Syllabus: MAE 127
Statistical Methods for Environmental Sciences and Engineering

Prof. Sarah Gille
Lectures: Monday/Wednesday/Friday 10:00-10:50, Sequoyah 148
Office hours: EBUII 473 Monday, Wednesday before class from 8:30 until about 9:45 or by appointment. I'm also available in the classroom, before and after class, or by e-mail.
SIO Office: Nierenberg Hall 348 (e-mail or call for an appointment)
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Objectives: This course will teach you methods for analyzing data, with specific applications for environmental problems. By the end of the class you should be able to apply a variety of data analysis techniques, including computing correlations, estimating parameters through least-squares fitting, and computing spectra. You should be able to decide what method to answer specific questions with your data. And for each data analysis method that you learn, you should be able to estimate uncertainties.

Reading:

- No required textbook.

- Primary reading to be distributed or made available in electronic form. (This may include articles or chapters from text books.)

- Optional: Taylor, J. R., 1982: *An Introduction to Error Analysis.* University Science Books, 327 pp., $38 (This has the virtue of being inexpensive and clearly written, but we'll only use it for part of the class and will only cover part of the book.)

- Optional software: *MATLAB & Simulink Student Version Release 14 with Service Pack 1*, Mathworks, for use on home computer. Includes book *Learning Matlab*, which can also be purchased separately.

Grading:

- 50% problem sets.

- 20% midterm

- 30% final exam

- Late assignments will not ordinarily be accepted.

Schedule

- March 28: Introduction to the course.
- March 30: Basic statistics: means, medians, modes and all that.
- April 1: *Computer session in EBUII 239.* Getting started with Matlab. Homework 1 assigned.
- April 4: Probability density functions. Computing means, variances from PDFs.
- April 6: Estimating errors. Error propagation.
- April 8: *Computer session in EBUII 239.* More Matlab tips. Homework 1 due. Homework 2 assigned.
- April 11: Errors on the mean. Significance of differences.
- April 13: What happens if errors aren't Gaussian?
- April 15: Correlation. What makes a correlation significant? Homework 2 due. Homework 3 assigned.
- April 18: Least-squares fits: defining the problem.
- April 20: Matlab and linear algebra.
- April 22: Least-squares fits: finding solutions. Homework 3 due. Homework 4 assigned.
- April 25: Least-squares fits: estimating uncertainties.
- April 27: Catch-up and review.
- April 29: Midterm.
- May 2: Weighted least-squares fits; fitting complex quantities.
- May 4: Goodness of fit. Does adding an extra parameter help?
- May 6: Decorrelation and degrees of freedom. Homework 4 due. Homework 5 assigned.
- May 9: Sinusoidal variability. Spectral analysis.
- May 11: Fourier transforms.
- May 13: The fast Fourier transform. Homework 5 due. Homework 6 assigned.
- May 16: Spectra.
- May 18: Uncertainties and spectra.
- May 20: Coherence. Homework 6 due. Homework 7 assigned.
- May 23: Rotary spectra.
- May 25: Empirical orthogonal functions.
- May 27: How EOFs differ from spectra. Homework 7 due. Homework 8 assigned.
- May 30: *Memorial Day. No Class.*
- June 1: Uncertainty and EOFs.
- June 3: Course summary. Exam review. Homework 8 due.
- Tuesday, June 7: final exam (8-11 am)

References on Reserve

Bendat, J. S. and A. G. Piersol, 1986: *Random Data: Analysis and Measurement Procedures.* John Wiley & Sons, 566 pp.

Bevington, P. and D. K. Robinson, 2002: *Data Reduction and Error Analysis for the Physical Sciences*, McGraw-Hill Science/Engineering/Math; 3rd edition, 336 pp.

Chatfield, C., 2003: *The Analysis of Time Series: An Introduction*, Sixth Edition, Chapman & Hall/CRC, 352 pp.

Daley, R., 1991: *Atmospheric Data Analysis.* Cambridge University Press, 457 pp.

Emery, W. J. and R. E. Thomson, 2001: *Data Analysis Methods in Physical Oceanography*, 2nd edition. Elsevier, 638 pp.

Lawson, C. L. and R. J. Hanson, 1974: *Solving Least Squares Problems.* Prentice-Hall, 340 pp. (reprinted 1997)

Meyer, S. L., 1992: *Data Analysis for Scientists and Engineers*, Peer Management Consultants Ltd; Reprint edition, 513 pp.

Noble, B., and J. W. Daniel, 1988: *Applied Linear Algebra*, 3rd edition. Prentice-Hall, 521 pp.

Preisendorfer, R. W., 1988: *Principal Component Analysis in Meteorology and Oceanography*, Elsevier, 425 pp.

Press, W. H., B. P. Flannery, S. A. Teukolsky and W. T. Vetterline, 1986: *Numerical Recipes.* Cambridge University Press, 818 pp.

Strang, G., 1976: *Linear Algebra and Its Applications.* Academic Press, 414 pp.

Taylor, J. R., 1982: *An Introduction to Error Analysis.* University Science Books, 270 pp.

Wilks, D. S., 1995: *Statistical Methods in the Atmospheric Sciences : An Introduction* (International Geophysics Series), Academic Press, 467 pp.

Wunsch, C., 1996: *The Ocean Circulation Inverse Problem.* Cambridge University Press, 442 pp.