Syllabus: SIOC 221A, Analysis of Physical Oceanographic Data

Sarah Gille
Credits: 4 units (4 contact hours + ∼8 hours reading and assigments per week
Class Meetings: Monday and Wednesday, 8:30-9:50, Spiess 330
Discussion: Friday, 9:30-10:20 or 9:00-9:50, Spiess 330
Final presentations: Monday, December 6, 8:00-10:59, Spiess 330
Office hours: To be posted. Let me know what will help you

e-mail: sgille@ucsd.edu *Telephone (office):* 858-822-4425
Telephone (cell): 858-366-3228

Course website: see Canvas or for public materials: http://pordlabs.ucsd.edu/sgille/sioc221a
Grading: letter or S/U

Course Description: Fundamental elements of analysis of geophysical and oceanographic time series, including sampling problems, least-squares techniques, spectral analysis, interpretation of series, design of experiments.

Course Objectives: During this class you will learn (or refresh your knowledge of) basic statistics, Fourier transforms, time-series analysis methods including least-squares fitting, spectral analysis, and coherence analysis. In addition to learning analysis methods, you should also 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 6 December, 8:00-11:00). 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, 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, post questions/reflections on the course discussion board on Canvas. Feel free to identify topics that need clarification on the course discussion board.

Themes that emerge on the discussion board 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.) Bonus points may be awarded for exemplary class participation in any form.

Pandemic contingencies: This quarter could present a multitude of pandemic-related adventures. We will aim to have class in-person and masked. Please do not come to campus if you are feeling ill. Course materials including recordings of lectures (hopefully) will be available via Canvas. If for any reason we need to switch to an all remote format, Zoom links and other logistical details will be available via Canvas.

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

1. understand time series analysis, including Fourier transforms, spectra, and coherence,
2. be able to think critically about data analysis problems,
3. 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:

— Introduction: statistics, probability density functions, mean, standard deviation, skewness, kurtosis

— Error propagation

— Least-squares fitting

— The Fourier transform

— Spectra, spectral uncertainties, using Monte Carlo methods (and fake data) to evaluate formal uncertainties

— Windowing and filtering

— Cross-spectra, coherence, uncertainties of coherence

— Multi-dimensional spectral analysis

— Alternative approaches for computing spectra: multitaper and maximum entropy methods

Time permitting, we might get to:

— Rotary spectra

— Filter design

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 221A

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.

Koopmans, L. H., 1995: *The spectral analysis of time series*, 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, 1984: *Statistical Analysis in Climate Research*, Cambridge University Press.

Electronic version on Canvas for class use:

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

Hard-copy resources (not on reserve this year):

Helstrom, C. W., 1991: *Probability and stochastic processes for engineers*. Macmillan.

Papoulis, A. and S. U. Pillai, 2002: *Probability, random variables, and stochastic processes*. McGraw-Hill.

Percival, D. B. and A. T. Walden, 1993: *Spectral analysis for physical applications : multitaper and conventional univariate techniques*, Cambridge.