Climate Change
Key Concepts and FAQs

Kailey Marcinkowski
Chris Swanston

Partners In Action
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Northern Institute of Applied Climate Science

Climate
Carbon
Bioenergy

Provides practical information, resources, education, and technical assistance related to forests and climate change.

Supports the integration of climate change information into natural resource management.

Regional multi-institutional partnership:

www.nrs.fs.fed.us/niacs/
Climate Change Resource Center

www.fs.usda.gov/ccrc/

- climate basics
- climate/carbon tools
- videos
- extras!
- topic pages
Climate Change Concepts and FAQs

- Refresher/introduction
- FAQs
- FAQs Answered
- Climate Change in the Midwest
Climate Change Concepts and FAQs
Climate Change Concepts and FAQs

http://www.pmel.noaa.gov/elnino/impacts-of-el-nino/
weather

climate

short term

long term
weather

climate

short term

long term
warming of about 1.4 degrees Fahrenheit for the globe from 1880 to 2012

graph data from the NASA Goddard Institute for Space Studies
warming of about 1.4 degrees Fahrenheit for the globe from 1880 to 2012
warming of around 2 degrees Fahrenheit for the United States since 1895

graph data from the NASA Goddard Institute for Space Studies
hasn’t climate change happened before?  
isn’t climate change a natural process?
hasn’t climate change happened before?

isn’t climate change a natural process?

yes!
Hasn’t climate change happened before?
Isn’t climate change a natural process?

Yes!

Milankovitch Cycles
hasn’t climate change happened before? isn’t climate change a natural process? 

yes!
hasn’t climate change happened before? isn’t climate change a natural process?

Temperature and Carbon Dioxide over the Past 400,000 Years

- Temperature change in degrees Fahrenheit (compared with 1960-1990 baseline)
- Atmospheric carbon dioxide (parts per million)

Graph data from the NOAA NCDC and Mauna Loa Observatory
hasn’t climate change happened before? isn’t climate change a natural process?

Temperature and Carbon Dioxide over the Past 400,000 Years

- Temperature change in degrees Fahrenheit (compared with 1960-1990 baseline)
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Graph data from the NOAA NCDC and Mauna Loa Observatory
Is current climate change part of the natural process?

Greenhouse Gases

- More rapidly
- Fossil fuels
- Land-use change
is current climate change part of the natural process?

Greenhouse Gases

- carbon dioxide: fossil fuel use
- methane: fossil fuel use, livestock, farming
- water vapor: oceans, large bodies of water, water vapor increases as temperatures increase
Greenhouse Gases

- carbon dioxide
  - fossil fuel use
- methane
  - fossil fuel use
  - livestock
  - farming
- water vapor
  - oceans
  - large bodies of water
  - water vapor increases as temperatures increase

is current climate change part of the natural process?
why are they called “greenhouse” gases?  
what is the greenhouse gas effect?
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without the greenhouse effect, the average temperature on Earth would be about ZERO degrees Fahrenheit.
why are they called “greenhouse” gases?
what is the greenhouse gas effect?

without the greenhouse effect, the average temperature on Earth would be about ZERO degrees Fahrenheit.
Just a short recap:

- weather and climate are different
  - think outfit vs. closet

- increasing global temperatures
  - 1.4 degrees between 1880 and 2012

- increasing temperatures in the United States
  - nearly 2 degrees since 1895

- changes in climate are a natural process
  - humans disrupting natural climate system
  - concentration of carbon dioxide is highest its been in 400,000 years

- changes caused by increases in greenhouse gases
  - carbon dioxide, methane, water vapor
  - different lifetimes in the atmosphere (carbon dioxide = decades)

- greenhouse gas effect is a natural process
  - Earth would be 0 degrees without it!
  - more greenhouse gases in the atmosphere = more warming
General Circulation Models

- Ocean
- Atmosphere
- Land Surface
- Cryosphere
aren’t climate models uncertain?

isn’t there uncertainty in future projections?
aren’t climate models uncertain?
isn’t there uncertainty in future projections?

yes!
Cloud Dynamics
- Reflect the sun's radiation
- Re-emit Earth's radiation

Forcings
- Climate drivers
- External
- Positive or negative

Extremes
- Outside of expectations
- Small scales

Feedbacks
- Amplify/diminish forcings
- Internal
- Loop

Model Uncertainty
climate models

future greenhouse gas emissions

demographics
economics
technology
Just a short recap:

• general circulation models simulate future global climate
  • oceans, atmosphere, land surfaces, cryosphere

• uncertainty within general circulation models
  • cloud dynamics, forcings, extremes, feedbacks
  • models still do a good job of replicating past climate

• uncertainty with future greenhouse gas emissions
  • expectations about future demographics, economics, technology
  • emissions scenarios = inputs into climate models

• range of plausible futures
  • use a range of climate models
  • use a range of emissions scenarios
  • despite uncertainties, can still plan for range of futures
Regional Changes

1895-2011

0.83°F

1950-2011

0.97°F

Source: Climate Wizard
Regional Projections

**B1**
- 2040–2069: 4.4 °F
- 2070–2099: 3.9 °F

**A2**
- 2040–2069: 6.0 °F
- 2070–2099: 9.1 °F

Source: Climate Wizard
Precipitation Trends

1951-2006

0.18 in.

Source: Climate Wizard
Precipitation Projections

B1
2040–2069

5.2%

2070–2099

8.0%

A2
2040–2069

5.6%

2070–2099

13.0%

Source: Climate Wizard
Water Resources

Observed Percent Change in Very Heavy Precipitation
1958-2012

Northeast: 71%
Southeast: 27%
Midwest: 37%
Great Plains: 16%
Southwest: 5%
Northwest: 12%
Alaska: 11%
Hawaii: -12%

erosion
aquatic ecosystems
infrastructure, operations, and human health

National Climate Assessment 2014
Water Resources

high magnitude snowfall  lake effect snowfall

National Climate Assessment 2014
snow-water equivalent  

earlier snowmelt
Great Lakes

- ice cover
- erosion
- flooding
- aquatic ecosystems

Ice Cover in the Great Lakes

Great Lakes Ice Coverage Decline
Lake Superior: +4.5F twice the rate of air temperature increase. Project to rise +7F by 2050 and +12F by 2100.


Great Lakes

Lake Superior: +4.5°F twice the rate of air temperature increase
Project to rise +7°F by 2050 and +12°F by 2100

Lake Huron: +5.2°F 1968-2002

Lake Ontario: +2.7°F 1968-2002

algae
invasive species
aquatic ecosystems

National Climate Assessment 2014
Growing Season

Observed Increase in Frost-free Season Length (days)
1991-2012 relative to 1901-1960

- Northeast: 10
- Southeast: 6
- Midwest: 9
- Great Plains: 10
- Southwest: 19
- Northwest: 16

National Climate Assessment 2014
Quaking Aspen

Current

Importance Value
Low
High

2070-2100 Low

2070-2100 High

National Climate Assessment 2014
Just a short recap:

- Midwest temperature changes
  - increased over the last 100+ and 50+ years
  - projected to increase from 4-9 degrees Fahrenheit by 2100

- Midwest precipitation changes
  - slight increase over the past 50 years
  - projected to increase and become wetter by 2100

- Climate change effects
  - more frequent heavy precipitation events
  - more lake effect snow, less SWE, earlier snowmelt
  - decreasing lake ice and increasing lake surface water temperatures
  - increase in length of growing season
  - changes in species range
Who Ya Gonna Call?

NIACS!

- **Advocate** for climate informed management and adaptation
- **Support/Coach**
  - Work with a diversity of landowners, agencies and groups
- **Facilitate**
- **Outreach/Educator/Cheerleader**
  - Climate change issues and impacts
  - Adaptation strategies and actions
- **Translate**
  - Synthesize and translate technical information to land managers

www.nrs.fs.fed.us/niacs/
thank you!

if you’d like *even* more information, check out the climate change resource center (

(www.fs.usda.gov/ccrc/)

And feel free to contact me at kfmarcin@mtu.edu OR kfmarcinkowski@fs.fed.us

questions?
<table>
<thead>
<tr>
<th>Sources</th>
<th>Sinks</th>
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<tbody>
<tr>
<td><strong>Vegetation</strong> (550 ± 100)</td>
<td><strong>Atmosphere</strong> (805)</td>
</tr>
<tr>
<td><strong>Soil</strong> (2,300)</td>
<td><strong>Lithosphere</strong> 8.4 ± 0.5</td>
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<tr>
<td><strong>Ocean</strong> 90</td>
<td><strong>Surface ocean</strong> (700-1,000)</td>
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<tr>
<td>120 + 2.3 ± 1.1</td>
<td><strong>Deep ocean</strong> (38,000)</td>
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<tr>
<td>60</td>
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<td>photosynthesis</td>
<td>1.1 ± 0.7</td>
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<tr>
<td>decomposition</td>
<td><strong>fossil fuels</strong> (5,000-10,000)</td>
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<tr>
<td>respiration</td>
<td>8.4 ± 0.5</td>
</tr>
<tr>
<td>storage</td>
<td>90 + 2.2 ± 0.4</td>
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