ECOSYSTEMS AND CLIMATE
FREC 5204
Fall 2018

TIME
Lecture and discussion: Mondays and Wednesdays, 9:05 - 9:55 AM
Lab: Tuesday, 3 – 5 PM

ROOM
Lecture and discussion: Cheatham Hall Room 218
Lab: Cheatham Hall Room 217

INSTRUCTOR
Dr. R. Quinn Thomas
310B Cheatham Hall
rqthomas@vt.edu
540-231-7608
Office hours by appointment

REQUIRED TEXTBOOK
Bonan, G. 2015. *Ecological Climatology: Concepts and Applications*. 3rd Edition. Cambridge University Press

Available online:
http://ebooks.cambridge.org.ezproxy.lib.vt.edu/ebook.jsf?bid=CBO9781107339200

CATALOGUE DESCRIPTION
Interactions between climate dynamics and ecosystem structure and function. Topics in surface energy balance, hydrology, carbon recycling, ecology, climate dynamics, micrometeorology. Modeling ecosystem-climate feedbacks using scientific software programming. Pre: Graduate Standing. (2H, 3L, 3C)

COURSE OVERVIEW
This course is an exploration into the fundamentals of terrestrial ecosystem and climate interactions. It will challenge students to think about the Earth as a system and the role of the biosphere in climate patterns. The central teaching tool is the incremental development of a simple Earth System model that addresses key mechanisms in ecosystem and climate dynamics. As we develop the model by adding more processes and feedbacks, we will examine processes in greater detail through lectures, discussions, and problem sets. In addition to model development using the R programing language, students will have hand-on exposure to analyzing high-frequency observations of weather, hydrology, and carbon cycling, and analyzing simulations from a widely-used climate model. The course will culminate with independent projects that further explore mechanisms and feedbacks in the simple Earth System model.

LEARNING OBJECTIVES
- Describe how biogeophysical and biochemical ecosystem processes influence climate

- Conceptualize feedbacks in the climate system
- Use differential equations in the R software to model climate-ecosystem interactions
- Analyze biometeorology data and climate model simulations
- Interpret primary literature in climate – ecosystem interactions

TOPIC OUTLINE
Note: The topics covered are subject to change

Week	Date	Topic	Book Reading	Discussion Reading
1	20-Aug	Introduction	Chapter 1 & 2	
1	22-Aug	Energy and energy fluxes	Chapter 3	
2	27-Aug	Energy and energy fluxes	Chapter 3	
2	29-Aug	Water and Carbon Intro	Chapter 3	
3	3-Sep	Labor Day		
3	5-Sep	Atmospheric Radiation and Atmospheric Circulation	Chapter 4; Chapter 5	
4	10-Sep	Surface Energy fluxes	Chapter 12	
4	12-Sep	Measuring Surface Energy fluxes	Chapter 7	
5	17-Sep	Surface Energy fluxes	Chapter 14	
5	19-Sep	Biogeophysics climate-vegetation dynamics	Chapter 27	
6	24-Sep	Atmospheric Circulation and Earth's climates	Chapter 5 & 6	
6	26-Sep	Climate Variability	Chapter 7	
7	1-Oct	Historical climate change	Chapter 8	
7	3-Oct	Contemporary climate change and radiative forcing	Chapter 8	
8	8-Oct	Physical climate feedbacks	Chapter 8	
8	10-Oct	Carbon cycle-climate feedbacks	Chapter 29	
9	15-Oct	Carbon cycle-climate feedbacks	Chapter 29	
9	17-Oct	Carbon cycle-climate feedbacks	CO_2 fertilization discussion	Three paper zipper
10	22-Oct	Carbon cycle-climate feedbacks	Chapter 29	
10	24-Oct	Freshwater systems and climate		Cole et al. 2007
11	29-Oct	Methane and Permafrost		Schuur et al. 2015
11	31-Nov	Tropical Forests and Drought		Three paper zipper

12	5-Nov	Land-use and land-cover	Chapter 23, Chapter 28	
12	7-Nov	Land-use and land-cover	Chapter 23, Chapter 28	Pongratz et al. 2010
13	12-Nov	Aerosols, Chemistry, and climate	Chapter 31	Unger 2014
13	14-Nov	Nitrogen, chemistry, and climate	Chapter 30	Pinder et al. 2012
	19 -Nov	Thanksgiving Break		
	21 -Nov	Thanksgiving Break		
14	26-Nov	Urbanization	Chapter 32	Oleson et al. 2010 Hu et al. 2016
14	28-Nov	Land-Management	Management discussion	Erb et al 2016
15	3-Dec	Climate Interventions	Chapter 33	Arora and Montenegro 2011
15	5-Dec	Wrap-up		

LAB SCHEDULE

Week	Date	Lab	Topic
1	21-Aug	1	Energy balance and intro to R
2	28-Aug	2	Simulating Energy Balance 1
3	4-Sep	3	Simulating Energy Balance 2
4	11-Sep		No Lab
5	18-Sep	4	Simulating the Atmosphere
6	25-Sep	5	Anthropogenic Greenhouse gases
7	2-Oct	6	Climate modeling: 101
8	9-Oct	7	Climate modeling: Scenarios
9	16-Oct	8	Climate modeling: Carbon-cycle feedbacks
10	23-Oct	9	Climate modeling: Quantifying carbon-climate feedbacks
11	30-Oct	10	Daisyworld
12	6-Nov	Projects	Start Project
13	13-Nov	Projects	Work on project
	20-Nov	Thanksgiving	Thanksgiving
14	27-Nov	Projects	Work on project
15	4-Dec	Presentations	Present projects

ASSESSMENT

Assessment of student performance will be based upon the traditional A-F plus/minus grading scale. Assessment will be based on the following assignments:

Assignment	**Percent of final grade**
Problem sets There is a short quiz associated with each lecture. The purpose of the quiz is to evaluate your understanding of fundamentals so that we can address challenging areas or engage on a deeper level in class. **You have three attempts to answer the questions on each quiz and you are required to attempt the quiz once before the associated lecture**. You will have your two additional available to use after lecture.	40
Lab exercises Computer exercises will use excel and R for simulations. The programing knowledge required is limited and will be taught in the course. It is encouraged to download R (via R studio) on your computer and explore the basics of the programing language. R studio can be found at http://www.rstudio.com. A good introduction to R is on the Canvas in the resources folder (Eller – Intro to R.pdf). There is no need to learn all the commands in the R introduction PDF so do not let it frustrate you!	30
Project You will be applying the modeling skills that you learned during the lab exercises to a problem of your choice. The key requirement in the project is to extend the simple Earth system model that we build in class to address a question in ecosystem-climate interactions. You will present your project results to the class and submit a written report.	30

COURSE POLICIES

This is a graduate-level course that approaches the topic of ecosystem-climate interactions through a hands-on modeling approach. Therefore, the course requires being enthusiastic about engaging the modeling aspect of the course. We will use a hands-on approach in which each class period builds on the previous class period: this means you need to come to class prepared by completing the reading assignments before class, making sure that you understand the topics covered in previous class periods, and that your version of the model that we are building through the semester is up to date. Please consult with me if you miss a class period for research or personal reasons. We will need to make sure that you are able to stay current in the course. If you feel that you are falling behind, I encourage you to seek help from your peers and from me. Please schedule a meeting with me through email or by talking after class.

You are required to come to class with the textbook because we will be doing problems from the textbook in class and you will need it as a reference. You are also required to come to class with a calculator or a computer for performing calculations. You are also recommended to come to lab with a computer that has R installed.

Being successful in science requires the communication of ideas verbally. Therefore, students are required to engage in discussion throughout the course and lead one of the discussions.

Students are expected to abide by the principles of the Virginia Tech Honors System. The Virginia Tech Honor Code can be found at: http://www.honorsystem.vt.edu. You may work together on the model development during class but you must have your own version of the model we are developing. You are expected to individually complete your essay and modeling project.

You are strongly encouraged to complete the Student Perceptions of Teaching (SPOT) questionnaire. Constructive student feedback is important for enhancing the learning experience in this course. Changes to the class and instruction may result from suggestions that are shared with me. Comments about specific aspects of the course or instruction are most helpful. For example, past comments indicated that real-world examples were important for helping students to understand key concepts, and so more of these examples were added to the course materials.