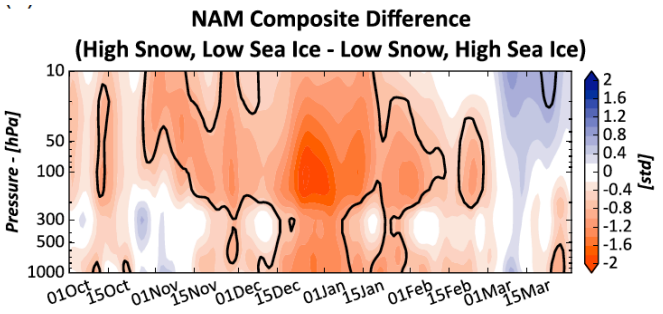
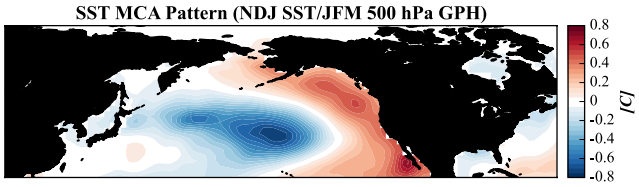




METR 5433 Advanced Statistical Meteorology

Spring 2021
Time: T/Th 2:00 - 3:15 PM
ONLINE (via Zoom)

Instructor
Dr. Jason C. Furtado (he/him)

Email: jfurtado@ou.edu
Twitter: @wxjay
Office Hours: By appointment.

Course Description

Data analysis is a routine part of research in the atmospheric sciences. As such, having the right set of tools and the prowess on how to use those tools is an important part to understanding the behavior of the Earth climate system.

This course offers an overview of some advanced statistical methods used to interpret data in the atmospheric and oceanic sciences. The course is designed to be an ***applied* course:** i.e., the goal is to gain a working knowledge of the statistical tools most commonly used in the atmospheric sciences. Major topics include: (A) regression/correlation and epoch analyses; (B) time series analysis (e.g., power spectra, filtering); (C) matrix methods for signal decomposition (e.g., EOFs, CCA); and (D) objective mapping and covariance modeling.

The course is intended for graduate students and senior undergraduates (with permission). Although previous knowledge of probability and statistics is preferable, a short review of statistical measures will be provided. You will also need knowledge of a software package to analyze data (e.g., Python, MATLAB, NCL). In-class examples will be done using Python / Jupyter Notebooks.

GOALS	
	1. Apply statistical theory directly to real-world meteorological and climate data to discern spatiotemporal characteristics. 2. Gain further statistical (and dynamical) understanding of the environmental system of interest and answer real world research questions in the atmospheric sciences. 3. Evaluate critically journal articles and research presentations which employ these techniques. 4. Develop a personal data "toolkit" of statistical methods that can be applied to your own research problems and tasks.

Learning During the COVID-19 Pandemic

These are not normal times. Instead, it is an extremely stressful time for everyone. We have made a lot of adjustments in our day-to-day lives over the last year. In addition to a shift to online or very-different in-person classes and working conditions, you may have loved ones for whom you are caring, who have fallen ill, or you may get sick yourself. Geopolitical conditions in the US are also tumultuous at the moment. All of this stress is creating high anxiety for everyone. Please know that **you are not alone in feeling this way.** As such, I will work with you in every way that I can and be as helpful as I can.

Some of you may be attending class from environments that may make learning challenging. I will keep this in mind and be as accommodating and understanding as possible. Please reach out to me if you are having issues or difficulties. I will not judge you or think less of you for asking for help.

At the same time, please understand that teaching online introduces challenges and obstacles for me as your professor as well. There may be times when technology fails or materials are delayed because of technical issues. However, I am committed to do the best I can to make this class a success.

I also pledge to be reasonably flexible to support all students as we navigate life and learning during these times. Sometimes we just don't feel OK, and that is **perfectly fine.** Collectively, I hope we can have a class that maintains great interactions and learning. We will likely have to make some tweaks and changes along the way to make sure it is a success, but we can do it!

Required Text

There is no required text for the class. Most of the class will be taught with my own personal notes. However, there are several sources and texts that will be useful:

- Dennis Hartmann class notes on objective analysis: http://www.atmos.washington.edu/~dennis/552_Notes_ftp.html
- *Discrete Inverse and State Estimation Problems* - Carl Wunsch, Cambridge Press
- *Statistical Methods in the Atmospheric Sciences* (4th Edition) - Daniel Wilks, Academic Press

Course Web Page

The web page will be accessible via https://canvas.ou.edu (log on using your OU 4+4). There you will find course materials (e.g., class notes, assignments, and in-class coding examples), grades, and other news and announcements about the course.

Grading

Homework Assignments: 70%
Final Project: 30%

Homework Assignments. There will be about 6 homework assignments throughout the semester. Homework assignments must be **typed** and electronically submitted through Canvas. All plots included with your assignment should have proper units, labels, colorbars, and informative captions. As figures are ways to convey information, they should also be aesthetically pleasing (e.g., don't oversaturate your colorbars or make the images/font hard-to-read). The homework assignments are intended for you to apply the knowledge you learn in the course directly to either synthetic or real data. You may work with others on the assignments, but you must turn in your own work.

Final Project. The final project will involve you using *at least two (2) statistical techniques learned in the course* to answer a research problem. The project must be chosen based on one or more research questions that you would like to answer, ***not*** the type of data analysis you would like to apply to a given dataset. Approval of the project by the instructor is required. More details will be provided in class.

- Arrive to class on time and prepared to learn.
- Submit assignments timely. **No late submissions are allowed without prior approval.**
- Take an **active role** in the learning process and **ask questions** when needed.
- Seek assistance from me if you do not understand the material or need help with an assignment.
- Be courteous to other students. Place all phones on vibrate/silence, do not text/use social media during class, and keep talking to a minimum.

EXPECTATIONS OF THE STUDENT

Computing

A main goal of the course is to have you work with data using computer software packages and develop your own "statistical toolbox" for later use. All students who do not have a School of Meteorology (SoM) computer account may obtain one from Shawn Riley (NWC 5640). **I will use Python in this course for in-class coding exercises and solution sets.** Python is also open-source and can be installed on your own machine. Instructions on installing Python on your local machine and other access will be provided in class. **NOTE:** Although I will be using Python in class, you are free to use whatever software package with which you feel comfortable for your homework assignments. Your grades will be based on the results you submit, not on the coding language.

Online Course Mechanics

COURSE STYLE. The overall structure of the class will consist of lectures, both traditional and interactive, covering the major topics. The course will also feature in-class coding sessions, whereby students will work in teams and use Jupyter Notebooks (i.e., Python-based interactive coding templates) to practice techniques and develop code. Questions and interactions during class are welcome and highly encouraged. If you don't ask questions when things are unclear, then neither of us benefit from classroom lecture.

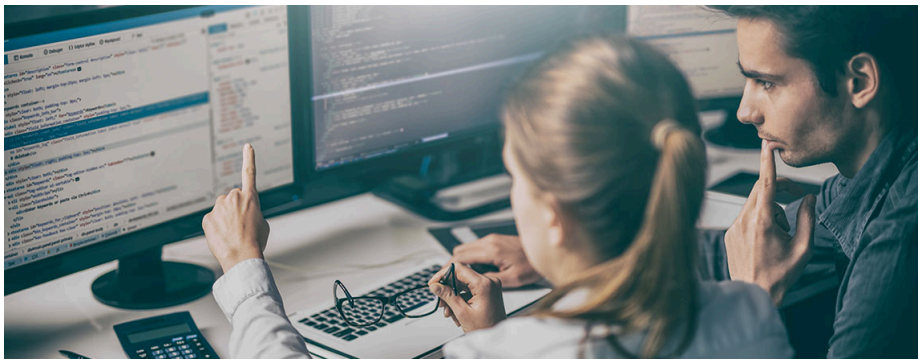
LECTURES. Because of the COVID-19 pandemic, this course will be a **synchronous online course** - i.e., we will meet live online via Zoom. The Zoom link will be available on Canvas and sent out to students via email. All class meetings will be recorded, and the links to these recordings will be placed on Canvas within 24 hours of the class meeting. Even those the recordings will be available, **please plan to attend class "live" if possible.** This aspect is especially important for in-class coding workshops. Written class notes during lecture will be provided to the students with the recordings.

To ask a question during lecture, you have several options.

- You may raise your hand using the Zoom "Raise Hand" feature. I will then call on you.
- You may write your question in the chat, and I will answer it orally.
- You may politely unmute yourself when appropriate and ask a question.

ONLINE LECTURE ETIQUETTE

- Unless asking a question or in group discussions / breakouts, please keep yourself muted to avoid background noises.
- Please consider turning on your webcam, if you are comfortable doing so.
- DO NOT USE CAPS IN THE CHAT. THIS IS CONSIDERED SHOUTING.
- Log onto the Zoom lecture ~5-10 minutes **before class** to ensure audio and video are working.
- Close all other browser tabs and applications on your computer not pertinent to class.



IN-CLASS CODING WORKSHOPS. The in-class coding workshops will be conducted via Zoom's Breakout Rooms. You are free to set up your own groups of 2-4 students, if you would like, or I will randomly assign students to groups. You should use these Breakout Rooms to work on the code together, though each of you should have your **own copy of the code**. These in-class coding exercises are excellent starting points for homework assignments, so it is important to complete them and have them "working" so that you can adapt them to your own homework. I will pop into these breakout rooms to see how you are progressing and answer any questions. You will also have the option to page me to come into your room to answer questions. Please follow all of the same online etiquette rules when in these breakout rooms.

OFFICE HOURS. All office hours will be conducted via Zoom. Office hours are **by appointment**. Use the Bookings site to set up an appointment:

https://outlook.office365.com/owa/calendar/METR5433AdvancedStatisticalMeteorology@ou.edu/bookings/

COMMUNICATION PLAN. Email will be the primary form of communication. I will respond to emails within 24 hours if sent on weekdays; 48-72 hours if sent on weekends or holidays. To make things easier, please start the subject line of your email with **[METR 5433]**.

Attendance Policy

A temporary university policy has been established to protect the OU community by ensuring that students who are ill or required to isolate feel encouraged to remain at home. Missing a class session or other class activity due to illness or isolation will not result in a penalty for the absence, and the student will not be asked to provide formal documentation from a healthcare provider to excuse the absence. This policy is based on all students and faculty adhering to the principles of integrity, honesty, and concern for others.

Students who are experiencing symptoms of COVID-19, including cough, fever, shortness of breath, muscle pain, headache, chills, sore throat, loss of taste or smell, congestion or runny nose, nausea or vomiting, or diarrhea or who have been in close contact with others who have symptoms should:

- Remain at home to protect others.
- Ensure that any needed screening has been conducted (COVID-19 Screening and Reporting Tool) and any needed treatment obtained.
- Contact the instructor prior to absence or inability to participate, if possible, and provide an honest report of the reason for which you cannot attend class or complete a course activity.
- Continue to complete coursework to the extent possible, using Canvas, Zoom, and other online tools.
- Submit assignments electronically to the extent possible and as directed by the instructor.
- Communicate with the instructor to arrange modifications to deadlines or work requirements or reschedule exams or other important course activities, when it is necessary.

Copyright Statement for Recordings of Course Sessions

Sessions of this course will be recorded or live-streamed. These recordings are the intellectual property of the individual faculty member and may not be shared or reproduced without the explicit, written consent of the faculty member. In addition, privacy rights of others such as students, guest lecturers, and providers of copyrighted material displayed in the recording may be of concern. Students may not share any course recordings with individuals not enrolled in the class or upload them to any other online environment.

Reasonable Accommodation Policy

The University of Oklahoma is committed to providing reasonable accommodation for all students with disabilities. Students with disabilities who require accommodation in this course are requested to speak with me as soon as possible. Students with disabilities must be registered with the Accessibility and Disability Resource Center (ADRC) prior to receiving accommodations in this course. The ADRC is located in University Community Center (730 College Ave). Phone: 405.325.3852. E-mail: drc@ou.edu. Once registered, please notify the instructor if you wish to use this space for assignments.

Academic Misconduct

Cheating is strictly prohibited at the University of Oklahoma. Simply put, it devalues your degree and ends up marring your character and reputation. For specific definitions on what constitutes cheating,

review the Student's Guide to Academic Integrity at http://integrity.ou.edu/students.html. If you are caught cheating, I am obligated to report it. Sanctions for academic misconduct can include expulsion from the University and an F in this course. **BOTTOM LINE:** Don't cheat – it's not worth it.

To be successful in this class, all work must be **yours and yours alone**. You may work together on homework assignments and in-class group exercises, but you must submit your own original work for any and all grading.

Religious Holidays

University policy allows for excused absences for students that result from religious observances and to provide without penalty for the rescheduling of examinations and additional required classwork that may fall on religious holidays. Any student who has a religious holiday fall on one of the exam days, please see the instructor no later than one week before the exam so as to make other arrangements.

Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405.325.2215 or smo@ou.edu. Incidents may also be reported confidentially to OU Advocates (405.615.0013) 24 hours a day, 7 days a week. Please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies may be directed to: Bobby J. Mason, University Equal Opportunity Officer and Title IX Coordinator at 405.325.3546 or bjm@ou.edu. For more information, please visit http://www.ou.edu/eoo.html.

Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy- or childbirth-related issues, please contact the instructor or the Disability Resource Center at 405.325.3852 as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Final Exam Preparation Period

NOTE: *There is no final exam in this course, but there is a final project.*

Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's Final Exam Preparation Period policy (https://apps.hr.ou.edu/FacultyHandbook#4.10).

Mental Health Support Services

If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019. To schedule an appointment call (405) 325-2911. For more information please visit http://www.ou.edu/ucc.

Emergency Protocol

During an emergency, there are official university procedures that will maximize your safety.

Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather

1. ***LOOK*** for severe weather refuge location maps located inside most OU buildings near the entrances.
2. ***SEEK*** refuge inside a building. Do not leave one building to seek shelter in another building that you deem safer. If outside, get into the nearest building.
3. ***GO*** to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows.
4. ***GET IN, GET DOWN, COVER UP***.
5. ***WAIT*** for official notice to resume normal activities.

Link to Severe Weather Refuge Areas , *Severe Weather Preparedness - Video*

Armed Subject/Campus Intruder: If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots:

1. ***GET OUT***: If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call 911.
2. ***HIDE OUT***: If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room.
3. ***TAKE OUT***: As a last resort fight to defend yourself.

For more information, visit http://www.ou.edu/emergencypreparedness.html
Shots Fired on Campus Procedure - Video

Fire Alarm/General Emergency: If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates:

1. ***LEAVE*** the building. Do not use the elevators.
2. ***KNOW*** at least two building exits.
3. ***ASSIST*** those that may need help.
4. ***PROCEED*** to the emergency assembly area.
5. ***ONCE*** *safely outside,* ***NOTIFY*** *first responders of anyone that may still be inside building due to mobility issues.*
6. ***WAIT*** for official notice before attempting to re-enter the building.

OU Fire Safety on Campus

Course Outline

I. Introduction, Fundamental Statistics, and Least Squares Methods

(a) Review of fundamental statistical measures / Statistical tests
(b) Linear algebra review
(c) Composite / Epoch analysis
(d) Regression / correlation theory and its applications
(e) Significance Testing

II. Matrix Methods

(a) Empirical orthogonal functions (EOFs) / principal component analysis (PCA)
(b) Extended and multivariate EOFs
(c) Maximum covariance analysis (MCA) & canonical correlation analysis (CCA)

III. Time Series Analysis

(a) Autocorrelation
(b) Harmonic analysis, power spectral analysis, and significance testing for spectral peaks
(c) Cross-spectral analysis
(d) Filtering and filter designs

IV. Additional Topics (as time allows)

(a) Wavelet analysis
(b) Objective Mapping / Kriging
(c) Other topics based on student interest

FINAL EXAM PERIOD: MONDAY, MAY 10, 2021 1:30pm - 3:30pm