 2014. Broadband ocean-bottom seismology, *Annu. Rev. Earth Planet. Sc.*, **42**, 27–43, doi: 10.1146/annurev-earth-060313-054818.
- Suetsugu, D., Isse, T., Tanaka, S., Obayashi, M., Shiobara, H., Sugioka, H., Kanazawa, T., Y. F., Barruol, G. & Reymond, D., 2009. South Pacific mantle plumes imaged by seismic observation on islands and seafloor, *Geochem. Geophys. Geosys.*, **10**(11), Q11014, doi: 10.1029/2009GC002533.
- Sugioka, H., Fukao, Y. & Kanazawa, T., 2010. Evidence for infragravity wave-tide resonance in deep oceans, *Nat. Commun.*, **1**(7), 1–7.
- Sugioka, H., Hamano, Y., Baba, K., Kasaya, T., Tada, N. & Suetsugu, D., 2014. Tsunami: Ocean dynamo generator, *Sci. Rep.*, **4**(3596), doi: 10.1038/srep03596.
- Suhadolc, P. & Panza, G. F., 1989, Physical properties of the lithosphere-aestheonsphere system in Europe from geophysical data, in *The lithosphere in Italy. Advances in Earth science research*, edited by A. Boriani, M. Bonafede, G. B. Piccardo, & G. B. Vai, vol. 80 of **Atti dei Convegni Lincei**, pp. 15–40, Accademia Nazionale dei Lincei, Rome, Italy.
- Sukhovich, A., Irissou, J.-O., Simons, F. J., Ogé, A., Hello, Y. M., Deschamps, A. & Nolet, G., 2011. Automatic discrimination of underwater acoustic signals generated by teleseismic *P*-waves: A probabilistic approach, *Geophys. Res. Lett.*, **38**(18), L18605, doi: 10.1029/2011GL048474.
- Sukhovich, A., Ogé, A., Simons, F. J., Deschamps, A., Hello, Y. & Nolet, G., 2011. A probabilistic approach to the discrimination of underwater acoustic signals due to *p*-waves generated by teleseismic events, *Geophys. Res. Abstr.*, **13**, 2314.

- Sukhovich, A., Nolet, G., Hello, Y., Simons, F. J. & Bonnieux, S., 2013. First observations of tele-seismic P-waves with autonomous underwater robots: towards future global network of mobile seismometers, *Geophys. Res. Abstr.*, **15**, 3931.
- Sukhovich, A., Irisson, J.-O., Perrot, J. & Nolet, G., 2014. Automatic recognition of *T* and tele-seismic *P* waves by statistical analysis of their spectra: An application to continuous records of moored hydrophones, *J. Geophys. Res.*, **119**(8), 6469–6485, doi: 10.1002/2013JB010936.
- Sukhovich, A., Bonnieux, S., Hello, Y., Irisson, J.-O., Simons, F. J. & Nolet, G., 2015. Seismic monitoring in the oceans by autonomous floats, *Nat. Commun.*, **6**, 8027, doi: 10.1038/ncomms9027.
- Sun, Y., Bowman, K. P., Genton, M. G. & Tokay, A., 2015. A matérn model of the spatial covariance structure of point rain rates, *Stoch. Env. Res. Risk A.*, **29**, 411–416, doi: 10.1007/s00477-014-0923-2.
- Sussman, G. J. & Wisdom, J., 2001. *Structure and Interpretation of Classical Mechanics*, The MIT Press, Cambridge, Mass.
- Swain, C. J., 2000. Reduction-to-the-pole of regional magnetic data with variable field direction, and its stabilisation at low inclinations, *Explor. Geoph.*, **31**, 78–83.
- Swain, C. J. & Kirby, J. F., 2003. The effect of “noise” on estimates of the elastic thickness of the continental lithosphere by the coherence method, *Geophys. Res. Lett.*, **30**(11), 1574, doi: 10.1029/2003GL017070.
- Swain, C. J. & Kirby, J. F., 2003. The coherence method using a thin anisotropic elastic plate model, *Geophys. Res. Lett.*, **30**(19), 2014, doi: 10.1029/2003GL018350.
- Swain, C. J. & Kirby, J. F., 2006. An effective elastic thickness map of Australia from wavelet transforms of gravity and topography using Forsyth’s method, *Geophys. Res. Lett.*, **33**, L02314, doi: 10.1029/2005GL025090.
- Swallow, J. C., 1955. A neutral-buoyancy float for measuring deep currents, *Deep-Sea Res.*, **3**(1), 74–81, doi: 10.1016/0146-6313(55)90037-X.
- Swarztrauber, P. N., 1979. On the spectral approximation of discrete scalar and vector functions on the sphere, *SIAM J. Numer. Anal.*, **16**(6), 934–949.
- Swarztrauber, P. N. & Spatz, W. F., 2000. Generalized discrete spherical harmonic transforms, *J. Comput. Phys.*, **159**(2), 213–230.
- Sweldens, W., 1995, The Lifting Scheme: A new philosophy in biorthogonal wavelet constructions, in *Wavelet Applications in Signal and Image Processing III*, edited by A. F. Laine & M. Unser, vol. 2569, pp. 68–79, doi: 10.1117/12.217619, SPIE, Bellingham, WA.
- Sweldens, W., 1996. The lifting scheme: A custom-design construction of biorthogonal wavelets, *Appl. Comput. Harmon. Anal.*, **3**(2), 186–200, doi: 10.1006/acha.1996.0015.

- Sweldens, W., 1996. Wavelets: What next?, *Proc. IEEE*, **84**(4), 680–685.
- Sweldens, W., 1996. Wavelets and the lifting scheme: A 5 minute tour, *Z. Angew. Math. Mech.*, **76** (Suppl. 2), 41–44.
- Sweldens, W., 1997. The lifting scheme: A construction of second generation wavelets, *SIAM J. Math. Anal.*, **29**(2), 511–546.
- Sweldens, W. & Schröder, P., 1996, Building your own wavelets at home, in *Wavelets in Computer Graphics*, pp. 15–87, ACM Siggraph.
- Swenson, S. & Wahr, J. M., 2002. Methods for inferring regional surface-mass anomalies from Gravity Recovery and Climate Experiment (GRACE) measurements of time-variable gravity, *J. Geophys. Res.*, **107**(B9), 2193, doi: 10.1029/2001JB000576.
- Swenson, S. & Wahr, J. M., 2002. Estimated effects of the vertical structure of atmospheric mass on the time-variable geoid, *J. Geophys. Res.*, **107**(B9), 2194, doi: 10.1029/2000JB000024.
- Swenson, S. & Wahr, J. M., 2006. Post-processing removal of correlated errors in GRACE data, *Geophys. Res. Lett.*, **33**(8), L08402, doi: 10.1029/2005GL025285.
- Swenson, S. & Wahr, J. M., 2011. Estimating signal loss in regularized GRACE gravity field solutions, *J. Geophys. Res.*, **115**, 693–702, doi: 10.1111/j.1365-246X.2011.04977.x.
- Swenson, S., Wahr, J. M. & Milly, P. C. D., 2003. Estimated accuracies of regional water storage variations inferred from the Gravity Recovery and Climate Experiment (GRACE), *Water Resources Res.*, **39**(8), 1223, doi: 10.1029/2002WR001808.
- Swenson, S., Yeh, P. J.-F., Wahr, J. M. & Famiglietti, J., 2006. A comparison of terrestrial water storage variations from GRACE with in situ measurements from Illinois, *Geophys. Res. Lett.*, **33**(8), L16401, doi: 10.1029/2006GL026962.
- Swenson, S., Chambers, D. & Wahr, J., 2008. Estimating geocenter variations from a combination of GRACE and ocean model output, *J. Geophys. Res.*, **113**, B08410, doi: 10.1029/2007JB005338.
- Swinbank, R. & Purser, R. J., 2006. Fibonacci grids: A novel approach to global modelling, *Quart. J. Royal Meteor. Soc.*, **132**(619), 1769–1793.
- Sykes, L. & Davis, D. M., 1987. The yields of Soviet strategic weapons, *Sc. Am.*, **256**(1), 29–37.
- Sykulski, A. M., Olhede, S. C., Lilly, J. M. & Early, J. J., 2016. On parametric modelling and inference for complex-valued time series, *arXiv:1306.5993v2*.
- Sykulski, A. M., Olhede, S. C., Lilly, J. M. & Early, J. J., 2017. Frequency-domain stochastic modeling of stationary bivariate or complex-valued signals, *IEEE T. Signal Process.*, **65**(12), 3136–3151, doi: 10.1109/TSP.2017.2686334.
- Symes, W. W., 2009. The seismic reflection inverse problem, *Inv. Probl.*, **25**(12), 123008, doi: 10.1088/0266-5611/25/12/123008.

- Szegö, G., 1975. *Orthogonal Polynomials*, Amer. Math. Society, Providence, R.I., 4th edn.
- Tackley, P. J., Stevenson, D. J., Glatzmaier, G. A. & Schubert, G., 1993. Effects of an endothermic phase transition at 670 km depth in a spherical model of convection in the Earth's mantle, *Nature*, **361**, 699–704, doi: 10.1038/361699a0.
- Tae-Kyung, H. & Kennett, B. L. N., 2002. A wavelet-based method for simulation of two-dimensional elastic wave propagation, *Geophys. J. Int.*, **150**(3), 610–638.
- Takahashi, T., 1955. Analysis of the dispersion curves of Love-waves, *Bull. Earthquake Res. Inst.*, **33**, 287–296.
- Takahashi, T., 1957. The dispersion of Rayleigh waves in heterogeneous media, *Bull. Earthquake Res. Inst.*, **35**, 297–308.
- Takeuchi, H. & Saito, M., 1972, Seismic surface waves, in *Seismology: Surface Waves and Earth Oscillations*, edited by B. A. Bolt, B. Alder, S. Fernbach, & M. Rotenberg, vol. 11 of **Methods in Computational Physics**, pp. 217–295, Academic Press, San Diego, Calif.
- Talandier, J., 1993. French Polynesia Tsunami Warning Center (CPPT), *Nat. Haz.*, **7**(3), 237–256, doi: 10.1007/BF00662649.
- Talandier, J. & Okal, E. A., 1998. On the mechanism of conversion of seismic waves to and from *T* waves in the vicinity of island shores, *B. Seismol. Soc. Am.*, **88**(2), 621–632.
- Talandier, J. & Okal, E. A., 2001, Identification criteria for sources of *T* waves recorded in French Polynesia, in *Monitoring the Comprehensive Nuclear-Test-Ban Treaty: Hydroacoustics*, edited by C. deGroot Hedlin & J. Orcutt, vol. 158, pp. 567–603, doi: 10.1007/978-3-0348-8270-5_7, Birkhäuser, Basel.
- Talandier, J., Hyvernaud, O., Okal, E. A. & Piserchia, P.-F., 2002. Long-range detection of hydroacoustic signals from large icebergs in the Ross Sea, Antarctica, *Earth Planet. Sci. Lett.*, **203**(1), 519–534, doi: 10.1016/S0012-821X(02)00867-1.
- Talandier, J., Hyvernaud, O. & Maury, R. C., 2016. Unusual seismic activity in 2011 and 2013 at the submarine volcano Rocard, Society hot spot (French Polynesia), *Geophys. Res. Lett.*, **43**(9), 4247–4254, doi: 10.1002/2016GL068342.
- Talwani, M. & Ewing, M., 1960. Rapid computation of gravitational attraction of three-dimensional bodies of arbitrary shape, *Geophysics*, **25**, 203–225, doi: 10.1190/1.1438687.
- Talwani, M., Worzel, J. L. & Landisman, M., 1959. Rapid gravity computations for two-dimensional bodies with application to the Mendocino submarine fracture zone, *J. Geophys. Res.*, **64**(1), 49–59.
- Tamisiea, M. E., Mitrovica, J. X., Davis, J. L. & Milne, G. A., 2003. Long wavelength sea level and solid surface perturbations driven by polar ice mass variations: fingerprinting Greenland and Antarctic ice sheet flux, *Space Sci. Rev.*, **108**(1), 81–93.

- Tanaka, K. L., Senske, D. A., Price, M. & Kirk, R. L., 1997, Physiography, geomorphic/geologic mapping and stratigraphy of Venus, in *Venus II: Geology, geophysics, atmosphere, and solar wind environment*, edited by S. W. Bougher, D. M. Hunten, & R. J. Philips, p. 667, Univ. Ariz. Press, Tucson, AZ.
- Tanaka, K. L., Skinner, J. A., Dohm, J. M., Irwin, R. P., Kolb, E. J., Fortezzo, C. M., Platz, T., Michael, G. G. & Hare, T. M., 2014, Geologic map of Mars, U. S. Geological Survey Scientific Investigations Map 3292, scale 1:20,000,000, Pamphlet 43.
- Tanaka, S., Obayashi, M., Suetsugu, D., H. Shiobara, H. S., Yoshimitsu, J., Kanazawa, T., Fukao, Y. & Barruol, G., 2009. P-wave tomography of the mantle beneath the South Pacific Superswell revealed by joint ocean floor and islands broadband seismic experiments, *Phys. Earth Planet. Inter.*, **172**(3–4), 268–277, doi: 10.1016/j.pepi.2008.10.016.
- Tanaka, S., Suetsugu, D., Shiobara, H., Sugioka, H., Kanazawa, T., Fukao, Y., Barruol, G. & Raymond, D., 2009. On the vertical extent of the large low shear velocity province beneath the South Pacific Superswell, *Geophys. Res. Lett.*, **36**(7), L07305, doi: 10.1029/2009GL037568.
- Tanaka, S., Suetsugu, D., Shiobara, H., Sugioka, H., Kanazawa, T., Fukao, Y., Barruol, G. & Raymond, D., 2009. On the vertical extent of the large low shear velocity province beneath the South Pacific Superswell, *Geophys. Res. Lett.*, **36**(7), L07305, doi: 10.1029/2009GL037568.
- Tanaka, Y. & Heki, K., 2014. Long- and short-term postseismic gravity changes of megathrust earthquakes from satellite gravimetry, *Geophys. Res. Lett.*, **41**, 5451–5456, doi: 10.1002/2014GL060559.
- Tanimoto, T., 1986. Free oscillations of a slightly anisotropic Earth, *Geophys. J. R. Astron. Soc.*, **87**, 493–517.
- Tanimoto, T., 1990. Modelling curved surface wave paths: membrane surface wave synthetics, *Geophys. J. Int.*, **102**(1), 89–100, doi: 10.1111/j.1365–246X.1990.tb00532.x.
- Tanimoto, T., 1995. Formalism for traveltimes inversion with finite frequency effects, *Geophys. J. Int.*, **121**(1), 103–110, doi: 10.1111/j.1365–246X.1995.tb03513.x.
- Tanimoto, T., 2005. The oceanic excitation hypothesis for the continuous oscillations of the Earth, *Geophys. J. Int.*, **160**(1), 276–288, doi: 10.1111/j.1365–246X.2004.02484.x.
- Tape, C., Liu, Q. & Tromp, J., 2007. Finite-frequency tomography using adjoint methods — Methodology and examples using membrane surface waves, *Geophys. J. Int.*, **168**, 1105–1129, doi: 10.1111/j.1365–246X.2006.03191.x.
- Tape, C., Liu, Q., Maggi, A. & Tromp, J., 2009. Adjoint tomography of the Southern California crust, *Science*, **325**(5943), 988–992, doi: 10.1126/science.1175298.
- Tape, C., Liu, Q., Maggi, A. & Tromp, J., 2010. Seismic tomography of the southern California crust based on spectral-element and adjoint methods, *Geophys. J. Int.*, **180**(1), 433–462, doi: 10.1111/j.1365–246X.2009.04429.x.

- Tape, C. A., 2009, *Seismic tomography of southern California using adjoint methods*, Ph.D. thesis, Calif. Inst. Technol., Pasadena, Calif.
- Tape, W. & Tape, C., 2013. The classical model for moment tensors, *Geophys. J. Int.*, **195**(3), 1701–1720, doi: 10.1093/gji/ggt302.
- Tape, W. & Tape, C., 2019. The eigenvalue lune as a window on moment tensors, *Geophys. J. Int.*, **216**(1), 19–33, doi: 10.1093/gji/ggy373.
- Tapley, B. D., Bettadpur, S., Ries, J. C., Thompson, P. F. & Watkins, M. M., 2004. GRACE measurements of mass variability in the Earth system, *Science*, **305**(5683), 503–505, doi: 10.1126/science.1099192.
- Tapley, B. D., Bettadpur, S., Watkins, M. M. & Reigber, C., 2004. The Gravity Recovery And Climate Experiment: Mission overview and early results, *Geophys. Res. Lett.*, **31**(9), L09607, doi: 10.1029/2004GL019920.
- Tarantola, A., 1984. Linearized inversion of seismic reflection data, *Geophys. Prospect.*, **34**(2), 998–1015, doi: 10.1111/j.1365–2478.1984.tb00751.x.
- Tarantola, A., 1984. Inversion of seismic reflection data in the acoustic approximation, *Geophysics*, **49**(8), 1259–1266, doi: 10.1190/1.1441754.
- Tarantola, A., 1986. A strategy for nonlinear elastic inversion of seismic reflection data, *Geophysics*, **51**(10), 1893–1903, doi: 10.1190/1.1442046.
- Tarantola, A., 1987. *Inverse Problem Theory*, Elsevier, Amsterdam, Neth.
- Tarantola, A., 1987, Inversion of travel time and seismic waveforms, in *Seismic Tomography*, edited by G. Nolet, chap. 6, pp. 135–157, Reidel, Hingham, Mass.
- Tarantola, A., 1988. Theoretical background for the inversion of seismic waveforms, including elasticity and attenuation, *Pure Appl. Geophys.*, **128**(1–2), 365–399.
- Tarantola, A., 2005. *Inverse problem theory and methods for model parameter estimation*, SIAM, Philadelphia, Penn.
- Tarantola, A. & Nercessian, A., 1984. Three-dimensional inversion without blocks, *Geophys. J. R. Astron. Soc.*, **76**, 299–306.
- Tarantola, A. & Valette, B., 1982. Generalized nonlinear inverse problems solved using the least squares criterion, *Rev. Geophys. Space Phys.*, **20**(2), 219–232.
- Tarantola, A. & Valette, B., 1982. Inverse problems = Quest for information, *J. Geophys.*, **50**, 159–170.
- Tarbut, E., Lutgens, F. K. & Tasa, D., 2007. *Earth: An introduction to physical geology*, Pearson Prentice Hall, Upper Saddle River, N. J., 9th edn.

- Tarduno, J. A., Duncan, R. A., Scholl, D. W., Cottrell, R. D., Steinberger, B., Thordarson, T., Kerr, B. C., Neal, C. R., Frey, F. A., Torii, M. & Carvallo, C., 2003. The Emperor Seamounts: Southward motion of the Hawaiian hotspot plume in Earth's mantle, *Science*, **301**(5636), 1064–1069.
- Tarquini, S., Isola, I., Favalli, M., Mazzarini, F., Bisson, M., Pareschi, M. T. & Boschi, E., 2007. TINITALY/01: a new triangular irregular network of Italy, *Ann. Geophys.–Italy*, **50**(3), 407–425, doi: 10.4401/ag-4424.
- Tarquini, S., Vinci, S., Favallia, M., Doumaz, F., Fornaciai, A. & Nannipieri, L., 2012. Release of a 10-m-resolution DEM for the Italian territory: Comparison with global-coverage DEMs and anaglyph-mode exploration via the web, *Comput. Geosci.*, **38**(1), 168–170, doi: 10.1016/j.cageo.2011.04.018.
- Tassara, A., Swain, C., Hackney, R. & Kirby, J., 2007. Elastic thickness structure of South America estimated using wavelets and satellite-derived gravity data, *Earth Planet. Sci. Lett.*, **253**(1–2), 17–36, doi: 10.1016/j.epsl.2006.10.008.
- Tatom, F. B., Knupp, K. R. & Vitton, S. J., 1995. Tornado detection based on seismic signal, *J. Appl. Meteor.*, **34**, 572–582, doi: 10.1175/1520-0450(1995)034<0572:TDBOSS>2.0.CO;2.
- Tauzin, B., Debayle, E. & Wittlinger, G., 2008. The mantle transition zone as seen by global *Pds* phases: No clear evidence for a thin transition zone beneath hotspots, *J. Geophys. Res.*, **113**(B8), B08309, doi: 10.1029/2007JB005364.
- Taylor, K. E., 2001. Summarizing multiple aspects of model performance in a single diagram, *J. Geophys. Res.*, **106**(D7), 7183–7192, doi: 10.1029/2000JD900719.
- Taylor, K. M., Procopio, M. J., Young, C. J. & Meyer, F. G., 2011. Estimation of arrival times from seismic waves: a manifold-based approach, *Geophys. J. Int.*, **185**(1), 435–452, doi: 10.1111/j.1365-246X.2011.04947.x.
- Tedesco, M. & Fettweis, X., 2012. 21st century projections of surface mass balance changes for major drainage systems of the Greenland ice sheet, *Environ. Res. Lett.*, **7**, 045405, doi: 10.1088/1748-9326/7/4/045405.
- Tedesco, M., Fettweis, X., van den Broeke, M. R., van de Wal, R. S. W., Smeets, C. J. P. P., van de Berg, W. J., Serreze, M. C. & Box, J. E., 2011. The role of albedo and accumulation in the 2010 melting record in greenland, *Environ. Res. Lett.*, **6**, 014005, doi: 10.1088/1748-9326/6/1/014005.
- Tegmark, M., 1995. A method for extracting maximum resolution power spectra from galaxy surveys, *Astroph. J.*, **455**, 429–438.
- Tegmark, M., 1996. A method for extracting maximum resolution power spectra from microwave sky maps, *Mon. Not. R. Astron. Soc.*, **280**, 299–308.
- Tegmark, M., 1996. The angular power spectrum of the four-year *cobe* data, *Astroph. J.*, **464**, L35–L38.

- Tegmark, M., 1997. How to make maps from cosmic microwave background data without losing information, *Astroph. J.*, **480**(2), L87–L90.
- Tegmark, M., 1997. How to measure CMB power spectra without losing information, *Phys. Rev. D*, **55**(10), 5895–5907.
- Tegmark, M. & de Oliveira-Costa, A., 2001. How to measure CMB polarization power spectra without losing information, *Phys. Rev. D*, **64**, 063001.
- Tegmark, M., Taylor, A. N. & Heavens, A. F., 1997. Karhunen-Loève eigenvalue problems in cosmology: How should we tackle large data sets?, *Astroph. J.*, **480**(1), 22–35.
- Tejero, R. & Ruiz, J., 2002. Thermal and mechanical structure of the central Iberian Peninsula lithosphere, *Tectonophysics*, **350**, 49–62.
- Temmerman, S. & Kirwan, M. L., 2015. Building land with a rising sea, *Science*, **349**(6248), 588–589.
- Tepp, G. & Dziak, R. P., 2021. The seismo-acoustics of submarine volcanic eruptions, *J. Geophys. Res.*, **126**(4), e20912, doi: 10.1029/2020JB020912.
- ter Voorde, M., van Balen, R. T., Bertotti, G. & Cloetingh, S. A. P. L., 1998. The influence of a stratified rheology on the flexural response of the lithosphere to (un)loading by extensional faulting, *Geophys. J. Int.*, **134**, 721–735.
- Terras, A., 1985. *Harmonic Analysis on Symmetric Spaces and Applications*, vol. 1, Springer, New York.
- Tesauro, M., Audet, P., Kaban, M. K., Bürgmann, R. & Cloetingh, S., 2012. The effective elastic thickness of the continental lithosphere: Comparison between rheological and inverse approaches, *Geochem. Geophys. Geosys.*, **13**(9), doi: 10.1029/2012GC004162.
- Tesauro, M., Kaban, M. K. & Cloetingh, S. A. P. L., 2012. Global strength and elastic thickness of the lithosphere, *Global Planet. Change*, **90–91**, 51–57, doi: 10.1016/j.gloplacha.2011.12.003.
- Tesoniero, A., Auer, L., Boschi, L. & Cammarano, F., 2015. Hydration of marginal basins and compositional variations within the continental lithospheric mantle inferred from a new global model of shear and compressional velocity, *J. Geophys. Res.*, **120**, 7789–7813, doi: 10.1002/2015JB012026.
- Tessler, Z. D., Vörösmary, C. J., Grossberg, M., Gladkova, I., Aizenman, H., Syvitski, J. P. M. & Fofoula-Georgiou, E., 2015. Profiling risk and sustainability in coastal deltas of the world, *Science*, **349**(6248), 638–643.
- Tester, J. & others, ., 2006, The future of geothermal energy, Tech. rep., Massachusetts Institute of Technology, Cambridge, Mass.
- Thacker, W. C., 1988, Three lectures on fitting numerical models to observations, Tech. Rep. GKSS 87/E/65, GKSS-Forschungszentrum, Geesthacht, Germany.

- Thatcher, W., Foulger, G. R., Julian, B. R., Svarc, J., Quilty, E. & Bawden, G. W., 1999. Present-day deformation across the Basin and Range Province, Western United States., *Science*, **283**, 1714–1718.
- The Economist, 2008. Plumbing the depths: A new generation of mermaids looks at oceanic earthquakes, *The Economist*, p. 02/09/2008.
- The Nippon Foundation, GEBCO & Seabed 2030, 2020. *Roadmap for Future Ocean Floor Mapping*, The Nippon Foundation, 11th edn.
- Thean, T., 2013. Secrets of the Southern Ocean, *Discovery — Research at Princeton*, pp. 18–22.
- Thébault, E., 2008. A proposal for regional modelling at the Earth's surface, R-SCHA2D, *Geophys. J. Int.*, **174**, 118–134, doi: 10.1111/j.1365–246X.2008.03823.x.
- Thébault, E., Schott, J. J., Mande, M. & Hoffbeck, J. P., 2004. A new proposal for spherical cap harmonic modelling, *Geophys. J. Int.*, **159**(1), 83–103, doi: 10.1111/j.1365–246X.2004.02361.x.
- Thébault, E., Schott, J. J. & Mande, M., 2006. Revised spherical cap harmonic analysis (R-SCHA): Validation and properties, *J. Geophys. Res.*, **111**(B1), B01102, doi: 10.1029/2005JB003836.
- Thébault, E., Finlay, C. C., Beggan, C. D., Alken, P., Aubert, J., Barrois, O., Bertrand, F., Bondar, T., Boness, A., Brocco, L., Canet, E., Chambodut, A., Chulliat, A., Coisson, P., Civet, F., Du, A., Fournier, A., Fratter, I., Gillet, N., Brian Hamilton, M. H., Hulot, G., Jager, T., Korte, M., Kuang, W., Lalanne, X., Langlais, B., Léger, J.-M., Lesur, V., Lowes, F. J., Macmillan, S., Mande, M., Manoj, C., Maus, S., Olsen, N., Petrov, V., Ridley, V., Rother, M., Sabaka, T. J., Saturnino, D., Schachtschneider, R., Sirol, O., Tangborn, A., Thomson, A., Tøffner-Clausen, L., Vigneron, P., Wardinski, I. & Zvereva, T., 2015. International Geomagnetic Reference Field: the 12th generation, *Earth Planets Space*, **67**, 79, doi: 10.1186/s40623–015–0228–9.
- Theil, H., 1965. The analysis of disturbances in regression analysis, *JASTA*, **60**(312), 1067–1079.
- Thomas, P. D., 1965. Geodesic arc length on the reference ellipsoid to second-order terms in the flattening, *J. Geophys. Res.*, **70**, 3331–3340.
- Thomas, R., Csatho, B., Davis, C., Kim, C., Krabill, W., Manizade, S., McConnell, J. & Sonntag, J., 2001. Mass balance of higher-elevation parts of the Greenland ice sheet, *J. Geophys. Res.*, **106**(D24), 33707–33716.
- Thomas, R., Rignot, E., Casassa, G., Kanagaratnam, P., Acuña, C., Akins, T., Brecher, H., Frederick, E., Gogineni, P., Krabill, W., Manizade, S., Ramamoorthy, H., Rivera, A., Russell, R., Sonntag, J., Swift, R., Yungel, J. & Zwally, J., 2004. Accelerated sea-level rise from West Antarctica, *Science*, **306**, 255–258, doi: 10.1126/science.1099650.
- Thomas, R., Frederick, E., Krabill, W., Manizade, S. & Martin, C., 2006. Progressive increase in ice loss from Greenland, *Geophys. Res. Lett.*, **33**, L10503, doi: 10.1029/2006GL026075.

- Thompson, A. B., 1992. Water in the Earth's upper mantle, *Nature*, **358**, 295–302, doi: 10.1038/358295a0.
- Thompson, D. A., Hammond, J. O. S., Kendall, J.-M., Stuart, G. W., Helffrich, G. R., Keir, D., Ayele, A. & Goitom, B., 2015. Hydrous upwelling across the mantle transition zone beneath the Afar Triple Junction, *Geochem. Geophys. Geosys.*, **16**(3), 834–846, doi: 10.1002/2014GC005648.
- Thompson, D. O. & Chimenti, D. E., 1997. *Review of Progress in Quantitative Nondestructive Evaluation*, Springer, New York, 16th edn.
- Thompson, D. T., 1982. EULDPH: A new technique for making computer-assisted depth estimates from magnetic data, *Geophysics*, **47**(1), 31–37, doi: 10.1190/1.1441278.
- Thomson, A. B., 1992. Water in the Earth's upper mantle, *Nature*, **358**, 295–302.
- Thomson, D. J., 1977. Spectrum estimation techniques for characterization and development of WT4 waveguide, I, *Bell Syst. Tech. J.*, **56**(9), 1769–1815.
- Thomson, D. J., 1977. Spectrum estimation techniques for characterization and development of WT4 waveguide, II, *Bell Syst. Tech. J.*, **56**(10), 1983–2005.
- Thomson, D. J., 1982. Spectrum estimation and harmonic analysis, *Proc. IEEE*, **70**(9), 1055–1096, doi: 10.1109/PROC.1982.12433.
- Thomson, D. J., 1990. Quadratic-inverse spectrum estimates: applications to paleoclimatology, *Phil. Trans. R. Soc. London, Ser. A*, **332**(1627), 539–597.
- Thomson, D. J., 2001, Multitaper analysis of nonstationary and nonlinear time series data, in *Non-linear and nonstationary signal processing*, edited by W. J. Fitzgerald, R. L. Smith, A. T. Walden, & P. C. Young, chap. 11, pp. 317–394, Cambridge Univ. Press, Cambridge, UK.
- Thomson, D. J., 2007. Jackknifing multitaper spectrum estimates, *IEEE Signal Process. Mag.*, **20**, 20–30, doi: 10.1109/MSP.2007.4286561.
- Thomson, D. J. & Chave, A. D., 1991, Jackknifed error estimates for spectra, coherences, and transfer functions, in *Advances in Spectrum Analysis and Array Processing*, edited by S. Haykin, vol. 1, chap. 2, pp. 58–113, Prentice-Hall, Englewood Cliffs, N. J.
- Thomson, D. J., Lanzerotti, L. J. & MacLennan, C. G., 2001. Interplanetary magnetic field: Statistical properties and discrete modes, *J. Geophys. Res.*, **106**(A8), 15941–15962.
- Thomson, D. J., Lanzerotti, L. J., Vernon, F. L., Lessard, M. R. & Smith, L. T. P., 2007. Solar modal structure of the engineering environment, *Proc. IEEE*, **95**, 1085–1132.
- Thurber, C. H., 1983. Earthquake locations and three-dimensional crustal structure in the Coyote Lake area, central California, *J. Geophys. Res.*, **88**(B10), 8226–8236, doi: 10.1029/JB088iB10p08226.

- Thurber, C. H., 1992. Hypocenter-velocity structure coupling in local earthquake tomography, *Phys. Earth Planet. Inter.*, **75**(1–3), 55–62, doi: 10.1016/0031-9201(92)90117-E.
- Thybo, H. & Perchuc, E., 1997. The seismic 8° discontinuity and partial melting in continental mantle, *Science*, **275**, 1626–1629, doi: 10.1126/science.275.5306.1626.
- Tian, J., Yang, M., Lyle, M. W., Wilkens, R. & Schackford, J. K., 2013. Obliquity and long eccentricity pacing of the Middle Miocene climate transition, *GCUBED*, **14**(6), 1740–1755, doi: 10.1002/ggge.20108.
- Tian, Y., Hung, S.-H., Nolet, G., Montelli, R. & Dahlen, F. A., 2007. Dynamic ray tracing and traveltimes corrections for global seismic tomography, *J. Comput. Phys.*, **226**, 672–687, doi: 10.1016/j.jcp.2007.04.025.
- Tian, Y., Montelli, R., Nolet, G. & Dahlen, F. A., 2007. Computing traveltimes and amplitude sensitivity kernels in finite-frequency tomography, *J. Comput. Phys.*, **226**, 2271–2288, doi: 10.1016/j.jcp.2007.07.004.
- Tian, Y., Sigloch, K. & Nolet, G., 2009. Multiple-frequency *SH*-wave tomography of the western US upper mantle, *Geophys. J. Int.*, **178**(3), 1384–1402, doi: 10.1111/j.1365-246X.2009.04225.x.
- Tian, Y., Zhou, Y., Sigloch, K., Nolet, G. & Laske, G., 2011. Structure of North American mantle constrained by simultaneous inversion of multiple-frequency *SH*, *SS*, and Love waves, *J. Geophys. Res.*, **116**, B02307, doi: 10.1029/2010JB007704.
- Tiberi, C., Diamant, M., Lyon-Caen, H. & King, T., 2001. Moho topography beneath the Corinth Rift area (Greece) from inversion of gravity data, *Geophys. J. Int.*, **145**, 797–808.
- Tibi, R., Wiens, D. A., Shiobara, H., Sugioka, H. & Shore, P. J., 2006. Depth of the 660-km discontinuity near the Mariana slab from an array of ocean bottom seismographs, *Geophys. Res. Lett.*, **33**(2), L02313, doi: 10.1029/2005GL024523.
- Tibuleac, I. M. & Herrin, E., 1999. Lower mantle lateral heterogeneity beneath the Caribbean Sea, *Science*, **285**, 1711–1715, doi: 10.1126/science.285.5434.1711.
- Tibuleac, I. M. & Herrin, E. T., 1999. An automatic method for determination of *Lg* arrival times using wavelet transforms, *Seismol. Res. Lett.*, **70**(5), 577–595, doi: 10.1785/gssrl.70.5.577.
- Tibuleac, I. M., Herrin, E. T., Britton, J. M., Shumway, R. & Rosca, A. C., 2003. Automatic determination of secondary seismic phase arrival times using wavelet transforms, *Seismol. Res. Lett.*, **74**(6), 884–892, doi: 10.1785/gssrl.74.6.884.
- Tichelaar, B. W. & Ruff, L. J., 1989. How good are our best models? Jackknifing, bootstrapping, and earthquake depth, *Eos Trans. AGU*, **70**(20), 593 & 605–606, doi: 10.1029/89EO00156.
- Tichelaar, B. W. & van Luik, K. W., 1995. Sonic logging of compressional-wave velocities in a very slow formation, *Geophysics*, **60**(6), 1627–1633, doi: 10.1190/1.1443895.

- Tikhonov, A. N. & Arsenin, V. Y., 1977. *Solutions of Ill-posed Problems*, V. H. Winston & Sons, Washington D. C.
- Tikhotskii, S. A., Fokin, I. V. & Schur, D. Y., 2011. Traveltime seismic tomography with adaptive wavelet parameterization, *Izvestiya, Phys. Solid Earth*, **47**(4), 326–344.
- Tikhotsky, S. & Achauer, U., 2008. Inversion of controlled-source seismic tomography and gravity data with the self-adaptive wavelet parametrization of velocities and interfaces, *Geophys. J. Int.*, **172**, 619–630, doi: 10.1111/j.1365–246X.2007.03648.x.
- Timoshenko, S. & Woinowsky-Krieger, S., 1959. *Theory of Plates and Shells*, McGraw-Hill, New York, 2nd edn.
- Tiwari, V. M. & Mishra, D. C., 1999. Estimation of effective elastic thickness from gravity and topography data under the Deccan Volcanic Province, India, *Earth Planet. Sci. Lett.*, **171**, 289–299.
- Tkalčić, H., 2015. Complex inner core of the Earth: The last frontier of global seismology, *Rev. Geophys.*, **53**(1), 59–94, doi: 10.1002/2014RG000469.
- Tkalčić, H. & Romanowicz, B., 2002. Short scale heterogeneity in the lowermost mantle: insights from *PcP-P* and *ScS-S* data, *Earth Planet. Sci. Lett.*, **201**(1), 57–68, doi: 10.1016/S0012–821X(02)00657–X.
- Tokeshi, K., Harutoonian, P., Leo, C. J. & Liyanapathirana, S., 2013. Use of surface waves for geotechnical engineering applications in Western Sydney, *Adv. Geosci.*, **35**, 37–44, doi: 10.5194/adgeo–35–37–2013.
- Tokimatsu, K., Tamura, S. & Kojima, H., 1992. Effects of multiple modes on Rayleigh wave dispersion characteristics, *J. Geotech. Eng.*, **118**(10), 1529–1543.
- Toksöz, M. N. & Anderson, D. L., 1966. Phase velocities of long-period surface waves and structure of the upper mantle, I. great-circle Love and Rayleigh wave data, *J. Geophys. Res.*, **71**, 1649–1658.
- Toksöz, M. N., Sleep, N. H. & Smith, A. T., 1973. Evolution of the downgoing lithosphere and the mechanisms of deep focus earthquakes, *Geophys. J. R. Astron. Soc.*, **35**(1–3), 285–310.
- Toksöz, M. N., Dainty, A. M., Solomon, S. C. & Anderson, K. R., 1974. Structure of the Moon, *Rev. Geophys. Space Phys.*, **12**(4), 539–567.
- Tolman, L. H., 2009, User manual and system documentation of WAVEWATCH III (TM) version 3.14, Tech. Rep. 276, Environmental Modeling Center, Marine Modeling and Analysis Branch.
- Tolstoy, I., 1959. Modes, rays, and travel times, *J. Geophys. Res.*, **64**, 815–821.
- Tolstoy, I. & Ewing, M., 1950. The *T* phase of shallow-focus earthquakes, *B. Seismol. Soc. Am.*, **40**(1), 25–51.

- Tolstoy, I. & Usdin, E., 1953. Dispersive properties of stratified elastic and liquid media: A ray theory, *Geophysics*, **18**, 844–871, doi: 10.1190/1.1437939.
- Tolstoy, M., Cowen, J. P., Baker, E. T., Fornari, D. J., Rubin, K. H., Shank, T. M., Waldhauser, F., Bohnenstiehl, D. R., Forsyth, D. W., Holmes, R. C., Love, B., Perfit, M. R., Weekly, R. T., Soule, S. A. & Glazer, B., 2006. A sea-floor spreading event captured by seismometers, *Science*, **314**(5807), 1920–1922, doi: 10.1126/science.1133950.
- Tommasi, A., 1998. Forward modeling of the development of seismic anisotropy in the upper mantle, *Earth Planet. Sci. Lett.*, **160**, 1–13.
- Tommasi, A. & Vauchez, A., 2001. Continental rifting parallel to ancient collisional belts; An effect of the mechanical anisotropy of the lithospheric mantle, *Earth Planet. Sci. Lett.*, **185**, 199–210.
- Tommasi, A., Tikoff, B. & Vauchez, A., 1999. Upper mantle tectonics: Three-dimensional deformation, olivine crystallographic fabrics and seismic properties, *Earth Planet. Sci. Lett.*, **168**, 173–186.
- Tommasi, A., Knoll, M., Vauchez, A., Signorelli, J. W., Thoraval, C. & Logé, R., 2008. Structural reactivation in plate tectonics controlled by olivine crystal anisotropy, *Nature Geosci.*, **2**, 423–427, doi: 10.1038/ngeo528.
- Tompson, A. F. B., Ababou, R. & Gelhar, L. W., 1989. Implementation of the three-dimensional turning bands random field generator, *Water Resources Res.*, **25**(10), 2227–2243.
- Tong, C., Guðmundsson, Ó. & Kennett, B. L. N., 1994. Shear wave splitting in refracted waves returned from the upper mantle transition zone beneath northern Australia, *J. Geophys. Res.*, **99**(B8), 15783–15797.
- Toomey, D. R., Purdy, G. M., Solomon, S. C. & Wilcock, W. S. D., 1990. The three-dimensional seismic velocity structure of the East Pacific Rise near latitude 9° 30' N, *Nature*, **347**, 639–645, doi: 10.1038/347639a0.
- Toomey, D. R., Allen, R. M., Barclay, A. H., Bell, S. W., Bromirski, P. D., Carlson, R. L., Chen, X., Collins, J. A., Dziak, R. P., Evers, B., Forsyth, D. W., Gerstoft, P., Hooft, E. E., Livelybrooks, D., Lodewyk, J. A., Luther, D. S., McGuire, J. J., Schwartz, S. Y., Tolstoy, M., Tréhu, A. M., Weirathmueller, M. & Wilcock, W. S. D., 2014. The Cascadia Initiative: A sea change in seismological studies of subduction zones, *Oceanography*, **27**(2), 138–150, doi: 10.5670/oceanog.2014.49.
- Torrence, C. & Compo, G. P., 1998. A practical guide to wavelet analysis, *B. Am. Meteorol. Soc.*, **79**(1), 61–78.
- Touzi, R. & Lopes, A., 1996. Statistics of the Stokes parameters and of the complex coherence parameters in one-look and multilook speckle fields, *IEEE T. Geosci. Remote*, **34**(2), 519–531, doi: 10.1109/36.485128.

- Touzi, R., Lopes, A. & Vachon, P., 1996, Estimation of the coherence function for interferometric SAR applications, in *European Conference on Synthetic Aperture Radar 1996*, pp. 241–244, Königswinter, Germany.
- Touzi, R., Lopes, A., Bruniquel, J. & Vachon, P., 1999. Coherence estimation for SAR imagery, *IEEE T. Geosci. Remote*, **37**(1), 135–149.
- Tozer, B., Sandwell, D. T., Smith, W. H. F., Olson, C., Beale, J. R. & Wessel, P., 2019. Global bathymetry and topography at 15 arc sec: SRTM15+, *Earth Space Sci.*, **6**(10), 1847–1864, doi: 10.1029/2019EA000658.
- Tralie, J. W., 2019, *Seismological Analysis of the Mohorovičić and Mantle Discontinuities Below Cape Verde Using Receiver Functions*, A. B. Thesis, Princeton University.
- Trampert, J., 1990. Comparison of iterative back-projection inversion and generalized inversion without blocks — Case-studies in attenuation tomography — Comment, *Geophys. J. Int.*, **103**, 755–756.
- Trampert, J., 1998. Global seismic tomography: the inverse problem and beyond, *Inv. Probl.*, **14**(3), 371–385.
- Trampert, J. & Snieder, R., 1996. Model estimations biased by truncated expansions: Possible artifacts in seismic tomography, *Science*, **271**(5253), 1257–1260, doi: 10.1126/science.271.5253.1257.
- Trampert, J. & Spetzler, J., 2006. Surface wave tomography: finite-frequency effects lost in the null space, *Geophys. J. Int.*, **164**(2), 394–400, doi: 10.1111/j.1365–246X.2006.02864.x.
- Trampert, J. & van der Hilst, R. D., 2005, Towards a quantitative interpretation of global seismic tomography, in *Earth's Deep Mantle: Structure, Composition, and Evolution*, edited by R. D. van der Hilst, J. Bass, J. Matas, & J. Trampert, vol. 160 of **Geophysical Monograph**, pp. 47–62, Amer. Geophys. Union, Washington, D. C.
- Trampert, J. & van Heijst, H. J., 2002. Global azimuthal anisotropy in the transition zone, *Science*, **296**(5571), 197–1299.
- Trampert, J. & Woodhouse, J. H., 1995. Global phase-velocity maps of Love and Rayleigh-waves between 40 and 150 seconds, *Geophys. J. Int.*, **122**(2), 675–690.
- Trampert, J. & Woodhouse, J. H., 1996. High resolution global phase velocity distributions, *Geophys. Res. Lett.*, **23**(1), 21–24.
- Trampert, J. & Woodhouse, J. H., 2001. Assessment of global phase velocity models, *Geophys. J. Int.*, **144**(1), 165–174, doi: 10.1046/j.1365–246x.2001.00307.x.
- Trampert, J. & Woodhouse, J. H., 2003. Global anisotropic phase velocity maps for fundamental mode surface waves between 40 and 150 s, *Geophys. J. Int.*, **154**(1), 154–165, doi: 10.1046/j.1365–246X.2003.01952.x.

- Trampert, J., Deschamps, F., Resovsky, J. & Yuen, D., 2004. Probabilistic tomography maps chemical heterogeneities throughout the lower mantle, *Science*, **306**, 853–856.
- Trauth, M. H., 2015. *MATLAB Recipes for Earth Sciences*, Springer, New York, 4th edn.
- Tregoning, P., Boers, R., O’Brien, D. & Hendy, M., 1998. Accuracy of absolute precipitable water vapor estimates from GPS observations, *J. Geophys. Res.*, **103**(D22), 28701–28710.
- Tricomi, F. G., 1970. *Integral Equations*, Interscience, New York, 5th edn.
- Trifonov, D. A., 2003. On the position uncertainty measure on the circle, *J. Phys. A: Math. Gen.*, **36**, 11873–11879.
- Trifonov, D. A., 2003. Comment on “on the uncertainty relations and squeezed states for the quantum mechanics on a circle”, *J. Phys. A: Math. Gen.*, **36**, 2197–2202.
- Trnkoczy, A., 2012. Understanding and parameter setting of STA/LTA trigger algorithm, in *New Manual of Seismological Observatory Practice 2 (NMSOP-2)*, edited by P. Bormann, chap. IS 8.1, pp. 1–20, doi: 10.2312/GFZ.NMSOP-2_IS_8.1, Deutsches GeoForschungsZentrum, IASPEI, Potsdam, Germany.
- Tröltzsch, F., 2010. *Optimal Control of Partial Differential Equations: Theory, Methods and Applications*, vol. 112 of **Graduate Studies in Mathematics**, American Mathematical Society, Providence, Rhode Island.
- Tromp, J., 2020. Seismic wavefield imaging of Earth’s interior across scales, *Nat. Rev. Earth Env.*, **1**, 40–53, doi: 10.1038/s43017-019-0003-8.
- Tromp, J. & Bachmann, E., 2019. Source encoding for adjoint tomography, *Geophys. J. Int.*, **218**(3), 2019–2044, doi: 10.1093/gji/ggz271.
- Tromp, J., Tape, C. & Liu, Q., 2005. Seismic tomography, adjoint methods, time reversal and banana-doughnut kernels, *Geophys. J. Int.*, **160**(1), 195–216, doi: 10.1111/j.1365-246X.2004.02453.x.
- Tromp, J., Komatitsch, D., Hjörleifsdóttir, V., Liu, Q., Zhu, H., Peter, D., Bozdağ, E., McRitchie, D., Friberg, P., Trabant, C. & Hutko, A., 2010. Near real-time simulations of global CMT earthquakes, *Geophys. J. Int.*, **183**(1), 381–389, doi: 10.1111/j.1365-246X.2010.04734.x.
- Tromp, J., Luo, Y., Hanasoge, S. & Peter, D., 2010. Noise cross-correlation sensitivity kernels, *Geophys. J. Int.*, **183**(2), 791–819, doi: 10.1111/j.1365-246X.2010.04721.x.
- Tscherning, C. C., 1996. Isotropic reproducing kernels for the inner of a sphere or spherical shell and their use as density covariance functions, *Math. Geol.*, **28**(2), 161–168, doi: 10.1007/BF02084211.
- Tsekhmistrenko, M., Sigloch, K., Hosseini, K. & Barruol, G., 2021. A tree of Indo-African mantle plumes imaged by seismic tomography, *Nature Geosci.*, **14**(8), 612–619, doi: 10.1038/s41561-021-00762-9.

- Tselentis, G.-A., Martakis, N., Paraskevopoulos, P. & Lois, A., 2011. High-resolution passive seismic tomography for 3D velocity, Poisson's ratio ν , and P-wave quality q_p in the Delvina hydrocarbon field, southern Albania, *Geophysics*, **76**(3), B89–B112, doi: 10.1190/1.3560016.
- Tsui, J. B.-Y., 2000. *Fundamentals of Global Positioning System receivers: A software approach*, John Wiley, New York, NY.
- Tucker, G. E. & Bras, R. L., 2000. A stochastic approach to modeling the role of rainfall variability in drainage basin evolution, *Water Resources Res.*, **36**(7), 1953–1964, doi: 10.1029/2000WR900065.
- Tucker, J. M., Hauri, E. H., Pietruszka, A. J., Garcia, M. O., Marske, J. P. & Trusdell, F. A., 2019. A high carbon content of the Hawaiian mantle from olivine-hosted melt inclusions, *Geochim. Cosmochim. Acta*, **254**, 156–172, doi: 10.1016/j.gca.2019.04.001.
- Tücks, M., 1996, *Navier-Splines und ihre Anwendung in der Deformationsanalyse*, Ph.D. thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern.
- Tukey, J. W., 1967, An introduction to the calculations of numerical spectrum analysis, in *Advanced Seminar on Spectral Analysis of Time Series*, edited by B. Harris, pp. 25–46, John Wiley, New York.
- Tukey, J. W., 1984, Styles of spectrum analysis, in *The Collected Works of John W. Tukey*, edited by D. R. Brillinger, vol. 2, pp. 1143–1153, Wadsworth, Belmont, Calif.
- Tullis, T. E., 1988. Rock friction constitutive behavior from laboratory experiments and its implications for an earthquake prediction field monitoring program, *Pure Appl. Geophys.*, **126**(2–4), 555–588.
- Turcotte, D. L. & McAdoo, D. C., 1979. Geoid anomalies and the thickness of the lithosphere, *J. Geophys. Res.*, **84**(B5), 2381–2387.
- Turcotte, D. L. & Oxburgh, E. R., 1967. Finite amplitude convective cells and continental drift, *J. Fluid Mech.*, **28**(1), 29–42, doi: 10.1017/S0022112067001880.
- Turcotte, D. L. & Schubert, G., 1982. *Geodynamics, Application of Continuum Physics to Geological Problems*, John Wiley, New York.
- Turcotte, D. L. & Schubert, G., 2002. *Geodynamics*, Cambridge Univ. Press, New York, 2nd edn.
- Turcotte, D. L., Willemann, R. J., Haxby, W. F. & Norberry, J., 1981. Role of membrane stresses in the support of planetary topography, *J. Geophys. Res.*, **86**, 3951–3959.
- Turin, G. L., 1960. An introduction to matched filters, *IRE Trans. Inf. Theory*, **6**(3), 311–329.
- Turpault, M.-P. & Trotignon, L., 1994. The dissolution of biotite single crystals in dilute HNO_3 at 24°C: Evidence of an anisotropic corrosion process of micas in acidic solutions, *Geochim. Cosmochim. Acta*, **58**(13), 2761–2775.

- Tuzun, R. E., Burkhardt, P. & Secrest, D., 1998. Accurate computation of individual and tables of $3 - j$ and $6 - j$ symbols, *Comput. Phys. Comm.*, **112**(2–3), 112–148.
- Tversky, A. & Kahneman, D., 1983. Extensional versus intuitive reasoning: The conjunction fallacy in probability judgment, *Psych. Rev.*, **90**(4), 293–315.
- Tyack, P. L., 2009. Human-generated sound and marine mammals, *PT*, **62**(11), 39–44, doi: 10.1063/1.3265235.
- Udías, A., 2000. *Principles of Seismology*, Cambridge Univ. Press, Cambridge, UK.
- Ulmer, P. & Trommsdorff, V., 1995. Serpentine stability to mantle depths and subduction-related magmatism, *Science*, **268**, 858–861.
- Ulug, A. & Berckhemer, H., 1984. Frequency dependence of Q for seismic body waves in the Earth's mantle, *J. Geophys.*, **56**, 9–19.
- Um, J. & Thurber, C., 1987. A fast algorithm for two-point seismic ray tracing, *B. Seismol. Soc. Am.*, **77**(3), 972–986, doi: 10.1785/BSSA0770030972.
- University College London, 2006. Mermaids detect earthquakes, *Homepage*, pp. www.ucl.ac.uk/news/news--articles/0606/06062701.
- Usevitch, B. E., 2001. A tutorial on modern lossy wavelet image compression: foundations of JPEG 2000, *IEEE Signal Process. Mag.*, **5**, 22–35, doi: 10.1109/79.952803.
- Ussami, N., Cogo de Sa, N. & Molina, E. C., 1993. Gravity map of Brazil; 1. Regional and residual isostatic anomalies and their correlation with major tectonic provinces, *J. Geophys. Res.*, **98**(B2), 2199–2208.
- Uytterhoeven, G., van Wulpen, F., Jansen, M., Roose, D. & Bultheel, A., 1998, WAILI: A software library for image processing using integer wavelet transforms, in *Medical Imaging 1998: Image Processing*, edited by K. M. Hanson, vol. 3338, pp. 1490–1501, Int. Soc. Opt. Eng.
- Vacher, P., Mocquet, A. & Sotin, C., 1998. Computation of seismic profiles from mineral physics: the importance of the non-olivine components for explaining the 660 km depth discontinuity, *Phys. Earth Planet. Inter.*, **106**(3), 275–298, doi: 10.1016/S0031-9201(98)00076-4.
- Vackář, J., Burjánek, J., Gallovič, F., Zahradník, J. & Clinton, J., 2017. Bayesian ISOLA: new tool for automated centroid moment tensor inversion, *Geophys. J. Int.*, **210**(2), 693–705, doi: 10.1093/gji/ggx158.
- Vaezi, Y. & van der Baan, M., 2014. Analysis of instrument self-noise and microseismic event detection using power spectral density estimates, *Geophys. J. Int.*, p. doi: 10.1093/gji/ggu036.
- Valentine, A. P. & Trampert, J., 2012. Data space reduction, quality assessment and searching of seismograms: autoencoder networks for waveform data, *Geophys. J. Int.*, **189**(2), 1183–1202, doi: 10.1111/j.1365-246X.2012.05429.x.

- Valentine, A. P. & Woodhouse, J. H., 2010. Reducing errors in seismic tomography: combined inversion for sources and structure, *Geophys. J. Int.*, **180**(2), 847–857, doi: 10.1111/j.1365–246X.2009.04452.x.
- Valentine, A. P. & Woodhouse, J. H., 2010. Approaches to automated data selection for global seismic tomography, *Geophys. J. Int.*, **182**(2), 1001–1012, doi: 10.1111/j.1365–246X.2010.04658.x.
- van Brummen, A., 2017, *Seismic site characterization and crustal structure below Princeton Campus*, A. B. Thesis, Princeton University.
- van de Ville, D. & Unser, M., 2008. Complex wavelet bases, steerability, and the Marr-like pyramid, *IEEE T. Image Proc.*, **17**(11), 2063–2080, doi: 10.1109/TIP.2008.2004797.
- van de Ville, D., Philips, W. & Lemahieu, I., 2002. On the N-dimensional extension of the discrete prolate spheroidal window, *IEEE T. Signal Process.*, **9**(3), 89–91.
- van den Berg, A. P., van Keken, P. & Yuen, D. A., 1993. The effects of a composite non-Newtonian and Newtonian rheology on mantle convection, *Geophys. J. Int.*, **115**(1), 62–78, doi: 10.1111/j.1365–246X.1993.tb05588.x.
- van den Berg, E. & Friedlander, M. P., 2008. Probing the Pareto frontier for basis pursuit solutions, *SIAM J. Sci. Comput.*, **31**(2), 890–912, doi: 10.1137/080714488.
- van den Broeke, M., Bamber, J., Ettema, J., Rignot, E., Schrama, E., van de Berg, W. J., van Meijgaard, E., Velicogna, I. & Wouters, B., 2009. Partitioning recent Greenland mass loss, *Science*, **326**(5955), 984–986, doi: 10.1126/science.1178176.
- van der Hilst, R. D. & de Hoop, M. V., 2005. Banana-doughnut kernels and mantle tomography, *Geophys. J. Int.*, **163**(3), 956–961, doi: 10.1111/j.1365–246X.2005.02817.x.
- van der Hilst, R. D. & Káráson, H., 1999. Compositional heterogeneity in the bottom 1000 kilometers of Earth’s mantle: Toward a hybrid convection model, *Science*, **283**(5409), 1885–1888.
- van der Hilst, R. D. & McDonough, W. F., eds., 1999. *Composition, Deep Structure and Evolution of Continents*, Elsevier.
- van der Hilst, R. D., Engdahl, E. R. & Spakman, W., 1993. Tomographic inversion of *P*-data and *pP*-data for aspherical mantle structure below the northwest Pacific region, *Geophys. J. Int.*, **115**(1), 264–302.
- van der Hilst, R. D., Kennett, B. L. N., Christie, D. & Grant, J., 1994. Project SKIPPY explores the lithosphere and mantle beneath Australia, *Eos Trans. AGU*, **75**, 177–181.
- van der Hilst, R. D., Widiyantoro, S. & Engdahl, E. R., 1997. Evidence for deep mantle circulation from global tomography, *Nature*, **386**, 578–584, doi: 10.1038/386578a0.
- van der Hilst, R. D., Kennett, B. L. N. & Shibutani, T., 1998, Upper mantle structure beneath Australia from portable array deployments, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klootwijk, vol. 26 of **Geodyn. Ser.**, pp. 39–57, Amer. Geophys. Union, Washington, D. C.

- van der Lee, S., 1998. Observations and origin of Rayleigh-wave amplitude anomalies, *Geophys. J. Int.*, **135**(2), 691–699.
- van der Lee, S., 2001. Deep below North America, *Science*, **294**, 1297–1298.
- van der Lee, S. & Nolet, G., 1997. Seismic image of the subducted trailing fragments of the Farallon plate, *Nature*, **386**, 266–269.
- van der Lee, S. & Nolet, G., 1997. Upper mantle *S*-velocity structure of North America, *J. Geophys. Res.*, **102**(B10), 22,815–22,838.
- van der Lee, S., James, D. & Silver, P., 2001. Upper mantle *S* velocity structure of central and western South America, *J. Geophys. Res.*, **106**(12), 30821–30834.
- van der Meijde, M., Marone, F., Giardini, D. & van der Lee, S., 2003. Seismic evidence for water deep in Earth's upper mantle, *Science*, **300**, 1556–1558.
- van der Sluijs, M. A., 2014. A common miscitation of William Gilbert, *Eos Trans. AGU*, **95**(16), 137, doi: 10.1002/2014EO160005.
- van der Sluis, A. & van der Vorst, H. A., 1986. The rate of convergence of conjugate gradients, *Numer. Math.*, **48**(5), 543–560.
- van der Sluis, A. & van der Vorst, H. A., 1987, Numerical solution of large sparse linear algebraic systems arising from tomographic problems, in *Seismic Tomography*, edited by G. Nolet, chap. 3, pp. 49–83, Reidel, Hingham, Mass.
- van Geet, M., Swennen, R. & Wevers, M., 2000. Quantitative analysis of reservoir rocks by microfocus X-ray computerised tomography, *Sedimentary Geology*, **132**, 25–36.
- van Geet, M., Swennen, R. & David, P., 2001. Quantitative coal characterisation by means of microfocus X-ray computer tomography, colour image analysis and back-scattered scanning electron microscopy, *Intern. J. Coal Geol.*, **46**, 11–25.
- van Geet, M., Swennen, R. & Wevers, M., 2001. Towards 3-d petrography: Application of microfocus computer tomography in geological science, *Comput. Geosci.*, **27**(9), 1091–1099.
- van Gelderen, M. & Koop, R., 1997. The use of degree variances in satellite gradiometry, *J. Geod.*, **71**, 337–343.
- van Gerven, L., Deschamps, F. & van der Hilst, R. D., 2004. Geophysical for chemical variations in the Australian continental mantle, *Geophys. Res. Lett.*, **31**, L17607, doi: 10.1029/2004GL020307.
- van Heijst, H. J. & Woodhouse, J. H., 1997. Measuring surface-wave overtone phase velocities using a mode-branch stripping technique, *Geophys. J. Int.*, **131**, 209–230.
- van Heijst, H. J. & Woodhouse, J. H., 1999. Global high-resolution phase velocity distributions of overtone and fundamental-mode surface waves determined by mode branch stripping, *Geophys. J. Int.*, **137**(3), 601–620.

- van Herwaarden, D. P., Afanasiev, M., Thrastarson, S. & Fichtner, A., 2021. Evolutionary full-waveform inversion, *Geophys. J. Int.*, **224**(1), 306–311, doi: 10.1093/gji/ggaa459.
- van Keken, M. D. B. P. E. & Ito, G., 2015, Hotspots, large igneous provinces, and melting anomalies, in *Treatise on Geophysics*, pp. 393–459, doi: 10.1016/B978-0-444-53802-4.00133-0, Elsevier, 2nd edn.
- van Keken, P. E., Hauri, E. H. & Ballentine, C. J., 2002. Mantle mixing: The generation, preservation and destruction of chemical heterogeneity, *Annu. Rev. Earth Planet. Sc.*, **30**, 493–525.
- van Leeuwen, T. & Herrmann, F., 2013. Fast waveform inversion without source-encoding, *Geophys. Prospect.*, **61**(1), 10–19, doi: 10.1111/j.1365-2478.2012.01096.x.
- van Wijk, K., Scales, J. A., Navidi, W. & Tenorio, L., 2002. Data and model uncertainty estimation for linear inversion, *Geophys. J. Int.*, **149**, 625–632.
- van Zuilen, M. A., Lepland, A. & Arrhenius, G., 2002. Reassessing the evidence for the earliest traces of life, *Nature*, **418**, 627–630.
- Vanacore, E., Niu, F. & Kawakatsu, H., 2006. Observations of the mid-mantle discontinuity beneath Indonesia from *S* to *P* converted waveforms, *Geophys. Res. Lett.*, **33**(4), L04302, doi: 10.1029/2005GL025106.
- VanDecar, J. C. & Crosson, R. S., 1990. Determination of teleseismic relative phase arrival times using multi-channel cross-correlation and least squares, *B. Seismol. Soc. Am.*, **80**(1), 150–169.
- VanDecar, J. C. & Snieder, R., 1994. Obtaining smooth solutions to large, linear inverse problems, *Geophysics*, **59**(5), 818–829, doi: 10.1190/1.1443640.
- VanDecar, J. C., James, D. E. & ao, M. A., 1995. Seismic evidence for a fossil mantle plume beneath South America and implications for plate driving forces, *Nature*, **378**, 25–31, doi: 10.1038/378025a0.
- Vanmarcke, E., 1983. *Random Fields. Analysis and Synthesis*, MIT Press, Cambridge, Mass., 1st edn.
- Vanmarcke, E., 2010. *Random Fields. Analysis and Synthesis*, World Scientific, Singapore, 2nd edn.
- Varin, C., 2008. On composite marginal likelihoods, *AStA Adv. Stat. Anal.*, **92**(1), 1–28, doi: 10.1007/s10182-008-0060-7.
- Varin, C., Reid, N. & Firth, D., 2011. An overview of composite likelihood methods, *Stat. Sinica.*, **21**(1), 5–42.
- Varshalovich, D. A., Moskalev, A. N. & Khersonskii, V. K., 1988. *Quantum theory of angular momentum*, World Scientific, Singapore.

- Vasco, D. W., Johnson, L. R., Pulliam, R. J. & Earle, P. S., 1994. Robust inversion of IASP91 travel time residuals for mantle P and S velocity structure, earthquake mislocations, and station corrections, *J. Geophys. Res.*, **99**, 13727–13755.
- Vasco, D. W., Johnson, L. R. & Marques, O., 1999. Global Earth structure: Inference and assessment, *Geophys. J. Int.*, **137**(2), 381–407.
- Vasudevan, K. & Cook, F. A., 2001. Time-frequency analysis of deep crustal reflection seismic data using Wigner-Ville distributions, *Can. J. Earth Sci.*, **38**, 1027–1035.
- Vauchez, A. & Barruol, G., 1996. Shear-wave splitting in the Appalachians and the Pyrenees: Importance of the inherited tectonic fabric of the lithosphere, *Phys. Earth Planet. Inter.*, **95**, 127–138.
- Vauchez, A. & Nicolas, A., 1991. Mountain building: Strike-parallel motion and mantle anisotropy, *Tectonophysics*, **185**(3–4), 183–201.
- Vauchez, A., Tommasi, A. & Barruol, G., 1998. Rheological heterogeneity, mechanical anisotropy and deformation of the continental lithosphere, *Tectonophysics*, **296**, 61–86.
- Červený, V., 2001. *Seismic Ray Theory*, Cambridge Univ. Press, Cambridge, UK.
- Veevers, J. J., ed., 1984. *Phanerozoic Earth History of Australia*, Oxford Univ. Press, New York.
- Veith, K. F., 1998. Comment on "empirical determination of depth-distance corrections for m_b and m_w from Global Seismograph Network stations" by g. nolet et al., *Geophys. Res. Lett.*, **25**(22), 4241–4242.
- Veith, K. F. & Clawson, G. E., 1972. Magnitude from short-period P data, *B. Seismol. Soc. Am.*, **62**(2), 435–452.
- Velicogna, I., 2009. Increasing rates of ice mass loss from the Greenland and Antarctic ice sheets revealed by GRACE, *Geophys. Res. Lett.*, **36**(19), L19503, doi: 10.1029/2009GL040222.
- Velicogna, I. & Wahr, J., 2013. Time-variable gravity observations of ice sheet mass balance: Precision and limitations of the GRACE satellite data, *Geophys. Res. Lett.*, **40**, 3055–3063, doi:10.1002/grl.50527.
- Velicogna, I. & Wahr, J. M., 2005. Greenland mass balance from GRACE, *Geophys. Res. Lett.*, **32**, L18505, doi: 10.1029/2005GL023955.
- Velicogna, I. & Wahr, J. M., 2006. Measurements of time-variable gravity show mass loss in Antarctica, *Science*, **311**, 1754–1756, doi: 10.1126/science.1123785.
- Velicogna, I. & Wahr, J. M., 2006. Acceleration of Greenland ice mass loss in spring 2004, *Nature*, **443**, 329–331, doi: 10.1038/nature.05168.
- Velicogna, I., Sutterley, T. C. & van den Broeke, M. R., 2014. Regional acceleration in ice mass loss from Greenland and Antarctica using GRACE time-variable gravity data, *Geophys. Res. Lett.*, **41**(22), 8130–8137, doi: 10.1002/2014GL061052.

- Vening Meinesz, F. A., 1931. Une nouvelle méthode pour la réduction isostatique régionale de l'intensité de la pesanteur, *Bull. Géod.*, **29**(1), 33–51.
- Vening Meinesz, F. A., 1964. *The earth's crust and mantle*, Elsevier, Amsterdam, Neth.
- Vermeesch, P. M. & Morgan, J. V., 2004. Chicxulub central crater structure: Initial results from physical property measurements and combined velocity and gravity modeling, *Meteoritics Planet. Sc.*, **39**(7), 1019–1034.
- Vermeulen, J. M. & Doornbos, D. J., 1977. Mantle heterogeneity and mislocation patterns for seismic networks, *J. Geophys.*, **45**, 545–559.
- Versteeg, R. J., 1993. Sensitivity of prestack depth migration to the velocity model, *Geophysics*, **58**(6), 873–882.
- Vetterli, M., 2001. Wavelets, approximation, and compression, *IEEE Signal Process. Mag.*, **18**(5), 59–73, doi: 10.1109/79.952805.
- Viale, E. & Dempski, K., 2004. *Advanced Lighting*, <http://www.gameinstitute.com/>.
- Vidale, J. E. & Houston, H., 1993. The depth dependence of earthquake duration and implications for rupture mechanisms, *Nature*, **365**, 45–47.
- Vigil, J. F., Pike, R. J. & Howell, D. G., 2000. A tapestry of time and terrain, Investigations Series 2720, United States Geological Survey, <http://pubs.usgs.gov/imap/i2720/>.
- Villaseñor, A., Bergman, E. A., Boyd, T. M., Engdahl, E. R., Frazier, D. W., Harden, M. M., Orth, J. L., Parkes, R. L. & Shedlock, K. M., 1997. Toward a comprehensive catalog of global historical seismicity, *Eos Trans. AGU*, **78**(50), 581–588, doi: 10.1029/97EO00346.
- Vincent, H. T., 2001, *Models, Algorithms, and Measurements for Underwater Acoustic Positioning*, Ph.D. thesis, University of Rhode Island, Kingston, Rhode Island.
- Vincent, H. T. & Hu, S.-L. J., 2002. Method and system for determining underwater effective sound velocity, *United States Patent*, **6388948**.
- Vincent, H. T. & Hu, S.-L. J., 2002. Geodetic position estimation for underwater acoustic sensors, *United States Patent*, **6028823**.
- Vincent, H. T. & Simons, F. J., 2011. Son-O-Mermaid: A green instrument platform for the blue ocean, *Geophys. Res. Abstr.*, **13**, 12908.
- Vinnik, L., 1977. Detection of waves converted from *P* to *sv* in the mantle., *Phys. Earth Planet. Inter.*, **15**, 39–45.
- Vinnik, L. & Farra, V., 2002. Subcratonic low-velocity layer and flood basalts, *Geophys. Res. Lett.*, **29**(4), 1049, doi: 10.1029/2001GL014064.
- Vinnik, L., Chevrot, S. & Montagner, J.-P., 1997. Evidence for a stagnant plume in the transition zone?, *Geophys. Res. Lett.*, **24**(9), 1007–1010, doi: 10.1029/97GL00786.

- Vinnik, L., Breger, L. & Romanowicz, B., 1998. Anisotropic structures at the base of the Earth's mantle, *Nature*, **393**, 564–567, doi: 10.1038/31208.
- Vinnik, L. P., Kosarev, G. & Makeeva, L., 1984. Lithosphere anisotropy from the observation of *sk*s and *sk*ks waves, *Doklady Akademii Nauk SSSR*, **278**(6), 1335–1339.
- Vinnik, L. P., Farra, V. & Romanowicz, B., 1989. Azimuthal anisotropy in the Earth from observations of *sk*s at GEOSCOPE and NARS broad-band stations, *Geophys. J. Int.*, **79**(5), 1542–1558.
- Vinnik, L. P., Makeyeva, L. I., Milev, A. & Usenko, A. Y., 1992. Global patterns of azimuthal anisotropy and deformations in the continental mantle, *Geophys. J. Int.*, **111**, 433–447.
- Vinnik, L. P., Green, R. W. E. & Nicolaysen, L. O., 1995. Recent deformations of the deep continental root beneath southern Africa, *Nature*, **375**(6526), 50–52.
- Vinnik, L. P., Green, R. W. E. & Nicolaysen, L. O., 1996. Seismic constraints on dynamics of the mantle of the Kaapvaal craton, *Phys. Earth Planet. Inter.*, **95**, 139–151.
- Vinnik, L. P., Oreshin, S. I., Speziale, S. & Weber, M., 2010. Mid-mantle layering from SKS receiver functions, *Geophys. Res. Lett.*, **37**(24), L24302, doi: 10.1029/2010GL045323.
- Virieux, J., 1986. *P*-*SV* wave propagation in heterogeneous media: Velocity-stress finite-difference method, *Geophysics*, **51**(4), 889–901, doi:10.1190/1.1442147.
- Virieux, J. & Ekstroöm, G., 1991. Ray tracing on a heterogenous sphere by Lie series, *Geophys. J. Int.*, **104**, 11–27, doi:.
- Virieux, J. & Farra, V., 1991. Ray tracing in 3-D complex isotropic media: An analysis of the problem, *Geophysics*, **56**(12), 2057–2069.
- Virieux, J. & Operto, S., 2009. An overview of full-waveform inversion in exploration geophysics, *Geophysics*, **74**(6), WCC1–WCC26, doi: 10.1190/1.3238367.
- Visser, R. L. M., Drury, M. R., Strating, E. H. H. & van der Wal, D., 1991. Shear zones in the upper mantle: A case study in an Alpine lherzolite massif, *Geology*, **19**, 990–993, doi: 10.1130/0091-7613(1991)019<0990:SZITUM>2.3.CO;2.
- Vlaar, N., 1966. The field from an SH point source in a continuously layered inhomogeneous half-space II. fthe field in a half-space, *B. Seismol. Soc. Am.*, **56**, 1305–1315.
- Vlaar, N., 1983. Thermal anomalies and magmatism due to lithospheric doubling and shifting, *Earth Planet. Sci. Lett.*, **65**, 322–330.
- Vlaar, N. J., 1966. The field from an SH-point source in a continuously layered inhomogeneous medium: I. The field in a layer of finite depth, *B. Seismol. Soc. Am.*, **56**, 715–724.
- Vlaar, N. J., 1976. On the excitation of the Earth's seismic normal modes, *Pure Appl. Geophys.*, **114**, 864–875.

- Vlaar, N. J., 1982. Lithospheric doubling as a cause of intracontinental tectonics, *Proc. R. Neth. Acad. Sci., Ser. B.*, **85**(4), 469–483.
- Vlaar, N. J., 2000. Continental emergence and growth on a cooling earth, *Tectonophysics*, **322**, 191–202, doi: 10.1016/S0040-1951(00)00063-9.
- Vlaar, N. J. & Wortel, M. J. R., 1978. Gravity and the earthquake mechanism, *Phys. Earth Planet. Inter.*, **16**, 240–246, doi: 10.1016/0031-9201(78)90017-1.
- Vlaar, N. J., Nolet, G., Wortel, M. J. R. & Cloetingh, S. A. P. L., eds., 1988. *Mathematical Geophysics: A Survey of Recent Developments in Seismology and Geodynamics*, Reidel, Dordrecht, Neth.
- Vlaar, N. J., van Keken, P. E. & van den Berg, A. P., 1994. Cooling of the Earth in the Archaean: Consequences of pressure-release melting in a hotter mantle, *Earth Planet. Sci. Lett.*, **121**, 1–18.
- Vogeley, M. S. & Szalay, A. S., 1996. Eigenmode analysis of galaxy redshift surveys — 1 Theory and methods, *Astroph. J.*, **465**(1), 34–53.
- Vonesch, C. & Unser, M., 2008. A fast thresholded Landweber algorithm for wavelet-regularized multidimensional deconvolution, *IEEE T. Image Proc.*, **17**(4), 539–549.
- Voorhies, C. V., 2008. Thickness of the magnetic crust of Mars, *J. Geophys. Res.*, **113**, E04004, doi: 10.1029/2007JE002928.
- Voorhies, C. V., Sabaka, T. J. & Purucker, M., 2002. On magnetic spectra of Earth and Mars, *J. Geophys. Res.*, **107**(E6), 5034, doi: 10.1029/2001JE001534.
- Vuong, Q. H., 1989. Likelihood ratio tests for model selection and non-nested hypotheses, *Econometrica*, **57**(2), 307–333.
- Wahba, G., 1990. *Spline Models for Observational Data*, vol. 59 of **CBMS-NSF Regional Conference Series in Applied Mathematics**, Society for Industrial & Applied Mathematics, Philadelphia, Penn.
- Wahr, J. M., Molenaar, M. & Bryan, F., 1998. Time variability of the Earth’s gravity field: Hydrological and oceanic effects and their possible detection using GRACE, *J. Geophys. Res.*, **103**(B12), 30205–30229, doi: 10.1029/98JB02844.
- Wahr, J. M., Swenson, S. & Velicogna, I., 2006. Accuracy of GRACE mass estimates, *Geophys. Res. Lett.*, **33**, L06401, doi: 10.1029/2005GL025305.
- Wald, D. J., Quitoriano, V., Worden, C. B., Hopper, M. & Dewey, J. W., 2012. USGS “Did You Feel It?” Internet-based macroseismic intensity maps, *Annals of Geophysics*, **54**(6), 688–707, doi: 10.4401/ag-5354.
- Walden, A. T., 1990. Improved low-frequency decay estimation using the multitaper spectral-analysis method, *Geophysics*, **38**, 61–86.

- Walden, A. T., 1990. Maximum likelihood estimation of magnitude-squared multiple and ordinary coherence, *Signal Process.*, **19**, 75–82.
- Walden, A. T., 2000. A unified view of multitaper multivariate spectral estimation, *Biometrika*, **87**(4), 767–788.
- Walden, A. T., McCoy, E. J. & Percival, D. B., 1994. The variance of multitaper spectrum estimates for real Gaussian processes, *IEEE T. Signal Process.*, **2**, 479–482.
- Walden, A. T., McCoy, E. J. & Percival, D. B., 1995. The effective bandwidth of a multitaper spectral estimator, *Biometrika*, **82**(1), 201–214.
- Walden, A. T., Percival, D. B. & McCoy, E. J., 1998. Spectrum estimation by wavelet thresholding of multitaper estimators, *IEEE T. Signal Process.*, **46**(12), 3153–3165.
- Waldhauser, F. & Ellsworth, W. L., 2000. A double-difference earthquake location algorithm: Method and application to the Northern Hayward Fault, California, *B. Seismol. Soc. Am.*, **90**(6), 1353–1368.
- Walker, S. C. & Buckingham, M. J., 2012. Spatial coherence and cross correlation of three-dimensional ambient noise fields in the ocean, *J. Acoust. Soc. Am.*, **131**(2), 1079–1086, doi: 10.1121/1.3676700.
- Wall, J. V., 1979. Practical statistics for astronomers – I. Definitions, the normal distribution, detection of signal, *Quart. J. R. Astron. Soc.*, **20**, 138–152.
- Wall, J. V., 1996. Practical statistics for astronomers – II. Correlation, data-modelling and sample comparison, *Quart. J. R. Astron. Soc.*, **37**, 519–563.
- Wallace, L. M., Webb, S. C., Ito, Y., Mochizuki, K., Hino, R., Henrys, S., Schwartz, S. Y. & Sheehan, A. F., 2016. Slow slip near the trench at the Hikurangi subduction zone, New Zealand, *Science*, **352**(6286), 701–704, doi: 10.1126/science.aaf2349.
- Wallace, T. C., Helmberger, D. V. & Mellman, G. R., 1981. A technique for the inversion of regional data in source parameter studies, *J. Geophys. Res.*, **86**(B3), 1679–1685, doi: 10.1029/JB086iB03p01679.
- Walter, G. & Soleski, T., 2005. A new friendly method of computing prolate spheroidal wave functions and wavelets, *Appl. Comput. Harmon. Anal.*, **19**, 432–443.
- Walter, G. G. & Shen, X., 2004. Wavelets based on prolate spheroidal wave functions, *J. Fourier Anal. Appl.*, **10**(1), 1–26, doi: 10.1007/s00041-004-8001-7.
- Walter, G. G. & Shen, X., 2005. Wavelet like behavior of Slepian functions and their use in density estimation, *Comm. Stat. Theory Meth.*, **34**(3), 687–711.
- Walter, G. G. & Soleski, T., 2008. Error estimates for the PSWF method in MRI, *Contemp. Math.*, **451**, 262.

- Waltham, D., Docherty, C. & Taberner, C., 2000. Decoupled flexure in the South Pyrenean foreland, *J. Geophys. Res.*, **105**(B7), 16329–16339.
- Wamba, M. D., Montagner, J.-P., Romanowicz, B. & Barruol, G., 2021. Multi-mode waveform tomography of the Indian Ocean upper and mid-mantle around the Réunion hotspot, *J. Geophys. Res.*, **126**, e2020JB021490, doi: 10.1029/2020JB021490.
- Wamba, M. D., Montagner, J.-P. & Romanowicz, B., 2023. Imaging deep-mantle plumbing beneath La Réunion and Comores hot spots: Vertical plume conduits and horizontal ponding zones, *Sci. Adv.*, **9**, eade3723, doi: 10.1126/sciadv.ade3723.
- Wanamaker, B. J. & Kohlstedt, D. L., 1991. The effect of melt composition on the wetting angle between silicate melts and olivine, *Phys. Chem. Minerals*, **18**, 26–36.
- Wandelt, B. D. & Górski, K. M., 2001. Fast convolution on the sphere, *Phys. Rev. D*, **63**(12), 123002.
- Wandelt, B. D. & Hansen, F. K., 2003. Fast, exact CMB power spectrum estimation for a certain class of observational strategies, *Phys. Rev. D*, **67**(023001).
- Wandelt, B. D., Hivon, E. & Górski, K. M., 2001. Cosmic microwave background anisotropy power spectrum statistics for high precision cosmology, *Phys. Rev. D*, **64**(8), 083003.
- Wang, L., Shum, C. K., Simons, F. J., Tassara, A., Erkan, K., Dai, C., Gruber, T., Rummel, R. & Stummer, C., 2011. 2010 M8.8 Chilean Maule earthquake coseismic deformation using spaceborne gravimetry, *Geophys. Res. Abstr.*, **13**, 9548.
- Wang, L., Shum, C. K., Simons, F. J., Tapley, B. D. & Dai, C., 2012. Coseismic and postseismic deformation of the 2011 Tohoku-Oki earthquake constrained by GRACE gravimetry, *Geophys. Res. Lett.*, **39**(7), L07301, doi: 10.1029/2012GL051104.
- Wang, L., Shum, C. K., Simons, F. J., Tassara, A., Erkan, K., Jekeli, C., Braun, A., Kuo, C., Lee, H. & Yuan, D.-N., 2012. Coseismic slip of the 2010 Mw 8.8 Great Maule, Chile, earthquake quantified by the inversion of GRACE observations, *Earth Planet. Sci. Lett.*, **335–336**, 167–179, doi: 10.1016/j.epsl.2012.04.044.
- Wang, T., Lin, J., Tucholke, B. & Chen, Y. J., 2011. Crustal thickness anomalies in the North Atlantic Ocean basin from gravity analysis, *Geochem. Geophys. Geosyst.*, **12**(3), Q0AE02, doi: 10.1029/2010GC003402.
- Wang, T., Tucholke, B. E. & Lin, J., 2015. Spatial and temporal variations in crustal production at the mid-atlantic ridge, *J. Geophys. Res.*, **120**(4), 2119–2142, doi: 10.1002/2014JB011501.
- Wang, W., McMechan, G. A., Tang, C. & Xie, F., 2016. Up/down and P/S decompositions of elastic wavefields using complex seismic traces with applications to calculating Poynting vectors and angle-domain common-image gathers from reverse time migrations, *Geophysics*, **81**(4), S181–S194, doi: 10.1190/geo2015–0456.1.

- Wang, Y. & Houseman, G. A., 1995. Tomographic inversion of reflection seismic amplitude data for velocity variation, *Geophys. J. Int.*, **123**(2), 355–372, doi:10.1111/j.1365–246X.1995.tb06859.x.
- Wang, Y. & Mareschal, J.-C., 1999. Elastic thickness of the lithosphere in the central Canadian shield, *Geophys. Res. Lett.*, **26**(19), 3033–3036.
- Wang, Z. & Dahlen, F. A., 1995. Spherical-spline parameterization of three-dimensional Earth models, *Geophys. Res. Lett.*, **22**, 3099–3102.
- Wang, Z. & Dahlen, F. A., 1995. Validity of surface-wave ray theory on a laterally heterogeneous Earth, *Geophys. J. Int.*, **123**, 757–773.
- Wang, Z., Tromp, J. & Ekström, G., 1998. Global and regional surface-wave inversions: A spherical-spline parameterization, *Geophys. Res. Lett.*, **25**(2), 207–210.
- Ward, J. P. & Unser, M., 2014. Harmonic singular integrals and steerable wavelets in $l_2(\mathbb{R}^d)$, *Appl. Comput. Harmon. Anal.*, **36**, 183–197, doi: 10.1016/j.acha.2013.03.006.
- Ward, P. D. & Brownlee, D., 2000. *Rare Earth: Why Complex Life is Uncommon in the Universe*, Springer, New York.
- Warner, M. R. & Guasch, L., 2016. Adaptive waveform inversion: Theory, *Geophysics*, **81**(6), R429–R445, doi: 10.1190/geo2015–0387.1.
- Warren, L. M. & Shearer, P. M., 2000. Investigating the frequency dependence of mantle q by stacking P and pp spectra, *J. Geophys. Res.*, **105**, 25391–25402.
- Wasserman, L., 2004. *All of Statistics. A concise course in statistical inference*, Springer, New York, NY.
- Waszek, L., Schmerr, N. C. & Ballmer, M. D., 2018. Global observations of reflectors in the mid-mantle with implications for mantle structure and dynamics, *Nat. Commun.*, **9**(1), 1–13, doi: 10.1038/s41467–017–02709–4.
- Waszek, L., Tauzin, B., Schmerr, N. C., Ballmer, M. D. & Afonso, J. C., 2021. A poorly mixed mantle transition zone and its thermal state inferred from seismic waves, *Nature Geosci.*, **14**(12), 949–955, doi: 10.1038/s41561–021–00850–w.
- Watkins, M. M., Wiese, D. N., Yuan, D.-N., Boening, C. & Landerer, F. W., 2015. Improved methods for observing Earth’s time variable mass distribution with GRACE using spherical cap mascons, *J. Geophys. Res.*, **120**(4), 2648–2671, doi: 10.1002/2014JB011547V.
- Watson, G. N., 1918. The diffraction of electric waves round the Earth, *Proc. R. Soc. London, Ser. A*, **95**(666), 83–99.
- Watson, G. N., 1919. The transmission of electric waves round the Earth, *Proc. R. Soc. London, Ser. A*, **95**(673), 546–563.

- Watson, G. N., 1995. *A Treatise on the Theory of Bessel Functions*, Cambridge Univ. Press, Cambridge, UK, 2nd edn.
- Watts, A. B., 1978. An analysis of isostasy in the world's oceans, 1, Hawaiian-Emperor seamount chain, *J. Geophys. Res.*, **83**(B12), 5989–6004.
- Watts, A. B., 2001. *Isostasy and Flexure of the Lithosphere*, Cambridge Univ. Press, Cambridge, UK.
- Watts, A. B. & Moore, J. D. P., 2017. Flexural isostasy: Constraints from gravity and topography power spectra, *J. Geophys. Res.*, **122**, 8417–8430, doi: 10.1002/2017JB014571.
- Watts, A. B. & Zhong, S., 2000. Observations of flexure and the rheology of oceanic lithosphere, *Geophys. J. Int.*, **142**, 855–875.
- Watts, A. B., Bodine, J. H. & Ribe, N. M., 1980. Observations of flexure and the geological evolution of the Pacific Ocean basin, *Nature*, **283**(5747), 532–537, doi: 10.1038/283532a0.
- Watts, A. B., ten Brink, U. S., Buhl, P. & Brocher, T. M., 1985. A multichannel seismic study of lithospheric flexure across the Hawaiian-Emperor seamount chain, *Nature*, **315**(6015), 105–111, doi: 10.1038/315105a0.
- Watts, A. B., Sandwell, D. T., Smith, W. H. F. & Wessel, P., 2006. Global gravity, bathymetry, and the distribution of submarine volcanism through space and time, *J. Geophys. Res.*, **111**(B8), B08408.
- Watts, D. J., Dodds, P. S. & Newman, M. E. J., 2002. Identity and search in social networks, *Science*, **296**(5571), 1302–1305.
- WAVEWATCH III, 2019, User manual and system documentation of WAVEWATCH III(R) version 6.07, Tech. Rep. 333, Environmental Modeling Center, Marine Modeling and Analysis Branch.
- Wdowinski, S. & Eriksson, S., 2009. Geodesy in the 21st century, *Eos Trans. AGU*, **90**(18), 153–155.
- Weatherall, P., Marks, K. M., Jakobsson, M., Schmitt, T., Tani, S., Arndt, J. E., Rovere, M., Chayes, D., Ferrini, V. & Wigley, R., 2015. A new digital bathymetric model of the world's oceans, *Earth Space Sci.*, **2**(8), 331–345, doi: 10.1002/2015EA000107.
- Webb, D. C., Simonetti, P. J. & Jones, C. P., 2001. SLOCUM: An underwater glider propelled by environmental energy, *IEEE J. Ocean. Eng.*, **26**(4), 447–452.
- Webb, S. C., 1988. Long-period acoustic and seismic measurements and ocean floor currents, *IEEE J. Ocean. Eng.*, **13**(4), 263–270.
- Webb, S. C., 1998. Broadband seismology and noise under the ocean, *Rev. Geophys.*, **36**(1), 105–142, doi: 10.1029/97RG02287.
- Webb, S. C. & Cox, C. S., 1986. Observations and modeling of seafloor microseisms, *J. Geophys. Res.*, **91**(B7), 7343–7358.

- Webb, S. C. & Crawford, W. C., 2003. Shallow-water broadband OBS seismology, *B. Seismol. Soc. Am.*, **100**(4), 1770–1778, doi: 10.1785/0120090203.
- Weber, R. C., Lin, P. Y., Garnero, E. J., Williams, Q. & Lognonné, P., 2011. Seismic detection of the lunar core, *Science*, **331**(6015), 309–312.
- Wedin, P. A., 1983. On angles between subspaces of a finite dimensional inner product space, *Matrix Pencils*, **973**, 263–285, doi: 10.1007/BFb0062107.
- Weeraratne, D. S., Forsyth, D. W. & Fischer, K. M., 2003. Evidence for an upper mantle plume beneath the Tanzanian craton from Rayleigh wave tomography, *J. Geophys. Res.*, **108**(B9), 2427, doi: 10.1029/2002JB002273.
- Weglein, A. B. & Secrest, B. G., 1990. Wavelet estimation for a multidimensional acoustic or elastic earth, *Geophysics*, **55**(7), 902–913, doi: 10.1190/1.1442905.
- Wei, L., Kennedy, R. A. & Lamahewa, T. A., 2010. Signal concentration on unit sphere: An azimuthally moment weighting approach, in *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, pp. 1–4, IEEE.
- Wei, L., Kennedy, R. A. & Lamahewa, T. A., 2011. Quadratic variational framework for signal design on the 2-sphere, *IEEE T. Signal Process.*, **59**(11), 5243–5252, doi: 10.1109/TSP.2011.2162506.
- Wei, S. S. & Chen, Y. J., 2016. Seismic evidence of the Hainan mantle plume by receiver function analysis in southern China, *Geophys. Res. Lett.*, **43**(17), 8978–8985, doi: 10.1002/2016GL069513.
- wei Zhou, H., 1990. Mapping of P-wave slab anomalies beneath the Tonga, Kermadec and New Hebrides arcs, *Phys. Earth Planet. Inter.*, **61**, 199–229.
- Weideman, J. A. C. & Reddy, S. C., 2000. A MATLAB differentiation matrix suite, *ACM T. Math. Software*, **26**(4), 465–519.
- Weidner, D. J., 1985. A mineral physics test of a pyrolite mantle, *Geophys. Res. Lett.*, **12**, 417–420.
- Weiss, B. P., Vali, H., Baudenbacher, F. J., Kirschvink, J. L., Stewart, S. T. & Shuster, D. L., 2002. Records of an ancient Martian magnetic field in ALH84001, *Earth Planet. Sci. Lett.*, **201**, 449–463.
- Welch, E. F., 2012, *Inversion of first order Eulerian gravitational potential perturbations for the seismic moment tensor: a normal modes approach*, A. B. Thesis, Princeton University.
- Welch, P. D., 1967. The use of Fast Fourier Transform for the estimation of power spectra: A method based on time averaging over short, modified periodograms, *IEEE Trans. Audio Electroacoust.*, **15**, 70–73.
- Wellman, P., 1976. Gravity trends and the growth of Australia: A tentative correlation, *J. Geol. Soc. Austral.*, **23**, 11–14.

- Wellman, P., 1979. On the isostatic compensation of Australian topography, *BMR J. Aust. Geol. Geophys.*, **4**, 373–382.
- Wellman, P., 1979. On the Cainozoic uplift of the southeastern Australian highland, *BMR J. Aust. Geol. Geophys.*, **26**, 1–9.
- Wellman, P., 1982. Australian seismic refraction results, isostasy and altitude anomalies, *Nature*, **298**, 138–841.
- Wellman, P., 1998, Mapping of geophysical domains in the Australian continental crust using gravity and magnetic anomalies, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klotwijk, vol. 26 of **Geodyn. Ser.**, pp. 59–71, Amer. Geophys. Union, Washington, D. C.
- Wen, L. & Helmberger, D. V., 1998. Ultra-low velocity zones near the core-mantle boundary from broadband *pkp* precursors, *Science*, **279**, 1701–1703.
- Wenk, H. R. & Tomé, C. N., 1999. Modeling dynamic recrystallization of olivine aggregates deformed in simple shear, *J. Geophys. Res.*, **104**(B11), 25513–25527.
- Wenk, H. R., Bennett, K., Canova, G. R. & Molinari, A., 1991. Modeling plastic-deformation of peridotite with the self-consistent theory, *J. Geophys. Res.*, **96**(B5), 8337–8349.
- Wenz, G. M., 1962. Acoustic ambient noise in the ocean: Spectra and sources, *J. Acoust. Soc. Am.*, **34**(12).
- Wenzhong, W., Xu, Y., Sun, D., Ni, S., Wentcovitch, R. & Wu, Z., 2020. Velocity and density characteristics of subducted oceanic crust and the origin of lower-mantle heterogeneities, *Nat. Commun.*, **11**(1), 1–8, doi: 10.1038/s41467-019-13720-2.
- Wernicke, B., Clayton, R., Ducea, M., Jones, C. H., Park, S., Ruppert, S., Saleeby, J., Snow, J. K., Squires, L., Fliedner, M., Jiracek, G., Keller, R., Klemperer, S., Luetgert, J., Malin, P., Miller, K., Mooney, W., Oliver, H. & Phinney, R., 1996. Origin of high mountains in the continents: The southern Sierra Nevada, *Science*, **271**, 190–193, doi: 10.1126/science.271.5246.190.
- Wesnousky, S. G., 2006. Predicting the endpoints of earthquake ruptures, *Nature*, **444**(358–360, doi: 10.1038/nature05275).
- Wessel, P., 2010. Tools for analyzing intersecting tracks: Tthe x2sys package, *Comput. Geosci.*, **36**, 348–354, doi: 10.1016/j.cageo.2009.05.009.
- Wessel, P. & Kroenke, L., 1997. A geometric technique for relocating hotspots and refining absolute plate motions, *Nature*, **387**(6631), 365–369, doi: 10.1038/387365a0.
- Wessel, P. & Smith, W. H. F., 1991. Free software helps map and display data, *EOS*, **72**(41), 441–446, doi: 10.1029/90EO00319.
- Wessel, P. & Smith, W. H. F., 1995. New version of the Generic Mapping Tools released, *Eos Trans. AGU*, **76**(33), 329, doi: 10.1002/2013EO450001.

- Wessel, P. & Smith, W. H. F., 1998. New, improved version of Generic Mapping Tools released, *Eos Trans. AGU*, **79**(47), 579, doi: 10.1029/98EO00426.
- Wessel, P., Sandwell, D. T. & Kim, S.-S., 2010. The global seamount census, *Oceanography*, **23**(1), 24–33, doi: 10.5670/oceanog.2010.60.
- Wessel, P., Smith, W. H. F., Scharroo, R., Luis, J. & Wobbe, F., 2013. Generic Mapping Tools: Improved version released, *Eos Trans. AGU*, **94**(45), 409–410, doi: 10.1002/2013EO450001.
- Westerhold, T., Röhl, U., Donner, B., McCarren, H. H. & Zachos, J. C., 2011. A complete high-resolution Paleocene benthic stable isotope record for the central Pacific (ODP Site 1209), *Paleoceanography*, **26**(2), PA2216, doi: 10.1029/2010PA002092.
- Waler, K. A. & Gubbins, D., 1981. Spherical harmonic analysis of the geomagnetic field: an example of a linear inverse problem, *Geophys. J. Int.*, **65**(3), 645–693, doi: 10.1111/j.1365–246X.1981.tb04877.x.
- Waler, K. A. & Purucker, M. E., 2005. A spatially continuous magnetization model for Mars, *J. Geophys. Res.*, **110**, E09001, doi: 10.1029/2004JE002393.
- Whipple, K. X., 1999. Geomorphic limits to climate-induced increases in topographic relief, *Nature*, **401**, 39–43.
- Whitchurch, A., 2015. Continental complexity, *Nature Geosci.*, **8**, 502, doi: 10.1038/ngeo2479.
- Whitehouse, P. L., Bentley, M. J., Milne, G. A., King, M. A. & Thomas, I. D., 2012. A new glacial isostatic adjustment model for Antarctica: calibrated and tested using observations of relative sea-level change and present-day uplift rates, *Geophys. J. Int.*, **190**(3), 1464–1482, doi: 10.1111/j.1365–246X.2012.05557.x.
- Whitmarsh, R. B., 1970. An ocean bottom pop-up seismic recorder, *Mar. Geophys. Res.*, **1**(1), 91–98, doi: 10.1007/BF00310012.
- Whitmarsh, R. B., Manatschal, G. & Minshull, T. A., 2001. Evolution of magma-poor continental margins from rifting to seafloor spreading, *Nature*, **413**, 150–154.
- Whitmore, N. D., 1983. Iterative depth migration by backward time propagation.
- Whitmore, N. D., Valenciano, A. A., Sollner, W. & Lu, S., 2010. Imaging of primaries and multiples using a dual-sensor towed streamer.
- Whittaker, J. M., Müller, R. D., Roest, W. R., Wessel, P. & Smith, W. H. F., 2008. How supercontinents and superoceans affect seafloor roughness, *Nature*, **456**, 938–941, doi: 10.1038/nature07573.
- Whittle, P., 1953. Estimation and information in stationary time series, *Arkiv Mat.*, **2**(23), 423–434.
- Whittle, P., 1954. On stationary processes in the plane, *Biometrika*, **41**(3–4), 434–449, doi: 10.2307/2332724.

- Whittle, P., 1983. *Prediction and regulation by linear least-square methods*, Blackwell, 2nd edn.
- Wiaux, Y., Jacques, L. & Vandergheynst, P., 2005. Correspondence principle between spherical and Euclidean wavelets, *Astroph. J.*, **632**, 15–28, doi: 10.1086/432926.
- Wiaux, Y., McEwen, J. D. & Vielva, P., 2007. Complex data processing: Fast wavelet analysis on the sphere, *J. Fourier Anal. Appl.*, **13**(4), 477–493, doi: 10.1007/s00041–006–6917–9.
- Wicht, J., Stellmach, S. & Harder, H., 2010, Numerical dynamo simulations: From basic concepts to realistic models, in *Handbook of Geomathematics*, edited by W. Freeden, M. Z. Nashed, & T. Sonar, chap. 16, pp. 459–502, doi: 10.1007/978–3–642–01546–5_16, Springer, Heidelberg, Germany.
- Widiyantoro, S., Gorbato, A., Kennett, B. L. N. & Fukao, Y., 2000. Improving global shear wave traveltimes tomography using three-dimensional ray tracing and iterative inversion, *Geophys. J. Int.*, **141**(3), 747–758, doi: 10.1046/j.1365–246x.2000.00112.x.
- Wieczorek, M., 2014. SHTOOLS: Version 2.9.1, *Zenodo*, p. doi: 10.5281/zenodo.12158.
- Wieczorek, M. A., 2007, The gravity and topography of the terrestrial planets, in *Treatise on Geophysics*, edited by T. Spohn, vol. 10, pp. 165–206, doi: 10.1016/B978–044452748–6/00156–5, Elsevier, Amsterdam, Neth.
- Wieczorek, M. A., 2008. Constraints on the composition of the martian south polar cap from gravity and topography, *Icarus*, **196**(2), 506–517, doi: 10.1016/j.icarus.2007.10.026.
- Wieczorek, M. A., 2015, The gravity and topography of the terrestrial planets, in *Treatise on Geophysics*, edited by T. Spohn, vol. 10, pp. 153–2193, doi: 10.1016/B978–0–444–53802–4.00169–X, Elsevier, Amsterdam, Neth., 2nd edn.
- Wieczorek, M. A. & Phillips, R. J., 1997. The structure and compensation of the lunar highland crust, *J. Geophys. Res.*, **102**(E5), 10933–10943.
- Wieczorek, M. A. & Phillips, R. J., 1998. Potential anomalies on a sphere: Applications to the thickness of the lunar crust, *J. Geophys. Res.*, **103**(E1), 1715–1724.
- Wieczorek, M. A. & Simons, F. J., 2005. Localized spectral analysis on the sphere, *Geophys. J. Int.*, **162**(3), 655–675, doi: 10.1111/j.1365–246X.2005.02687.x.
- Wieczorek, M. A. & Simons, F. J., 2007. Minimum-variance multitaper estimation on the sphere, *J. Fourier Anal. Appl.*, **13**(6), 665–692, doi: 10.1007/s00041–006–6904–1.
- Wielandt, E., 1975. Generation of seismic waves by underwater explosions, *Geophys. J. R. Astron. Soc.*, **40**, 421–439.
- Wielandt, E., 1980. First-order asymptotic theory of the polar phase shift of Rayleigh waves, *Pure Appl. Geophys.*, **118**, 1214–1227.

- Wielandt, E., 2012, Seismic sensors and their calibration, in *New Manual of Seismological Observatory Practice 2 (NMSOP-2)*, edited by P. Bormann, chap. 5, pp. 1–51, doi: 10.2312/GFZ.NMSOP-2_ch5, GeoForschungsZentrum, Potsdam, Germany.
- Wielandt, E. & Knopoff, L., 1982. Dispersion of very long-period Rayleigh waves along the East Pacific rise: Evidence for S wave velocity anomalies to 450 km depth, *J. Geophys. Res.*, **87**, 8631–8641.
- Wielandt, E. & Schenk, H., 1983. On systematic errors in phase-velocity analysis, *J. Geophys.*, **52**, 1–6.
- Wielandt, E. & Steim, K. M., 1986. A digital very-broad-band seismograph, *Ann. Geophys.–Germany*, **4**(3), 227–232.
- Wielandt, E. & Streckeisen, G., 1982. The leaf-spring seismometer: Design and performance, *B. Seismol. Soc. Am.*, **72**(6), 2349–2367.
- Wienecke, S., Braitenberg, C. & Götze, H.-J., 2007. A new analytical solution estimating the flexural rigidity in the Central Andes, *Geophys. J. Int.*, **169**(3), 789–794, doi: 10.1111/j.1365–246X.2007.3396.x.
- Wiens, D. A., McGuire, J. J. & Shore, P. J., 1993. Evidence for transformational faulting from a deep double seismic zone in Tonga, *Nature*, **364**, 790–793.
- Wiese, D. N., Nerem, R. S. & Han, S. C., 2011. Expected improvements in determining continental hydrology, ice mass variations, ocean bottom pressure signals, and earthquakes using two pairs of dedicated satellites for temporal gravity recovery, *J. Geophys. Res.*, **116**, B11405, doi: 10.1029/2011JB008375.
- Wiggins, R. A., 1972. The general linear inverse problem: Implication of surface waves and free oscillations for earth structure, *Rev. Geophys. Space Phys.*, **10**, 251–285.
- Wiggins, R. A. & Saito, M., 1971. Evaluation of computational algorithms for the associated Legendre polynomials by interval analysis, *B. Seismol. Soc. Am.*, **61**, 375–381.
- Wiggins, S. M. & Hildebrand, J. A., 2007, High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring, in *Symposium on Underwater Technology and Workshop on Scientific Use of Submarine Cables and Related Technologies, 2007*, pp. 551–557, doi: 10.1109/UT.2007.370760, IEEE.
- Wilcock, W. S. D., Webb, S. C. & Bjarnason, I. T., 1999. The effect of local wind on seismic noise near 1 Hz at the MELT site and in Iceland, *B. Seismol. Soc. Am.*, **89**(6), 1543–1557.
- Wilks, S. S., 1938. The large-sample distribution of the likelihood ratio for testing composite hypotheses, *Ann. Math. Stat.*, **9**(1), 60–62.
- Willeit, S. D., Chapman, D. S. & Neugebauer, H. J., 1985. A thermomechanical model of continental lithosphere, *Nature*, **314**(6011), 520–523.

- Williams, E. F., Fernández-Ruiz, M. R., Magalhaes, R., Vanthillo, R., Zhan, Z., González-Herráez, M. & Martins, H. F., 2019. Distributed sensing of microseisms and teleseisms with submarine dark fibers, *Nat. Commun.*, **10**, 5778, doi: 10.1038/s41467-019-13262-7.
- Williams, J.-P. & Nimmo, F., 2004. Thermal evolution of the Martian core: Implications for an early dynamo, *Geology*, **32**(2), 97–100, doi: 10.1130/G19975.1.
- Williams, S. D. P., Moore, P., King, M. A. & Whitehouse, P. L., 2014. Revisiting GRACE Antarctic ice mass trends and accelerations considering autocorrelation, *Earth Planet. Sci. Lett.*, **385**, 12–21, doi: 10.1016/j.epsl.2013.10.016.
- Williamson, P. R., 1991. A guide to the limits of resolution imposed by scattering in ray tomography, *Geophysics*, **56**(2), 202–207.
- Williamson, P. R. & Worthington, M. H., 1993. Resolution limits in ray tomography due to wave behavior: Numerical experiments, *Geophysics*, **58**, 727–735.
- Willis, J. K. & Fu, L.-L., 2008. Combining altimeter and subsurface float data to estimate the time-averaged circulation in the upper ocean, *J. Geophys. Res.*, **113**, C12017, doi: 10.1029/2007JC004690.
- Willis, V. L. H. J. J. & Banerdt, W. B., 1997, Tectonic overview and synthesis, in *Venus II: Geology, geophysics, atmosphere, and solar wind environment*, edited by S. W. Bougher, D. M. Hunten, & R. J. Phillips, p. 667, Univ. Ariz. Press, Tucson, AZ.
- Wilson, J. T., 1966. Did the Atlantic close and then re-open?, *Nature*, **211**, 676–681.
- Wilson, J. T., 1973. Mantle plumes and plate motions, *Tectonophysics*, **19**(2), 149–164, doi: 10.1016/0040-1951(73)90037-1.
- Winant, C. D., 1974. The descent of neutrally buoyant floats, *Deep-Sea Res.*, **21**, 445–453.
- Winch, D. E., 1966. A criticism of the Gram-Schmidt orthogonalization process applied to spherical harmonic analysis, *J. Geophys. Res.*, **71**(21), 5165–5170.
- Winch, D. E., Ivers, D. J., Turner, J. P. R. & Stening, R. J., 2005. Geomagnetism and Schmidt quasi-normalization, *Geophys. J. Int.*, **160**(2), 487–504.
- Windheuser, U., 1995, *Sphärische Wavelets: Theorie und Anwendungen in der Physikalischen Geodäsie*, Ph.D. thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern.
- Wingham, D. J., 1992. The reconstruction of a band-limited function and its Fourier transform from a finite number of samples at arbitrary locations by Singular Value Decomposition, *IEEE T. Signal Process.*, **40**(3), 559–570, doi: 10.1109/78.120799.
- Wit, J. S., 1981. Advances in antisubmarine warfare, *Sc. Am.*, **244**(2), 31–41.
- Withers, M., Aster, R., Young, C., Beiriger, J., Harris, M., Moore, S. & Trujillo, J., 1998. A comparison of select trigger algorithms for automated global seismic phase and event detection, *B. Seismol. Soc. Am.*, **88**(1), 95–106.

- Wittwer, T., Klees, R., Seitz, K. & Heck, B., 2008. Ultra-high degree spherical harmonic analysis and synthesis using extended-range arithmetic, *J. Geod.*, **82**, 223–229, doi: 10.1007/s00190-007-0172-y.
- Wölbern, I. & Rümpler, G., 2018. A sequence of up to 11 seismic discontinuities down to the midmantle beneath Southeast Asia, *Geochem. Geophys. Geosys.*, **19**(12), 4820–4835, doi: 10.1029/2018GC007827.
- Wolf, K., 2006, *Numerical aspects of harmonic spline wavelets for the satellite gravimetry problem*, Diploma thesis, Geomathematics Group, Dept. Mathematics, Univ. Kaiserslautern.
- Wolfe, C. J., 2002. On the mathematics of using difference operators to relocate earthquakes, *B. Seismol. Soc. Am.*, **92**(8), 2879–2892.
- Wolfe, C. J., Bjarnason, I. T., VanDecar, J. C. & Solomon, S. C., 1997. Seismic structure of the Iceland mantle plume, *Nature*, **385**(6613), 245–247.
- Wolfe, C. J., Bjarnason, I. T., VanDecar, J. C. & Solomon, S. C., 2002. Assessing the depth resolution of tomographic models of upper mantle structure beneath Iceland, *Geophys. Res. Lett.*, **29**(1), 1015, doi: 10.1029/2001GL013657.
- Wolfe, C. J., Solomon, S. C., Laske, G., Collins, J. A., Detrick, R. S., Orcutt, J. A., Bercovici, D. & Hauri, E. H., 2009. Mantle shear-wave velocity structure beneath the Hawaiian hot spot, *Science*, **326**(5958), 1388–1390, doi: 10.1126/science.1180165.
- Wong, A. P. S., Wijffels, S. E., Riser, S. C., Pouliquen, S., Hosoda, S., Roemmich, D., Gilson, J., Johnson, G. C., Martini, K., Murphy, D. J. et al., 2020. Argo data 1999–2019: Two million temperature-salinity profiles and subsurface velocity observations from a global array of profiling floats, *Front. Mar. Sci.*, pp. 700, doi: 10.3389/fmars.2020.00700.
- Wood, A. T. A. & Chan, G., 1994. Simulation of stationary Gaussian processes in $[0, 1]^d$, *J. Comput. Graph. Stat.*, pp. 409–432.
- Wood, B. J. & Helffrich, G. R., 1990. Internal structure of the Earth, *Nature*, **344**, 106.
- Wood, H. O., 1948. A possible layer for the transmission of fast *P* waves from surface disturbances, *B. Seismol. Soc. Am.*, **38**(1), 33–39.
- Wood, W. T., Holbrook, W. S., Sen, M. K. & Stoffa, P. L., 2008. Full waveform inversion of reflection seismic data for ocean temperature profiles, *Geophys. Res. Lett.*, **35**(4), doi: 10.1029/2007GL032359.
- Woodhouse, J. H., 1974. Surface waves in a laterally varying layered structure, *Geophys. J. R. Astron. Soc.*, **37**, 461–490.
- Woodhouse, J. H., 1976. On Rayleigh’s principle, *Geophys. J. R. Astron. Soc.*, **46**, 11–22.
- Woodhouse, J. H., 1988, The calculation of eigenfrequencies and eigenfunctions of the free oscillations of the Earth and the Sun, in *Seismological algorithms: Computational Methods and Computer Programs*, edited by D. J. Doornbos, chap. IV.2, Academic Press, San Diego, Calif.

- Woodhouse, J. H. & Dziewoński, A. M., 1984. Mapping the upper mantle: Three-dimensional modeling of Earth structure by inversion of seismic waveforms, *J. Geophys. Res.*, **89**(B7), 5953–5986.
- Woods, M. T., Lévêque, J.-J., Okal, E. A. & Cara, M., 1991. Two-station measurements of Rayleigh wave group velocity along the Hawai’ian Swell, *GRL*, **18**(1), 105–108.
- Woodward, M. J., 1992. Wave-equation tomography, *Geophysics*, **57**(1), 15–26, doi: 10.1190/1.1443179.
- Woodward, M. J., Nichols, D., Zdraveva, O., Whitfield, P. & Johns, T., 2008. A decade of tomography, *Geophysics*, **73**(5), VE5–VE11, doi: 10.1190/1.2969907.
- Woodward, R. L., Forte, A. M., Su, W.-j. & Dziewoński, A. M., 1993, Constraints on the large-scale structure of the Earth’s mantle, in *Evolution of the Earth and Planets*, edited by R. J. E. Takahashi & D. Rubie, vol. 74 of **Geophysical Monograph**, pp. 89–109, Amer. Geophys. Union, Washington, D. C.
- Wookey, J., Kendall, J.-M. & Barruol, G., 2002. Mid-mantle deformation inferred from seismic anisotropy, *Nature*, **415**, 777–780.
- Woollard, G. P., 1959. Crustal structure from gravity and seismic measurements, *J. Geophys. Res.*, **64**(10), 1521–1545.
- Worcester, P. F., Dzieciuch, M. A. & Sagen, H., 2020. Ocean acoustics in the rapidly changing arctic, *Acoustics Today*, **16**(1), 55–64, doi: 10.1121/AT.2020.16.1.55.
- Working Group, B., 1990. Evidence for early Proterozoic plate tectonics from seismic reflection profiles in the Baltic shield, *Nature*, **348**, 34–38.
- Workman, R. K. & Hart, S. R., 2005. Major and trace element composition of the depleted MORB mantle (DMM), *Earth Planet. Sci. Lett.*, **231**(1), 53–72, doi: 10.1016/j.epsl.2004.12.005.
- Wortel, M. J. R., 1984. Spatial and temporal variations in the Andean subduction zone, *J. Geol. Soc. London*, **141**, 783–791.
- Wortel, M. J. R. & Vlaar, N. J., 1978. Age-dependent subduction of oceanic lithosphere beneath western South America, *Phys. Earth Planet. Inter.*, **17**, 201–208.
- Wortel, M. J. R., Goes, S. D. B. & Spakman, W., 1990. Structure and seismicity of the Aegean subduction zone, *Terra Nova*, **2**, 554–562.
- Wortel, R. & Cloetingh, S., 1981. On the origin of the Cocos-Nazca spreading center, *Geology*, **9**, 425–430.
- Wouters, B., Chambers, D. & Schrama, E. J. O., 2008. GRACE observes small-scale mass loss in Greenland, *Geophys. Res. Lett.*, **35**, L20501, doi: 10.1029/2008GL034816.

- Wouters, B., Bamber, J. L., van den Broeke, M. R., Lenaerts, J. T. M. & Sasgen, I., 2013. Limits in detecting acceleration of ice sheet mass loss due to climate variability, *Nature Geosci.*, **6**(8), 613–616, doi: 10.1038/ngeo1874.
- Wright, I. C., Jr, W. W. C., de Cornel EJ Ronde, Reymond, D., Hyvernaud, O., Gennerich, H.-H., Stoffers, P., Mackay, K., Dunkin, M. A. & Bannister, S. C., 2008. Collapse and reconstruction of Monowai submarine volcano, Kermadec arc, 1998–2004, *J. Geophys. Res.*, **113**(B8), B08S03, doi: 10.1029/2007JB005138.
- Wu, F. V., Borisov, D., Simons, F. J. & Williamson, P., 2021, Waveform inversion for shear velocity and attenuation via the spectral-element adjoint method, in *SEG Tech. Prog. Expanded Abstracts*, pp. 697–701, doi: 10.1190/segam2021–3581151.1, Soc. Explor. Geophys., Denver, Col.
- Wu, G., Mainprize, J. G. & Yaffe, M. J., 2012. Spectral analysis of mammographic images using a multitaper method, *Medical Physics*, **39**(2), 801–810, doi: 10.1118/1.3676740.
- Wu, Q., Li, Y., Zhang, R. & Zeng, R., 2007. Wavelet modelling of broad-band receiver functions, *Geophys. J. Int.*, **170**, 534–544, doi: 10.1111/j.1365–246X.2007.03467.x.
- Wu, R.-S. & Aki, K., 1985. Scattering characteristics of elastic waves by an elastic heterogeneity, *Geophysics*, **50**(4), 582–595, doi: 10.1190/1.1441934.
- Wu, R.-S. & Flatté, S. M., 1990. Transmission fluctuations across an array and heterogeneities in the crust and upper mantle, *Pure Appl. Geophys.*, **132**(1–2), 175–196, doi: 10.1007/BF00874362.
- Wu, R.-S. & Toksöz, M. N., 1987. Diffraction tomography and multisource holography applied to seismic imaging, *Geophysics*, **52**(1), 11–25, doi: 10.1190/1.1442237.
- Wu, R.-S. & Xie, X.-B., 1991. Numerical tests of stochastic tomography, *Phys. Earth Planet. Inter.*, **67**, 180–193.
- Wu, R.-S. & Yang, F., 1997, Seismic imaging in wavelet domain: Decomposition and compression of imaging operator, in *Wavelet Applications in Signal and Image Processing V*, edited by A. Aldroubi, A. F. Laine, & M. A. Unser, vol. 3169, pp. 148–162, SPIE.
- Wu, R.-S. & Zheng, Y., 2014. Non-linear partial derivative and its DeWolf approximation for non-linear seismic inversion, *Geophys. J. Int.*, **196**(3), 1827–1843, doi: 10.1093/gji/ggt496.
- Wu, R.-S., Luo, J. & Wu, B., 2014. Seismic envelope inversion and modulation signal model, *Geophysics*, **79**(3), WA13–WA24, doi: 10.1190/GEO2013–0294.1.
- Wu, W. & Irving, J. C. E., 2018. Array-based iterative measurements of SmKS travel times and their constraints on outermost core structure, *Presented at 2018 Fall Meeting, AGU, Washington, D.C., 10–14 Dec*, abstract DI21B-0021, pp. DI21B–0021.
- Wu, W., Ni, S. & Irving, J. C. E., 2019. Inferring Earth’s discontinuous chemical layering from the 660-kilometer boundary topography, *Science*, **363**(6428), 736–740, doi: 10.1126/science.aav0822.

- Wu, W., Zhan, Z., Peng, S., Ni, S. & Callies, J., 2020. Seismic ocean thermometry, *Science*, **369**(6510), 1510–1515, doi: 10.1126/science.abb9519.
- Wu, X., Blom, R. G., Ivins, E. R., Oyafuso, F. A. & Zhong, M., 2009. Improved inverse and probabilistic methods for geophysical applications of GRACE gravity data, *Geophys. J. Int.*, **177**, 865–877, doi: 10.1111/j.1365–246X.2009.04141.x.
- Wu, X., Heflin, M. B., Schotman, H., Vermeersen, B. L. A., Dong, D., Gross, R. S., Ivins, E. R., Moore, A. W. & Owen, S. E., 2010. Simultaneous estimation of global present-day water transport and glacial isostatic adjustment, *Nature Geosci.*, **3**, 642–646, doi: 10.1038/ngeo938.
- Wu, Y.-M., Yen, H.-Y., Zhao, L., Huang, B.-S. & Liang, W.-T., 2006. Magnitude determination using initial *P*-waves: A single-station approach, *Geophys. Res. Lett.*, **33**, L05306, doi: 10.1029/2005GL025395.
- Wulveryck, J. M. & Mouze, D., 1999. Spectral response measurements of an X-ray sensor camera by a fluorescence wavelength dispersive spectrometer, *Rev. Sci. Instrum.*, **70**(9), 3549–3553.
- Wunsch, C., 1988. Transient tracers as a problem in control theory, *J. Geophys. Res.*, **93**(C7), 8099–8110.
- Wunsch, C., 2000. Moon, tides and climate, *Nature*, **405**, 743–744.
- Wunsch, C. & Heimbach, P., 2007. Practical global oceanic state estimation, *Physica D: Nonlinear Phenomena*, **230**(1), 197–208, doi: 10.1016/j.physd.2006.09.040.
- Wyssession, M., 1995. The inner workings of the Earth, *Am. Scientist*, **83**(2), 134–147.
- Wyssession, M. E., 1996. Large-scale structure at the core-mantle boundary from diffracted waves, *Nature*, **382**, 244–248.
- Wyssession, M. E., Valenzuela, R. W., Zhu, A.-N. & Bartkó, L., 1995. Investigating the base of the mantle using differential travel times, *Phys. Earth Planet. Inter.*, **92**, 67–84.
- Wyssession, M. E., Langenhorst, A., Fouch, M. J., Fischer, K. M., Al-Eqabi, G. I., Shore, P. J. & Clarke, T. J., 1999. Lateral variations in compressional/shear velocities at the base of the mantle, *Science*, **284**, 120–125.
- Xia, J., Miller, R. D. & Park, C. B., 1999. Estimation of near-surface shear-wave velocity by inversion of Rayleigh waves, *Geophysics*, **64**(3), 691–700, doi: 10.1190/1.1444578.
- Xia, J., Miller, R. D., Park, C. B. & Tian, G., 2002. Determining *Q* of near-surface materials from Rayleigh waves, *J. Appl. Geoph.*, **51**(2), 121–129, doi: 10.1016/S0926–9851(02)00228–8.
- Xia, J., Miller, R. D., Park, C. B. & Tian, G., 2003. Inversion of high frequency surface waves with fundamental and higher modes, *J. Glaciol.*, **52**(1), 45–57, doi: 10.1016/S0926–9851(02)00239–2.
- Xiao, H., Rokhlin, V. & Yarvin, N., 2001. Prolate spheroidal wavefunctions, quadrature and interpolation, *Inv. Probl.*, **17**, 805–838, doi: 10.1088/0266–5611/17/4/315.

- Xie, J. & Zhu, J., 2008. Estimation of the surface and mid-depth currents from Argo floats in the Pacific and error analysis, *J. Mar. Sys.*, **73**, 61–75, doi: 10.1016/j.jmarsys.2007.09.001.
- Xu, P., 1992. Determination of surface gravity anomalies using gradiometric observables, *Geophys. J. Int.*, **110**, 321–332.
- Xu, P., 1992. The value of minimum norm estimation of geopotential fields, *Geophys. J. Int.*, **111**, 170–178.
- Xu, P., 1998. Truncated SVD methods for discrete linear ill-posed problems, *Geophys. J. Int.*, **135**(2), 505–514, doi: 10.1046/j.1365–246X.1998.00652.x.
- Xu, P. & Grafarend, E., 1996. Statistics and geometry of the eigenspectra of three-dimensional second-rank symmetric random tensors, *Geophys. J. Int.*, **127**, 744–756, doi: 10.1111/j.1365–246X.1996.tb04053.x.
- Xu, Y.-L., 1996. Fast evaluation of the Gaunt coefficients, *Math. Comput.*, **65**(216), 1601–1612.
- Xu, Y.-L., 1997. Fast evaluation of Gaunt coefficients: recursive approach, *J. Comput. Appl. Math.*, **85**, 53–65.
- Yamakoshi, Y. & Sato, T., 1982. Iterative image restoration from data available in multiple restricted regions, *Appl. Opt.*, **21**(24), 4473–4480.
- Yamazaki, D., Ikeshima, D., Tawatari, R., Yamaguchi, T., O’Loughlin, F., Neal, J. C., Sampson, C. C., Kanae, S. & Bates, P. D., 2017. A high-accuracy map of global terrain elevations, *Geophys. Res. Lett.*, **44**, 5844–5853, doi: 10.1002/2017GL072874.
- Yamazaki, T. & Oda, H., 2002. Orbital influence on Earth’s magnetic field: 100,000-year periodicity in inclination, *Science*, **295**.
- Yang, H.-Y., Zhao, L. & Hung, S.-H., 2010. Synthetic seismograms by normal-mode summation: a new derivation and numerical examples, *Geophys. J. Int.*, **183**(3), 1613–1632, doi: 10.1111/j.1365–246X.2010.04820.x.
- Yang, Q. X., Lindquist, M. A., Shepp, L., Zhang, C.-H., Wang, J. & Smith, M. B., 2002. Two dimensional prolate spheroidal wave functions for MRI, *J. Magnet. Reson.*, **158**, 43–51.
- Yang, X., Pavlis, G. L. & Wang, Y., 2016. A quality control method for teleseismic *P*-wave receiver functions, *B. Seismol. Soc. Am.*, **106**(5), 1948–1962, doi: 10.1785/0120150347.
- Yanovskaya, T. B. & Ditmar, P. G., 1987. A generalization of the Backus-Gilbert method for the estimation of lateral variations of surface wave speed, *Izvestiya, Fizika Zemli*, **6**, 30–40 (in Russian).
- Yanovskaya, T. B. & Ditmar, P. G., 1990. Smoothness criteria in surface wave tomography, *Geophys. J. Int.*, **102**, 63–72.
- Yao, K., 1967. Application of reproducing kernel Hilbert spaces — Bandlimited signal models, *Inform. Control*, **11**(4), 429–444.

- Yao, T., Pu, J., Lu, A., Wang, Y. & Yu, W., 2007. Recent glacial retreat and its impact on hydrological processes on the Tibetan Plateau, China, and surrounding regions, *Arctic, Antarctic & Alpine Res.*, **39**(4), 642–650.
- Yao, Z. S. & Roberts, R. G., 1999. A practical regularization for seismic tomography, *Geophys. J. Int.*, **138**, 293–299.
- Yeo, B. T. T., Ou, W. & Golland, P., 2008. On the construction of invertible filter banks on the 2-sphere, *IEEE T. Image Proc.*, **17**(3), 283–300, doi: 10.1109/TIP.2007.915550.
- Yilmaz, Ö., 2001. *Seismic Data Analysis*, vol. 1–2, Soc. Explor. Geophys., Tulsa, OK.
- Yogodzinski, G. M., Lees, J. M., Churikova, T. G., Dorendorf, F., Wöerner, G. & Volynets, O. N., 2001. Geochemical evidence for the melting of subducting oceanic lithosphere at plate edges, *Nature*, **409**, 500–504.
- Yomogida, K., 1992. Fresnel zone inversion for lateral heterogeneities in the earth, *Pure Appl. Geophys.*, **138**(3), 391–406.
- Yoshizawa, K. & Kennett, B. L. N., 2002. Non-linear waveform inversion for surface waves with a neighbourhood algorithm—application to multimode dispersion measurements, *Geophys. J. Int.*, **149**, 118–133.
- Yoshizawa, K. & Kennett, B. L. N., 2002. Determination of the influence zone for surface wave paths, *Geophys. J. Int.*, **149**, 440–453, doi: 10.1046/j.1365–246X.2002.01659.x.
- Yoshizawa, K. & Kennett, B. L. N., 2004. Multimode surface wave tomography for the Australian region using a three-stage approach incorporating finite frequency effects, *J. Geophys. Res.*, **109**, B02310, doi: 10.1029/2002JB002254.
- Yoshizawa, K. & Kennett, B. L. N., 2005. Sensitivity kernels for finite-frequency surface waves, *Geophys. J. Int.*, **162**(3), 910–926, doi: 10.1111/j.1365–246X.2005.02707.x.
- Young, G. A. & Smith, R. L., 2005. *Essentials of Statistical Inference*, vol. 16 of **Cambridge Series on Statistical and Probabilistic Mathematics**, Cambridge Univ. Press, Cambridge, U.K.
- Young, G. B. & Braille, L. W., 1976. A computer program for the application of Zoeppritz's amplitude equations and Knott's energy equations, *B. Seismol. Soc. Am.*, **66**(6), 1881–1885.
- Young, P. C., 2015. Refined instrumental variable estimation: Maximum likelihood optimization of a unified boxjenkins model, *Automatica*, **52**, 35–46, doi: 10.1016/j.automatica.2014.10.126.
- Yu, C., Day, E. A., de Hoop, M. V., Campillo, M. & van der Hilst, R. D., 2017. Mapping mantle transition zone discontinuities beneath the Central Pacific with array processing of SS precursors, *J. Geophys. Res.*, **122**(12), 10–364, doi: 10.1002/2017JB014327.
- Yu, C., Day, E. A., de Hoop, M. V., Campillo, M., Goes, S., Blythe, R. A. & van der Hilst, R. D., 2018. Compositional heterogeneity near the base of the mantle transition zone beneath Hawaii, *Nat. Commun.*, **9**, 1266, doi: 10.1038/s41467–018–03654–6.

- Yu, Z., McMechan, G. A., Anno, P. D. & Ferguson, J. F., 2004. Wavelet transform-based prestack multiscale Kirchhoff migration, *Geophysics*, **69**(6), 1505–1512, doi: 10.1190/1.1836823.
- Yu, Z. J. & Russell, C. T., 2009. Rotation period of Jupiter from the observation of its magnetic field, *Geophys. Res. Lett.*, **36**, L20202, doi: 10.1029/2009GL040094.
- Yuan, D. & Nazarian, S., 1993. Automated surface wave method: Inversion technique, *J. Geotech. Eng.*, **119**(7), 1112–1126.
- Yuan, D. N., Sjogren, W. L., Konopliv, A. S. & Kucinskis, A. B., 2001. Gravity field of Mars: A 75th degree and order model, *J. Geophys. Res.*, **106**(E10), 23377–23401.
- Yuan, X., Kind, R., Li, X. & Wang, R., 2006. The *S* receiver functions: synthetics and data example, *Geophys. J. Int.*, **165**(2), 555–564, doi: 10.1111/j.1365–246X.2006.02885.x.
- Yuan, Y. O. & Simons, F. J., 2014. Multiscale adjoint waveform-difference tomography using wavelets, *Geophysics*, **79**(3), WA79–WA95, doi: 10.1190/GEO2013–0383.1.
- Yuan, Y. O., Simons, F. J. & Bozdağ, E., 2014, Full-waveform adjoint tomography in a multiscale perspective, in *SEG Tech. Prog. Expanded Abstracts*, pp. 1194–1199, doi: 10.1190/segam2014–0816.1, Soc. Explor. Geophys., Denver, Col.
- Yuan, Y. O., Simons, F. J. & Bozdağ, E., 2015. Multiscale adjoint tomography for surface and body waves, *Geophysics*, **80**(5), R281–R302, doi: 10.1190/GEO2014–0461.1.
- Yuan, Y. O., Simons, F. J. & Tromp, J., 2016. Double-difference adjoint seismic tomography, *Geophys. J. Int.*, **206**(3), 1599–1618, doi: 10.1093/gji/ggw233.
- Yuan, Y. O., Simons, F. J. & Tromp, J., 2016. Double-difference adjoint tomography, *Geophys. Res. Abstr.*, **18**, 9066.
- Yuan, Y. O., Bozdağ, E., Ciardelli, C., Gao, F. & Simons, F. J., 2019. The exponentiated phase measurement, and objective-function hybridization for adjoint waveform tomography, *Geophys. J. Int.*, **221**(2), 1145–1164, doi: 10.1093/gji/ggaa063.
- Yuen, D. A., Vincent, A. P., Kido, M. & Vecsey, L., 2002. Geophysical applications of multidimensional filtering with wavelets, *Pure Appl. Geophys.*, **159**(10), 2285–2309.
- Zaldarriaga, M. & Seljak, U., 1997. All-sky analysis of polarization in the microwave background, *Phys. Rev. D*, **55**(4), 1830–1840.
- Zaldarriaga, M. & Seljak, U., 2000. CMBFAST for spatially closed universes, *Astroph. J.*, **129**(2), 431–434.
- Zaldarriaga, M., Seljak, U. & Bertschinger, E., 1998. Integral solution for the microwave background anisotropies in nonflat universes, *Astroph. J.*, **494**(2), 491–502.
- Zamani, A., Samiee, J. & Kirby, J. F., 2013. Estimating the mechanical anisotropy of the Iranian lithosphere using the wavelet coherence method, *Tectonophysics*, **601**, 139–147. doi: 10.1016/j.tecto.2013.05.005.

- Zamani, A., Samiee, J. & Kirby, J. F., 2014. The effective elastic thickness of the lithosphere in the collision zone between Arabia and Eurasia in Iran, *J. Geod.*, p. doi: 10.1016/j.jog.2014.06.002.
- Zammit-Mangion, A., Rougier, J., Bamber, J. & Schön, N., 2014. Resolving the Antarctic contribution to sea-level rise: a hierarchical modelling framework, *Environmetrics*, **25**(4), 245–264, doi: 10.1002/env.224.
- Zanandrea, A., Neto, C. R., Rosa, R. R. & Ramos, F. F., 2000. Analysis of geomagnetic pulsations using multiwavelets spectral and polarization method, *Physica A*, **283**, 175–180.
- Zandt, G. & Ammon, C. J., 1995. Continental crustal composition constrained by measurements of crustal Poisson's ratio, *Nature*, **374**, 152–154.
- Zaroli, C., Lambotte, S. & Lévêque, J.-J., 2015. Joint inversion of normal-mode and finite-frequency *s*-wave data using an irregular tomographic grid, *Geophys. J. Int.*, **203**(3), 1665–1681, doi: 10.1093/gji/ggv388.
- Zaroli, C., Koelemeijer, P. & Lambootte, S., 2017. Toward seeing the Earth's interior through unbiased tomographic lenses, *Geophys. Res. Lett.*, **44**, 11399–11408, doi: 10.1002/2017GL074996.
- Zeitler, P. K., Meltzer, A. S., Koons, P. O., Craw, D., Hallet, B., Chamberlain, C. P., Kidd, W. S. F., Park, S. K., Seeber, L., Bishop, M. & Schroder, J., 2001. Erosion, Himalayan geodynamics, and the geomorphology of metamorphism, *GSA Today*, **11**, 4–9.
- Zelt, C. A. & Barton, P. J., 1998. Three-dimensional seismic refraction tomography: A comparison of two methods applied to data from the Faeroe Basin, *J. Geophys. Res.*, **103**(B4), 7187–7210.
- Zhang, H. & Thurber, C. H., 2003. Double-difference tomography: The method and its application to the Hayward Fault, California, *B. Seismol. Soc. Am.*, **93**(5), 1875–1889, doi: 10.1785/0120020190.
- Zhang, H., Thurber, C. & Rowe, C., 2003. Automatic *p*-wave arrival detection and picking with multiscale wavelet analysis for single-component recordings, *B. Seismol. Soc. Am.*, **93**(5), 1904–1912, doi: 10.1785/0120020241.
- Zhang, J., Tang, Y. & Li, H., 2017. STA/LTA fractal dimension algorithm of detecting the *p*-wave arrival, *B. Seismol. Soc. Am.*, **108**(1), 230–237, doi: 10.1785/0120170099.
- Zhang, M., Stephenson, P. J., O'Reilly, S. Y., McCulloch, M. T. & Norman, M., 2001. Petrogenesis and geodynamic implications of Late Cenozoic basalts in North Queensland, Australia: Trace element and Sr-Nd-Pb isotope evidence, *J. Petrol.*, **42**(4), 685–719.
- Zhang, Q., Mao, W., Zhou, H., Zhang, H. & Chen, Y., 2018. Hybrid-domain simultaneous-source full waveform inversion without crosstalk noise, *Geophys. J. Int.*, **215**(3), 1659–1681, doi: 10.1093/gji/ggy366.
- Zhang, S. Q. & Karato, S., 1995. Lattice preferred orientation of olivine aggregates deformed in simple shear, *Nature*, **375**(6534), 774–777.

- Zhang, S. X. & Chan, L. S., 2003. Possible effects of misidentified mode number on Rayleigh wave inversion, *J. Appl. Geoph.*, **53**(1), 17–29, doi: 10.1016/S0926–9851(03)00014–4.
- Zhang, X., 1994. Wavenumber spectrum of very short wind waves: An application of two-dimensional Slepian windows to spectral estimation, *J. Atmos. Ocean Tech.*, **11**, 489–505.
- Zhang, Y., Scheibner, E., Hobbs, B. E., Ord, A., Drummond, B. J. & Cox, S. J. D., 1998, Lithospheric structure in Southeast Australia: A model based on gravity, geoid and mechanical analyses, in *Structure and Evolution of the Australian Continent*, edited by J. Braun, J. C. Dooley, B. Goleby, R. D. van der Hilst, & C. Klootwijk, vol. 26 of **Geodyn. Ser.**, pp. 89–108, Amer. Geophys. Union, Washington, D. C.
- Zhang, Y. S. & Tanimoto, T., 1992. Ridges, hotspots and their interaction as observed in seismic velocity maps, *Nature*, **355**, 45–49.
- Zhang, Y.-S. & Tanimoto, T., 1993. High-resolution global upper-mantle structure and plate-tectonics, *J. Geophys. Res.*, **98**(B6), 9793–9823.
- Zhang, Z. M., Liou, J. G. & Coleman, R. G., 1984. An outline of the plate tectonics of China, *Geol. Soc. Amer. Bull.*, **95**, 295–312.
- Zhao, D., 2001. Seismological structure of subduction zones and its implications for arc magmatism and dynamics, *Phys. Earth Planet. Inter.*, **127**, 197–214.
- Zhao, D., 2015. *Multiscale Seismic Tomography*, Springer, Tokyo, Japan, doi: 10.1007/978-4-431-55360-1 edn.
- Zhao, D. & Lei, J., 2004. Seismic ray path variations in a 3D global velocity model, *Phys. Earth Planet. Inter.*, **141**, 153–166.
- Zhao, D., Horiuchi, S. & Hasegawa, A., 1990. 3-D seismic velocity structure of the crust and the uppermost mantle in the northeastern Japan Arc, *Tectonophysics*, **181**, 135–149.
- Zhao, D., Horiuchi, S. & Hasegawa, A., 1992. Seismic velocity structure of the crust beneath the Japan Islands, *Tectonophysics*, **212**, 289–301.
- Zhao, D., Matsuzawa, T. & Hasegawa, A., 1997. Morphology of the subducting slab boundary in the northeastern Japan arc, *Phys. Earth Planet. Inter.*, **102**, 89–104.
- Zhao, D., Xu, Y., Wiens, D. A., Dorman, L., Hildebrand, J. & Webb, S., 1997. Depth extent of the Lau back-arc spreading center and its relation to subduction processes, *Science*, **278**(5336), 254–257, doi: 10.1126/science.278.5336.254.
- Zhao, D., Xu, Y., Wiens, D. A., Dorman, L., Hildebrand, J. & Webb, S., 1997. Depth extent of the Lau backarc spreading center and its relationship to subduction processes, *Science*, **278**, 254–257, doi: 10.1126/science.278.5336.254.
- Zhao, L. & Chevrot, S., 2003. SS-wave sensitivity to upper mantle structure: Implications for the mapping of transition zone discontinuity topographies, *Geophys. Res. Lett.*, **30**(11), 1590, doi: 10.1029/2003GL017223.

- Zhao, L. & Dahlen, F. A., 1993. Asymptotic eigenfrequencies of the Earth's normal modes, *Geophys. J. Int.*, **115**, 729–758.
- Zhao, L. & Dahlen, F. A., 1995. Asymptotic normal modes of the Earth — II. Eigenfunctions, *Geophys. J. Int.*, **121**, 585–626.
- Zhao, L. & Dahlen, F. A., 1995. Asymptotic normal modes of the Earth — III. Fréchet kernel and group velocity, *Geophys. J. Int.*, **122**, 299–325.
- Zhao, L. & Dahlen, F. A., 1996. Mode-sum to ray-sum transformation in a spherical and an aspherical earth, *Geophys. J. Int.*, **126**, 389–412.
- Zhao, L. & Jordan, T. H., 1998. Sensitivity of frequency-dependent traveltimes to laterally heterogeneous, anisotropic Earth structure, *Geophys. J. Int.*, **133**, 683–704.
- Zhao, L. & Jordan, T. H., 2006. Structural sensitivities of finite-frequency seismic waves: a full-wave approach, *Geophys. J. Int.*, **165**(3), 981–990, doi: 10.1111/j.1365-246X.2006.02993.x.
- Zhao, L., Jordan, T. H. & Chapman, C. H., 2000. Three-dimensional Fréchet differential kernels for seismic delay times, *Geophys. J. Int.*, **141**(3), 558–576, doi: 10.1046/j.1365-246x.2000.00085.x.
- Zhao, L.-S. & Helmberger, D. V., 1994. Source estimation from broadband regional seismograms, *B. Seismol. Soc. Am.*, **84**(1), 91–104.
- Zhong, S., 1997. Dynamics of crustal compensation and its influences on crustal isostasy, *J. Geophys. Res.*, **102**(B7), 15287–15299.
- Zhong, S. & Gurnis, M., 1995. Mantle convection with plates and mobile, faulted plate margins, *Science*, **267**, 838–843.
- Zhong, S. & Gurnis, M., 1996. Interaction of weak faults and non-newtonian rheology produces plate tectonics in a 3D model of mantle flow, *Nature*, **383**, 245–247.
- Zhong, S. & Zuber, M. T., 2000. Long-wavelength topographic relaxation for self-gravitating planets and implications for the time-dependent compensation of surface topography, *J. Geophys. Res.*, **105**(E2), 4153–4164.
- Zhou, H.-W., Hu, H., Zou, Z., Wo, Y. & Youn, O., 2018. Reverse time migration: A prospect of seismic imaging methodology, *Earth Sci. Rev.*, **179**, 207–227, doi: 10.1016/j.earscirev.2018.02.008.
- Zhou, Y., 2009. Surface-wave sensitivity to 3-D anelasticity, *Geophys. J. Int.*, **178**(3), 1403–1410, doi: 10.1111/j.1365-246X.2009.04230.x.
- Zhou, Y., Rushforth, C. K. & Frost, R. L., 1984. Singular value decomposition, singular vectors, and the discrete prolate spheroidal sequences, *Proc. IEEE Int. Conf. Acoust. Speech Signal Process.*, **9**(1), 92–95.

- Zhou, Y., Dahlen, F. A. & Nolet, G., 2004. Three-dimensional sensitivity kernels for surface wave observables, *Geophys. J. Int.*, **158**(1), 142–168, doi: 10.1111/j.1365–246X.2004.02324.x.
- Zhou, Y., Dahlen, F. A. & Nolet, G., 2005. Finite-frequency effects in global surface-wave tomography, *Geophys. J. Int.*, **163**(3), 1087–1111, doi: 10.1111/j.1365–246X.2005.02780.x.
- Zhu, H. & Tromp, J., 2013. Mapping tectonic deformation in the crust and upper mantle beneath Europe and the North Atlantic Ocean, *Science*, **341**(6148), 871–875, doi: 10.1126/science.1241335.
- Zhu, H., Luo, Y., Nissen-Meyer, T., Morency, C. & Tromp, J., 2009. Elastic imaging and time-lapse migration based on adjoint methods, *Geophysics*, **74**(6), WCA167–WCA177, doi: 10.1190/1.3261747.
- Zhu, H., Bozdağ, E., Peter, D. & Tromp, J., 2012. Structure of the European upper mantle revealed by adjoint tomography, *Nature Geosci.*, **5**(7), 493–498, doi: 10.1038/ngeo1501.
- Zhu, H., Bozdağ, E., Duffy, T. S. & Tromp, J., 2013. Seismic attenuation beneath Europe and the North Atlantic: Implications for water in the mantle, *Earth Planet. Sci. Lett.*, **381**, 1–11, doi: 10.1016/j.epsl.2013.08.030.
- Zhu, W., Mousavi, S. M. & Beroza, G. C., 2019. Seismic signal denoising and decomposition using deep neural networks, *IEEE T. Geosci. Remote*, **57**(11), 9476–9488.
- Zielhuis, A., 1992, *S-Wave Velocity below Europe from Delay-Time and Waveform Inversions*, Ph.D. thesis, Utrecht Univ., Utrecht, Neth.
- Zielhuis, A. & Nolet, G., 1994. Shear-wave velocity variations in the upper-mantle beneath central Europe, *Geophys. J. Int.*, **117**, 695–715.
- Zielhuis, A. & Nolet, G., 1994. Deep seismic expression of an ancient plate boundary in Europe, *Science*, **265**, 79–81.
- Zielhuis, A. & van der Hilst, R. D., 1996. Upper-mantle shear velocity beneath eastern Australia from inversion of waveforms from SKIPPY portable arrays, *Geophys. J. Int.*, **127**, 1–16.
- Zienkiewicz, O. C., 1977. *The Finite Element Method*, McGraw-Hill, London, UK, 3rd edn.
- Zoback, M. L., 1992. First- and second-order patterns of stress in the lithosphere: The World Stress Map project, *J. Geophys. Res.*, **97**(B8), 11703–11728.
- Zuber, M. T., 2001. The crust and mantle of Mars, *Nature*, **412**, 220–227.
- Zuber, M. T. & Parmentier, E. M., 1996. Finite amplitude folding of a continuously viscosity-stratified lithosphere, *J. Geophys. Res.*, **101**(B3), 5489–5498.
- Zuber, M. T., Bechtel, T. D. & Forsyth, D. W., 1989. Effective elastic thicknesses of the lithosphere and mechanisms of isostatic compensation in Australia, *J. Geophys. Res.*, **94**(B7), 9353–9367.

- Zuber, M. T., Smith, D. E., Lemoine, F. G. & Neumann, G. A., 1994. The shape and internal structure of the Moon from the Clementine mission, *Science*, **266**, 1839–1843.
- Zuber, M. T., Smith, D. E., Solomon, S. C., Abshire, J. B., Afzal, R. S., Aharonson, O., Fishbaugh, K., Ford, P. G., Frey, H. V., Garvin, J. B., Head, J. W., Ivanov, A. B., Johnson, C. L., Muhleman, D. O., Neumann, G. A., Pettengill, G. H., Phillips, R. J., Sun, X., Zwally, H. J., Banerdt, W. B. & Duxbury, T. C., 1998. Observations of the North polar region of Mars from the Mars Orbiter Laser Altimeter, *Science*, **282**, 2053–2060.
- Zuber, M. T., Smith, D. E., Cheng, A. F., Garvin, J. B., Aharonson, O., Cole, T. D., Dunn, P. J., Guo, Y., Lemoine, F. G., Neumann, G. A., Rowlands, D. D. & Torrence, M. H., 2000. The shape of 433 Eros from the NEAR-Shoemaker Laser Rangefinder, *Science*, **289**, 2097–2101.
- Zuber, M. T., Solomon, S. C., Phillips, R. J., Smith, D. E., Tyler, G. L., Aharonson, O., Balmino, G., Banerdt, W. B., Head, J. W., Johnson, C. L., Lemoine, F. G., McGovern, P. J., Neumann, G. A., Rowlands, D. D. & Zhong, S., 2000. Internal structure and early thermal evolution of Mars from Mars Global Surveyor topography and gravity, *Science*, **287**(5459), 1788–1793.
- Zuberi, A. & Alkhalifah, T., 2013. Imaging by forward propagating the data: Theory and application, *Geophysics*, **61**, 248–267, doi: 10.1111/1365-2478.12006.
- Zwally, H. J., Li, J., Brenner, A. C., Beckley, M., Cornejo, H. G., DiMarzio, J., Giovinetto, M. B., Neumann, T. A., Robbins, J., Saba, J. L., Yi, D. & Wang, W., 2011. Greenland ice sheet mass balance: distribution of increased mass loss with climate warming; 2003–07 versus 1992–2002, *J. Glaciol.*, **57**(201), 88–102.
- Zwally, H. J., Giovinetto, M. B., Beckley, M. A. & Saba, J. L., 2012, Antarctic and Greenland drainage systems, http://icesat4.gsfc.nasa.gov/cryo_data/ant_grn_drainage_systems.php, GSFC Cryospheric Sciences Laboratory, Greenbelt, Md.
- Zwally, H. J., Li, J., Robbins, J. W., Saba, J. L., Yi, D. & Brenner, A. C., 2015. Mass gains of the Antractic ice sheet exceed losses, *J. Glaciol.*, **61**(230), 1019–1036, doi: 10.3189/2015JoG15J071.