CLIMATE 588
REGIONAL SCALE CLIMATE:
DOWNSCALING TECHNIQUES AND APPLICATIONS

Winter 2018
4 credits

Professor:
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Location and Time:
T 10-12 2238 SRB
Th 10-12 SRB CAEN Lab
North Campus

Office Hours:
By appointment

COURSE DESCRIPTION: Global change is impacting an increasing number of sectors in science, engineering and policy, creating a need for high-resolution, future climate data used in impact assessments and mitigation plans. Because current future climate model simulations are run at a relatively coarse spatial resolution, an understanding of the methods of downscaling is necessary for local and regional scale applications. The primary objective of this course is to understand regional climate processes, downscaling techniques and tools for analysis. Topics will include: (1) a basic overview of atmospheric processes included in global and regional climate models, (2) information about grid structure, resolution and regional map projections, (3) data available for present-day and future climate analyses, (4) statistical downscaling, (5) dynamical downscaling, (6) multi-model ensembles and methods for assessing uncertainty in future climate model simulations, and (7) example applications of these downscaling methods.

An important component of this course is an integration of lectures, assigned journal papers, and hands-on data analysis. For the data analysis, we will spend approximately one class period per week in the SRB CAEN Lab learning to work with and analyze climate data. A course project will involve the application of these techniques to a project of the student's choice.

PREREQUISITES: The course will include an intensive data analysis component, and while some programming experience (UNIX, Matlab, other visualization software) will be helpful it is not required. Previous studies in atmospheric science are not required and relevant atmospheric topics will be included in course lectures.

TEXT:
Assigned reading and discussions: In this semester, we will be focusing on the Fourth National Climate Assessment, Volume 1 (NCA4; https://science2017.globalchange.gov/) as well as the draft Volume 2. Please look at the syllabus to see which chapters of Volume 1 we will be discussing (there are a total of five chapters that we will review). Also, Volume 2 is currently open for comment until 31 January 2018, so you will likely need to download your section before that date (see Assignments, below).

Suggested reading for atmospheric background:
***Atmospheric Science, Second Edition: An Introductory Survey*,** J.M. Wallace and P.V. Hobbs, Academic Press, 2006. An excellent, intro level book that covers all of the atmospheric science basics.

Parameterization Schemes: Keys to Understanding Numerical Weather Prediction Models, D.J. Stensrud, Cambridge University Press, 2009. While this book is written about weather models, it is a great overview of different parameterization schemes used in many general circulation models.

GRADING:

Weight	Type	Date
25%	Homework	6 Assignments
20%	Class reading discussions and questions (NCA4 V1)	4 discussions
10%	NCAV4 V2 reports	Tuesday, 20 February
20%	Oral Presentation of Final Project	12 & 17 April
25%	Written Final Project	Monday, 23 April

DATA ANALYSIS COMPONENT: As noted above, programming is not a prerequisite for the course. However, the class will be very data intensive and if you are unfamiliar with large data files and visualization software, be prepared to invest the time to learn these resources quickly. Data visualization software is needed for this analysis, and the course will be taught using a freely available packaged called NCL (http://www.ncl.ucar.edu/). The use of other software for the course (e.g., Matlab, IDL, VIS5D, Ferret) is acceptable but will not be supported by the instructor. Please see the schedule for planned classes in the CAEN lab. Any changes to the attached schedule will be announced in class and on CTools.

ASSIGNMENTS: There will be four types of assignments in the class.

1. **CLASS READINGS:** We will have four one-hour discussion sections that review the NCA V1 report (see identified chapters on the syllabus below). Please read ahead of time, and **email me three questions for discussion** for each chapter on the day prior to the discussion (by 5PM). This includes
    a. January 24: Chapter 2 (discussion on January 25, first hour of lab)
    b. February 7: Chapter 4 (discussion on February 8, first hour of lab)
    c. March 7: Chapters 5 and 6 (discussion on March 8, first hour of lab)
    d. March 21: Chapter 3 (discussion on March 22, first hour of lab
2. **NCA4 V2 PRESENTATIONS:** The second volume of the NCA4 is still under review until January 31, 2017. Please select a section of the NCA4V2 that you would like to present to the class in a 10-minute summary. These sections are organized by sector (e.g., water, energy, forests, agriculture, human health, etc.) or by region (Northeast, Southeast, Alaska, etc.). Each student will present one section in class on Tuesday, February 20.

3. **LAB HOMEWORK:** There will be about six lab assignments based on data and NCL analysis. Lab homework is designed to develop the skills you need to develop the analysis for the final project.
4. **FINAL PROJECT:** The objective of the final project is to allow you to apply your knowledge from the course to develop a hypothesis-driven project. Hopefully, this project will be relevant to your dissertation research, and the goal is to develop a publication-ready manuscript. The final project will include an oral presentation (approximately 15-20 minutes; 20% of the grade) and a written report in journal format (25% of the grade). In the event that you can develop your project into a submission to a peer-reviewed publication, it is expected that all other students who may have contributed to the project and the instructor will be co-authors.

HOMEWORK POLICY: Programming assignments are due at the beginning of class on the specified due dates. Each day (or fraction of a day) the assignment is late, the assignment grade will be reduced by 10%. Homework assignments may include both a reading assignment and an analysis component.

HONOR CODE: Read it: http://www.engin.umich.edu/students/honorcode/ All policies apply.

CLIMATE 588: Regional Scale Climate: Winter 2018: Tentative Course Outline

Blue = CAEN Lab Sessions: Homework (H) assigned (A) and due dates (D)

Wk	Date	Topic	Reading	Lab Homework
1	4 Jan	Course Introduction & Overview		
2	9 Jan	Atm Science basics: Scale dep procs I		
	11 Jan	CAEN LAB: Introduction (Unix, NetCDF, NCL)		H1A
3	16 Jan	Atm Science basics: Scale dep procs II		
	18 Jan	CAEN LAB: NCL continued		H1D/H2A
4	23 Jan	Atm Science basics: Scale dep procs II		
	25 Jan	CAEN LAB: NCL continued	NCA Ch .2	H2D/H3A
5	30 Jan	Model grids: Resolution and projections		
	1 Feb	CAEN LAB: NCL continued		H3D/H4A
6	6 Feb	Data: Observations and GCMs		
	8 Feb	CAEN LAB: Regridding	NCA Ch. 4	H4D/H5A
7	*13 Feb*	*No class: ALS out of town*		
	15 Feb	*No class: ALS out of town*		H5D/H6A
8	20 Feb	NCA Volume 2 reports	V2 reports	
	22 Feb	CAEN LAB: NCO/CDO		H6D
9	*27 Feb*	*Winter break*		
	1 Mar	*Winter break*		
10	6 Mar	Downscaling techniques: Dynamical		
	8 Mar	CAEN LAB: Project work	NCA Ch. 5/6	Abstracts due
11	13 Mar	Downscaling techniques: Statistical		
	15 Mar	CAEN LAB: Project work		
12	20 Mar	Detection and Attribution		
	22 Mar	CAEN LAB: Project work	NCA Ch. 3	
13	27 Mar	Multi-model ensembles		
	29 Mar	CAEN LAB: Project work		Figure outline due
14	3 Apr	Uncertainty Assessment		
	5 Apr	CAEN LAB: Project work		
15	10 Apr	Seasonal and decadal predictions		
	12 Apr	Project presentations		
16	17 Apr	Project presentations		