Syllabus: SIOC 221B, Analysis of Physical Oceanographic Data

Sarah Gille
Credits: 4 units (3-4 contact hours + ∼8 hours reading and assigments per week)
Class Meetings: Wednesday and Friday, 2:00-3:20, Spiess 330
Discussion: To be arranged, if helpful
Final presentations: Monday, March 20, 3:00-5:59, Spiess 330 (and possibly also in class on March 17)
Office hours: To be posted. Let me know what will help you

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Course website: see Canvas or for public materials: http://pordlabs.ucsd.edu/sgille/sioc221b
Grading: letter or S/U

Course Description: Techniques for analysis of physical oceanographic data involving many simultaneous processes, including probability densities, sampling errors, spectral analysis, empirical orthogonal functions, correlation, linear estimation, objective mapping.

Course Objectives: During this class you will learn (or advance your knowledge of) data analysis. We will focus on the following topics centered around model fitting, mapping, and interpreting gridded fields. In addition to learning data analysis methods, you should also continue to develop your programming skills so that you are able to put the methods that we discuss in class into practice, and you should refine your skills in interpreting scientific figures.

Course requirements: Complete weekly problem sets (by due dates). You may work on most of the problem sets collaboratively, but you need to work through the problems yourself and write up your own work. If you work in a group, please identify your collaborators. (Science is collaborative, and we always acknowledge our sources and our collaborators.) A mid-term problem set will have about the same scope as the regular problem sets, but you will complete it independently, and you will be asked to sign a statement indicating that the work you submit is your own. The final problem set will be a project based on data that you choose and will also be completed independently. Each problem set will contribute approximately equally to your final grade.

In lieu of a final exam, you will prepare and present a final project based on a data set of your choosing. This will take place during the final exam time slot (Monday 20 March, 3:00-6:00). The final exam will count as two problem sets: one grade for the oral presentation and a second for the write up.

Participation also matters. You should come to class prepared to think and engage, take notes, write code and calculate (using a laptop), and interact with me and with each other. You have multiple ways to demonstrate your engagement in the class. I will post course notes and small segments of textbook reading, which will be available in electronic form. Mini-lectures will also be posted for you to view on your own schedule. You can review this material in advance of class. Feel free to identify topics that need clarification on the course discussion board on Canvas or via email to me. The themes that you identify will help determine how we use our in-class time. Class time will be split between lecture, discussion, group learning, and questions/answers/work time for problem sets. Please come to class ready to ask questions and to interact. (If you aren't able to attend class, you can catch up through the asynchronous recording, assuming that the podcasting system works correctly.) Bonus points may be awarded for exemplary class participation in any form.

Course Learning Outcomes: By the end of the term you should

1. understand different approaches for fitting a "model" to data
2. understand ways to use a singular value decomposition to assess variability in data
3. understand strategies for mapping observations and coherence,
4. be able to think critically about data analysis problems,
5. have sufficent the programming skills needed to analyze data using these techniques.

Everyone starts this class with a different background, and your goal is to advance your own skills—not to compete against your classmates. Please set learning goals for yourself (e.g. to learn Matlab, learn python, develop skills in latex) that reflect your own starting point. And please support each other, and help everyone to learn.

Grading:

- 8† homeworks: 10% each
- final project presentation: 10%
- final project write-up: 10%

†Note: Each assignment is equally weighted. We might end up with 7 or 9 homeworks, depending on schedule details, in which case each homework, presentation, and write-up would represent 1/9th or 1/11th of your total grade.

Topics:

- Autocovariancer functions and degrees of freedom
- Least-squares fitting, weighted least squares, constrained least squares
  - Uncertainties in fitted coefficients
  - Underdetermined systesms and singular value decomposition
  - Nonlinear minimization
- Eigensystems
- Empirical orthogonal functions (principal component analysis)
- Objective mapping

As time permits, we may consider wavelets, complex demodulation, machine learning, simulated annealing, or other topics.

Academic Integrity: "Academic Integrity is expected of everyone at UC San Diego. This means that you must be honest, fair, responsible, respectful, and trustworthy in all of your actions. Lying, cheating or any other forms of dishonesty will not be tolerated because they undermine learning and the University's ability to certify students' knowledge and abilities. Thus, any attempt to get, or help another get, a grade by cheating, lying or dishonesty will be reported to the Academic Integrity Office and will result sanctions. Sanctions can include an F in this class and suspension or dismissal from the University. So, think carefully before you act by asking yourself: a) is what I'm about to do or submit for credit an honest, fair, respectful, responsible and trustworthy representation of my knowledge and abilities at this time and, b) would my instructor approve of my action? You are ultimately the only person responsible for your behavior. So, if you are unsure, don't ask a friend-ask your instructor, instructional assistant, or the Academic Integrity Office. You can learn more about academic integrity at academicintegrity.ucsd.edu" (Source: Academic Integrity Office, 2018)

Inclusion: Let's aim to foster an inclusive environment in our classroom and through our in-class and out-of-class discussions. We should aim to establish an environment that supports diversity of thoughts, that draws on the broad range of perspectives and experiences that each of you brings to class, and that respects your identities (including race, gender, class, sexuality, etc.).

If you have a name and/or set of pronouns that differ from those that appear in your official university records, please let me know.

If for any reason you feel that your performance in class is being impacted by your experiences outside of class, please don't hesitate to let me know. I am available as a resource, as are your other faculty, and the department staff.

Please don't hesitate to contact me if you have suggestions to improve the course materials or the way the class operates. Likewise, if anything comes up in class that makes you feel uncomfortable, please chat with me.

Texts on reserve for SIOC 221B

Electronic resources (available on line and in hard copy):

Bendat, J. S. and A. G. Piersol, 2010: *Random Data: Analysis and Measurement Procedures*. John Wiley & Sons, 4th edition.

Lawson, C. L. and R. J. Hanson, 1995: *Solving Least Squares Problems*. SIAM.

Martin, B. R., 2012: *Statistics for Physical Sciences*. Elsevier.

Menke, W., 2018: *Geophysical Data Analysis: Discrete Inverse Theory*. Academic Press.

Thomson, R. E. and W. J. Emery, 2014: *Data Analysis Methods in Physical Oceanography*, 3rd edition, Elsevier.

von Storch, H. and F. W. Zwiers, 2001: *Statistical Analysis in Climate Research*, Cambridge University Press.

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

Electronic version on Canvas for class use:

Martin, B. R., 2012: *Statistics for Physical Sciences: An Introduction*, Elsevier.