Course Syllabus

Advanced Academic Programs
Zanvyl Krieger School of Arts and Sciences
Johns Hopkins University
AS.420.619 – Climate Dynamics

Course and Instructor Information

Instructor Information

Instructor: Nathaniel S Winstead, Ph. D.
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Course Description

There is a huge interest in understanding the climate at multiple scales. This course will provide an overview of the chemical and physical climate system, feedbacks, and the basic physical balances governing atmospheric circulations and climate with an eye on understanding the basics of climate models. The course will cover energy transfer in the ocean-atmosphere system, mathematical modelling of the ocean and atmosphere, modeling of these systems and the basics on how to construct a climate model and explore the current state of climate models.

Course Overview

The primary objective of this class is to explore the complex physics and dynamics underlying the atmosphere – ocean system with a special emphasis on the application of these concepts to the understanding and interpretation of climate models. Climate models are our primary tool for predicting the future state of the climate system and policy makers must rely on accurate output from these models to make good policy decisions. However, to many, these models are a mysterious “black-box” that seems to produce realistic looking predictions but how these predictions are generated is poorly understood. Through two parallel threads, this course will open up the “black box” to unlock some of the mysteries of climate modeling.

The first thread: “Climate Dynamics” is designed to provide an understanding of the major components of the climate system – particularly the atmosphere and ocean since these are the primary drivers of the climate system. In this thread, we will examine the chemical and physical climate system, the basic underlying physics governing the atmospheric and oceanic general circulation from global scales to turbulence. We will view the climate system as a deeply connected, nonlinear dynamical system full of energy transfer processes, feedbacks and fluid dynamics.

The second thread: “Climate Modeling” is designed to tie together the concepts in the first thread with a deep understanding of the modeling of the complex climate system. A history of numerical modeling of the climate system will be the first stop on our journey. We will look at different types of models, the

major issues involved in constructing a climate model and we will explore the current state of climate models. When it comes to modeling, there is nothing better than a hands-on approach so a series of exercises and discussion have been designed where you will run a global climate model and analyze the output from it.

Together, these two threads will provide an in depth understanding of the major elements of the climate system and you will come out of the class with a deep understanding of the underlying science behind all of those IPCC predictions.

Course Goals & Learning Objectives

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

- Assess the earth's climate within the context of the sun and other planets.
- Analyze the physics that underpins the chemical and physical climate system and the close interconnections between each sub-system within.
- Analyze the data sources that inform our understanding of climate and its forcers over deep time
- Examine the history and legacy of the modeling of the earth system including numerical weather prediction, ocean, and climate modeling.
- Peek "under the hood" of these earth system models to evaluate their structure, capabilities, and limitations

Course Materials

The following resources are **required** for this course:

Textbook

- **The Atmosphere and Ocean: A Physical Introduction**, 3rd Edition Neil C. Wells ISBN: 978-0-470-69469-5 Nov 2011 424 pages.

Note: An additional resource that we will be referencing is the Intergovernmental Panel on Climate Change (IPCC) 5th Synthesis Report. This report is available for download from https://www.ipcc.ch/

- IPCC, 2014: *Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp.

Software

- License for EdGCM climate model. The student license may be purchased at the EdGCM: Educational Global Climate Model website.

Specific Technology Requirements & Skills for this Course

This course requires the use of a computer that complies with the following hardware specifications: Windows XP or higher; or MacOS 10.3.9 - 10.11.

Learning online requires some basic knowledge of computer technology. At a minimum, you need to be able to:

- Navigate in and use Blackboard; the Blackboard Student Orientation course on your "My Institution" page

- Create and save MS Word documents; review MS Word training and tutorials for PC users (all versions); Word Help for Mac users
- Microsoft Office or equivalent – specifically Excel for visualizing model output
- Find basic resources on the Internet
- Create and organize files & folders on your computer
- Send, receive, and manage email
- For Mac users, some additional software requirements (e.g. Panoply visualization software)
- Synchronous sessions will be a weekly feature of the course, a web cam (optional) and microphone (required) are needed to participate.

Assignments and Grading Policy

Assignments

In the table below, you will find a brief description of the various assignments in this course including due dates assignment weights, and frequency.

Assignments	Due Dates	Assignment Value
Course Paper: Course paper based on student selected climate topic	Topic due by Module 7 Paper due on Last day of Class	280 points (25%)
Homeworks: 7 physics based homework problems roughly bi-weekly	Bi-Weekly	40 points each for a total of 280 points (25%)
Modeling Project: EdGCM analysis and modeling project • **Set up and run climate model with test modules** by Module 4. • **Parameter study various climate conditions** by Module 7. • **Climate Prediction based on climate model** -- Students will configure their own climate model solution by Module 10. A final report with conclusions will be presented in PowerPoint format in Module 13 and each student must comment on two other's students' results and contrast/compare with their model.	Initial Milestone is 2 x CO2 case by Module 4 Parameter Study Due by Module 7 Final Modeling project due by Module 13	2xCO2 case study: 50 points Parameter Study: 80 points Final Project: 150 points For a total of 280 points (25%)
Course Engagement *Weekly Discussion Activities* online discussions; student-to-student interaction You are expected to have an active presence in course discussions,	Weekly	20 points per week for a total of 280 points (25%)

and complete course activities as noted in the assignment guidelines to maximize your learning. Participation in activities should be consistent, of high quality, and reflect both a high level of academic thinking and your own personal perspectives, opinion, and ideas. *Synchronous Sessions:* Weekly zoom meetings with the professor. During these sessions, answers to your questions will be given, insight to the geophysical processes of atmosphere and ocean, and insights into climate models and the modeling project will be given. * *Individual Check-in:* Individual project check-in zoom sessions will be held during Modules 10, 11 and 12 (one per student). This will be an opportunity for two-way feedback regarding how the final project is going.*		
Total		**1120 points (100%)**

-While climate chats and individual check-in sessions are not graded, they are considered an important component of course engagement and are highly encouraged.

Grading Policy

Letter Grade	Percentage
A+	98% to 100%
A	94% and less than 98%
A-	90% and less than 94%
B+	88% and less than 90%
B	84% and less than 88%
B-	80% and less than 84%
C	70% and less than 80%
F	0% and less than 70%

This course will follow the Advanced Academic Programs Grading Policies.

Assignment Submission
Students are required to adhere to the following guidelines when submitting written work:

- Use APA format
- Adhere to word limits for each assignment
- Cite sources properly

Please review the JHU Ethics Statement below prior to submission.

Assignment Feedback
The instructor will aim to return assignments to you within 7 days and you will receive feedback in the My Grades area of the course which can be accessed via the navigation menu.

Late Policy
You are expected to contact your instructor in advance if you think you cannot meet an assignment deadline. However, if an assignment is late and prior arrangements have not been made with the instructor, the assignment score will suffer a 20% late penalty.

Synchronous Sessions
The instructor will hold live, synchronous sessions in Zoom. These sessions will provide an opportunity for real-time map discussions and climate analysis that will help cement the physics thread for the course. Therefore, attendance for synchronous sessions, while not required, is highly recommended. If you cannot attend a synchronous session, you will be responsible for watching the recording at a later time.

Time Management Expectations
It is expected that you look ahead to schedule your time. Plan to complete coursework across several days of the week rather than all in one day. Some assignments require that you work on them for multiple weeks. Be sure to review the assignment directions at the beginning of the course so that you can plan your time accordingly. Please seek help before becoming frustrated and spending a significant amount of time to resolve an issue.

Important: A special note on the EdGCM climate model: It is particularly important that you install and run the EdGCM climate model as soon as possible. Each simulation can take as long as 12 – 24 hours to run depending on the operating system and computer specifications.

Directions for Students

Next Steps: Carefully review the remaining sections of the syllabus before beginning the first week's activities, which are located in the **Lessons** area of the navigation menu in your online course.

Once you feel that you are ready to dive into the first week's activities, select **Lessons** on the navigation menu. Then, select **Module 1** to begin.

About Your Course

Course Structure

What To Expect in this Course

This course is 14 modules and includes individual, whole group discussions and activities, and video lectures and other forms of course instruction in a weekly cycle of instruction. Each module begins on a Wednesday and ends on the following Tuesday. Please review the course syllabus thoroughly to learn about specific course outcomes and requirements. Be sure to refer to the Checklist each week, which provides a week-at-a-glance and shows targeted dates for the completion of activities.

Course Policies

Course Participation

Participation Requirements
You are expected to log into Blackboard regularly throughout the week - a daily check-in is recommended. It is your responsibility to read all announcements and discussion postings within your assigned forums. You should revisit the discussion multiple times over the week to contribute to the dialogue.

Group Work
Group work may be assigned as part of this course. If group work is required, you are expected to work equitably within your group to complete collaborative group activities. If group work is assigned, you will have an opportunity to privately rate your own participation and that of your group-mates.

Online Etiquette
In this course, online discussion will primarily take place in our online discussion board. In all textual online communication, it is important to follow proper rules of online etiquette - communicating with others in a proper and respectful way. For helpful tips, please these Ground Rules for Online Discussions.

Course Protocols and Getting Help

Amendments to the Course
Changes to the course will be posted in the Announcements section of your course. Please check announcements every time that you log into your online course.

Course Communication
You should communicate often with your classmates and the instructor. The majority of communication will take place within the Discussion forums. When you have a question about an assignment or a question about the course, please contact your instructor, or post your question in the course's "Syllabus & Assignment Question" forum.

Email Communication
For questions regarding course activities and assignments that would be general interest to other students, please post those in the Discussion forum. If you have a question regarding course activities and assignments of a personal nature, please send an email message to the instructor and observe the following guidelines:

- Include the title of the course in the subject field (e.g., JHU Insert Name of Course).
- Keep messages concise, and check spelling and grammar.
- Sign your full name (the sender's email is not always obvious).

Feel free to contact your instructor with comments, questions, and concerns. All email messages will be sent to you via your JHU email account, so you should be in the habit of checking that account every day or you should ensure that your JHU email account forwards messages to another account of your choice.

Email messages will be responded to within 24-48 hours.

University Policies

General

This course adheres to all University policies described in the academic catalog. Please pay close attention to the following policies:

Students with Disabilities

Johns Hopkins University is committed to providing reasonable and appropriate accommodations to students with disabilities. Students with documented disabilities should contact the coordinator listed on the Disability Accommodations page. Further information and a link to the Student Request for Accommodation form can also be found on the Disability Accommodations page.

Ethics & Plagiarism

JHU Ethics Statement: The strength of the university depends on academic and personal integrity. In this course, you must be honest and truthful. Ethical violations include cheating on exams, plagiarism, reuse of assignments, improper use of the Internet and electronic devices, unauthorized collaboration, alteration of graded assignments, forgery and falsification, lying, facilitating academic dishonesty, and unfair competition. Report any violations you witness to the instructor.

Read and adhere to JHU's Notice on Plagiarism.

Dropping the Course

You are responsible for understanding the university's policies and procedures regarding withdrawing from courses found in the current catalog. You should be aware of the current deadlines according to the Academic Calendar.

Getting Help

You have a variety of methods to get help on Blackboard. Please consult the resource listed in the "Blackboard Help" link for important information. **If you encounter technical difficulty in completing or submitting any online assessment, please immediately contact the designated help desk listed on the AAP online support page.** Also, contact your instructor at the email address listed in the syllabus.

Copyright Policy

All course material are the property of JHU and are to be used for the student's individual academic purpose only. Any dissemination, copying, reproducing, modification, displaying, or transmitting of any course material content for any other purpose is prohibited, will be considered misconduct under the JHU Copyright Compliance Policy, and may be cause for disciplinary action. In addition, encouraging academic dishonesty or cheating by distributing information about course materials or assignments which would give an unfair advantage to others may violate AAP's Code of Conduct and the University's Student Conduct Code. Specifically, recordings, course materials, and lecture notes may not be exchanged or distributed for commercial purposes, for compensation, or for any purpose other than use by students enrolled in the class. Other distributions of such materials by students may be deemed to violate the above University policies and be subject to disciplinary action.

Code of Conduct

To better support all students, the Johns Hopkins University non-academic Student Conduct Code has been integrated and updated to include all divisions of the University. In addition, it is important to note that all AAP students are still accountable for the Code of Conduct for Advanced Academic Programs.

Title IX

Confidentiality and Mandatory Reporting

As an instructor, one of my responsibilities is to help create a safe and inclusive learning environment on our campus. I also have mandatory reporting responsibilities related to my role as a Responsible Employee under the Sexual Misconduct Policy & Procedures (which prohibits sexual harassment, sexual assault, relationship violence and stalking), as well as the General Anti-Harassment Policy (which prohibits all types of protected status based discrimination and harassment). It is my goal that you feel able to share information related to your life experiences in classroom discussions, in your written work, and in our one-on-one meetings. I will seek to keep information you share private to the greatest extent possible. However, I am required to share information that I learn of regarding sexual misconduct, as well as protected status based harassment and discrimination, with the Office of Institutional Equity (OIE). For a list of individuals/offices who can speak with you confidentially, please see Appendix B of the JHU Sexual Misconduct Policies and Laws.

For more information on both policies mentioned above, please see: JHU Relevant Policies, Codes, Statements and Principles. Please also note that certain faculty and other University community members also have a duty as a designated Campus Safety Authority under the Clery Act to notify campus security of certain crimes, as well as a duty under State law and University policy to report suspected child abuse and/or neglect.

Tentative Course Schedule

Activity and assignment details will be explained in detail within each week's corresponding learning module (Lessons in Blackboard). If you have any questions, please contact your instructor.

This schedule is subject to change with fair notice. Any changes will be posted via Announcements in Blackboard.

Module	Dates	Topics	Activities & Assessments
1	Sep 4 – Sep 10	Introduction to the Climate System (Chapter 1)	Homework Assignment 1 Synchronous Session 1 Online Discussion 1
2	Sep 11 – Sep 17	Introduction to Climate, Weather and Ocean Modeling	Homework Assignment 2 Synchronous Session 2 Online Discussion 2
3	Sep 18 – Sep 24	The Energy Budget and Thermal Distribution of the Atmosphere and Upper Ocean (Chapter 3)	Homework Assignment 3 Online Discussion 3
4	Sep 25 – Oct 01	Structure of the Atmosphere and Ocean (Chapter 2 and 5)	Online Discussion 4 Modeling Project Part I due
5	Oct 02 – Oct 08	The role of water in the atmosphere and climate (Chapter 4)	Homework Assignment 4 Online Discussion 5
6	Oct 09 – Oct 15	Climate Energetics (Chapters 5 and 9)	Online Discussion 6
7	Oct 16 – Oct 22	The general circulation Part I: Equations of Motion, Governing Forces and the Major Current Systems (Chapters 6 - 9)	Paper Topic Due Online Discussion 7 Modeling Project Parameter Study Due
8	Oct 23 – Oct 29	The General Circulation Part II: A Closer Look at the Tropics (Chapters 6 - 9)	Homework Assignment 5 Online Discussion 8
9	Oct 30 – Nov 05	The General Circulation Part III: A Closer Look at the Mid-latitudes (Chapter 6 - 9)	Online Discussion 9
10	Nov 06 – Nov 12	The General Circulation Part IV: A closer look at the Oceans (Chapter 6 - 9)	Homework Assignment 6 Online Discussion 10 Individual Project Check-in

			Sessions
11	Nov 13 – Nov 19	Climate Change Part I: Measuring the Climate with and without Thermometers (Chapter 12 and IPCC reports)	Online Discussion 11 Individual Project Check-in Sessions
12	Nov 20 – Nov 26	Climate Change Part II: Climate Change Context – Modern vs. Historical Climate (Chapter 12 and IPCC reports)	Homework Assignment 7 Online Discussion 12 Individual Project Check-in Sessions
THANKSGIVING BREAK – NO NEW ASSIGNMENTS			
13	Dec 04 – Dec 10	Climate Change Part III: Forecasting the Future Climate (Chapter 12 and IPCC reports)	Modeling Final Project due Online Discussion 13
14	Dec 11 – Dec 17	Course Wrap-Up	Paper Due