Lindsey J. Heagy

Postdoctoral Researcher
Department of Statistics
University of California, Berkeley

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Research Interests

Themes

- Computational and data-science techniques for geoscience problems relevant to society
- Combining geophysical inversion strategies and statistical techniques to integrate heterogeneous data types (e.g. geophysical, geologic, hydrologic, and rock-physics data).
- Interactive computing for data-driven interpretation

Current Projects

- Interactive, high-performance computing for geophysical simulations and inversions using Jupyter on NERSC
- Machine learning in physics: examining neural networks for data governed by partial differential equations
- Electromagnetic geophysical methods in settings with large contrasts electrical and magnetic physical properties

Education

2012 – 2018 **PhD** in Geophysics, University of British Columbia
Thesis: Electromagnetic imaging for subsurface injections
Advisor: Douglas Oldenburg
Themes: inverse problems, numerical simulations, electromagnetics

2008 – 2012 **BSc** with Honors in Geophysics, University of Alberta
First Class Honors

Appointments

Nov. 2018 – present **Postdoctoral Researcher**, Department of Statistics, University of California, Berkeley
Advisor: Fernando Pérez
Themes: Machine learning in the physical sciences, interactive computing, statistical techniques for geoscience

Professional Experience

Apr. 2016 – Sep. 2017 **Aranz Geo Canada Limited** (Calgary, AB)
Computational Geophysics Consultant (part-time)

Nov. 2015 – Apr. 2016 **3point Science Inc** (Calgary, AB)
Computational Geophysicist (part-time)

Jun. 2014 – Aug. 2014 **Schlumberger Doll Research** (Boston, MA)
Geophysics Intern

Jun. 2013 – Aug. 2013 **Schlumberger Electromagnetic Imaging** (Richmond, CA)
Geophysics Intern

May 2012 – Aug. 2012 **ConocoPhillips Canada** (Calgary, AB)
Geophysics Summer Student

May 2011 – Aug. 2011 **Alfred Wegener Institute of Polar and Marine Research** (Bremerhaven, Germany)
Geophysics Summer Student

Awards

2016 **UBC Library: Innovative Dissemination of Research Award**
Awarded for the SimPEG framework and community development. With Rowan Cockett and Seogi Kang. ($1,000)

2014 – 2017 **NSERC Vanier Scholarship**
Vanier Scholars demonstrate leadership skills and a high standard of scholarly achievement in graduate studies in the social sciences and/or humanities, natural sciences and/or engineering and health. The Vanier Scholarship is the top graduate scholarship in Canada. ($50,000 × 3)

2014 – 2017 **Alexander Graham Bell Canada Graduate Scholarship**
Awarded to high caliber scholars who are engaged in a doctoral program in the natural sciences or engineering ($35,000 × 3, declined)

2014 – 2018 **Four Year Fellowship (FYF) for PhD Students**
Selection based on academic excellence, upon the recommendation of the graduate program at UBC ($18,000 × 4, declined 3/4)

2013 **Special UBC Graduate Scholarship - W.H. Mathews Scholarship**
Awarded for academic achievement in Earth, Ocean and Atmospheric Sciences at UBC ($5,000)

2012 **Governor General's Silver Medal**
Awarded annually to the three undergraduate students (institution-wide) who achieve the highest academic standing overall upon graduation from his/her Bachelor degree program.

2012 **Lieutenant-Governor's Gold Medal**
Awarded to the convocating student from an Honours program in the Faculty of Science who has shown the highest distinction in scholarship (University of Alberta)

2012 **APEGGA Past Presidents' Medal in Geophysics**
Awarded to the convocating student who is a Canadian Citizen or Permanent Resident with the highest academic standing in a specialization or honours program in Geophysics on the basis of the final year

2011 **The APEGGA Scholarship in Geophysics**
Awarded on the basis of superior academic achievement in Honors Geophysics or Specialization in Geophysics ($3,000 × 2)

2010 – 2012 **The David K Robertson Award in Geophysics and Geology**
Awarded to a student entering the third year of a BSc Specializing in Geology or Geophysics on the basis of passion and talent in their field of study, demonstrated leadership, participation in extracurricular activities, and academic standing. ($\$5,000 \times 2$)

2010 – 2012 **The Encana Geology and Geophysics Scholarship**
Awarded to student(s) with superior academic achievement entering the third or fourth year of study for a Bachelor of Science with a major in Geology or Geophysical Sciences. ($\$3,500 \times 2$)

2009 – 2011 **Louise McKinney Post Secondary Scholarship, Government of Alberta**
Recognizes students for their academic achievements at a provincial level and encourages them to continue in their undergraduate program of study ($\$2,500 \times 3$)

2009 **Pearl Cuthbertson Memorial Award**
Awarded to a student entering the second year of study for a Bachelor of Science degree who has completed Science 100. Selection based on academic standing and demonstrated determination, curiosity and enthusiasm for science. ($\$2,000 \times 2$)

2009 **Pearson Book Prize**
Awarded for academic achievement in Writing Studies in Science 100

2008 – 2012 **Dean's Honor Roll, University of Alberta**
Awarded for academic achievement ($\times 4$)

Grants

Pending

2019 **Senior Personnel**: NSF - EarthCube Data Capabilities: Collaborative Proposal: Jupyter meets the Earth: Enabling discovery in geoscience through interactive computing at scale
PIs: Fernando Pérez (UC Berkeley), Laurel Larsen (UC Berkeley), Joe Hamman (NCAR)

2019 **Senior Personnel**: NSF - INFEWS/T3 RCN to Facilitate collaboration through the sharing of FEW data and methods
PI: Rosemary Knight (Stanford), co-PIs: Fernando Pérez (UC Berkeley), Isha Ray (UC Berkeley), Mark Lubell (UC Davis), Kate Maher (Stanford)

Awarded

2019 **Senior Personnel**: Geoscientists Without Borders ($\$50,000$)
Improving Water Security in Mon State, Myanmar via Geophysical Capacity Building
PI: Douglas Oldenburg (UBC)

Completed

2014 **co-PI**: Science Center for Learning and Teaching - Development Grant ($\$2,500$)
For development of online interactive resources for undergraduate geophysics at the University of British Columbia
PI: Douglas Oldenburg (UBC)

Publications

Peer Reviewed Publications (submitted or in review)

2019 Fournier, D., **Heagy, L. J.** & Oldenburg, D. W., 2019. Sparse magnetic vector inversion in spherical coordinates: Application to the Kevitsa Ni-Cu-PGE magnetic anomaly, Finland. *Geophysics* **(submitted)**

Heagy, L. J. & Oldenburg, D. W., 2019. Direct current resistivity with steel-cased wells. *Geophysical Journal International* **(in revision)**. arXiv:1810.12446

Heagy, L. J., Kang, S., Cockett, R. & Oldenburg, D. W., 2019. Open source software for simulations and inversions of airborne electromagnetic data. *Exploration Geophysics* **(in press)**. arXiv:1902.08238

Kang, S., Oldenburg, D. W. & **Heagy, L. J.** & 2019. Detecting induced polarization effects in time-domain data: a modeling study using stretched exponentials. *Exploration Geophysics* **(in press)**.

Peer Reviewed Publications

2019 **Heagy, L. J.** & Oldenburg, D. W., 2019. Modeling electromagnetics on cylindrical meshes with applications to steel-cased wells. *Computers & Geosciences*. doi:10.1016/j.cageo.2018.11.010

2018 Cockett, R., **Heagy, L. J.** & Haber, E., 2018. Efficient 3D inversions using the Richards equation. *Computers & Geosciences*. doi:10.1016/j.cageo.2018.04.006

2017 **Heagy, L. J.**, Cockett, R., Kang, S., Rosenkjaer, G. K., & Oldenburg, D. W., 2017. A framework for simulation and inversion in electromagnetics. *Computers & Geosciences*. doi:10.1016/j.cageo.2017.06.018

2016 Caudillo-Mata, L. A., Haber, E., **Heagy, L. J.** & Schwarzbach, C., 2016. A framework for the upscaling of the electrical conductivity in the quasi-static Maxwell's equations. *Journal of Computational and Applied Mathematics*. doi:10.1016/j.cam.2016.11.051

2015 Cockett, R., Kang, S., **Heagy, L. J.**, Pidlisecky, A. & Oldenburg, D. W., 2015. SimPEG: An open source framework for simulation and gradient based parameter estimation in geophysical applications. *Computers & Geosciences*. doi:10.1016/j.cageo.2015.09.015

Non Peer Reviewed Publications

2018 Barba, L. A., Barker, L. J., Blank, D. S., Brown, J., Downey, A. B., George, T., **Heagy, L. J.**, Mandli, K. T., Moore, J. K., Lippert, D., Niemeyer, K. E., Watkins, R. R., West, R. H., Wickes, E., Willing, C., & Zingale M., 2018. Teaching and Learning with Jupyter. (https://jupyter4edu.github.io/jupyter-edu-book/)

2017 Kang, S., **Heagy, L. J.**, Cockett, R., & Oldenburg, D. W., 2017. Exploring nonlinear inversions: A 1D magnetotelluric example. *The Leading Edge*. doi:10.1190/tle36080696.1

2016 Cockett, R., **Heagy, L. J.** & Oldenburg D. W., 2016. Pixels and their neighbors: Finite volume. *The Leading Edge*. doi:10.1190/tle35080703.1

Patents

2014 Wilt, M., Cuevas, N., & **Heagy L. J.**, 2014. Determining proppant and fluid distribution. *US Patent App. 14/494,313*

Presentations

(∗ : invited, † : award)

2019 ∗ [upcoming] **Heagy, L. J.** & Oldenburg, D. W., 2019. Exploring the Physics of Electromagnetics with Steel-Cased Wells Using Open-Source Tools. *International Union of Geodesy and Geophysics (IUGG) 2019*

∗ [upcoming] **Heagy, L. J.**, 2019. Sharing Reproducible Computations on Binder. *Symposium on Data Science and Statistics (SDSS) 2019*

2018 ∗ **Heagy, L. J.**, Kang, S., Cockett, R., &Oldenburg, D. W., 2018. Open source software for simulations and inversions of airborne electromagnetic data. *AEM 2018: 7th International Workshop on Airborne Electromagnetics*

2017 **Heagy, L. J.**, Cockett, R. & Oldenburg, D. W., 2017. Modular electromagnetic simulations with applications to steel cased wells. *6th International Symposium on Three-Dimensional Electromagnetics*.

Heagy, L. J. & Cockett, R., 2017. Deploying a reproducible course. *JupyterCon 2017*. youtube: https://youtu.be/XY3Tq9Wd1_A

Heagy, L. J. & Cockett, R., 2017. Interactive Geophysics. *SciPy Conference*. youtube: https://youtu.be/NuUe2ja5LCE

Heagy L. J., Fournier, D., Kang, S. & Miller, C., 2017. Simulation and parameter estimation in geophysics. *British Columbia Geophysical Society Meeting*

Heagy, L. J.,, 2016. Using open source tools to refactor geoscience education. *SciPy Conference*. youtube: https://youtu.be/IW2LDsevvDk

∗ **Heagy, L. J.**, Cockett, R., & Oldenburg, D. W., 2016. GeoSci: practices to collaboratively build online resources for geophysics education. *AGU Fall Meeting*

∗ **Heagy, L. J.** & Oldenburg, D. W., 2016. Examining the impact of steel cased wells on electromagnetic signals. *AGU Fall Meeting*

∗ Kang, S., Cockett, R., **Heagy, L. J.** and Oldenburg, D. W., 2016. Practices to enable the geophysical research spectrum: from fundamentals to applications. *AGU Fall Meeting*

Yang, D., Oldenburg, D. W. & **Heagy, L. J.**, 2016. 3D DC resistivity modeling of steel casing for reservoir monitoring using equivalent resistor network. *SEG Annual Meeting*. doi:10.1190/segam2016-13868475.1

2015 Cockett, R., **Heagy, L. J.**, Kang, S. & Rosenkjaer, G. K., 2015. Development practices and lessons learned in developing SimPEG. *AGU Fall Meeting*

Heagy, L. J., 2015. Using Python to Span the Gap between Education, Research, and Industry Applications in Geophysics. *SciPy Conference*. youtube: https://youtu.be/4msHJMBvzaI

Heagy, L. J., Cockett, R., Kang, S., Rosenkjaer, G. K. & Oldenburg, D. W., 2015. simpegEM: An open-source resource for simulation and parameter estimation problems in electromagnetic geophysics. *AGU Fall Meeting*

Heagy, L. J., Cockett, R., Kang, S. & Oldenburg, D. W., 2015. Real simulation tools in introductory courses: packaging and repurposing our research code. *AGU Fall Meeting*

Heagy, L. J., Cockett, R., Oldenburg, D. W. & Wilt, M., 2015. Modelling electromagnetic problems in the presence of cased wells. *SEG Annual Meeting*. doi:10.1190/segam2015-5931035.1

Kang, S., Cockett, R., **Heagy, L. J.**, & Oldenburg, D. W., 2015. Moving between dimensions in electromagnetic inversions. *SEG Annual Meeting*. doi:10.1190/segam2015-5930379.1

2014

Caudillo-Mata, L. A., Haber, E., **Heagy, L. J.**, & Oldenburg, D. W., 2014. Numerical upscaling of electrical conductivity: A problem specific approach to generate coarse-scale models. *SEG Annual Meeting*. doi:10.1190/segam2014-1488.1

Devriese, S. G. R., Corcoran, N., Cowan, D., Davis, K., Bild-Enkin, D., Fournier, D., **Heagy, L. J.**, Kang, S., Marchant, D., McMillan, M. S., Mitchell, M., Rosenkjar, G. K., Yang, D. & Oldenburg, D. W., 2014. Magnetic inversion of three airborne data sets over the Tli Kwi Cho kimberlite complex. *SEG Annual Meeting*. doi:10.1190/segam2014-1205.1

Fournier, D., **Heagy, L. J.**, Corcoran, N., Cowan, D., Devriese, S. G. R., Bild-Enkin, D., Davis, K., Kang, S., Marchant, D., McMillan, M. S., Mitchell, M., Rosenkjar, G. K., Yang, D., Oldenburg, D. W., 2014. Multi-EM systems inversion - Towards a common conductivity model for the Tli Kwi Cho complex. *SEG Annual Meeting*. doi:10.1190/segam2014-1110.1

Fournier, D., **Heagy, L. J.**, Corcoran, N., Cowan, D., Devriese, S. G. R., Bild-Enkin, D., Davis, K., Kang, S., Marchant, D., McMillan, M. S., Mitchell, M., Rosenkjar, G. K., Yang, D., Oldenburg, D. W., 2014. Multi-EM systems inversion - Towards a common conductivity model for the Tli Kwi Cho complex. *SEG Annual Meeting*. doi:10.1190/segam2014-1110.1

Heagy, L. J., Cockett, R., & Oldenburg, D. W., 2014. Parametrized inversion framework for proppant volume in a hydraulically fractured reservoir. *SEG Annual Meeting*. doi:10.1190/segam2014-1639.1

†**Heagy, L. J.**, Oldenburg, D. W. & Chen, J., 2014. Where does the proppant go? Examining the application of electromagnetic methods for hydraulic fracture characterization. *CSEG GeoConvention*

† Student Honourable Mention: Integrated Poster

∗ **Heagy, L. J.** & Oldenburg, D. W., 2014. Using electromagnetics to delineate proppant distribution in a hydraulically fractured reservoir. *SEG Development and Production Forum, Santa Rosa CA.*

Wilt, M., **Heagy, L. J.** & Chen, J., 2014. Hydrofracture Mapping and Monitoring with Borehole Electromagnetic (EM) Methods. *76th EAGE Conference and Exhibition*

2013 † **Heagy L. J.** & Oldenburg, D. W., 2013. Investigating the potential of using conductive or permeable proppant particles for hydraulic fracture characterization. *SEG Annual Meeting*. doi:10.1190/segam2013-1372.1
† Award of Merit (Best Student Paper, Annual Meeting

Software and Open Science

I contribute to a number of open-source software projects, all of which are accessible through my GitHub profile https://github.com/lheagy. Some of larger projects include:

2014 – present **GeoSci.xyz**
Core maintainer and contributor to online interactive textbooks for geophysics (http://geosci.xyz). Resources include:

- **Geophysics for Practicing Geoscientists:** an introductory resource on applied geophysics (http://gpg.geosci.xyz)
- **Electromagnetic Geophysics:** a graduate level resource on the theory and application of electromagnetic geophysical methods (http://gpg.geosci.xyz)
- **GeoSci Labs:** a collection of Jupyter notebooks for exploring concepts in geophysics (https://github.com/geoscixyz/geosci-labs)

2014 – present **SimPEG**
Core maintainer and community developer (https://simpeg.xyz). Software repositories include:

- **SimPEG:** software for numerical simulations and inversions in geophysics (https://github.com/simpeg/simpeg)
- **discretize:** meshing and discretization tools for finite volume and inverse problems (https://github.com/simpeg/discretize)
- **geoana:** analytic solutions for common physics problems relevant to geophysics (https://github.com/simpeg/geoana)

Teaching

Undergraduate

2013 – 2016 **Teaching Assistant:** EOSC 350: Environmental, Geotechnical, and Exploration Geophysics
University of British Columbia
Instructor: Douglas Oldenburg

2015 **Teaching Assistant:** Directed Studies: Inversion in Applied Geophysics
University of British Columbia
Instructor: Douglas Oldenburg

2012 **Teaching Assistant:** EOSC 354: Analysis of Time Series and Inverse Theory for Earth Scientists
University of British Columbia
Instructor: Michael Bostock

Workshops & Short Courses

2019 **Co-Instructor:** Deterministic inversion (April 8, 2019)
LAPIS 2019: La Plata International School on Astronomy and Geophysics (https://courses.geosci.xyz/lapis2019)
Lead Instructor: Douglas Oldenburg, Co-Instructor: Seogi Kang

2018 **Co-Instructor:** Best Practices for Modern Open-Source Research Codes (December 12, 2018)
AGU Fall Meeting 2018 in Washington, DC (https://github.com/agu-ossi/2018-agu-oss)
Co-Instructors: Leonardo Uieda, Lion Krischer and Florian Wagner

2018 **Co-Instructor:** 3D EM Modelling and Inversion with Open Source Resources (June 17, 2017)
AEM 2018: 7th International Workshop on Airborne Electromagnetics in Kolding, Denmark, (https://courses.geosci.xyz/aem2018)

2017 **Co-Instructor:** Geophysical Electromagnetics: Fundamentals and Applications (January 30, 2017 - December 13, 2017)
Society of Exploration Geophysics Distinguished Instructor Short Course (http://disc2017.geosci.xyz)
Lead instructor: Douglas Oldenburg, Co-Instructor: Seogi Kang

- Locations:
  - Denver, USA (January 30-31, 2017)
  - Perth, Australia (July 27-28, 2017)
  - Adelaide, Australia (August 2-3, 2017)
  - Brisbane, Austraila (August 7-8, 2017)
  - Delft, Netherlands (September 11-12, 2017)
  - Bonn, Germany (September 18-19, 2017)
  - Vienna, Austria (September 21-22, 2017)
  - Zurich, Switzerland (September 26-27, 2017)
  - Aarhus, Denmark (October 2-3, 2017)
  - Toronto, Canada (October 27, 2017)
  - Mexico City, Mexico (November 6-7, 2017)
  - Buenos Aires, Argentina (November 13-14, 2017)
  - Santiago, Chile (November 16-17, 2017)
  - Santa Cruz de la Sierra, Bolivia (November 22-23, 2017) - Cancelled
  - Rio de Janeiro, Brazil (November 28-29, 2017)
  - Calgary, Canada (December 5-6, 2017)
  - Vancouver, Canada (December 12-13, 2017)

2016 **Organizer:** Geophysical Simulation and Inversion (August 19-21, 2016)
Banff International Research Station,
(http://www.birs.ca/events/2016/2-day-workshops/16w2695)
Organized with Douglas Oldenburg, Adam Pidlisecky and Rowan Cockett

Service

Editorial

2017 – present **Editor:** Journal of Open Source Software
Topics: Geoscience, geophysics (http://joss.theoj.org/about)

Conferences

2019 **Chair**: SciPy Birds of a Feather (BoF) Sessions
SciPy Conference (https://www.scipy2019.scipy.org/bof-sessions)

2018 **Town Hall Organizer**: Community Forum: The role of an open-source software initiative within the AGU
American Geophysical Union (AGU) Annual Meeting
Co-organized with: Lion Krischer, Leonardo Uieda

Session Convener: Short Talks: A tour of open-source software packages for the geosciences
American Geophysical Union (AGU) Annual Meeting
Co-organized with Florian Wagner, Jens Klump and Lion Krischer

2017 **Panel Discussion Organizer:** Open Source Software in the Geosciences
American Geophysical Union (AGU) Annual Meeting (https://youtu.be/0GO4ZZ5Ry6M))
Co-organized with Anna Kelbert, Luz Andelica Caudillo Mata, Jared Peacock, Suzan van der Lee, Juan Lorenzo

Program Comittee Member: JupyterCon, August 22-25, New York, NY (https://conferences.oreilly.com/jupyter/jup-ny)

Mentoring

2014 – 2015 **Undergraduate Research Mentor** Research Experience Program at the University of British Columbia
Student: Mohamed Rassas
Project: A comparison of conventional and open channel hydraulic fracturing and the importance of imaging to optimize the fracturing process, presented at *the Multidisciplinary Undergraduate Research Conference at the University of British Columbia*

Media

2018 Guest on Episode 163: Python in Geoscience, May 25, 2018. *Talk Python to Me* by Michael Kennedy (https://talkpython.fm/)

2017 Guest on Episode 41, Apr. 24, 2017. *Undersampled Radio* by Graham Ganssle and Matt Hall (https://undersampledrad.io)

Guest on Episode 11, Jan. 24, 2017. *Seismic Soundoff* by the Society of Exploration Geophysicists (http://seg.org/podcast)

2012 Article: Science 100 pioneer grounded in geophysics. *University of Alberta Spring Convocation 2012: Celebrating Talented People* (https://www.ualberta.ca/news-and-events/newsarticles)