Introduction

Global Warming Science, EPS101

Eli Tziperman

https://courses.seas.harvard.edu/climate/eli/Courses/EPS101/

Global Warming Science

A hands-on intro to the science of global warming and its consequences

Hurricane Florence, 2018

September 1
Wind Speed (km/h)

0   105   ≥210
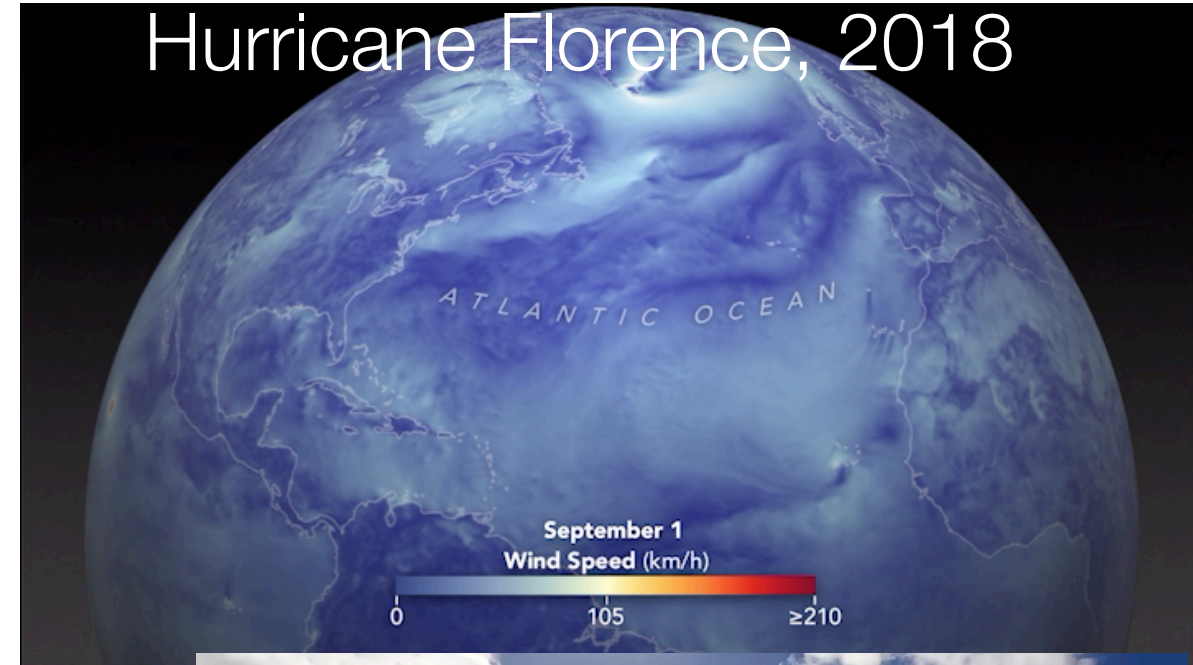
Venice flooding, 2019

San Angelo, Texas, 2011
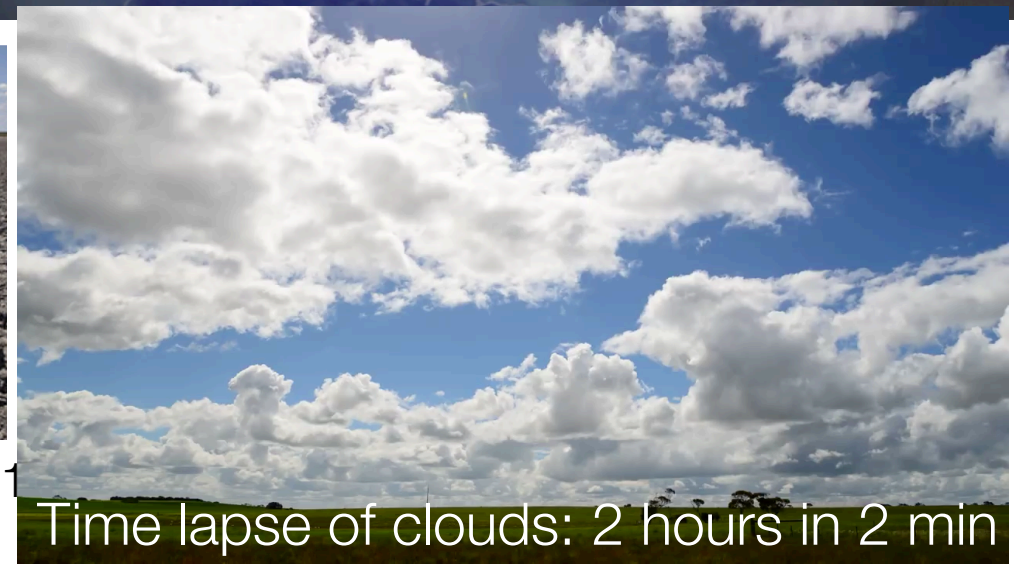
Time lapse of clouds: 2 hours in 2 min

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Time & location: Wednesday 3-5:45, HUCE seminar room 440, 4th floor, 26 Oxford St

Instructor: Eli Tziperman, eli@eps.harvard.edu; office hours: M & W 1–2; see Canvas.

TFs: Jacob, Sarah, and Sophie; please see Canvas for office hours

Prerequisites: differential equations, e.g., Math 21b, or 19a (come talk to me today if not)

Programming: Basic exposure to programming is assumed; students will be provided with code as easy-to-use Jupyter notebooks and be closely guided. **Bring laptops.**

Class structure: alternating lecture and Python work

HW help sessions: weekly, Tuesdays 4–6. Come to get help and help others!

Requirements:

- Attend all course meetings

- In-class Python: organize in pairs/groups, bring laptops, and finish after class as needed

- A weekly 1-page writing assignment after class, including for today's class.

- Help other students during one week workshop (**coaching**): volunteers for next week!

Grading: Writing tasks/workshops/presentations: 70%; coaching: 15%; Participation: 15%

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Class overview

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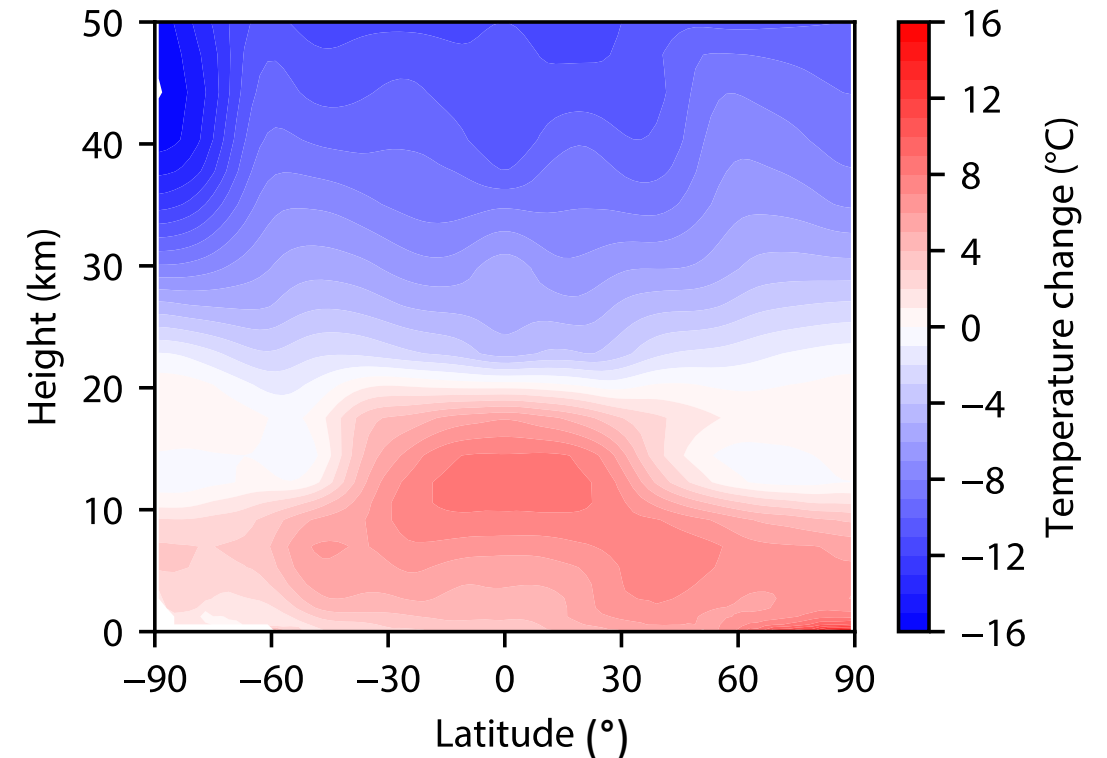

The Simpsons and global warming…

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The basics

1. **Greenhouse** effect: why is CO_2 causing warming? How and how much?

2. **Temperature**: how much is/ will it be warming? Was there a hiatus? Why more in the Arctic? Why is the stratosphere cooling? Climate sensitivity/ the role of the ocean.
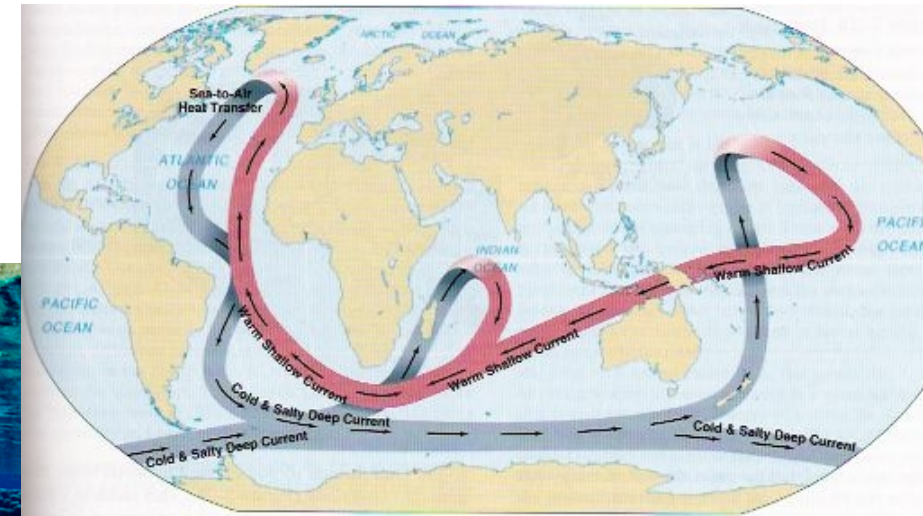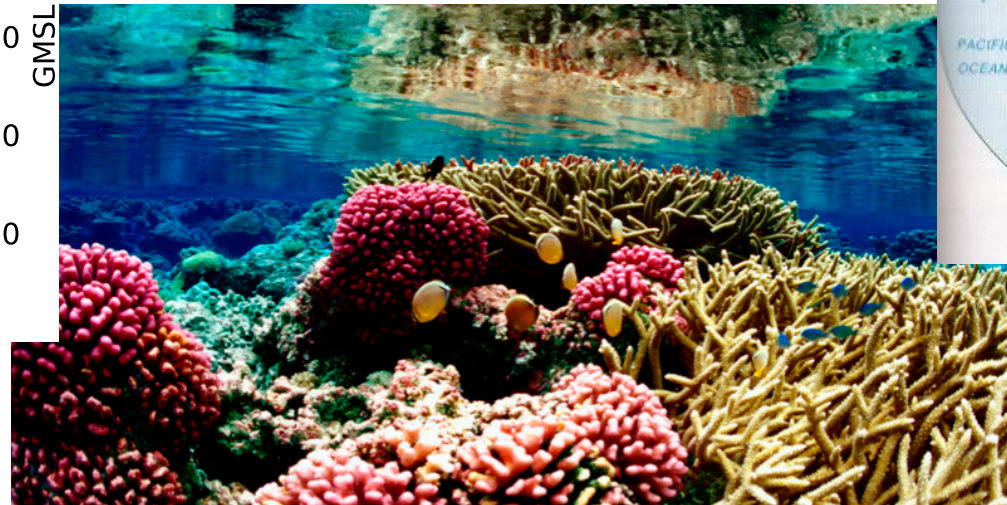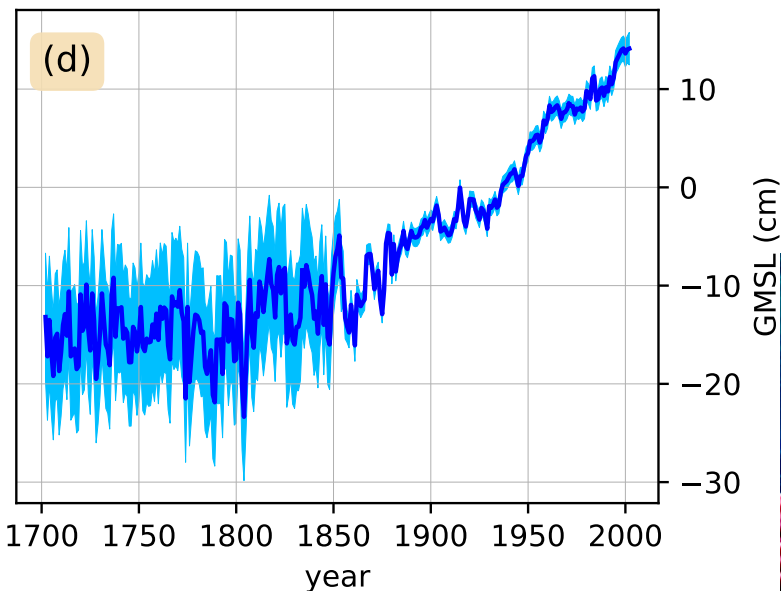
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The oceans

1. **Sea level** rise: is it rising? Accelerating? Will it accelerate? Global vs. local effects.

2. **Ocean acidification**: the other CO_2 problem! The chemistry, effects on ocean life

3. **Ocean circulation**: is it collapsing? Will it? Tipping points. The day after tomorrow!

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The atmosphere

1. **Hurricanes:** are they already getting stronger, how do they work, why we expect them to strengthen, analyzing past data, predicting future strength

2. **Clouds**: why are they the biggest source of uncertainty in predictions?
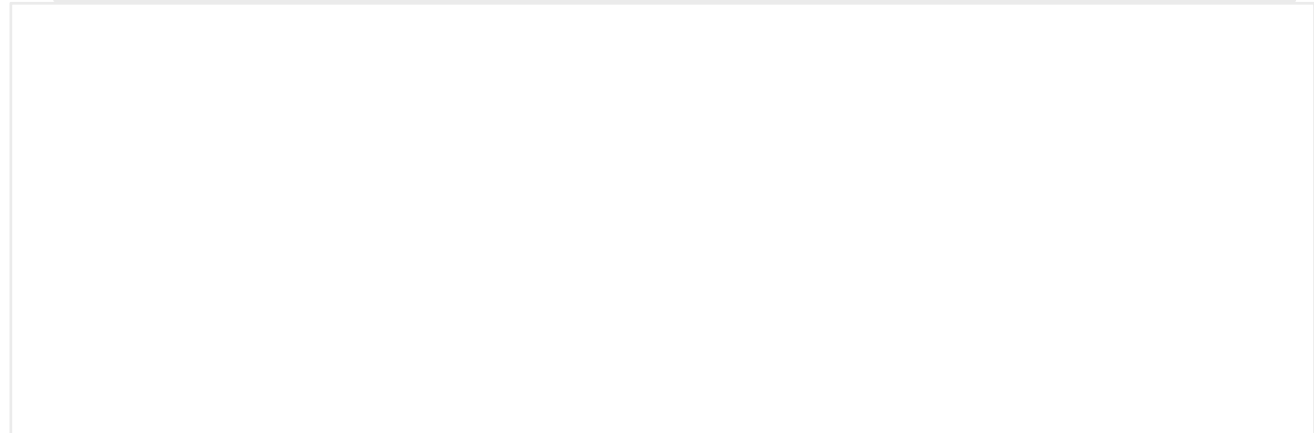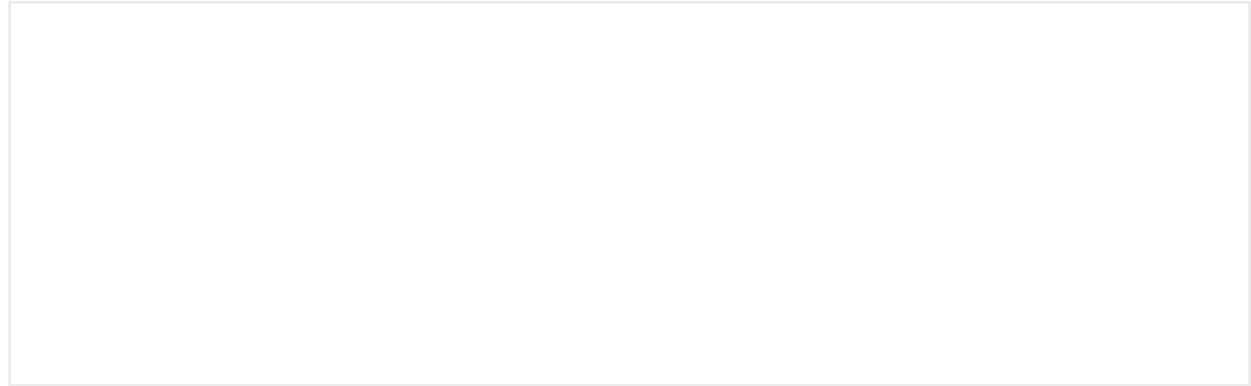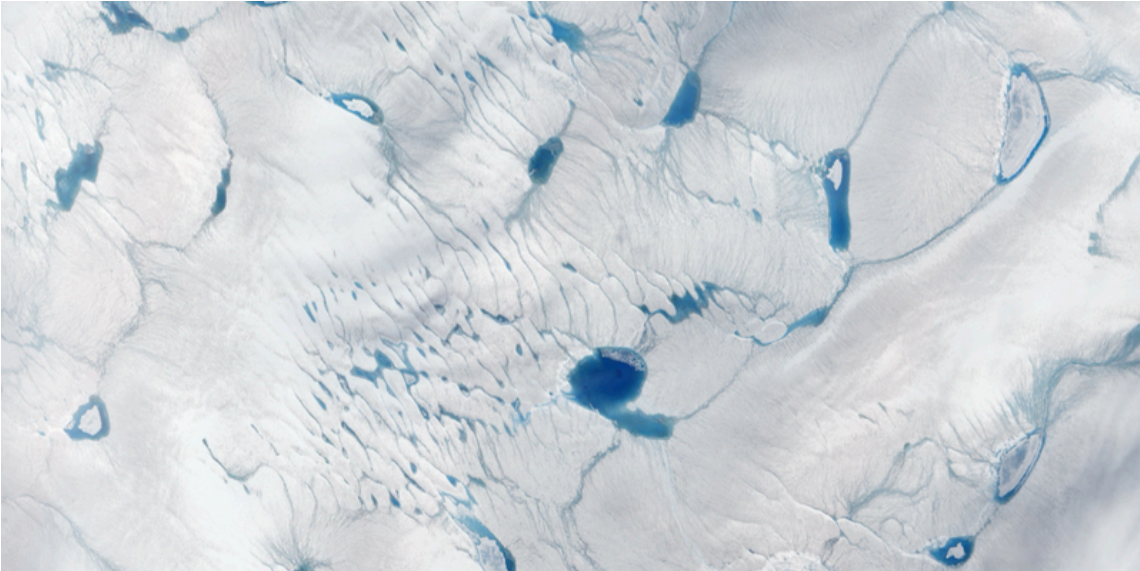
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The cryosphere

1. **Greenland & Antarctica**: how will they respond? Instabilities, ice stream acceleration

2. **Sea ice**: the canary in the coal mine. Why has it melted so much? What's next?

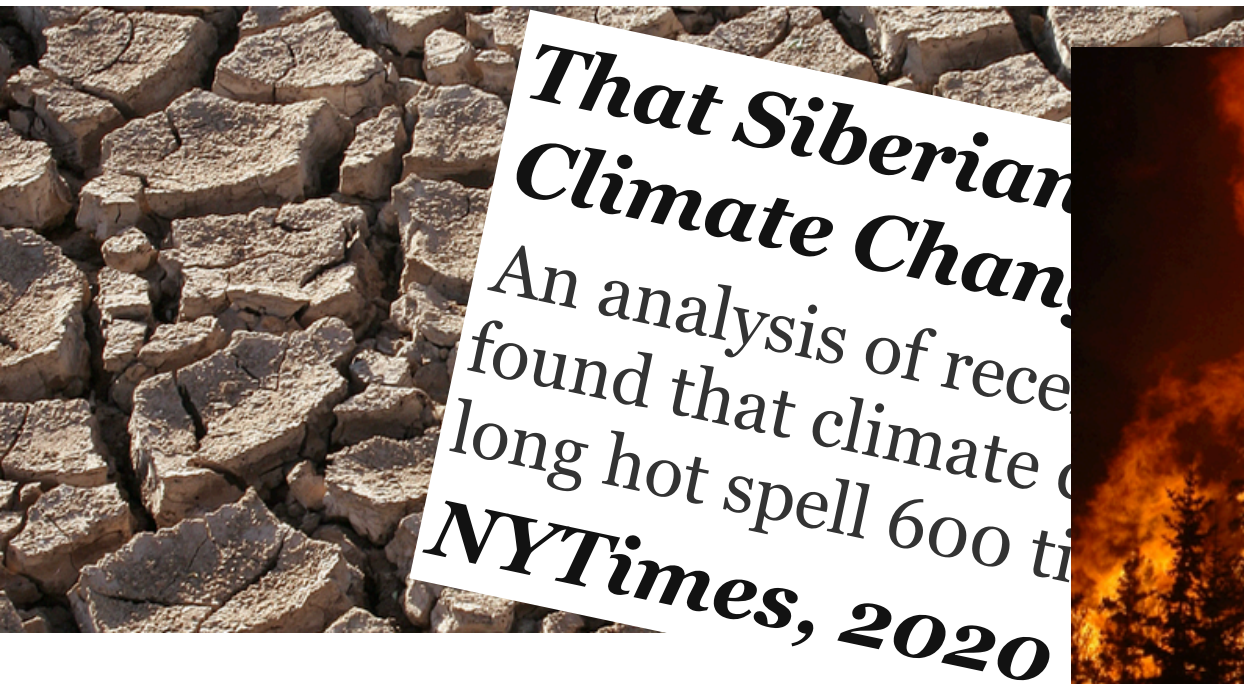3. **Mountain glaciers:** why have they been retreating so dramatically?

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Consequences of warming

1. **Droughts/Floods**: what's causing them? Will they get more frequent? Stronger? Why?

2. **Heat waves**: what's causing them? How do we understand their change with climate?

3. **Forest fires**: which ones are increasing? Is it related to anthropogenic warming?

That Siberian Climate Chan[ge]

An analysis of rece[nt]... found that climate [...] long hot spell 600 ti[mes...]

NYTimes, 2020

Writing assignment & Jupyter python workshop

1. **(A)** Ask chatGPT to write a 250-word summary of the state of knowledge of the topic covered. Prompt it to address the points under (5) below. **(B)** Then, write a one-page summary (single space, 12pt, one-page limit does not include the chatGPT text) using the following guidelines, **including an explicit criticism/endorsement of chatGPT's summary based on what we covered in class**.

2. Your *target audience: the President's science adviser*, a scientist but not a climate scientist.

3. Write based on material covered in class, workshop results, the guiding questions, and your research.

4. Introduce the issue and the motivation, discuss any changes observed so far, the worst case scenario for 2100, uncertainty, and the mechanisms/ feedbacks that take place or are expected to take place so that the adviser can understand the reason for the observed/expected changes.

5. Discuss strengths, weaknesses & uncertainty of available observations, analyses & predictions

6. In answering 5&6, use the guiding questions as needed; don't restrict yourself to them. Think broadly.

7. You may use technical terms after defining them. It is OK to use standard statistical terminology.

8. Conclude with a brief reasoned statement of the position you personally recommend the adviser take in public presentations on this issue.

9. **Submit two PDF files with writing and Jupyter workshop solution notebook (all cells evaluated in order, downloaded as pdf) via GradeScope by Wednesday at 2 pm.**

"The great global warming swindle"

Learning to deal with criticism…

Directed by: Martin Durkin
Country of origin: United Kingdom
Running time: 75 mins
Original release: Channel 4, 8 March 2007
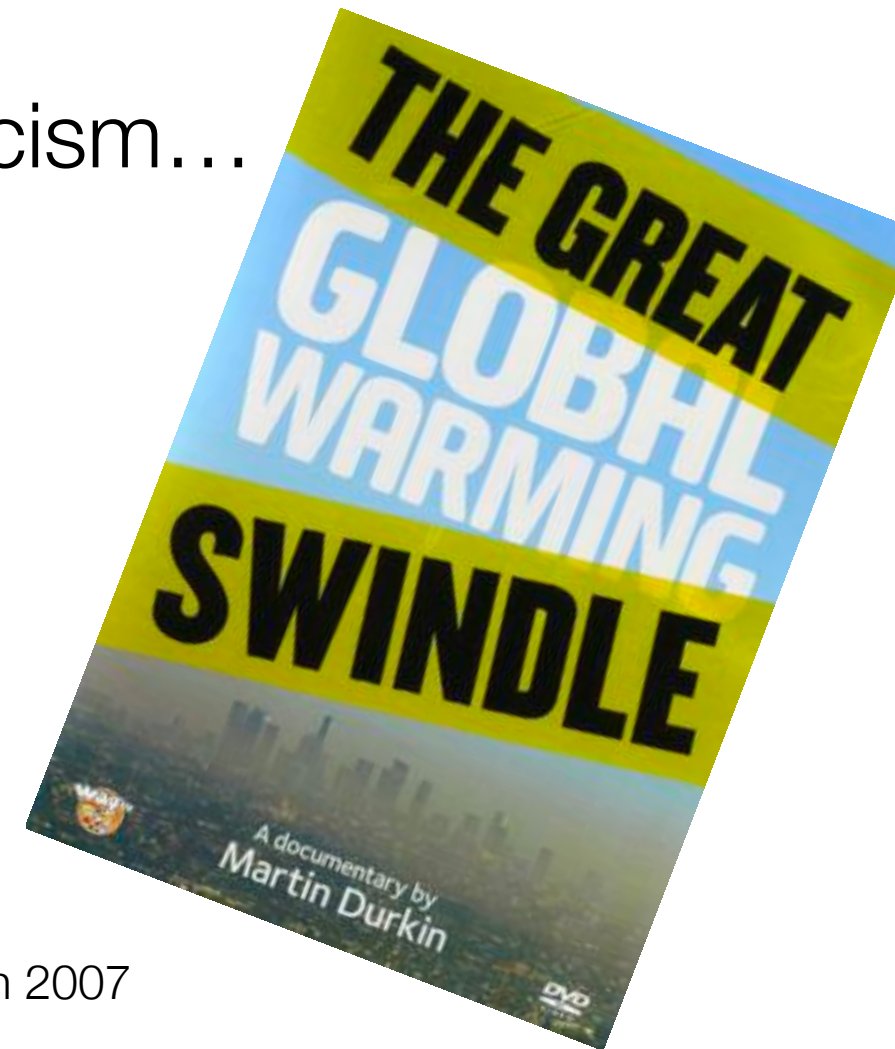
Essay assignment for the first class

Watch "The Great Global Warming Swindle" to the end. Write a one-page summary report (single space, 12pt) addressing:

- Identify one scientific (rather than political) claim denying that global warming is a significant concern you think is wrong and one you see as possibly reasonable, and explain your position on both.

- Choose three of the following five claims made in the movie. For each, ask chatGPT for a 30-word response supporting the claim and another one opposing it. Quote the responses in your report. Research this and express your reasoned opinion on each. (*Hint:* asking chatGPT for longer responses is a good way to start your research)

1. The current warming is due to the ending of the Little Ice Age.

2. Most warming occurred in the early 20th century before CO_2 rose.

3. Earth's temperature is always changing.

4. CO_2 is a very minor greenhouse gas, much less important than water vapor.

5. Magnetic solar activity affects cloud formation, causing global warming.

- Conclude with a 50-word summary of your view of climate change as you start this class.

Your target audience: the President's Science Adviser, a scientist but not a climate scientist.

Example claims made in the *great global warming swindle*

Science examples:

1. None of the major climate changes of the last 1000 years can be explained by CO_2

2. I believe in global warming, but not that it's us or CO_2

3. There were periods with ten times as much CO_2, we should see the consequences in the geologic record

For each *scientific* claim you find: is it falsifiable? An example of a non-falsifiable statement:

"I believe in global warming, but not that it's us or CO_2"

Politics examples:

1. There is no consensus among climate scientists
2. The IPCC and its final conclusions are political
3. Climate scientists need the problem in order to get funding

workshop: introduction to python

TODO now:

- Go to EPS101 course Canvas site -> FAS on demand -> start Jupyter server.

- [Alternatively, hopefully not needed: install the latest anaconda from https://www.anaconda.com/products/individual#download-section]

- Download the 1st-class python code and data set from the course web page: https://courses.seas.harvard.edu/climate/eli/Courses/EPS101/ introducing_python.ipynb, introducing_python_variables.pickle

- Upload both files to Jupyter server and star going over the workshop.

Starting the JupyterHub notebook server on Canvas