CEE 491/ATMO 752
CLIMATE MODELING, DATA ANALYSIS, AND APPLICATIONS
Fall 2016
University of Hawaii at Manoa –
Department of Civil and Environmental Engineering
& Department of Atmospheric Sciences

Instructor: Christina Karamperidou, Ph.D. (808-956-7110; ckaramp@hawaii.edu). Office hours TBA.

References:

- Class notes distributed by the instructor
- *Optional:* Climate Modeling for Scientists & Engineers, by Drake, John B, University of Tennessee, Knoxville, Tenessee, SIAM publications. Additional material at www.siam.org/books/mm19 (free)
- *Optional:* Climate System Dynamics and Modelling, by Hugues Goossee, Cambridge University Press
- Additional reading material assigned before classes.

Class Meetings: TTh 9:00AM-10:15AM, Aug 23 to Dec 6, 2016, Holmes #242

Laulima website: https://laulima.hawaii.edu/portal

Course Description
This course will cover basic principles of regional and global climate modeling, and climate data analysis methods for engineers and environmental scientists, with a focus on applications.

Pre: senior standing or higher. Some background in partial differential equations, computer programming languages (e.g. R), fluid mechanics/dynamics and basic statistical analysis is desirable.

Course Outline
The class is organized in three parts:

- **Part I:** Basics of the climate system
- **Part II:** Basics of climate modeling
- **Part III:** Analysis of climate model output and use in engineering applications.

The first part of the class focuses on basic principles of the climate system, the components of the climate system, and basic mechanisms of climate variability and change at the spatial and temporal timescales of interest for engineering applications and decision-making. The second part discusses the basic notions in climate dynamics that are used in climate modeling of increasing complexity (from 1D to 3D and state-of-the-art Global Climate Models), and includes in-class and homework exercises using simple climate models. The third part of the class focuses on methods of statistical analysis and processing of climate model output, which are frequently used in the climate science and engineering fields (regressions, EOF analysis, signal processing techniques). Additional focus will be given on preparing model output for use in engineering applications, decision-making models, and on estimating and communicating uncertainty of climate model projections.

Students will learn:

- Basic principles of the climate system, its components, and the basic global climate phenomena affecting regional climate at seasonal, interannual, decadal, and centennial time scales.
- Basics of building and running climate models of increasing complexity (from one-dimensional to state-of-the-art climate models).
- How to access climate model data of interest, compare with observational data, and perform basic climate data processing online and offline.
- Overview of advanced statistical methods used frequently in climate studies and applications.
- Assess and effectively communicate uncertainty in climate model projections.

Term projects:
Students will choose an environmental engineering problem of their interest from a list of topics, such as regional precipitation, temperature variability and extremes, seawater intrusion into coastal aquifers, wind strength and/or direction, sea level variations etc. They will then be asked to use the appropriate climate model (1D,2D,3D), perform an experiment, or identify and download climate data from other sources, analyze the data and use them as input for the regional problem of their choice. The overarching goal is a term project that illustrates the use of climate modeling and output to answer a specific regional-scale problem, and identify and assess the uncertainty in the project findings and proposed solutions. Deliverables include a final report, and a final in-class presentation.

Grading:
In-class short exercises and quizzes (based on pre-assigned reading material). 25%
Term project (individual and/or group). 75%

<u>CEE 491 Tentative Outline (v.1) – updated 11/12/2015</u>

<u>Date</u>	**<u>Topics</u>**
Aug 23,25	**Part I**: Introduction. Basic mechanisms of climate variability and change. Spatial and temporal timescales in climate and associated decision-making
Aug 30, Sep 1	**Part I**: Introduction. Basic mechanisms of climate variability and change. Spatial and temporal timescales in climate and associated decision-making
Sep 6, 8	**Part I**: Basic components of the climate system (ocean, atmosphere, cloud, vegetation, land, ice sheets etc)
Sep 13, 15	**Part I**: Basic concepts and equations of geophysical fluid dynamics
Sep 20, 22	**Part I**: Basic concepts and equations of geophysical fluid dynamics
Sep 27, 29	**Part II**: Climate modeling: From 1D and 2D models dynamical models (basic matlab modeling exercises)
Oct 4, 6	**Part II**: Climate modeling: From 1D and 2D models dynamical models (basic matlab modeling exercises)
Oct 11, 13	**Part II**: 3D climate dynamical models: Components and parameterizations in global climate models, exercises with educational GCM
Oct 18, 20	**Part II**: 3D climate dynamical models: Running global GCMs
Oct 25, 27	**Part III**: Climate data access, online processing, and basic diagnostics
Nov 1,3	**Part III**: Climate data access, online processing, and basic diagnostics
Nov 10	**Part III**: Basic statistical methods frequently used in climate science and engineering
Nov 15, 17	**Part III**: Basic statistical methods frequently used in climate science and engineering. Estimating and communicating uncertainty.
Nov 22	**Part III**: Basic statistical methods frequently used in climate science and engineering. Estimating and communicating uncertainty.
Nov 29, Dec 1	**Part III**: Statistical and dynamical downscaling. Signal processing. Applications.
Dec 6, 8	**<u>Conclusions, Final presentations (may take additional day during exam week).</u>**