## SIO221a: Data Analysis Laboratory

Instructor: Matthew Alford (<u>malford@ucsd.edu</u>; 858-246-1646) Credits: 4 Time: M-W 11-12:20 Office Hours: As needed. Let me know how I can help!

**Course Description:** Fundamental elements of analysis of geophysical and oceanographic time series, including sampling problems, least-squares techniques, spectral analysis, interpretation of time and space series, introduction to programming and version control.

**Goals:** 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 will also develop your programming skills and version control practices so that you are able to put the methods that we discuss in class into practice by sharing clearly written code.

## **Course Requirements:**

*Prior to class:* The course assignments can be done using any analysis package / computing platform that you choose. I will attempt to do lectures in both MATLAB and Python, the most common two choices, and we will be using Github to practice version control in our code.

- 1) Please come to class on day one with an analysis package (preferably MATLAB or Python) installed, tested and ready.
- 2) You may also wish to use the very handy Jupyter notebooks. My lectures will all be in Jupyter notebooks! If you wish to use them, please have this set up and tested as well. MATLAB users will find <u>these instructions</u> handy.
- 3) Finally please set up an account on Github and make sure you can access the class repository.

*Homework.* 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.

*Final Presentations.* 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. 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.

## Grading:

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

## Topics:

Mean/standard deviation/pdfs— moments of pdfs - programming basics

Special PDFs - Gaussian, Chi-squared distribution - version control basics

Central Limit theorem, Error propagation

Correlation/covariance/projections onto modes

Fourier transform and spectra.

Spectral uncertainties

Windowing—degrees of freedom

Aliasing

Multidimensional spectra (e.g. Frequency/wavenumber spectra)

Coherence/cross spectra/transfer functions

Optional as time allows: spectrogram rotary spectra, multitaper, maximum entropy, advanced filtering, filter design, Monte Carlo

**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.