Syllabus - Land and Climate Interactions
GSEI 7200 (Spring 2023)

1. **Course Title**: Land and Climate Interactions

2. **Credit Hours/Prerequisites**: 3 credits (2 hour lecture and 1 hour lab)
   Prerequisites: A graduate-level course in environmental /hydrology /watershed/ ecosystem modeling or instructor approval

3. **Instructor:** Dr. Sanjiv Kumar, Assistant Professor, College of Forestry, Wildlife and Environment, Email: szk0139@auburn.edu

4. **When and Where:** TR 3:30 pm to 4:45 pm; Draughon Library 3033

5. **Office hours** by appointment

6. **Texts or Major Resources:**
   Bonan, G., Climate change and Terrestrial Ecosystem Modeling, Cambridge University Press, 2019

   Bonan G., Ecological Climatology: Concepts and Applications, Third Edition, Cambridge University Press, 2015

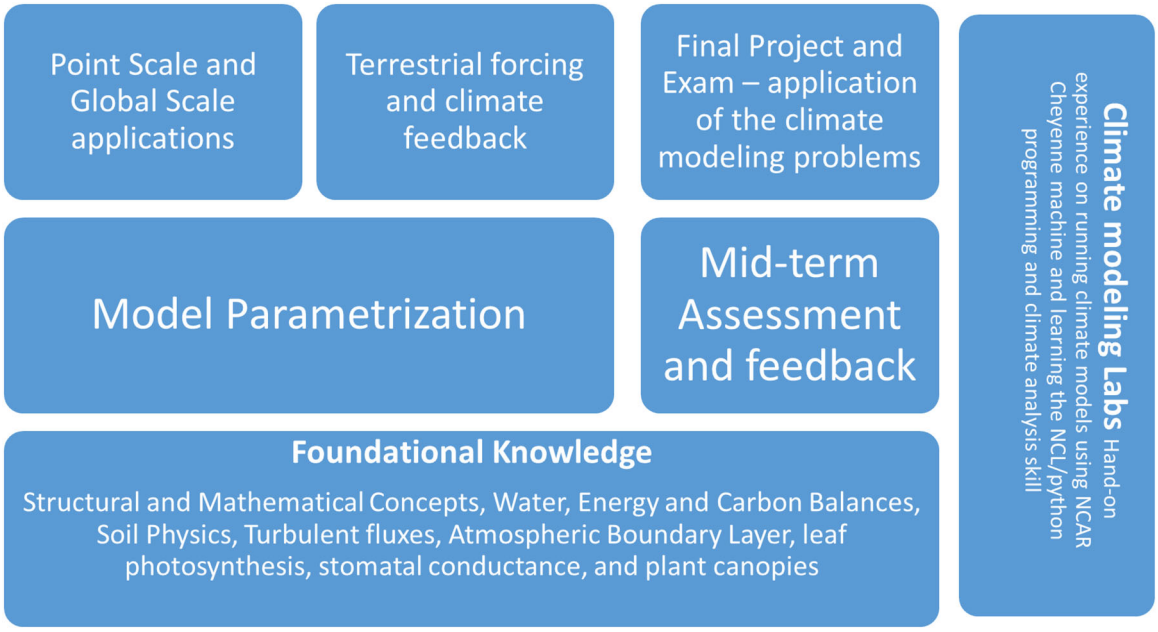
   Shuttleworth W. J., Terrestrial Hydrometeorology, John Wiley & Sons, Ltd, 2012

7. **Course Description:**
   This is an advanced graduate-level course designed to teach the modeling of land surface processes and study its impact on local, regional, and global climate. The land surface is an important component of the Earth's climate system. The land surface interacts with the overlying atmosphere through exchanges of carbon, water, and energy fluxes. Human modifications of the landscape, e.g. land use land cover change, and urbanization affect regional and local climate. Further, memory stored in the land surface provides an important source for climate and hydrological predictability at sub-seasonal to seasonal time scales. The goal of this course is to provide foundational knowledge of land processes that include hydrological, ecosystem, and boundary layer processes and hands-on experience in modeling of land processes in global/regional climate models. Students will learn about the basic physical principles, mathematical concepts, model parameterizations, and their applications in land-atmosphere interaction studies.

8. **Course Objectives/Outcomes:**
   - Students will learn about fundamental principles, including carbon, water, and energy balances, atmospheric boundary layer processes, and turbulent fluxes at the land surface.
   - Students will also learn about ecosystem processes involving vegetation and soil processes.

- Students will get training in running the Community Land Model and analyzing the outputs using NCAR Command Language.
- Homework assignments and tailored lab exercises will provide many opportunities to explore the discussed topic in-depth and get hand-on experience in running the global climate model.
- Students will also perform a research project on a selected course topic. This research project will contain a problem statement, experiment design, model simulations, analyzing model outputs, and presentation of results. As a part of the research project, students will also get an opportunity to perform land use change experiments or other similar experiments using the Community Earth System Modeling (CESM) framework.
- Students will participate in the 'think-pair-share' activity in class, and assignments will be due in a group of two students.

9. Visual Syllabus for GSEI 7200



10. <u>Teaching Philosophy</u>

Teaching is a joy, honor, and responsibility to transfer the best of the knowledge and learning skills to the next generation. I believe that undergraduate and graduate education provides the necessary fundamentals and tools for further exploration. As an instructor, I provide a conceptual understanding of the subject and a problem-solving approach to students. I believe in learning by doing and emphasize assignments and evaluations. Instructors are also role models for students and should establish expectations for a high level of scholarship among students. I recognize different learning styles among students; while some students prefer to learn by themselves using the course materials, others learn from instructors in the classroom environment. I appreciate diversity in the class, and I provide an inclusive learning environment to all.

I believe in hard work. All students can achieve the highest grade with their hard work. I recognize different backgrounds for the students, and some students may need to work harder than others. I have an open door (open email) policy, and available to answer any questions or feedback related to the course. There is also the option to resubmit the assignment based on the instructor's feedback. Most importantly, I believe that a university is a place of learning, and students can use the available resources to hone-up their skills and practice of scientific inquiry to the next level.

11. Lecture, Assignments and Research Project

Lecture and Lecture examinations: Lecture will be held in Draughon Library 3033. Students will get home assignments every alternate week and will have two weeks time to complete the assignment. Examination will consist of a Midterm exam and a Final exam, both of which include lecture and lab material. Examinations will consist of short- and long-answer essay questions and mathematical problem solving. Please bring your calculator or equivalent to the examination room. One-page cheat sheet that have different formulae is also allowed. Students are required to submit the cheat sheet along with the answer copy.

Theoretical aspect (first and second points in learning objectives) of the subject will be accessed through in-class participation, home assignments, and written portion of the final exam.

Each class lecture is divided into three smaller segments (15 minutes each), and there is 2-minute ‘think-pair-share’ activity between two segments.

Lab Assignments: Computer Lab will be available after the lecture in the School of Forestry and Wildlife Sciences each week. Students will get training in running CLM and analyzing model outputs using NCL. Instructor will provide detailed instruction for the lab work for the first 10-weeks of the semester. During this period, lab work will consist of in class assignment and a short report based on in-class assignment. The report will be due every two weeks before the next lab session begins. The report will be graded along with home assignments. In the last 6-weeks of the semester, students are encouraged to work on their project work; instructor will be available for the assistance.

Final Project: Students can select problem of their own interest that is related to the class materials, doable with available resources, and approved by the instructor. Students are required to make a thorough literature review about the problem, and make a in-class presentation about the problem statement, literature review, and the proposed solution and methodology during the 10th week of the class. Any credible question raised during the presentation should be adequately addressed in the final presentation and report. Performing model simulation is a must requirement for the final project. Students can work individually or in a team of two students depending upon the size of the project, and subject to approval of the instructor.

Final project presentation and report: Each student is required to submit a final report based

on the project. For a team project only one report is due, which identifies each individual's contributions. The final report can be upto 20 pages long, including illustration, and will be typed using 12-point font and one-inch margins, and double spacing. It should include six major parts, i.e., abstract, introduction, method description that include data and models, results, discussion, and conclusions. References should number 5 or more and be listed in the standard format at the end of the paper. Students are also required to make presentation about their findings in the final project during the last week of the class. Final project report is due in the last examination week of the semester.

12. Rubric and Grading Scale

Exams will be based on class lecture notes and lab exercises.

Final Exam	15% (written only)
Mid-term	15% (written only)
Home Assignments	40% (6 assignments, may involve lab work)
Final Project Presentation	10% (oral presentation, 10-15 minutes)
Final Project Report	20%

Final grades will be based on a 90-80-70-60 scale, but the instructor reserves the right to curve up.

Students will get feedback on their assignments within one week after the submission date. Based on the feedback student will allowed to resubmit the assignment if they want improved grade. Only one resubmission is allowed, and also within one week of receiving the feedback.

A total of 6 assignments will be due during the semester. Assignment submission will due two weeks after they have been posted.

13. Course policies

Attendance: Students are expected to attend all classes, and will be held responsible for any content covered in the event of an absence.

Excused Absences: Students are granted excused absences from class for the following reasons: illness of the student or serious illness of a member of the student's immediate family, the death of a member of the student's immediate family, trips for student organizations sponsored by an academic unit, trips for university classes, trips for participation in intercollegiate athletic events, subpoena for a court appearance, and religious holidays. Students who wish to have an excused absence from class for any other reason must contact the instructor in advance of the absence to request permission. The instructor will weigh the merits of the request, and render a decision. When feasible, the student must notify the instructor prior to the occurrence of any excused absences, but in no case shall such notification occur more than one week after the absence. Appropriate documentation for all excused absences is required. Please consult the *Student Policy* eHandbook for more information on excused absences.

Make-Up Policy: Arrangement to make up a missed major examination (e.g.:hour exams, mid-term exams) due to properly authorized excused absences must be initiated by the student within one week of the end of the period of the excused absence(s). Except in unusual circumstances, such as the continued absence of the student or the advent of university holidays, a make-up exam will take place within two weeks of the date that the student initiates arrangements for it. Except in extraordinary circumstances, no make-up exams will be arranged during the last three days before the final exam period begins.

Academic Honesty Policy: All portions of the Auburn University student academic honesty code (Title XII) found in the Student Policy eHandbook will apply to university courses. All academic honesty violations or alleged violations of the SGA Code of Laws will be reported to the Office of the Provost, which will then refer the case to the Academic Honesty Committee.

Disability Accommodations: Students who need accommodations are asked to electronically submit their approved accommodations through AU Access and to arrange a meeting during office hours the first week of classes, or as soon as possible if accommodations are needed immediately. If you have a conflict with my office hours, an alternate time can be arranged. To set up this meeting, please contact me by email. If you have not established accommodations through the Office of Accessibility, but need accommodations, make an appointment with the Office of Accessibility, 1228 Haley Center, 844-2096 (V/TT).

14. Course Schedule

Week 1-2: **Introduction and Important Structural and Mathematical Concepts**
Lab 1: Introduction to Community Land Model

Week 3-4: **Water, Energy and Carbon Balances at the Land Surface**
Lab 2: Running CLM point scale on your laptop

Week 5: **Soil Physics**
Lab 3: Continued from Lab 2

Week 6: **Surface energy balance and Turbulent fluxes**
Lab 4: Parmeter sensitivity using point scale simulation

Week 7: **Atmospheric Boundary Layer Processes**
Lab 5: Analysis of sensitivity run

Week 8: **Vegetation Processes: leaf photosynthesis, stomatal conductance, and plant canopies**
Lab 6: Running global scale CLM run on NCAR supecomputer

Week 9: **Vegetation Processes continued, and Mid-term exam**
Lab 7: Analysis of global scale CLM run

Week 10: **Research Project Proposal presentation**
Lab 8: Land-use change experiment

Week 11-12: Land Surface Modeling - simple land surface models, more complex land surface models, assembly of land surface models

Lab 9: Analysis of land-use change experiement

Week 13: **Comparison of land surface models at small and large scales**
Lab 10: Land-Atmosphere coupling experiment – Part 1

Week 14-15: **Terrestrial Forcing and Climate Feedbacks: soil moisture - vegetation - climate interactions, land use change impacts, urbanization**
Lab 11: Land-Atmosphere coupling experiment - Part 2

Week 16-17 **Final Project Presentations and Final Exam**
Lab 12: Project work