Are We Doomed?

An optimist’s guide to how research and policy can reduce the harmful effects of climate change, protect Wisconsin’s landscapes, and grow the economy

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Image: 20th Century Fox
Three things about me
Three things about me

• I was born and raised in New Jersey
Three things about me

• I was born and raised in New Jersey
• I live in Madison with my wife and three daughters
Three things about me

• I was born and raised in New Jersey
• I live in Madison with my wife and three daughters
• I am a climate scientist who has spent the past 2 decades studying how plants, climate, and weather all influence each other
Welcome to CCR

- Biogeochemistry

CCR researchers are investigating global and regional biogeochemistry, with a particular focus on the carbon cycle of the land biosphere and oceans and Great Lakes. Using data and models to elucidate natural carbon fluxes and the factors controlling them, and work to use this knowledge to improve predictive models.

- Climate Impacts
- Land Surface Processes
- Oceanography and Limnology
- Past Climates

Who We Are

Since 1948 we have grown into one of the leading departments in our field of Atmospheric and Oceanic Sciences. We have strong graduate and undergraduate programs which are nationally recognized. We graduate about 15 Ph.D. and M.S. students each year; our graduates are active in research labs and universities around the world. We graduate approximately 20 B.S. students each year; they choose options allowing a focus on weather systems or general atmospheric science.

Our faculty of 15 has long maintained breadth and special strength in three areas:

- Climate systems, including the ocean
- Satellite and remote sensing
- Weather systems, including synoptic-dynamic meteorology
Regional
Tall tower
Mature hardwood
Shrub wetland
Old-growth mixed forest
Source to atmosphere
Sink from atmosphere
Three things about climate
Three things about climate

• Climate is the average of weather
Baraboo, WI
2000-2010 average high and low temperature and 2017 weather
Three things about climate

• Climate is the average of weather
• Climate changes naturally and by humans
SC Wisconsin

SOUTH CENTRAL WISCONSIN (Div 4708) AVERAGE ANNUAL TEMPERATURE (1895-2017)

Wisconsin State Climatology Office

Averages courtesy of National Climatic Data Center using nClimDiv dataset
As of 5 Jan 2018

1901-2000 Ave. Annual Temp. = 45.6°F
N America

North America Land Temperature Anomalies, July
Three things about climate

- Climate is the average of weather
- Climate changes naturally and by humans
- The study of climate change is well-established. We know how climate changes and what’s is mostly causing current change
In most general terms, the Earth’s temperature is determined by the balance between incoming energy from the sun and the heat it radiates back to space.
What's Really Warming the World?

Skeptics of man-made climate change offer various natural causes to explain why the Earth has warmed 1.4 degrees Fahrenheit since 1880. But can these account for the planet's rising temperature? Watch to see how much different factors, both natural and industrial, contribute to global warming, based on findings from NASA's Goddard Institute for Space Studies.
Other evidence: decreasing radiocarbon content of atmosphere, acidification of ocean, increased water use efficiency of plants, concentrations tracks emissions
Global fossil fuel and cement emissions: 36.1 ± 1.8 GtCO$_2$ in 2013, 61% over 1990

- Projection for 2014: 37.0 ± 1.9 GtCO$_2$, 65% over 1990

Estimates for 2011, 2012, and 2013 are preliminary

Source: CDIAC; Le Quéré et al. 2014; Global Carbon Budget 2014
So what’s the big deal?
Projected Change in Seasonal Temperatures
1980 to 2055 (°F)

Warming is most pronounced in winter
## Earlier arrival of spring in Wisconsin

<table>
<thead>
<tr>
<th>Bird migration</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geese Arrival:</td>
<td><em>Baptista</em> first bloom:</td>
</tr>
<tr>
<td>29 days</td>
<td>18 days</td>
</tr>
<tr>
<td>Cardinal first song:</td>
<td><em>Butterfly weed</em> first</td>
</tr>
<tr>
<td>22 days</td>
<td>18 days</td>
</tr>
<tr>
<td>Robin arrival:</td>
<td><em>Marsh milkweed</em> first</td>
</tr>
<tr>
<td>9 days</td>
<td>13 days</td>
</tr>
</tbody>
</table>

55 ecological indicators of spring occurred on average 1.2 days earlier per decade from 1936 to 1998.


Slide adapted from C. Kucharik, UW-Madison
A change in Extreme Winters for Lake Mendota, Wisconsin

Extremes have shifted from cold extremes to warm extremes.
Crop Yields Decline under Higher Temperatures

**Corn**

**Soybean**
Forest Composition Shifts

Current

Lower Emissions

Higher Emissions

Forest Types:
- White/Red/Jack Pine
- Loblolly/Shortleaf Pine
- Spruce/Fir
- Oak/Pine
- Oak/Hickory
- Oak/Gum/Cypress
- Maple/Beech/Birch
- Elm/Ash/Cottonwood
- Aspen/Birch
- No Data
Brook trout streams
Source: WICCI
Why aren’t we doing something about it then?
The continued release of CO$_2$ to the atmosphere from burning fossil fuels would “almost certainly cause significant changes” and “could be deleterious from the point of view of human beings […] and marked changes in climate, not controllable through local or even national efforts.

U.S. President's Science Advisory to President Lyndon B. Johnson 1966
DOOMSDAY Thinking

• The imagery of the impossible leads to the art of the no deal
DATE WITH DISASTER Conspiracy theorist David Meade says the world will NOT end on September 23rd – but we’re in for SEVEN years of chaos

The Christian conspiracy theorist says people have misunderstood his prophecy - and September 23rd will just be a "sign".

By Emma Parry, Digital US Correspondent
22nd September 2017, 9:35 am | Updated: 22nd September 2017, 12:26 pm
Hurricane Strength and Ocean Temperatures

Kernal density functions of SSTs by hurricane category. Area under each curve represents 100% of hurricanes of that type. Hurricane wind speeds via HURDAT.
Fires, droughts and hurricanes: What's the link between climate and wildfires?

It was supposed to be a quiet year.
More than 1,200 people have died across India, Bangladesh and Nepal as a result of flooding.
Neil deGrasse Tyson says it might be 'too late' to recover from climate change

By Alexandra King, CNN

Updated 4:18 PM ET, Sun September 17, 2017
So what do you do about climate change?

• Denialism is a normal doomsday response
• So is alarmism. Trying an “all of the above” solution is paralyzing
• But, there are some levers we know work:
  – Rethinking agriculture
  – Reducing deforestation
  – Expanding our energy choices
  – Providing incentives to change
We do and believe like our neighbors

• Or at least, what we think are neighbors do and believe...
Estimated % of adults who think global warming is mostly caused by human activities, 2016

United States

<table>
<thead>
<tr>
<th></th>
<th>53%</th>
<th>32%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Human activities</td>
<td></td>
<td>Natural changes</td>
</tr>
</tbody>
</table>

Public Opinion Estimates, United States, 2016

**BELIEFS**

<table>
<thead>
<tr>
<th></th>
<th>50%</th>
<th>70%</th>
<th>12%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global warming is happening</td>
<td>Yes</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Global warming is caused mostly by human activities</td>
<td>Human activities</td>
<td>53%</td>
<td>32%</td>
</tr>
<tr>
<td>Most scientists think global warming is happening</td>
<td>Yes</td>
<td>49%</td>
<td>28%</td>
</tr>
<tr>
<td>Trust climate scientists about global warming</td>
<td>Somewhat/Strongly trust</td>
<td>71%</td>
<td>26%</td>
</tr>
</tbody>
</table>
“If you look at global warming alarmists, they don't like to look at the actual facts and the data. [...] I read this morning a Newsweek article from the 1970s talking about global cooling. [...] Now, the data proved to be not backing up that theory. So then all the advocates of global cooling suddenly shifted to global warming [...] and the solution interestingly enough was the exact same solution -- government control of the energy sector and every aspect of our lives.”
We do and believe like our neighbors

• Or at least, what we think are neighbors do and believe…

• BUT
Community standards can change
Community standards can change

- Education and generational change
  - Recycling
Community standards can change

- Education and generational change
  - Recycling
- Regulation
  - Acid rain
Community standards can change

- Education and generational change
  - Recycling
- Regulation
  - Acid rain
- Innovation
  - The Ozone Hole
KAYA IDENTITY

\[ F = P g e f \]

- \( F \) = Global CO\(_2\) emissions
- \( P \) = Global population
- \( g \) = Consumption per person
- \( e \) = Energy intensity of gross world product
- \( f \) = Carbon used to make all that energy

**Values:**
- 28.56 gigatons CO\(_2\)
- 6.8 billion people
- $10,000
- 7,000 BTUs per dollar
- 60 tons of CO\(_2\) per billion BTUs

[Source: http://climatemodels.uchicago.edu/kaya/]
Refocuses goal on temperature below 2 C limit (global emissions will need to peak in less than 20 years, sources must balance sinks by 2050)

Let countries determine their contribution

$100 billion fund for developing countries

Is set to be in force, now that > 55% of emissions included in ratified countries

Compliance and monitoring will be a key challenge
Commitments

- China: carbon intensity in 2020 40% below 2005 (emissions still rise), peak carbon emissions 2030
- U.S.: 2025 26-28% emissions below 2005 (double earlier pace), 2050 83% below
- South Korea: 30% below business as usual by 2020 (emissions doubled 1990-2005)
- Russia: 25%
- Brazil: 38-42% below 2020 projection, half by deforestation reduction (REDD)
- Australia: 5-20% below 2000 by 2020
- India: carbon intensity 20% lower by 2020
U.S. Emissions

- Carbon Capture & Storage

After Pacala and Socolow, 2004; ARI CarBen3 Spreadsheet
US forests annually sequester the equivalent of 10% of US carbon dioxide emissions from burning fossil fuels.

Forestry activities could remove another 100 to 200 Tg C/yr.

After nearly a century of building vehicles powered by fossil fuels, General Motors — one of the world’s largest automakers — announced Monday that the end of GM producing internal combustion engines is fast approaching.

The acceleration to an all-electric future will begin almost immediately, with GM releasing two new electric models next year and an additional 18 by 2023.
4% DENIERS (the climate is not changing)
14% FATALISTS (we can’t reduce climate change)
20% PESSIMISTS (we could reduce climate change but we won’t)
16% STRONG OPTIMISTS (we can and we will reduce climate change)
40% SOFT OPTIMISTS (we can and we might)
• “Higher temperatures and less-predictable weather would hurt poor farmers […] It would be a terrible injustice to let climate change undo any of the past half-century’s progress against poverty and disease—and doubly unfair because the people who will be hurt the most are the ones doing the least to cause the problem.”
What can you do?

- Be mindful of how choices you make today influence the lives for your and other folks’ grandchildren.
- Denialism and alarmism are both symptoms of doomsday thinking, be wary of either position.
- Seemingly small changes in habits of transportation, energy use, efficiency, many of which require limited government role, can influence your community, might even save money, & make a big impact.
- Some level of climate change is inevitable, so local adaptation to flooding, extreme heat, sea level are an essential role for local governments.
THANKS!

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Don’t be afraid, be curious