THE SAGA OF CLIMATE CHANGE

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Is This the Coldest Summer of the Rest of Our Lives?
If you are younger than 70, most summers have been the warmest of your life so far.
This pattern is not likely to change...

The past The future

Bars show the range in 2100 produced by several models
Here, following the approach of Kling et al. (2003), we first use average summer temperature and rainfall to characterize summer climate conditions for the states of Michigan and Illinois (Fig. 9) and the city of Chicago (Table 3). This time, however, we project changes under higher and lower future emissions scenarios. In both these cases, projected changes in average summer temperature and rainfall under climate change are expected to make the states feel as if they are shifting south and westward over time. Within a decade or two, summer in central Illinois is likely to feel more like southern Illinois does today, while Michigan summers may feel more like those of Indiana do today.

Fig. 9. Projected changes in summer average temperature and rainfall for Illinois and Michigan indicate that summers in these states will feel progressively more like summers currently experienced by states to their southwest under both SRES A1 higher (red) and B1 lower (yellow) future emissions scenarios. Both states are projected to warm considerably and have less summer rainfall.

Illinois summers in 2080 will feel like summer in Texas today

From Hayhoe et al., 2010
However, the future is uncertain

“Business as usual”

Fossil fuel use peaks in 2040

Fossil fuel use has already peaked
However, the future is uncertain

The different lines capture the *uncertainty* of human behavior.
Why is it so uncertain?

- Will new energy technologies make greenhouse gases obsolete?
- Will new oil discoveries make fossil fuels cheaper?
- Will governments subsidize or tax certain types of energy use?
But there is another source of uncertainty.

This cloud is our uncertainty in the climate system.
Why is the climate’s future so uncertain?
Why is the climate’s future so uncertain?

The receding edge of the Greenland Ice sheet
Why is the climate’s future so uncertain?

Light colored ice reflects sunlight and cools the climate

New plants absorb CO$_2$

Darker surface warms the climate
Why is the climate’s future so uncertain?

As temperatures rise

Will these new lands become forests and reduce atmospheric carbon dioxide?

Will these new lands remain unproductive and warm the climate?
Complex systems like Earth’s climate can be resilient to change.

**Meaning:** The system can be poked and prodded but stays more or less the same.
Complex systems like Earth’s climate can be very sensitive.

**Meaning:** The system can be nudged a little and change a lot!
Hot futures come from models that assume a sensitive climate system.

Colder futures come from models that assume a stable climate system.
Earth scientists use history to understand the sensitivity of the Earth’s climate.

- 50 million years ago, the arctic was a thriving forest.
- 500 million years ago the Earth was covered pole to pole with glaciers.
Humans have been quantitatively tracking climate for only ~100 years, which is not enough time to understand the behavior of the climate.
Earth Scientists rely on “proxies” to understand the full range of behavior of the climate.
The Saga of Climate Change

When you step back, and look at climate through a historical lens, you see that it has undergone massive reorganizations - often abruptly.

- Civilizations have been forced to migrate or collapse
- Animals have gone extinct
- Landscapes become unrecognizable (buried under ice or flooded by rising seas).

Antarctic Temperatures for the last 800,000 years!
Let’s say you didn’t take the trash out for a whole year.
Let’s say you didn’t take the trash out for a whole year

- May (last year)
- May
- February
- November
- July

- Bears Jersey*
- Bulls Jersey*
- Christmas stuff
- Dead leaves
- Halloween candy
- Sunscreen container

*Save your Sky Jersey
Let's say you didn’t take the trash out for 140 years. Rutherford B. Hayes was president in 1880. I was born in 2017. What clues might you look for to see if the temperatures used to be colder?
Glaciers build up ice for 1000’s or millions of years
These are layers of ice
Greenland has at least 150,000 years of ice
Antarctica has at least 2 million years of ice!
To the top of the ice sheet
View of Summit Camp from above
TENT CITY

“fog bow”
Recent history in the ice
ICE CORES = TIME MACHINE
PICKING A SITE
ESTABLISHING DRILL CAMP
DRILLING....
“CUTTER”

GREENLANDIC HIGH SCHOOLER
HOW DEEP IS 125,000 YEAR OLD ICE?
HOW DEEP IS 125,000 YEAR OLD ICE?

6 SEARS TOWERS!
Each layer of ice represents a different period of time all the way back ~million years ago.
SENDING THE ICE HOME TO CHICAGO
Back to the lab:

**Ioana:** undergraduate researcher

**Dariusz:** undergraduate researcher

Individual ice samples

Laser Absorption Spectrometer
2 million year history of Earth’s climate

Climate has always been sensitive…

but the future is unprecedented in the context of the last 2 million years

Climate has always been sensitive…
Not that long ago Chicago was under a mile of ice
You don’t have to go that far back in time to when sea levels would have been high enough to erase Florida.
Climate projections can seem abstract until they are viewed through the lens of history.
Thank you for your attention!