

ECON-4210

Economics of Climate Change*

Prof. Casey Wichman
Georgia Institute of Technology

Fall 2024

Course meeting time: Mon/Wed, 2:00 PM – 3:15 PM

Classroom: Skiles 256

Office hours: TBA

Office: Old Civil Engineering 310

Teaching Assistant (TA): Mehmet “Akif” Aglar <maglar3@gatech.edu>

TA Office Hours: TBA

Course description: This course will explore the economic causes and consequences of climate change—the “mother of all externalities”—and potential solutions. Misguided market forces, via unpriced and unregulated greenhouse gas (GHG) emissions, contribute to global warming. Because GHG emissions stem from economic decisions we make every day—from driving to work to powering our computers to eating a hamburger—the economic impact of policies aimed at reducing GHG emissions will be pervasive. In this course, we will use the tools of economics to understand the origins of climate change; to explore the effects of climate on different facets of the economy now and in the future; and to evaluate the effectiveness, costs, and benefits of policies designed to reduce climate change. Particular focus will be given to:

1. Understanding the methods used to measure and value damages from climate change
2. Analyzing the pros and cons of market-based policies designed to reduce GHG emissions
3. Investigating the role of adaptation and innovation as potential climate solutions
4. Evaluating the equity implications of climate impacts and climate policy

Students will acquire a broad understanding of the costs of unchecked climate change and an ability to evaluate current policy debates through an economic lens.

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1 Course Overview

1.1 Course Format

This course will be in-person and, naturally, synchronous. Throughout the semester, we may meet via Zoom to, e.g., host a guest lecturer virtually. These virtual meetings will be the rare exception rather than the rule. Any virtual sessions will be clearly communicated.

1.2 Learning Goals

The following is a list of competencies that I expect students to walk away from this course with:

1. Understand the (basic) science behind human-induced climate change along with the uncertainties involved.
2. Demonstrate the ability to interpret the measurement and scope of climate change damages.
3. Understand the rationale for and analyze the implications of government intervention as a potential solution to market failures and global externalities.
4. Be comfortable applying social cost of carbon to estimate the impacts of a policy change, especially for the estimation of benefits of reducing climate pollution.
5. Understand the basics of risk and uncertainty, including tipping points, fat tails, and catastrophic risk, and be able to communicate the meaning of those terms.
6. Analyze policy recommendations using knowledge about instrument choice and recognition of the distributional impacts. Make recommendations where necessary to account for environmental justice concerns and for political feasibility.

1.3 Prerequisites

Formally, Principles of Macroeconomics (ECON 2105) AND Principles of Microeconomics (ECON 2106) OR Economics and Policy (ECON 2100) are required. Informally, knowledge of basic statistics, calculus, and econometrics will be valuable for understanding readings and concepts at a deeper level, but not expected.

2 Course Expectations

2.1 Attendance

Attendance is expected and will be necessary to succeed in the course. Participation in class discussions will be strongly encouraged. Ask questions. If you do not understand something in class, you are almost certainly not the only one. If you never volunteer an incorrect answer, you aren't taking enough risks.

2.2 Canvas

The primary means of communication for this course will be conducted through Canvas. All course announcements, lecture materials, assignments, grades, etc., and other information will be posted there. Beyond course materials, I often link to podcasts, news articles, and other forms of media related to topics covered in the course (or on climate change more generally). I will organize each class week into a module to keep things tidy.

2.3 Email Policy

The safest bet is to send me a message through Canvas. That way, my course inbox stays separate from my occasionally messy email inbox. I am typically quite slow to respond to messages on weekends.

2.4 Grading

There will be no special extra credit or extra work of any kind for the purpose of raising a grade during or after the course. This is to ensure that everybody has equal opportunities to earn their grade and that grades are based on work during the course.

Neither exam grades nor course grades will be curved.

The final grade is calculated as follows (assignments are explained in more detail below):

Attendance & Participation	15 pts
Weekly reading responses ($n = 10$)	20 pts
Problem sets ($n = 4$)	20 pts
Midterm ($n = 1$)	20 pts
Final exam ($n = 1$)	25 pts
Total*	100 pts

Final grades are determined using the standard scale:

Course grade:	A	90–100%
	B	80–89.99%
	C	70–79.99%
	D	60–69.99%
	F	0–59.99%

Final grades are not rounded up. Hence, 89.99 is a B not an A. If you are taking this class pass or fail, a grade of C or higher is a passing grade. If you earn a D or an F, you will be given a failing grade for the course.

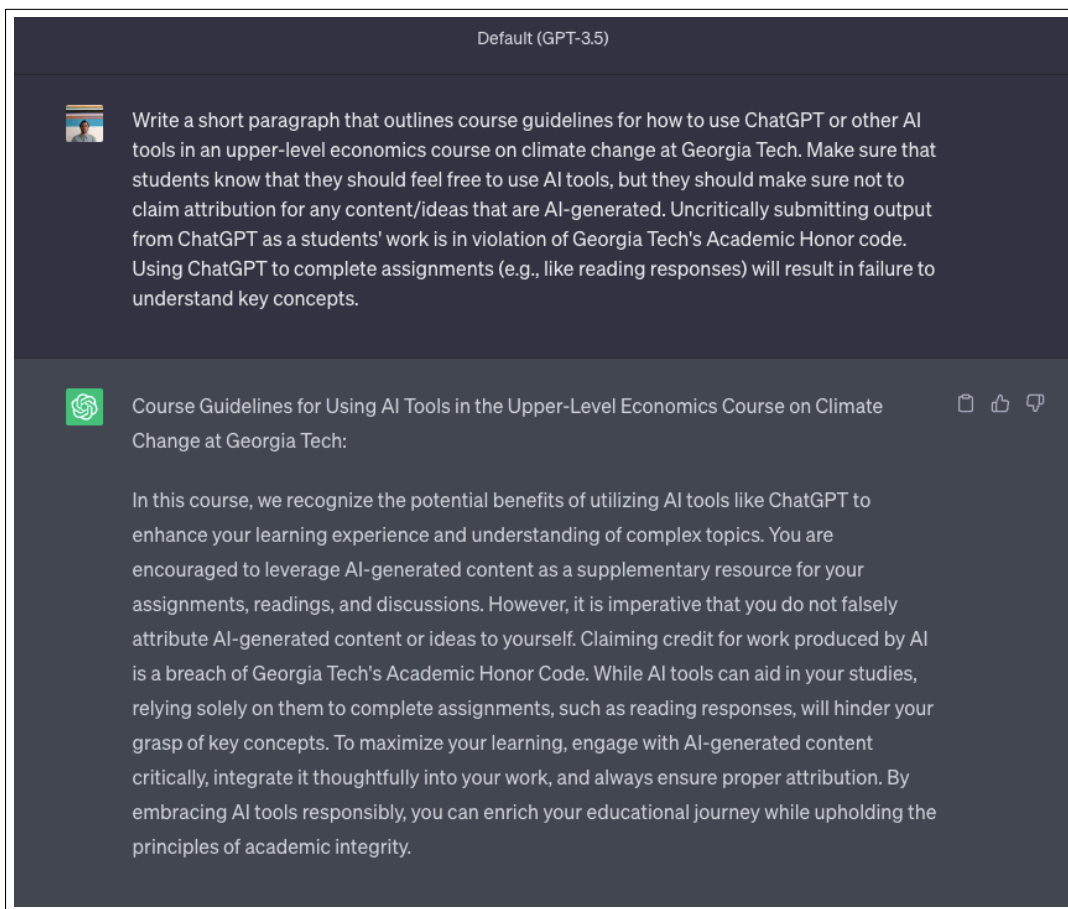
2.5 Academic integrity

Cheating is unacceptable. You are hereby reminded that you have pledged to uphold the honor code as follows:

Having read the Georgia Institute of Technology Academic Honor code, I understand and accept my responsibility as a member of the Georgia Tech community to uphold the Honor Code at all times. In addition, I understand my options for reporting honor violations as detailed in the code.

Should you be caught cheating in this class you will be prosecuted according to the honor code and policies and procedures established by the Honor Advisory Council. Should you have any questions about this do not hesitate to contact me.

2.6 Course guidelines on using AI tools



2.7 Office Hours

I will hold “communal” office hours during a set time each week. These office hours are time I set aside each week to make myself available for students. You can visit my office hours with questions about course material, to discuss economic policy issues in the news, future course selection at Tech, fun hikes you’ve done around Atlanta, travel plans, and

anything else related or unrelated to the course. To discuss something privately, you can request a short meeting with me via Canvas.

2.8 Student-Faculty expectations agreement

At Georgia Tech, it is important to strive for an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some basic expectation that you can have of me and that I have of you. In the end, simple respect for knowledge, hard work, and cordial interactions will help build the environment we seek. Therefore, I encourage you to remain committed to the ideals of Georgia Tech while in this class.

2.9 Accommodations for 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 <http://disabilityservices.gatech.edu/>, as soon as possible, to make an appointment to discuss your special needs and to obtain an accommodations letter. Please also e-mail me as soon as possible to set up a time to discuss your learning needs.

2.10 Why is this syllabus so long?

This syllabus is intended to be a contract in addition to serving as a guide to the course. I promise to follow-through and implement the course as described, so as to set clear expectations for instruction. There should be no surprises. That said, throughout the course, circumstances may change that will require changes to the syllabus. These will be communicated clearly and I will make edits to the syllabus, if necessary, as the semester goes on.

3 Details on course assignments

- Attendance & Participation (15 pts)
 - Attendance and participation is expected.
 - There are 27 course meeting times, excluding the midterm and GT holidays. Everyone gets 2 “freebies” (no questions asked) – so, attending and participating in the other 25 lectures gets you the full 15 pts. That translates to 0.6 pts per class with a cap at 15 points. Attending 20 classes gets you $20 \times 0.6 = 12$ points.
- Weekly reading responses ($n = 10$, 2 pts each, 20 pts total)
 - Each week, students will be required to write a short (~ 200 – 250 word or ~ 2 paragraph) response paper on a designated reading (these readings will be marked in the course schedule). *This response needs to go beyond summarizing the reading* and make connections to other topics in the course, stories in the news, ongoing policy discussions, and/or practical matters in our lives. Other approaches might include reflecting on how the reading updated your thinking on an issue or, if you disagreed with a conclusion or fundamental assumption in the reading, expand on that idea.
 - The goal of these assignments are to get students thinking critically about a topic, issue, or proposed solution to an environmental problem.
 - Responses should be submitted via Canvas by 11:59 PM (ET) the day before class when the reading is assigned. This will allow me to read the responses before class. E.g., if the reading is assigned for a Wednesday, the response paper will be due on Tuesday by 11:59 PM (ET). Late responses will receive half credit (i.e., after 11:59 PM but before class). Responses received after class for which the reading is assigned will receive no credit.
 - There are 10 marked readings (these may change throughout the semester). You can choose to do responses for any 8 of them. Only your top 8 scores will count. Extra responses will not be counted as extra credit.
- Problem sets ($n = 4$, 5 pts each, 20 pts total)
 - Problem sets will force you to apply some of the concepts we’ve talked about in the course. They will vary in format and might involve demonstrating how standard economic tools can solve externality problems or they might involve providing an economic argument for/against a discussion about climate change in the news.
 - You may work on problem sets with others in the course, although you will be required to submit your own assignment.
 - You will be given ~ 1 week to complete each problem set. Details and due dates will be forthcoming during the semester.
- Midterm (in class) (20 pts)
- Take-home final exam (25 pts)

- △ Late assignments will receive a zero without a valid excuse. △
- △ For reasons of fairness, there will be no extra credit. △

4 Overview of course topics

The course will be split into two major sections. Part I will focus on the economic implications of climate change, how economist measure and value climate change impacts, and how those climate “damages” are accounted for in a benefit-cost analysis framework. Part II will focus on approaches to solving climate change from an economic perspective. We will discuss optimal climate policy—including its advantages, drawbacks, and distributional consequences—as well as adaptation strategies, unintended consequences, uncertainty, and the role of international cooperation.

Topics covered in this course are listed below alongside the bigger picture questions each topic addresses.

Bigger Questions	Detailed Topic	Class no.
Part I: Causes and Consequences of Climate Change		
What is climate change?	Intro. to climate science	2
How are the climate and the economy linked?	The economy and the climate	3
Why is climate change an economic problem?	Externalities and public goods	4–6
What are the costs and benefits of climate policy?	Benefit-cost analysis	7
Should I care about my grandchildren’s future?	Discounting benefits and costs	8
Can we put a price on climate impacts?	Measuring/valuing climate impacts and the social cost of carbon	9–12
Who bears the burden of climate impacts?	Equity & climate impacts	13
Part II: Economic Approaches to Solving Climate Change		
How would an economist solve climate change?	Optimal climate policy	15–17
Can’t we just live with climate change?	Adapting to climate change	18
Who pays for a carbon tax?	Equity & climate policy	19
Does behavior undermine climate policy?	Unintended consequences	20
What don’t we know about climate change?	Uncertainty, fat tails, & tipping points	21, 22
Can we address climate change on our own?	International cooperation	23
Can we fix climate change with this weird trick?	Geoengineering & offsets	24
Is changing our own behavior the solution?	Behavioral change	26

Readings

This course will be based heavily on readings from books and academic journal articles. Readings for each course meeting time are listed below. You will be expected to perform these readings before the listed class date. These readings may be updated over the course of the semester. All readings will be provided in electronic format via Canvas. Some articles will be more technical than others. Don't worry if you don't understand every detail. This is normal.

We will rely heavily on readings from the first book listed below. You can access .pdf copies from the Georgia Tech Library using the embedded links below. You are more than welcome to purchase these books if you would prefer a hard copy. Each of them can be found online for reasonable prices. That said, all readings will be provided electronically—there is no need to purchase anything for this course.

- **[Keohane & Olmstead:]** Keohane, Nathaniel O. and Sheila M. Olmstead, *Markets and the Environment*, Island Press, Second Edition, 2016. (Access provided via Georgia Tech Library)

A few more useful and interesting books that we will have readings from (I will provide these readings in PDF form; they are available via the Georgia Tech Library):

- **[Pindyck:]** Pindyck, Robert S., *Climate Future: Averting and Adapting to Climate Change*, Oxford University Press, 2022.
- **[Nordhaus:]** Nordhaus, Willam, *The Climate Casino: Risk, Uncertainty, and Economics for a Warming World*. Yale University Press, 2013. [Link (access provided via Georgia Tech Library)]
- **[Wagner & Weitzman:]** Wagner, Gernot and Martin L. Weitzman, *Climate Shock: The Economic Consequences of a Hotter Planet*, Princeton University Press.
- **[Kahn:]** Kahn, Matthew, E. *Adapting to Climate Change: Markets and the Management of an Uncertain Future*, Yale University Press, 2021.
- **[American Climate Prospectus:]** *American Climate Prospectus: Economic Risks in the United States*, 2014. [link]. (Think of this as a “coffee table book” highlighting and visualizing research on climate impacts.)

Articles marked with 🐝 are the readings that require a written "response" each week. See the Details on Course Assignments section above for more details.

Course Schedule

Week 1 (week of Aug. 19):

Class 1 – Overview of course

- ☐ Syllabus

Class 2 – What is climate change?

- ☐ Fullerton & Stavins: “How Economists See the Environment,” *Nature*, 1998. [link]
- ☐ Pindyck, Ch. 1 & 2
- ☐ Hsiang & Kopp: “An Economist’s Guide to Climate Change Science,” *Journal of Economic Perspectives*, 2018. [link]
- ☐ [Further reading:] IPCC, Climate Change 2021, The Physical Science Basis, Summary for Policy Makers, 2021. [link]
- ☐ [Further reading:] Nordhaus, Ch. 4.

Week 2 (week of Aug. 26):

Class 3 – How are the climate and the economy linked?

- ☐ Keohane & Olmstead, Ch. 1 (pp. 1–6).
- ☐ 🐝 Covert, Greenstone, & Knittel, “Will we ever stop using fossil fuels?” *Journal of Economic Perspectives*, 2016.
- ☐ Pindyck, Ch. 3 (up to 3.4.2)
- ☐ [Skim:] Nordhaus, “Climate Change: The Ultimate Challenge for Economics,” *American Economic Review*, 2019 (Nobel Prize Lecture). [link]

Class 4 – Why is climate change an economic problem? (I)

- ☐ Keohane & Olmstead, Chs. 2, 4, & 5.

Week 3 (week of Sep. 2):

Monday, 9/2 – Labor Day – No Class

Class 5 – Why is climate change an economic problem? (II)

- ☐ Keohane & Olmstead, Chs. 2, 4, & 5. (continued)
- ☐ Review of key microeconomics concepts

Week 4 (week of Sep 9):

Class 6 – Why is climate change an economic problem? (III)

- ☐ [Skim:] Coase, “The problem of social cost,” *Journal of Law & Economics*, 1960.
- ☐ Nijhuis, “The miracle of the commons,” aeon. [link]
- ☐ [Further reading]: Rosa & Dietz, “Human drivers of national greenhouse-gas emissions,” *Nature Climate Change*, 2012.

Class 7 – What are the costs and benefits of climate change policy?

- ☐ Keohane & Olmstead, Ch. 3.
- ☐ 🐝 Arrow et. al, “Is there a role for benefit-cost analysis in environmental, health, and safety regulation?” *Science*, 1996.
- ☐ [Further reading]: Nordhaus, Ch. 18.

Week 5 (week of Sep 16):

Class 8 – Should I care about my grandchildren’s future?

- ☐ Arrow et al., “Determining benefits and costs for future generations,” *Science*, 2013.
- ☐ Goulder & Stavins, “An eye on the future,” *Nature*, 2003.
- ☐ [Further reading]: Nordhaus, Ch. 16.

Class 9 – Can we put a price on climate impacts? (I - Social Cost of Carbon)

- ☐ “Social Cost of Carbon 101,” Resources for the Future, 2019. [Link]
- ☐ 🐝 Rennert et al., “Comprehensive evidence implies a higher social cost of carbon,” *Nature*, 2022.
- ☐ Pindyck, Ch. 3.4.2–end of Ch. 3.
- ☐ [Skim:] US EPA, “Draft Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances,” September 2022. [Link]
- ☐ [Skim:] Carleton & Greenstone, “A Guide to Updating the US Government’s Social Cost of Carbon,” *Review of Environmental Economics and Policy*, 2022.

Week 6 (week of Sep 23):

Class 10 – Can we put a price on climate impacts? (II - Measurement and Valuation)

- ☐ Auffhammer, “Quantifying economic damages from climate change,” *Journal of Economic Perspectives*, 2018.
- ☐ Hsiang et al., “Estimating economic damage from climate change in the United States,” *Science*, 2017.
- ☐ [Further reading:] Tol, “The economic effects of climate change”, *Journal of Economic Perspectives*, 2009.
- ☐ [Further reading:] Nordhaus, Ch. 6 & 12.

Class 11 – Can we put a price on climate impacts? (III - Market Impacts)

- ☐ 🐝 Burke, Hsiang, & Miguel, “Global non-linear effect of temperature on economic production,” *Nature*, 2015.
- ☐ Schlenker & Roberts, “Nonlinear temperature effects indicate severe damages to U.S. crop yields under climate change,” *Proceedings of the National Academy of Sciences*, 2009.
- ☐ [Further reading:] American Climate Prospectus, Chs. 5–10.
- ☐ [Further reading:] Nordhaus, Ch. 7 & 8.

Week 7 (week of Sep 30):

Class 12 – Can we put a price on climate impacts? (IV - Nonmarket Impacts)

- ☐ Chan & Wichman, “Climate change and recreation: Evidence from North American cycling,” *Environmental and Resource Economics*, 2020.
- ☐ Bastien-Olvera & Moore, “Use and non-use value of nature and the social cost of carbon,” *Nature Sustainability*, 2021.
- ☐ [Further reading:] Nordhaus, Ch. 9, 10, & 11.
- ☐ [Further reading:] American Climate Prospectus, Chs. 16–19.

Class 13 – Equity & climate impacts

- ☐ 🐝 Ricke, Drouet, Caldeira, & Tavoni, “Country-level social cost of carbon,” *Nature Climate Change*, 2018.

Week 8 (week of Oct 7):

Class 14 – Spillover / Review

Wednesday, 10/9 – Midterm (in-class)

Week 9 (week of Oct 14):

Monday, 10/14 – *Fall Break – No Class*

Class 15 – How would an economist solve climate change? (I)

- ☐ Keohane & Olmstead, Ch. 8.
- ☐ Pindyck, Ch. 6.
- ☐ [Skim:] Weitzman, “Prices vs. quantities,” *Review of Economic Studies*, 1974. (Skim through technical stuff!)
- ☐ [Further reading:] Nordhaus, Ch. 15, 19, & 20.

Week 10 (week of Oct 21):

Class 16 – How would an economist solve climate change? (II)

- ☐ 🐝 Metcalf, “How to set a price on carbon pollution,” *Scientific American*, 2020.
- ☐ Pindyck, Ch. 6.
- ☐ [Further reading:] Stiglitz, “Addressing climate change through price and non-price interventions,” *European Economic Review*, 2019.
- ☐ [Further reading:] Keohane & Olmstead, Ch. 9.
- ☐ [Further reading:] Nordhaus, Ch. 22.

Class 17 – Continuing discussion of policy instruments + in-class policy game

Week 11 (week of Oct 28):

Class 18 – Can't we just live with climate change?

- ☐ 🐝 Deschênes & Greenstone, "Climate change, mortality, and adaptation: Evidence from annual fluctuations in weather in the US," *American Economic Journal, Applied Economics*, 2011.
- ☐ Pindyck, Ch. 7.1 & 7.2.
- ☐ [Optional]: Cattaneo et al., "Human migration in the era of climate change," *Review of Environmental Economics and Policy*, 2019.

Class 19 – Who pays for a carbon tax?

- ☐ Shang, Baoping, "The poverty and distributional impacts of carbon pricing: Channels and policy implications," *Review of Environmental Economics and Policy*, 2023.
- ☐ Pizer & Sexton, "The distributional impacts of energy taxes," *Review of Environmental Economics and Policy*, 2021.
- ☐ [Further reading]: Williams, Gordon, Burtraw, Carbone, & Morgenstern, "The initial incidence of a carbon tax across income groups," *National Tax Journal*, 2015.
- ☐ [Further reading]: Grainger & Kolstad, "Who pays a price on carbon?" *Environmental and Resource Economics*, 2010.

Week 12 (week of Nov 4):

Class 20 – Does behavior undermine climate policy? (I)

- ☐ Owen, "The Efficiency Dilemma," *The New Yorker*, 2010. [link]
- ☐ 🐝 Gillingham, Rapson, & Wagner, "The rebound effect and energy efficiency policy," *Review of Environmental Economics and Policy*, 2015.
- ☐ Gillingham, Kotchen, Rapson, & Wagner, "The rebound effect is overplayed," *Nature*, 2013.

Class 21 – What don't we know about climate change? (I)

- ☐ Wagner & Weitzman, Ch. 3.
- ☐ Pindyck, Ch. 4.1.3–end of Ch. 4.
- ☐ [Skim]: Heal, "The economics of the climate," *Journal of Economic Literature*, 2017.
- ☐ [Skim]: Broeckner, "Unpleasant surprises in the greenhouse?" *Proceedings of the National Academy of Sciences*, 1987.
- ☐ [Further reading]: Nordhaus, Ch. 5.

Week 13 (week of Nov 11):

Class 22 – What don't we know about climate change? (II)

- ☐ Weitzman, "Fat tails and the social cost of carbon," *American Economic Review, Paper's & Proceedings*, 2014.
- ☐ [Skim]: Pindyck, "Climate change policy: What do the models tell us?" *Journal of Economic Literature*, 2013.
- ☐ [Skim]: Dietz, Rising, Stoerk, & Wagner, "Economic impacts of tipping points in the climate system," *Proceedings of the National Academy of Sciences*, 2021.

Class 23 – Can we address climate change on our own?

- ☐ 🐝 Clausing and Wolfram, "Carbon border adjustments, climate clubs, and subsidy races when climate policies vary," *Journal of Economic Literature*, 2023.
- ☐ [Additional reading]: Nordhaus, "Climate clubs: Overcoming free-riding in international climate policy," *American Economic Review*, 2015.
- ☐ [Additional reading]: Keohane & Victor, "Cooperation and discord in global climate policy," *Nature Climate Change*, 2016.

Week 14 (week of Nov 18):

Class 24 – Can we fix climate change with this weird trick?

- ☐ 🐝 Wagner & Weitzman, Chs. 5 & 6.
- ☐ Pindyck, Ch. 7.3 & 7.4.
- ☐ [Additional reading:] Heutel, Moreno-Cruz, & Ricke, "Climate engineering economics," *Annual Review of Resource Economics*, 2016.
- ☐ [Additional reading:] Sandler, "Collective action and geoengineering," *The Review of International Organizations*, 2018.

Class 25 – Spillover

Week 15 (week of Nov 27th):

Monday, 11/25 – Prof. Wichman at a conference – No Class

Wednesday, 11/27 – Thanksgiving Recess – No Class

Week 16 (week of Dec 2):

Class 26 – Final Instruction Day – No New Material

- ☐ *Discussion:* Is changing our own behavior the solution?