Idealized Models of Climate Processes

EESC 6926

Department of Earth and Environmental Science, Columbia University

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Meeting Times	MW 1-2:15
Office hours	At LDEO, by appointment
Course website	Courseworks
Prerequisites	Previous graduate-level coursework in atmosphere and/or ocean physics and/or chemistry. One year of calculus. GR6901 or equivalent programming experience. Or permission of instructor.
Textbook	There is no textbook. Readings will be posted on Courseworks.

COURSE DESCRIPTION:

This course teaches students to design and apply idealized models to study the fundamental properties of climate system processes and their interactions. Though these models typically have at their core only a handful of interacting differential equations, they can significantly advance process understanding. We cover three topical areas in climate system science: (1) the interpretation and attribution of atmospheric methane trends (2) the role of the ocean in regulating atmospheric carbon dioxide, and (3) the influence of climate system feedbacks on the Earth's energy balance. Throughout the course, emphasis is placed on identifying assumptions underlying conclusions drawn from simple models and the time scales over which different processes operate.

COURSE COMPONENTS:

Lecture: Lecture will be used to introduce basic principles of simple modeling and to introduce each of the three modules.

Lab: Much class time will be devoted to working through modeling exercises relevant to each module. Students will run existing models and modify these models to add new processes and/or use observations to evaluate the model or add constraints from observations.

Discussion: Interspersed with lab sessions, discussions that integrate the models run in class and the peer-reviewed literature will be held.

Final Project: Students will propose a unique final project in which they will further explore an existing model or create their own new model. Students will prepare a presentation and short-format style paper to summarize their work.

GRADING:

1. Labs		50%
2. Final Project		30%
3. Participation	(includes co-presenting a paper)	20%

LATE WORK:

Submitting work on time is critical so that you can stay fully engaged with our discussions. Work will receive a 10% reduction in credit for each day late.

ACADEMIC INTEGRITY:

Academic integrity is essential. Please make you are familiar with expectations and consequences as outlined in the Faculty Statement on Academic Integrity and Honor Code established by the students of Columbia College and the School of General Studies. If you have any further questions,

please contact the Professors. In this course, all infractions will result in loss of credit for the assignment in question, and will be reported per University policy.

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Bibliography (version 1)

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Week	Date	Topic	Reading, ***Assignment Due***
1	4-Sep	Introduction	
2	9-Sep	Lecture: Principles of mechanistic modeling	Sarmiento and Gruber, Ch 1; Held 2005
	11-Sep	Lecture: Principles of mechanistic modeling	Jacob Ch3 (through 3.2); Brasseur&Jacob (2017), Ch1 & Ch4.7
3	16-Sep	Lecture: Introduction to Methane	Saunois et al., 2016; Kirschke et al., 2013
	18-Sep	Lab 1: Methane (1 & 2 box - constant lifetime)	Dlugokencky et al., 2003
4	23-Sep	Discussion: Lab 1	Prinn et al., 2005; Montzka et al., 2011.
	25-Sep	Lab 2: Methane (changing emissions, lifetime)	***Lab 1 write up due*** ; Patra et al., 2014?
5	30-Sep	Discussion: Lab 2	Turner et al., 2018. Sections of Prather, 2007 (1,2,4)
	2-Oct	Discussion: Papers (student-led)	Nisbet et al. 2016; Schaefer et al., 2016;
6	7-Oct	Final Discussion, Methane	***Lab 2 write up due;*** Turner et al. 2017; Rigby et al., 2017; Prather & Holmes, 2017
	9-Oct	Lecture: Introduction to Ocean Biology and Carbon	Williams and Follows, Ch 5, 6
7	14-Oct	Lab 3: Ocean Bio & Carbon (3 box, biotic, carbon)	TBD
	16-Oct	Discussion: Lab 3	Ito and Follows 2005
8	21-Oct	Lab 4: Ocean Bio & Carbon (1 box, abiotic with carbon)	**Lab 3 write up due** McKinley et al. 2019
	23-Oct	Discussion: Lab 4	Gruber et al. 2019; Peters et al. 2017
9	28-Oct	Discussion: Papers (student-led)	Broecker et al. 1999; Sarmiento and Toggweiler 1984; Siegenthaler and Wenk 1984
	30-Oct	Final Discussion: Ocean Bio & Carbon	***Lab 4 write up due*** Marinov et al. 2006; Stephens and Keeling 2000
10	4-Nov	Election day holiday	
	6-Nov	Student Project Proposals	
11	11-Nov	Lecture: Introduction to Energy Balance Climate Models	Held 2005
	13-Nov	Lab 5: Budyko-Sellers EBCM	Sellers 1969, Budyko 1970
12	18-Nov	Discussion: Lab 5	
	20-Nov	Discussion: Papers (student-led)	Pierrehumbert et al., 2011
13	25-Nov	Final Discussion, EBCM	***Lab 5 write up due***
	27-Nov	Thanksgiving holiday	
14	2-Dec	Student Presentations	
	4-Dec	Student Presentations	
15	9-Dec	Final Discussion	***Final paper due***