Data Analysis in the Environmental Sciences

Course website: https://canvas.ucsc.edu/courses/86117

Instructor:
Claudie Beaulieu (she/her), Associate professor, Ocean Sciences Department
Office Hours: Th 12.00-1.00PM, F 1.00-2.00PM, in person (E&MS A443)

Teaching Assistant:
Jordana Sevigny
Office Hours: M 9-10AM, E&MS D318

In-person lectures:
TuTh 9.50-11.25AM Natural Sciences Annex 101

In-person Discussions:
Tu 12.15-1.15PM, Tu 03.30-4.30PM, Tu 4.45-5.45PM, E&MS D250

Land acknowledgement: *"The land on which we gather is the unceded territory of the Awaswas-speaking Uypi Tribe. The Amah Mutsun Tribal Band, comprised of the descendants of indigenous people taken to missions Santa Cruz and San Juan Bautista during Spanish colonization of the Central Coast, is today working hard to restore traditional stewardship practices on these lands and heal from historical trauma."*

LEARNING STATEMENT

Your success in this class is important to me. We are in uncertain times, and we are all affected differently. Also, we all learn differently. If there are aspects of this course that prevent you from learning or exclude you, please let me know as soon as possible. Together we can develop strategies to meet both your needs and the requirements of the course.

THE COURSE

Description: The main aim of this course is to introduce data analysis methods regularly encountered within environmental sciences. You will learn how to think about data, its uncertainty, how models and data are related and depend on underlying assumptions, and how to synthesize information contained in data. The class will focus on two main areas of study: 1) environmental sampling and risk analysis and 2) climate and environmental change detection. This class satisfies the Statistical Reasoning (SR) General Education requirement.
Prerequisite(s): MATH 11B or 19B or equivalent.

Learning outcomes:

1. Summarize, synthesize and visualize an environmental dataset;
2. Describe and quantify data and sampling uncertainties;
3. Use statistical distributions to assess environmental risk;
4. Justify and apply statistical tests to detect and quantify climate and environmental change;
5. Express, verify and discuss underlying assumptions in statistical tests and models;
6. Conduct data analysis in the R programming language.

Disclaimer: This syllabus is intended to provide guidance on topics to be covered in the class, and I will follow as closely as possible. However, I reserve the right to modify, supplement and make changes as needed if I judge it will benefit your learning.

LOGISTICS

This class is in-person.

What you can expect from us: The course is designed following campus guidance and with current public health guidelines in mind. However, these guidelines may change in accordance with shifting infection rates or the emergence of new variants. If updated public health recommendations and university requirements make our current course format unfeasible, in case of weather-prohibiting situations, or if we experience illness or need to self-isolate, we will alter the format. This includes moving in-person sessions onto Zoom. Also, we reserve the right to move select classes online if web-based modalities are deemed more desirable for delivering content, as long as the expectations and timing are communicated to students in advance. We will communicate clearly with you via Canvas announcement about any changes that occur. If you have questions about the changes, please reach out to me so we can answer them.

What we expect from you: If you experience an illness or exposure that requires you to miss lectures and discussion sections, please communicate with us as soon as possible. We will provide links to recordings of lectures so you can continue making progress in the class. Please visit the UCSC Risk Services page for information on actions you can take to help protect yourself and others from health risks caused by respiratory viruses, including COVID-19.

Communication: We welcome questions/concerns/comments in several ways:

1. During the Tuesday/Thursday lectures;
2. During discussion sections;
3. During office hours;
4. Canvas Discussions;
5. Canvas message. If you wanna talk to us about something private or ask a question in private, you can send us a message on Canvas. On the left side, click “Inbox,” then on top, click “Compose a new message.”

Please do NOT post solutions and answers to assignments (in whole or in part) on Canvas Discussions/Discord, ever, for any reason. It is, however, acceptable and encouraged to ask questions that many of your fellow classmates may also have. If you do post solutions, this can be considered a violation of the UCSC academic integrity policy and may lead to consequences as outlined by that policy:
https://registrar.ucsc.edu/navigator/section1/academicintegrity.

Add/drop/swap classes deadline: By October 15th. Other key dates for registration and enrolment can be found here:
https://registrar.ucsc.edu/calendars-resources/academic-calendar/

COURSE MATERIAL

Required software: We will use Rstudio to analyze data in this class. R/RStudio is a wonderful tool, as it is free, open-source code. It runs everywhere, on UNIX platforms, Windows and Macs. It also provides an engaged community. It is actively maintained, it has good connectivity to various types of data and other systems, and it's versatile enough to solve problems in many domains.

You will need to first download R here: http://www.r-project.org/. Then, RStudio here: https://www.rstudio.com/products/rstudio/download/, which is a more user-friendly interface of R including a console, syntax-highlighting editor that supports direct code execution, and a variety of robust tools for plotting, viewing history, debugging and managing your workspace. If you have no previous experience with a programming language, this might sound intimidating, but you can do this! Note that you are not expected to have any previous experience with programming in R at the beginning of this course, we will take it step-by-step. You can think about R as an additional tool in your toolbox!

All additional materials needed for this course are provided online through the course Canvas website.

ASSESSMENTS & GRADING

Problem sets	35%
Participation in pop quizzes	5%
Midterm exam	25%
Final exam	35%

Problem sets: There will be seven weekly assignments that together count for 35% of your final grade (each worth 5%). The assignments will be released on Canvas every Tuesdays after lecture and due on the following Tuesday. They should be submitted via Canvas (see schedule below). Discussion sections should be used to seek help with the problem sets. Each problem set typically contains different steps of data analysis such as calculations and interpretation. Your answers will be a mix of plots, numerical and text answers. These problem sets are your opportunity to apply the concepts covered in lectures/readings at low stakes, and prepare you for the take-home exams. You have the opportunity to re-submit the problem sets as many times as you wish **before the deadline**. Assignments close after the deadline, and will be reopened only with a compelling reason and an instructor approval.

Take-home exams: There will be a midterm and a final take-home exam due on 11/04/2025 (Midterm) and 12/09/2025 (Final). The midterm exam will cover material from weeks 1-4 and the final will cover the entire quarter. The take-home exams will count towards 25% and 35% of the final grade, respectively. The midterm and final exams will be open book, as in you are allowed to consult the course material while doing the exams. Copy of the R code generated to answer questions will have to be submitted as part of the exams. Take-home exams close after the deadline, and late submissions will be treated on an individual basis.

Participation: Your participation in pop quizzes is worth 5% of the final grade. To earn full points, you'll need to participate in pop quizzes at least ten times.

Instructor feedback: We will provide direct comments and feedback on your assignments. Please click here to learn how to access my comments in Canvas. For take-home exams, I will include a grading rubric that will be available to you prior to submitting your work. Please click here to learn how to access grading rubrics for assignments. Note that for numerical answers of the problem sets you'll receive feedback within Canvas instantaneously.

Group work and academic integrity: I encourage you to work in groups in this class, as students can achieve deeper learning through talking with other students. For example, discussing problem sets ideas and seeking help from classmates on Ed Discussion is encouraged, and will earn you points, but asking for a straight answer on a problem set is not allowed. While group work is encouraged, you must turn in your own work using your own words and your own code. Copying someone else's words/code is not allowed and can lead to serious consequences. Please see the following for a description of the UCSC Academic Integrity policy: https://registrar.ucsc.edu/navigator/section1/academicintegrity. I trust you to be honest and turn in your own work that reflects your own understanding.

Generative AI Policy: Our discipline allows for generative AI use under certain circumstances, but always with clear and open attribution. We have a reasonable expectation that work with your name on it was written by you, so your ethical use of AI is imperative. Please read this policy carefully if you plan to make use of AI resources in this class.

Authorized uses of AI tools

- Help with debugging code
- Finding sources
- Personalized tutoring; asking about concepts you'd like to see explained in a different way
- Editing for grammar, writing mechanics, and punctuation

Unauthorized uses of AI tools

- Using AI to write your code
- Using AI to answer quiz, exam, or homework questions
- Using AI to write discussion posts or annotations
- Using AI to make edits to your writing in ways that substantively change the voice of your work (in other words, using AI to write in ways that you cannot write on your own)

- Using AI to hide plagiarism or to mislead readers about the provenance of your submitted work

Citing AI use

If you use AI resources in any authorized way as described above, you must note that in your submitted work. You can do that by explaining exactly how you used it in a paragraph at the end of your assignment.

Grading scale:
As: 100-90]
Bs:]90-75]
Cs:]75-60]
Ds:]60-50]
F: <50%
The passing grade is a C (>65%). You are not competing for grades with other students. It is possible for everyone taking this class to get an A.

Tips for success:
1- Show up: class and discussion sections attendance and participation;
2- Plan ahead: Start the weekly problem set BEFORE discussion section, so that you can get help where needed early on;
3- Invest the time: UCSC's rule is to work ~15 hours per week outside lectures for a 5 credits course;
4- Work together: I guarantee you that you will achieve deeper learning by interacting with your peers;
5- Provide feedback: I will ask you for feedback weekly at the end of each problem sets. If some concepts were less well understood, I will make adjustments to lectures to revisit these concept;
6- Ask questions: I encourage you to ask questions as soon as you get confused. Because each week's material is built on the previous ones, it is important not to drag concepts less well understood;
7- Practice: I appreciate that learning a programming language can be frustrating. There is no better way to learn than by doing it;
8- Communicate: if you are experiencing unusual/difficult circumstances, please let us know so that we can best support you;
9- Remember that even if you may struggle at times, it is normal, and you belong in this class!

SCHEDULE

Schedule of lectures

Topic 1: Environmental sampling and risk
Week 1:
L1 (September 25th): Intro to environmental data analysis

Week 2:

L2 (September 30th): Intro to probabilities
L3 (October 2nd): Making sense of a new data set

Week 3:
L4 (October 7th): Probability distributions
L5 (October 9th): Probability distributions continued

Week 4:
L6 (October 14th): Normal distribution
L7 (October 16th): Central limit theorem

Week 5:
L8 (October 21st): Fitting distributions
L9 (October 23rd): Revision midterm

Topic 2: Climate and environmental change detection
Week 6:
L10 (October 28th): Frequency analysis
L11 (October 30th): Intro to hypothesis testing

Week 7:
L12 (November 4th): Intro to hypothesis testing
L13 (November 6th): Tests on the mean

Week 8:
No lecture on November 11th - Veterans Day
L15 (November 13th): Tests on mean & variance differences

Week 9:
L16 (November 18th): Correlation & how to lie with statistics
L17 (November 20th): Simple linear regression

Week 10:
L18 (November 25th): Trend detection
No lecture on November 27th - Thanksgiving Day

Week 11:
L19 (December 2nd): Multiple linear regression
L20 (December 4th): Revision for the final

Schedule of problem sets & exams:

	To be published on Canvas	Due (11.59 PM)
PS1	September 30th	October 7th
PS2	October 7th	October 14th
PS3	October 14th	October 21st

PS4	October 21st	October 28th
Midterm exam	October 28th	November 4th
PS5	November 4th	November 12th
PS6	November 11th	November 18th
PS7	November 18th	November 25th
Final exam	December 4th	December 11th

INTELLECTUAL PROPERTY

The materials in this course are the intellectual property of their creators. As a student, you have access to many of the materials in the course for the purpose of learning, engaging with your peers in the course, completing assignments, and so on. You have a moral and legal obligation to respect the rights of others by only using course materials for purposes associated with the course. For instance, you are not permitted to share, upload, stream, sell, republish, share the login information for, or otherwise disseminate any of the course materials, such as: videos, assignment prompts, slides, notes, syllabus, simulations, datasets, discussion threads. Conversely, any materials created solely by you (for example, final project) are your intellectual property and you may use them as you wish.

ACCESSIBILITY

UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, you have the right to have these met. Please submit your Accommodation Authorization Letter from the Disability Resource Center (DRC) to me by email, preferably within the first two weeks of the quarter. I would also like us to discuss ways we can ensure your full participation in the course. I encourage all students who may benefit from learning more about DRC services to contact DRC by phone at 831-459-2089 or by email at drc@ucsc.edu.

RELIGIOUS ACCOMMODATION

UC Santa Cruz welcomes diversity of religious beliefs and practices, recognizing the contributions differing experiences and viewpoints can bring to the community. There may be times when an academic requirement conflicts with religious observances and practices. If that happens, students may request the reasonable accommodation for religious practices. The instructor will review the situation in an effort to provide a reasonable accommodation without penalty. You should first discuss the conflict and your requested accommodation with your instructor early in the term. You or your instructor may also seek assistance from the Dean of Students office.

ALL-GENDER RESTROOMS

UC Santa Cruz is committed to the well-being of all students and cares about all students feeling safe and welcome, regardless of their gender identity, expression, and/or embodiment.

The Lionel Cantú Queer Center has worked with students and campus staff to create more safe and accessible restrooms for transgender and genderqueer students, staff, faculty, alumni, and UCSC visitors. A complete list of all-gender restrooms on campus was compiled and is maintained by the Cantú Queer Center.

TITLE IX/CARE ADVISORY

UC Santa Cruz is committed to providing a safe learning environment that is free of all forms of gender discrimination and sexual harassment, which are explicitly prohibited under Title IX. If you have experienced any form of sexual harassment, sexual assault, domestic violence, dating violence, or stalking, know that you are not alone. The Title IX Office, the Campus Advocacy, Resources & Education (CARE) office, and Counseling & Psychological Services (CAPS) are all resources that you can rely on for support.

Please be aware that if you tell me about a situation involving Title IX misconduct, I am required to share this information with the Title IX Coordinator. This reporting responsibility also applies to course TAs and tutors (as well to all UCSC employees who are not designated as "confidential" employees, which is a special designation granted to counselors and CARE advocates). Although I have to make that notification, you will control how your case will be handled, including whether or not you wish to pursue a formal complaint. The goal is to make sure that you are aware of the range of options available to you and that you have access to the resources you need.

Confidential resources are available through CARE. Confidentiality means CARE advocates will not share any information with Title IX, the police, parents, or anyone else without explicit permission. CARE advocates are trained to support you in understanding your rights and options, accessing health and counseling services, providing academic and housing accommodations, helping with legal protective orders, and more. You can contact CARE at (831) 502-2273 or care@ucsc.edu.

In addition to CARE, these resources are available to you:

- If you need help figuring out what resources you or someone else might need, visit the Sexual Violence Prevention & Response (SAFE) website, which provides information and resources for different situations.
- Counseling & Psychological Services (CAPS) can provide confidential counseling support. Call them at (831) 459-2628.
- You can also report gender discrimination and sexual harassment and violence directly to the University's Title IX Office, by calling (831) 459-2462 or by using their online reporting tool.
- Reports to law enforcement can be made to the UC Police Department, (831) 459-2231 ext. 1.
- For emergencies, call 911.

REPORT AN INCIDENT OF HATE OR BIAS

The University of California, Santa Cruz is committed to maintaining an objective, civil, diverse and supportive community, free of coercion, bias, hate, intimidation, dehumanization or exploitation. The Hate/Bias Response Team is a group of administrators who support and guide students seeking assistance in determining how to handle a bias incident involving another

student, a staff member, or a faculty member. To report an incident of hate or bias, please use the following form: Hate/Bias Report Form.

STUDENT SERVICES

Slug Support: https://deanofstudents.ucsc.edu/slug-support/program/
If you are facing financial challenges, food and housing insecurity, or other concerns, and you are not sure how to find the resources you need.

Basic Needs: https://basicneeds.ucsc.edu
If you are experiencing challenges related to basic needs, such as food, housing, health & wellness, or financial security, visit the Basic Needs hub for information about food pantries, accessible housing, mental health support, and financial aid options

Student Success: https://studentsuccess.ucsc.edu/resource-centers/index.html
UC Santa Cruz has a variety of resources to support your overall success at UC Santa Cruz, ensure accessible living and learning environments, help you when you're experiencing personal or academic challenges, and support you in building community.

CAPS (Counseling and Psychological Services): https://caps.ucsc.edu/
If you are in distress, managing heightened stress and anxiety, or want to get more support and a counselor's perspective on something you're going through, CAPS provides a variety of services for your needs—including immediate crisis support, scheduled individual appointments, group counseling, and workshops led by peer advisors.

Resource Centers: https://resourcecenters.ucsc.edu/index.html
UCSC Resource Centers offer counter-spaces for students who are queer, trans, nonbinary, womxn, and people of color, as well as impact institutional policies and campus climate. The Resource Centers engage the broader campus on issues and challenges facing our communities, and provide programs, physical spaces, and services to foster student's academic, personal, and professional growth, through community-based leadership development.

Slug HelpTechnology: https://its.ucsc.edu/index.html
The ITS Support Center is your single point of contact for all issues, problems or questions related to technology services and computing at UC Santa Cruz. To get technological help, simply email help@ucsc.edu.

On-Campus Emergency Contacts: https://www.ucsc.edu/help/
For all other help and support, including the health center and emergency services, start here.
Always dial 9-1-1 in the case of an emergency.