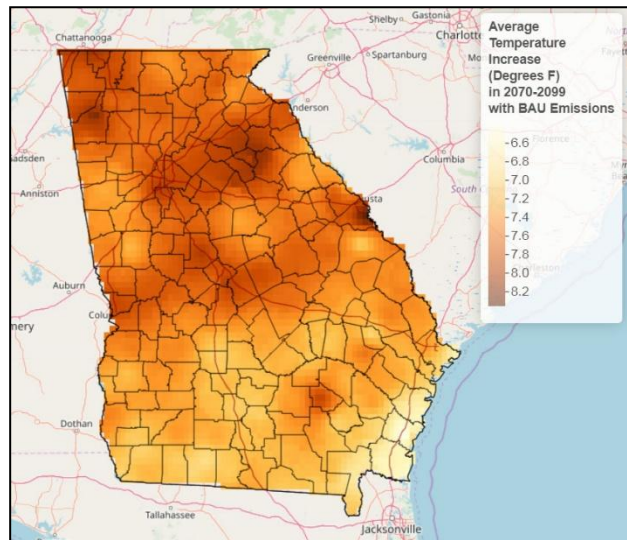


CP 4545 & CP 6545
Climate Change Analytics
William J. Drummond
Fall 2026

Course Syllabus

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Course Description

This is a course for students who want to confront the global problem of climate change using powerful, recently-developed tools from the fields of data science and geospatial analytics. The course's primary software environment is the R language and a suite of specialized R-based packages, but previous knowledge of R is not required or assumed.

Climate change analytics is especially challenging because the time horizons addressed can extend backward and forward for centuries, and any analysis of future climate change must deal with a broad range of unknowns while still applying scientific rigor. In addition, the rapid pace of climate change means that the past conditions are no longer a reliable guide for predicting future conditions. Instead, we must be guided by the output of climate models when we decide what actions we must take today to try to forestall or adapt to the worst effects of climate change in the future.

The course will address the major ways in which data analytics can help answer three major questions:

- What are the primary **causes** of climate change?
- What are the major **impacts** of climate change?
- What are the available **solutions** for climate change?

The course will, at many points, touch on climate change policy. However, climate change data and analysis methods, not policy, are the major foci of the course. Students who are also interested in climate change policy should consider these courses:

- CP 4190/6190: Introduction to Climate Change Planning
- CP 6217: Climate Change and the City
- PubP 6360: Sustainable Energy and Environmental Management
- PubP 6354: Climate Policy
- PubP 6701: Energy Technology and Policy

Learning Objectives

Students successfully completing this course will be able to:

- Create R scripts to import and format a variety of data related to climate change
- Utilize R to analyze climate change data to generate useful information
- Import and format relevant vector climate change spatial data
- Import and format relevant raster climate change spatial data
- Visualize climate change data through charting and mapping

Teaching Methods

The teaching methods for this class include a wide variety of methods, including lectures, in-class labs, class discussions, homework, required readings, LinkedInLearning videos, two tests, a final exam, and a series of small-scale projects. Students are expected to attend all classes. See below in the Grading section for class attendance details.

Course Materials

There are no required textbooks for this course. Additional materials or links to those materials will be posted on Canvas.

Course Software

The primary software environment will be the open-source R package and RStudio, supplemented with specialized R libraries for data wrangling and spatial analysis. However, prior experience with R or any other programming language is not a course pre-requisite. Students may use College of Design virtual machines with R, RStudio, and a pre-installed set of R libraries. But R, RStudio, and the necessary R libraries are all open-source software that students may download and install on personal computers.

Grading

See the [Georgia Tech Student-Faculty Expectations Agreement](#) in the Georgia Tech catalog for Institute-wide expectations for both students and faculty.

The [Georgia Tech Honor Code](#) is in effect throughout this course. You should review this code and make sure you understand your responsibilities. If you have any questions, please contact the instructor.

The two tests and final exam will take place during the designated classes and the GT-defined final exam period. Except in truly extraordinary circumstances as determined by the course instructor, you must take the tests and final exam on the scheduled days and times. **Plan now** to be in class for both tests and the final exam. See the course schedule below for details. Tests and the final will be held in the normal course classroom. They will have two components: short answer questions that are closed book, closed note, and closed computer, and hands-on questions that are open book, open note, and open computer.

Students will also complete a series of three small-scale projects. Each project will require students to implement a variation and/or extension of one of the class hands-on R exercises. Additional details on the projects will be distributed at the appropriate times in the course.

Test, exam, and project grades may be curved upward or downward depending on the actual distribution of grades in a particular test, exam, or project.

All students are expected to attend every class and roll will be taken in most classes. Each student is allowed four absences during the semester, with no explanation to the professor necessary. For a fifth absence students will lose 2½ of the 5 points for class participation, and students with a sixth absence will lose all 5 class participation points. This policy is effective beginning in week 2 of the semester. Students who must miss class for Georgia Tech sports teams or other official Georgia Tech activities will not have those absences count against the four allowed absences.

Each student's final grade in the course will be based upon these components:

Class attendance	5 percent
Test 1	15 percent
Test 2	20 percent
Final exam	30 percent
Small-Scale Project 1	10 percent
Small-Scale Project 2	10 percent
Small-Scale Project 3	10 percent
Total	100 percent

Course grades are assigned by the traditional grading scale:

90-100	-	A
80-90	-	B
70-80	-	C
60-70	-	D
Below 60	-	F

Throughout the course, work from undergraduate students and graduate students will be graded according to separate and appropriate standards. The small-scale projects will have a larger scope for graduate students, compared to undergraduate students. The project descriptions will give details.

Use of Generative AI and Large Language Models (LLMs)

This course encourages students to use the official Georgia Tech version of Microsoft Copilot, which is powered by ChatGPT. In the judgment of the course instructor, it is important for students to develop a critical perspective on the strengths and weaknesses of LLMs, and this can only be achieved by using LLMs for a broad variety of tasks. However, professionals in city planning and data analytics must also understand fundamental concepts and be prepared to carry out basic calculations without LLM support. That is why the tests and final exam have both a closed-book, closed computer short-answer section and an open-book, open-computer hands-on section.

For the course projects, students MAY NOT use LLMs to generate text. Students MAY use LLMs to correct and polish already-written text. If you do use LLMs to improve already-written text, you MUST turn in the initial already-written text as an appendix to the project with a brief explanation of how you used the LLM.

Students with Disabilities

If you are a student with learning needs that require special accommodation, contact the Office of Disability Services at 404.894.2563 or their website, as soon as possible, to discuss your needs and to obtain an accommodations letter. Then, make an appointment with me as soon as possible to discuss your learning needs.

Course Schedule

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Classes	Topics, Tests, Deliverables	Readings
Week 1: August 24 - August 26	Introduction to climate change analytics and R	Poulson: Intro, Chap 1, Chap 2
Week 2: August 31 - September 2	Overview of climate change science and emission coefficients	Chapple Wrang: Intro, Chap 1, 2 climate change science readings
Week 3: September 9	Electricity with eGRID and dplyr	Chapple Wrang: Intro, Chap 3, 4 electricity readings part 1
Week 4: September 14 - September 16	Electricity with eGRID and dplyr (continued)	Chapple Wrang: Chap 5, 6 electricity readings part 2
Week 5: September 21 - September 23	Electricity with eGRID, sf, and tmap	Chapple Wrang: Chap 7, 8 tmap: get started! vignette
Week 6: September 28 - September 30	Electricity with SEDS and ggplot	Chapple Viz: Intro, Chap 1, 2, 3
Week 7: October 7	<u>Test 1: October 7</u>	Chapple Viz: Chap 4, 5, 6
Week 8: October 12 - October 14	Climate models and scenarios with NCA LOCA data and rasters	Climate model readings part 1
Week 9: October 19 - October 21	Climate models and scenarios (continued)	Lovelace: Chap 9 Intro up to 9.2.7
Week 10: October 26 - October 28	Climate models with detailed netcdf data	Climate model readings part 2
Week 11: November 2 - November 4	<u>Project 2: Due October 26</u> Climate change impacts on human welfare and equity	Hsiang article
Week 12: November 9 - November 11	Climate change mitigation solutions overview	Drawdown Georgia readings
Week 13: November 16 - November 18	<u>Test 2: November 9</u> Systems dynamics models: RMI-EPS	RMI-EPS readings
Week 14: November 23	Integrated assessment models: GLIMPSE/GCAM	GLIMPSE/GCAM readings
Week 15: November 30 - December 2	<u>Project 3: Due November 23</u> Energy-economic models: NEMS	NEMS readings
Week 16: December 7	Climate justice	Climate justice readings
Week 17: Exam week	<u>Final exam: Wednesday, December 16, 11:20 AM - 2:10 PM</u>	

Course Reading Materials

Dates	Author	Location	Details
Week 1: August 20 - August 22	Poulson	linkedinlearning.gatech.edu	R for Data Science: Analysis and Visualization Intro and Chap 1, 2
Week 2: August 31 - September 2	Chapple (Wrang.)	linkedinlearning.gatech.edu Canvas readings folder pdf	Data Wrangling in R nas-climate-science-2021.pdf
Week 3: September 9	Chapple (Wrang.)	linkedinlearning.gatech.edu Online material	Data Wrangling in R: Intro, Chap 1, 2 EIA Electricity explained: start to Energy storage https://www.eia.gov/energyexplained/electricity/
Week 4: September 14 - September 16	Chapple (Wrang.)	linkedinlearning.gatech.edu Online material	Data Wrangling in R: Chap 3, 4 EIA Electricity explained: remaining sections https://www.eia.gov/energyexplained/electricity/
Week 5: September 21 - September 23	Chapple (Wrang.)	linkedinlearning.gatech.edu	Data Wrangling in R: Chap 5, 6
Week 6: September 28 - September 30	Chapple (Visualiz.)	linkedinlearning.gatech.edu	Data Visualization in R with ggplot2 Intro and Chap 1, 2, 3
Week 7: October 7	Chapple (Visualiz.)	linkedinlearning.gatech.edu	Data Visualization in R with ggplot2 Chap 4, 5
Week 8: October 12 - October 14	Multiple authors	Online material	Q&A: How do climate models work https://www.carbonbrief.org/qa-how-do-climate-models-work/ Sections "What is a climate model" to "What is CMIP"
Week 9: October 19 - October 21	Lovlace	Online material	Geocomputation with R: Chap 9 up through section 9.2.7 https://r.geocompx.org/adv-map
Week 10: October 26 - October 28	Multiple authors	Online material	Q&A: How do climate models work https://www.carbonbrief.org/qa-how-do-climate-models-work/ Sections past "What is CMIP"
Week 11: November 2 - November 4	Hsiang	Canvas readings folder pdf	hsiang-economic-damages-county-2017.pdf
Week 12: November 9 - November 11	Multiple authors	Online materials	Drawdown Georgia appropriate solutions for the state https://www.drawdownga.org/solutions
Week 13: November 16 - November 18	RMI-EPS	Online materials	Read sections Introduction through Using the Web Interface https://docs.energypolicy.solutions
Week 14: November 23	Dan Loughlin et al. PNNL	Canvas readings folder pdf Online material	GLIMPSE Users Guide, Sections 1.1 to 1.4 GCAM-USA description https://jgcri.github.io/gcam-doc/gcam-usa.html
Week 15: November 30 - December 2	EIA	Canvas readings folder pdf	NEMS Overview Annual Energy Outlook 2025, pp. 1-5
Week 16: December 7	CEJST	Online material	https://climateprogramportal.org/resource/climate-and-economic-justice-screening-tool-cejst/