COLUMBIA UNIVERSITY
School of Professional Studies

SUSC PS5020 Predicting the Effects of Climate Change on Global Forests

Thursday, 18:10-20:00

3 Credits

Instructor: **Brendan M. Buckley**, Lamont Research Professor at the Lamont-Doherty Earth Observatory of Columbia University, bmb@ldeo.columbia.edu, office (845) 365-8782; cell (845) 664-8397.

Office Hours: Day and time at LDEO TBD, or anytime by Zoom or phone by appointment

Response Policy: The instructor will endeavor to be available for short discussions before or after class, but formal meetings should be scheduled by other arrangement.

Course Overview

Forests are often called the *lungs of the earth*, owing to their role in converting atmospheric CO_2 into the life-sustaining Oxygen that we all breathe. Collectively, the global forests contribute to roughly 40% of the annual global carbon sink, and yet little is known about the drivers of terrestrial carbon sequestration, and the processes involved in these systems response to changes in climate. Forested landscapes comprise some of the most important habitats on planet Earth, by serving as refuge to diverse and often endangered flora and fauna, and as regulators of water and soils. Increasingly, fragmented forests serve vital roles near some of our most populated regions for a variety of ecosystems services, and yet they remain under-appreciated as a bulwark against climate change effects. Forest ecosystem services are particularly important for regions where forests are heavily exploited and are often the primary source of water and food for marginalized human populations. Accordingly, the effects of climate change can always be viewed through the lens of social and environmental justice, a recurring concern of this class.

There is no required text book for this class. We will, instead, utilize the current, primary scientific literature on the direct and indirect effects of climate change on forest ecosystems around the globe. Each student will be responsible for leading at least one paper review during the course of the semester, beginning with a posting on Canvas, prior to Thursday's class, to prompt online discussion. Online discussion is followed by a brief presentation of the paper in class, and further in-class dialogue. Depending on class size we typically have two paper discussions each week. Papers will be chosen that present the current state of our understanding regarding weekly classroom topics, and prompt exploration of solutions to forest loss mitigation and sustainability.

Weather and other factors permitting, we will conduct two Saturday field sessions – one at the Lamont Sanctuary Forest in Palisades, NY, followed by a field trip to the Black Rock Forest Sanctuary in Cornwall, NY (see syllabus for dates). During these sessions, students will experience primary forest data collection, complete simple, non-graded quantitative exercises that use these data, and brainstorm on the broader topic of forests and climate change to aid the development of their final class projects. **The field excursions will be voluntary, but attendance is *highly encouraged*. If unable to attend, you will need to obtain the relevant information that will be included on the two exams.**

There will be two brief, non-graded quantitative exercises to complete, one from each of the field excursions. These exercises will utilize freely available software that will be provided. The purpose of these exercises is to introduce you to data collection methodology and analyses, relevant to the general course

subject matter, and which may be useful for your final class projects. You will have access to multiple sources of data, including satellite, forest inventory, tree rings and other forest-climate related measurements.

This course will prepare students to assess the impacts of climate extremes on forest systems and to understand the complexities of response possibilities from diverse ecosystems. You will be taught to read and understand multi-disciplinary scientific papers from the current literature. In class, we will discuss the questions asked, techniques used and key findings of these papers, with discussions led by students first on Canvas, and then in class, as part of the formal class participation grade.

An undergraduate background in any field of science or engineering and mathematics through statistical and time-series analysis, and a strong interest in coupled natural-human systems, is desirable.

This course is approved to satisfy the Area 2- Methods of Earth Observation and Measurement for the MS in Sustainability Science program.

Through lectures, discussions, and hands-on experience with climate model output and ecophysiological data, students will learn to independently assess the reliability of published impact projections, and will be better equipped to engage in discourse on the broader subject of forest response to climate change. Students enrolled in this course will discuss:

1. Application of forest ecology, plant ecophysiology and climate change to real world problem solving.
2. Technologies for observing natural forest ecosystems and measuring radial growth, basal area increment, and identifying episodes of mortality and underlying causes.
3. The science that connects global-scale climate dynamics, dendrochronology, plant ecophysiology and forest response.
4. The strengths and weaknesses of science-based predictions of forest response to climate.
5. Applying scientific methods to problem solving and policy development.
6. Current policy proposals within the framework of the science that underpins it.

Learning Objectives

By the end of this course, students will be able to:

L1: Articulate the complexities of global forests and analyze their relationship to climate and the global carbon budget.

L2: Apply forest ecology, plant ecophysiology, climate change and carbon budgets to real world problem solving.

L3: Use technologies for observing natural forest ecosystems and measuring radial growth, basal area increment, and identifying episodes of mortality and underlying causes.

L4: Locate available datasets for use in primary research projects and relate primary science literature to current and future professionally oriented forest projects

L5: Effectively communicate the importance of sustainability science with regard to global forest ecosystems and regional and global climate variability.

Readings

There is no required textbook for the course, though several core texts are suggested below, and PDF versions of these will be provided through Canvas. **Required, weekly readings will be from recent, primary literature, and posted on Canvas. Important papers that are "hot off the press" may occasionally be introduced during the course of the semester.**

Suggested Core Texts:

1. Hans Lambers, F. Stuart Chapin III, Thijs L. Pons (2008). Plant Physiological Ecology, Second Edition. ISBN: 978-0-387-78340-6 (Print) 978-0-387-78341-3 (Online) *(Our library has an online edition).*
2. Bush, M., Flenley, J., & Gosling, W. (Eds.). (2011). Tropical rainforest responses to climatic change. Springer Science & Business Media.
3. Kasischke, E. S., & Stocks, B. J. (Eds.). (2012). Fire, climate change, and carbon cycling in the boreal forest (Vol. 138). Springer Science & Business Media.
4. McElwee, P.D. (2016). Forests are Gold: Trees, people and environmental rule in Vietnam. University of Washington Press, Seattle. 283 pp.
5. Vaganov, E.A., M.K. Hughes and A.V. Shashkin (2000). Growth Dynamics of Conifer Tree Rings: Images of Past and Future Environments. Springer

Resources

Columbia University Library

Columbia's extensive library system ranks in the top five academic libraries in the nation, with many of its services and resources available online: http://library.columbia.edu/.

US Forest Service Website

The USFS Forest Inventory Analysis (FIA) webpage is a great resource for information and data, and is available online: https://www.fia.fs.fed.usLinks to an external site..

KNMI Climate Explorer

The KNMI Climate Explorer (https://climexp.knmi.nl/start.cgiLinks to an external site.) is a very powerful web-based platform for analyzing data in the context of relationships with climate. We will be using this platform at some point during class.

SPS Academic Resources

The Office of Student Affairs provides students with academic counseling and support services such as online tutoring and career coaching: http://sps.columbia.edu/student-life-and-alumni-relations/academic-resources.

Programming

Students should be familiar with standard office software to support their completion of course assignments. Some other specific software applications may be taught and/or used for the completion of the final project.

Course Requirements (Assignments and Participation = 100 points)

Class Participation (5 points)

Students are expected to participate in class discussions each week based on the reading assignments and lectures that will be provided online. Your participation grade is based on the content of your comments on Canvas each week, and in class. It is not the volume of your comments, but the quality that counts. Take your time and be thoughtful. You are expected to read each of the papers carefully enough to glean the most obviously important information that will be included on the two exams.

Paper Presentation (5 points)

Each student will lead a discussion on one assigned paper during the course of the semester, first posted on Canvas by 5:00 Tuesday prior to Thursday's class (template provided), followed by a brief presentation of the paper at the beginning of class.

Two Quantitative Exercises (not graded)

During each of the two Saturday field excursions you will complete a simple Quantitative exercise based on the types of data we collect in the forest. These exercises are not graded, but for those not able to attend the field trips, all information will be provided.

Two Exams (2 x 20 points each = 40 points)

There will be two exams in this class, based on the first three lectures and readings and first field day at the Lamont Sanctuary Forest, and the second three lectures and readings and field day at Black Rock Forest, respectively. **These exams will be taken in-person, during the first half of class (see syllabus for dates).**

Letter of Intent Assignment (= 5 points)

Students will complete a semi-formal, 3-page Letter of Intent (1-2 pages of text, with figures and/or tables not to exceed 3 pages), or LOI, which is an outline of the research ideas proposed for your final class project. This assignment is an important step in garnering feedback from your peers (each other), regarding the project you propose to undertake as your final class project. Examples of LOIs will be provided on Canvas.

Final Presentation (= 15 points)

Prior to completing your final paper, you will present a 15-minute AGU-style oral presentation during a special-session class symposium. This catered event is usually held on a Saturday at the Lamont-Doherty campus.

Final Paper (= 30 points)

The final project will take the form of a 10-page NSF-style research proposal based on ideas formed during the semester, and due on the final day of class. This research idea will be developed throughout the class, and students are given wide latitude to pursue a research idea that she or he is most interested in as part of their professional development. The students will serve as each other's peer review for the "Letters of Intent" (LOI) presented via Canvas prior to deciding upon the ultimate proposal idea. The feedback obtained by the peer review process will be discussed in class in order to help formulate the final proposals during the latter half of the class.

Evaluation/Grading

Participation (10 points – 5 for paper discussion; 5 for Canvas/class interaction)

Class participation exercises provide important professional skills, such as oral and written communication and critical thinking. Completing the weekly readings and participation in discussions (on Canvas and in-class) is required. These readings are chosen to hone your ability to talk about the class subject matter and will help develop ideas for the final class project. Students will lead the class discussions on an assigned rotating basis by providing a written synopsis from a template put on Canvas, to which the rest of the class will respond with comments and questions. There will be an oral discussion of these papers during each class, and in combination with the Canvas discussions will inform about half of the class participation grade. Please come to class having read the material, having responded to points brought up on the Canvas Discussion thread, and ready to participate in classroom discussions. The importance of classroom participation gives us a window on your interests and grasp of the material and should not be overlooked. The students are expected to show critical thinking, respectful interactions with classmates and a positive attitude towards learning and freely discussing the topics proposed. Students will share the critical questions from their assignments with their peers using the Canvas Discussion platform and their paper review is to be posted by 17:00 two days before class (Tuesday) so that other students have the opportunity to respond before Thursday's class.

2 Exams (20 points each)

Two in-class exams (Exam 1 – 20 questions based on the first three lectures and readings; Exam 2 – 20 questions based on lectures 4-6 and readings), will demonstrate understanding of the materials presented in class and readings.

LOI, Final Presentation and Project Paper (50 points)

The LOI, the written final project report, and the class presentation, taken together, comprise 50% of the final class grade. The 10-page written report will be graded based on completeness (i.e., all of the elements of a NSF-style proposal as outlined in class) and on Intellectual Merit and Broader impacts. The class presentation is organized as an American Geophysical Union (AGU) format (15 minutes that includes 3 minutes for questions) and will be graded based on clarity, quality of the presentation materials, finishing in a timely manner, and responses to audience questions.

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ASSIGNMENT	% Weight
Participation	10
Exams	40
Letter of Intent	5
Final Project Presentation	15
Final Project Paper	30

FINAL GRADING SCALE

Grade	Percentage
A+	98–100 %
A	93–97.9 %
A-	90–92.9 %
B+	87–89.9 %
B	83–86.9 %
B-	80–82.9 %
C+	77–79.9 %
C	73–76.9 %
C-	70–72.9 %
D	60–69.9 %
F	59.9% and below

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Course Policies

Participation and Attendance

You are expected to come to class on time and prepared for an interesting, lively, and respectful discussion with your peers. If you miss an experience in class, you miss an important learning moment and the class misses your contribution. **More than one unexcused absence will affect your grade. Please consult the instructor in the event that an absence is unavoidable.**

Late work

Work that is not submitted on the due date noted in the course syllabus without advance notice and permission from the instructor will be graded down 1/3 of a grade for every day it is late (eg., from a B+ to a B).

Citation & Submission

All written assignments must cite sources and be submitted in person or to the course Canvas page (not via email).

School Policies

Copyright Policy

Please note—Due to copyright restrictions, online access to this material is limited to instructors and students currently registered for this course. Please be advised that by clicking the link to the electronic materials in this course, you have read and accept the following:

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials. Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

Academic Integrity

Columbia University expects its students to act with honesty and propriety at all times and to respect the rights of others. It is fundamental University policy that academic dishonesty in any guise or personal conduct of any sort that disrupts the life of the University or denigrates or endangers members of the University community is unacceptable and will be dealt with severely. It is essential to the academic integrity and vitality of this community that individuals do their own work and properly acknowledge the circumstances, ideas, sources, and assistance upon which that work is based. Academic honesty in class assignments and exams is expected of all students at all times.

SPS holds each member of its community responsible for understanding and abiding by the SPS Academic Integrity and Community Standards posted at http://sps.columbia.edu/student-life-and-alumni-relations/academic-integrity-and-community-standards. You are required to read these standards within the first few days of class. Ignorance of the School's policy concerning academic dishonesty shall not be a defense in any disciplinary proceedings.

Accessibility

Columbia is committed to providing equal access to qualified students with documented disabilities. A student's disability status and reasonable accommodations are individually determined based upon disability documentation and related information gathered through the intake process. For more

information regarding this service, please visit the University's Health Services website: http://health.columbia.edu/services/ods/support.

2023 Syllabus – SUSC PS5020 Predicting the Effects of Climate Change on Global Forests

Week 1 (09/07): Class Introduction, Opening Remarks

Week 2 (09/14): Origins of the Global Forest, demonstration of reading discussions

Assign papers 1-2 for student lead

Week 3 (09/21): How trees function, Ecophysiology of forest plants/trees/photosynthesis

Assign papers 3-4 for student lead

- *Saturday Session 1: Sept. 23, at LDEO Sanctuary Forest*

Week 4 (09/28): The Global Climate System, and its relevance to class

Assign papers 5-6 for student lead

Week 5 (10/05): EXAM 1, 20 Points

Final Project and presentation planning

Assign papers 7-8 for student lead

- *Saturday Session 2: Oct. 7, at Black Rock Forest*

Week 6 (10/12): Carbon above/below ground,

Assign papers 9-10 for student lead

Week 7 (10/19): Forest Ecosystems,

Assign papers 11-12 for student lead

Week 8 (10/26): Boreal/Temperate Biomes

Assign papers 13-14 for student lead

Week 9 (11/02): Tropical Biomes

Assign papers 15-16 for student lead

Week 10 (11/09): EXAM 2 (20 points)

Week 11 (11/16): Solutions 1; Carbon Offsets

Week 12 (11/30): Solutions 2; Green Intervention

Week 13 **(12/07)**: DISCUSSIONS (Last Class)

Week 14 **(12/14)**: **FINAL PAPERS DUE, 17:00**

* **Three Saturday Sessions:**

Saturday 1: LDEO Sanctuary

Saturday 2: Black Rock Forest

Saturday 3: Finals Symposium at LDEO

Grade based on 100 Points

5 pts. Class participation – weekly attendance, interactions with Canvas, comments in class

5 pts. Paper presentation – leading one scientific paper discussion on Canvas and in class

20 pts. Exam 1 – in class exam, based on first four lectures, field day, and papers read

20 pts. Exam 2 – in class exam, based on second four lectures, field day, and papers read

5 pts. Letter of Intent (LOI) – a one page document proposing final project

15 pts. Final Presentation – 15-minute AGU style lecture on final paper

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30 pts. Final Paper – 10-page research paper following class guidelines