

References

- [1] Mary P. Anderson, William W. Woessner, and Randall J. Hunt. *Applied Groundwater Modeling*. Academic Press, San Diego, second edition, 2015.
- [2] T. C. Chamberlin. The method of multiple working hypotheses. *Science (Old Series)*, 15(92), 1890.
- [3] A.P. Dempster, N.M. Laird, and D.B. Rubin. Maximum likelihood from incomplete data via em algorithm. *Journal of the Royal Statistical Society Series B-Methodological*, 39(1):1–38, 1977.
- [4] J. Doherty. PEST, model-independent parameter estimation—user manual (5th ed., with slight additions), 2010.
- [5] J. E. Doherty, M. N. Fienen, and R. J. Hunt. Approaches to highly parameterized inversion: Pilot-point theory, guidelines, and research directions. Technical report, United States Geological Survey Scientific Investigations Report 2010-5168, 2010.
- [6] J. E. Doherty and R. J. Hunt. Two statistics for evaluating parameter identifiability and error reduction. *Journal of Hydrology*, 366(1-4):119–127, 2009.
- [7] J. E. Doherty and R. J. Hunt. Approaches to highly parameterized inversion: A guide to using pest for groundwater-model calibration. Technical report, United States Geological Survey Scientific Investigations Report 2010-5169, 2010.
- [8] John Doherty and Steen Christensen. Use of paired simple and complex models to reduce predictive bias and quantify uncertainty. *Water Resources Research*, 47(12), 2011.
- [9] Doherty, John. Ground water model calibration using pilot points and regularization. *Ground Water*, 41(2):170–177, 2003.
- [10] Doherty, John and Welter, David. A short exploration of structural noise. *Water Resources Research*, 46(5, W05525), 2010.

- [11] M. Fienen, R. Hunt, D. Krabbenhoft, and T. Clemo. Obtaining parsimonious hydraulic conductivity fields using head and transport observations: A Bayesian geostatistical parameter estimation approach. *Water Resources Research*, 45:W08405, 2009.
 - [12] M. N. Fienen. We speak for the data. *Groundwater*, 51(2):157, 2013.
 - [13] M. N. Fienen, Thomas M. Clemo, and P. K. Kitanidis. An interactive Bayesian geostatistical inverse protocol for hydraulic tomography. *Water Resources Research*, 44:W00B01, 2008.
 - [14] M. N. Fienen, C. T. Muffels, and R. J. Hunt. On constraining pilot point calibration with regularization in PEST. *Ground Water*, 47(6):p. 835–844, 2009.
- Information regarding the use of PHIMLIM to control regularization strength in PEST.
- [15] Michael Fienen and Mark Bakker. Hess opinions: Repeatable research: what hydrologists can learn from the duke cancer research scandal. 20:3739–3743, 2016.
 - [16] Michael N. Fienen, Kenneth R. Bradbury, Maribeth Kniffin, and Paul M. Barlow. Depletion mapping and constrained optimization to support managing groundwater extraction. *Groundwater*, 56(1):18–31, 2018.
 - [17] M.N. Fienen, J.E. Doherty, R.J. Hunt, and H.W. Reeves. Using prediction uncertainty analysis to design hydrologic monitoring networks: Example applications from the great lakes water availability pilot project. Scientific investigations report 2010-5159, United States Geological Survey, 2010.
 - [18] M.N. Fienen, J. Luo, and P.K. Kitanidis. A Bayesian geostatistical transfer function approach to tracer test analysis. *Water Resources Research*, 42(7):W07426, 2006.
 - [19] M.N. Fienen, B.T. Nolan, D.T. Feinstein, and J.J. Starn. Metamodels to bridge the gap between modeling and decision support. *Groundwater*, 53(4), 2015.

- [20] R. J. Hunt, Doherty, John, and M. J. Tonkin. Are models too simple?—Arguments for increased parameterization. *Ground Water*, 45(3):p. 254–262, 2007.
- [21] E. T. Jaynes and G. Larry Bretthorst. *Probability theory : the logic of science*. Cambridge University Press, Cambridge, UK ; New York, NY, 2003.
- [22] M. C. Kennedy and A. O’Hagan. Bayesian calibration of computer models. *Journal of the Royal Statistical Society Series B-Statistical Methodology*, 63:425–450, 2001.
- [23] Peter K. Kitanidis. Quasi-linear geostatistical theory for inversing. *Water Resources Research*, 31(10):2411–2419, 1995.
- [24] Peter K. Kitanidis. *Introduction to Geostatistics: Applications in Hydrogeology*. Cambridge University Press, Cambridge, UK; New York, NY, 1997.
- [25] Peter K. Kitanidis and Efstratios G. Vomvoris. A geostatistical approach to the inverse problem in groundwater modeling (steady state) and one-dimensional simulations. *Water Resources Research*, 19(3):677–690, 1983.
- [26] A.T. Leaf, M.N. Fienen, R.J. Hunt, and C. Buchwald. Groundwater/surface-water interactions in the bad river watershed, wisconsin. *U.S. Geological Survey Scientific Investigations Report 2015–5162*, page 110 p., 2015.

An example of using data worth on a real model.

- [27] Moore, Catherine and Doherty, John. Role of the calibration process in reducing model predictive error. *Water Resources Research*, 41(5, W05020):14 p., 2005.
- [28] Moore, Catherine and Doherty, John. The cost of uniqueness in groundwater model calibration. *Advances in Water Resources*, 29(4):p. 605–623, 2006.
- [29] Moore, Catherine and Wöhling, Thomas and Doherty, John. Efficient regularization and uncertainty analysis using a global optimization methodology. *Water Resources Research*, 46(8, W08527), 2010.

- [30] Dean S Oliver, Albert C Reynolds, and Ning Liu. *Inverse theory for petroleum reservoir characterization and history matching*. Cambridge University Press, 2008.
- [31] M. J. Tonkin and Doherty, John. A hybrid regularized inversion methodology for highly parameterized environmental models. *Water Resources Research*, 41(10, W10412), 2005.
- [32] S.M. Westenbroek, J.E. Doherty, J.F. Walker, V.A. Kelson, R.J. Hunt, and T.B. Cera. Approaches in highly parameterized inversion—TSPROC, a general time-series processor to assist in model calibration and result summarization. Techniques and methods, book 7, section c7, xx p., United States Geological Survey, 2012.
- [33] J. T. White, J. E. Doherty, and J. D. Hughes. Quantifying the predictive consequences of model error with linear subspace analysis. *Water Resources Research*, 50(2):p. 1152–1173, 2014.
- [34] J. T. White, M. N. Fienen, P. M. Barlow, and D.E. Welter. A tool for efficient, model-independent management optimization under uncertainty. *Environmental Modeling and Software*, 2017.
- [35] Jeremy White, Michael Fienen, and John E. Doherty. A python framework for environmental model uncertainty analysis. 85:217–228, 2016.
- [36] Jeremy White, Matthew Knowling, Michael Fienen, Daniel Feinstein, Garry McDonald, and Catherine Moore. A non-intrusive approach for efficient stochastic emulation and optimization of model-based nitrate-loading management decision support (in press). *Environmental Modelling and Software*, 2020.
- [37] Jeremy T White, Linzy K Foster, Michael N Fienen, Matthew J Knowling, Brioch Hemmings, and James R Winterle. Towards reproducible environmental modeling for decision support: a worked example. *Frontiers in Earth Science, section Hydrosphere*, 2020.