Your Audience Cares About Climate Change and Its Local Impacts

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Bottom Line

- Climate is warming and change is projected to accelerate in next century with continued increases in fossil fuel emissions
- Vulnerable aspects of society and ecosystems are at risk from these changes without appropriate mitigation or adaptation measures
- The public increasingly supports action on climate change and is hungry for credible, legitimate, salient information on how to do so
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
Science Notes and News.

COAL CONSUMPTION AFFECTING CLIMATE.

The furnaces of the world are now burning about 2,000,000,000 tons of coal a year. When this is burned, uniting with oxygen, it adds about 7,000,000,000 tons of carbon dioxide to the atmosphere yearly. This tends to make the air a more effective blanket for the earth and to raise its temperature. The effect may be considerable in a few centuries.
What is Climate?

• Climate is the average of weather
  – “Climate is what you expect, weather is what you get” – Andrew John Herbertson
  – “Climate is your personality, weather is your mood” – Marshall Shepherd

• Climate changes naturally (over eons) and by humans (over centuries)
North America Land Temperature Anomalies, July
Global Land and Ocean Temperature Anomalies, July
The study of climate change is well-established. We know how climate changes and what is mostly causing current change.
“CO₂ is to climate what steroids was to baseball…” – Jason Samenow

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.

Total global emissions: 40.8 ± 2.7 GtCO₂ in 2016, 52% over 1990
Percentage land-use change: 42% in 1960, 12% averaged 2007-2016

Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; van der Werf et al. 2017; Le Quéré et al 2017; Global Carbon Budget 2017
The emission pledges submitted to the Paris climate summit avoid the worst effects of climate change (red), most studies suggest a likely temperature increase of about 3°C (brown).

Over 1000 scenarios from the IPCC Fifth Assessment Report are shown.

Source: Fuss et al 2014; CDIAC; Global Carbon Budget 2015
http://globalchange.mit.edu/focus-areas/uncertainty/gamble
So what’s the big deal?
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.
Study: Freak summer weather and wild jet-stream patterns are on the rise because of global warming

Simulation of jet stream pattern July 22. (VentuSky.com)

By Jason Samenow
October 31 at 2:16 PM
Projected Heavy Rainfall

Change in 2”+ inches per 24 hr rain events:
Statistically downscaled GCM, 1980-2055 (SRES A1B)

2-5 days more per decade

Source: UW-Madison
Nelson Institute
Center for Climatic Research
Projected Change in Seasonal Temperatures 1980 to 2055 (°F)

Warming is most pronounced in winter
Northward retreat of snow cover leads to northward track shift of synoptic mid-latitude cyclones

\[ R^2 = 0.472627211396 \]

R. Clare, UW-Madison

Retreat of North American snow cover

Northward displacement of mid-latitude cyclones

Area of depopulated zone [10^7 km^2]
## Earlier arrival of spring in Wisconsin

<table>
<thead>
<tr>
<th>Bird migration</th>
<th>Vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Geese Arrival:</strong> 29 days</td>
<td><em>Baptista</em> first bloom: 18 days</td>
</tr>
<tr>
<td><strong>Cardinal first song:</strong> 22 days</td>
<td><em>Butterfly weed</em> first bloom: 18 days</td>
</tr>
<tr>
<td><strong>Robin arrival:</strong> 9 days</td>
<td><em>Marsh milkweed</em> first bloom: 13 days</td>
</tr>
</tbody>
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### 55 ecological indicators of spring occurred on average 1.2 days earlier per decade from 1936 to 1998.


**Ellwood et al., 2013**

Photo: Jeffrey Phelps, Milw. Journal Sentinel

Leopold Shack
Photo: Aldo Leopold Foundation

Slide adapted from C. Kucharik, UW-Madison
Increased Stressors

Many forests are already under stress from other causes.

Climate change could make forests more susceptible to existing or new stressors.

Hemlock wooly adelgid: Pest limited by cold temps

Exotic Earthworms: Increase drought susceptibility

Invasive Plants: Outcompete stressed trees

Images: US Forest Service and L. Mehrhoff (UConn: invasives.org)

Matt Dallman, TNC
Crop Yields Decline under Higher Temperatures

**Corn**

**Soybean**

Chris Kucharik, UW-Madison
Wetland flux controls: how does interacting water table levels and temperature influence carbon dioxide and methane fluxes in northern Wisconsin?

Carolyn A. Pugh · David E. Reed · Ankur R. Desai · Benjamin N. Sulman
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

David Mladenoff, UW-Madison
Brook trout streams
Source: WICCI
Badgers want change but rarely hear or talk about it

- 7 in 10 believe global warming is happening and trust climate scientists
  - Around half believe it is caused mostly by humans or worry about it harms
- Up to 8 in 10 support policies to support research, regulation, renewables
- But only 1 in 4 hear about global warming or discuss it occasionally

http://climatecommunication.yale.edu/visualizations-data/ycom-us-2016/
7 in 10 say humans are as or more important as natural events for observed climate trends.
Thanks!

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• We have nearly 2 centuries of research on a change climate, human’s contribution and its impacts
• There is much to be done in communication of impacts, risks, evaluation of policies
• Broadcast met and NWS forecasters have an opportunity to be at the forefront of that discussion
• Planetary (inc. Earth) temperature is determined by interaction of sunlight warming Earth’s surface, and “greenhouse” gases that absorb infrared radiation (Fourier 1824, Tyndall 1861)

• CO₂ is a greenhouse warming gas and emitted from coal, oil, gas (Arrhenius 1896)

• Oceans can only take up a fraction of CO₂ produced by combustion (Revelle 1957)
• Atmospheric CO$_2$ increasing $\sim 2$ ppm/yr from fossil fuel combustion, with 50% going into land and ocean sinks (Keeling 1960, Tans 1990)

• Short and long term observed warming patterns are linked to greenhouse gases (Callendar 1938, Mann 1999)

• Significant warming in the 20$^{th}$ century is mostly explained by atmospheric CO$_2$ (Manabe 1967, Hansen 1984)
Shorter lake ice conditions influence recreation, fisheries, and algal blooms.

Extremes have shifted from cold extremes to warm extremes.

The graph shows the ice cover duration (in days) from 1850 to 2000. The trend line indicates a decrease in ice cover duration over time, with a percent of variation around the trend line of 80%. The longest 10 extremes are highlighted in blue, while the shortest 10 extremes are highlighted in red.

J.J. Magnuson March 2016