Climate Change: What Does It Mean For Idaho?

Lecture by Arjan Meddens

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Outline

1. Basic science of global warming
2. Recent climate change
3. Future predictions
4. Impacts in Pacific Northwest
Who evaluates climate science results and produces reports for governments and the public?

• **International Panel of Climate Change (IPCC)**
  - Set up by the World Meteorological Organization (WMO) and by the United Nations Environment Programme (UNEP).
  - Hundreds of scientists all over the world contribute to the work of the IPCC.

• **The 2001 report stated:**
  - Influence of human activities now evident
  - Rates of change too fast to be “just” natural cycles

• **The 2007 report:**
  - Warming of the climate system is certain as is now evident from observations of increases in global temperatures, widespread melting of snow and ice.
WEATHER: Meteorological conditions of the next Day – Month

CLIMATE: Long term conditions of the Meteorology over Years - Decades
Carbon dioxide (CO₂) and other greenhouse gases warm the planet.

Human activities have increased the concentration of the major greenhouse gases since 1750.

Average global temperature has increased 1.3°F since 1906. Warming since the 1950s very likely (>90% chance) due to human increases in GHG.

Evidence of change is increasingly evident throughout the Earth’s systems.

Without drastic changes in current emissions trends, greenhouse gas concentrations will increase dramatically over the next century and beyond.

Source: The Intergovernmental Panel on Climate Change (IPCC), www.ipcc.ch
Greenhouse gases (water vapor, CO2, CH4, N2O) play a critical role in determining global temperature. These special gases act like a “blanket”, trapping heat emitted by the Earth, which is warmed by the Sun. This greenhouse effect makes the Earth a livable planet, BUT....
A positive radiative forcing tends to warm the surface of the Earth, and negative forcing tends to cool the surface.
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Carbon Dioxide (CO2)
Methane (CH4)

+142%
Nitrous Oxide (N2O)

+18%
Fig. 4. A composite CO₂ record over six and a half ice age cycles, back to 650,000 years B.P. The record results from the combination of CO₂ data from three Antarctic ice cores: Dome C (black), 0 to 22 kyr B.P. (9, 77) and 390 to 650 kyr B.P. (this work including data from 31 depth intervals over termination V of (1)); Vostok (blue), 0 to 420 kyr B.P. (5, 7), and Taylor Dome (light green), 20 to 62 yr B.P. (8). Black line indicates δD from Dome C, 0 to 400 kyr B.P. (7) and 400 to 650 kyr B.P. (18). Blue line indicates δD from Vostok, 0 to 420 kyr B.P. (7).

7 to 8 C, or 13.5 F

Present

450,000 years ago
CO$_2$ record from Dome C Ice Core

Current concentration (380 ppm)

Fig. 4. A composite CO$_2$ record over six and a half ice age cycles, back to 650,000 years B.P. The record results from the combination of CO$_2$ data from three Antarctic ice cores: Dome C (black), 0 to 22 kyr B.P. (9, 71) and 390 to 650 kyr B.P. [this work including data from 31 depth intervals over termination V of (1)]; Vostok (blue), 0 to 420 kyr B.P. (5, 7), and Taylor Dome (light green), 20 to 62 yr B.P. (8). Black line indicates $\delta^13$C from Dome C, 0 to 400 kyr B.P. (7) and 400 to 650 kyr B.P. (18). Blue line indicates $\delta^13$C from Vostok, 0 to 420 kyr B.P. (7).

7 to 8 C, or 13.5 F

Present

450,000 years ago
Where Do These Increases Come From?

- **Human sources:**
  - Fossil fuel burning (oil, coal, natural gas) (CO₂, CH₄, N₂O)
  - Deforestation and land use change (CO₂)
  - Agricultural practices (CO₂, CH₄, N₂O)
  - Energy extraction (CO₂, CH₄)
  - Ruminant (e.g., cows) (CH₄)
  - Cement production (CO₂)
  - Landfills (CH₄)

- **Natural sources**
  - Wetlands (CH₄)
  - Oceans, soils (CO₂, N₂O)
  - Decomposition of organic matter (CO₂, CH₄)
Emissions principally from US, Canada, with other regions becoming more important
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Change in temperature over last 150 years

Global near-surface temperatures:
Annual anomalies 1850-2006

Temperature Difference (°C) with respect to 1961-1990

Based on Brohan et al. (2006)

Hadley Centre for Climate Change
Change in temperature over last 1000 years

Data from thermometers (red) and from tree rings, corals, ice cores and historical records (blue).

Source: IPCC 2001
Annual Temperature Trend 1901-2005
Models require both natural and anthropogenic forcings to simulate observations.

Observations

- Models w/natural forcing
- Models w/natural forcings, human forcings
Average annual temperature increased +1.5°F in the PNW during the 20th century

- Almost every station shows warming
- Extreme cold conditions have become rarer
- Low temperatures rose faster than high temperatures
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Source: The Intergovernmental Panel on Climate Change (IPCC), www.ipcc.ch
Observed changes in natural systems (20th century)

The extent and thickness of Arctic sea-ice is declining (extent is down 10-15%; thickness is down 40%)

Permafrost is thawing (with major implications for the region and the globe)

In the Northern Hemisphere, plants are flowering earlier, birds are arriving earlier, insects are emerging earlier
North pole – Summer sea ice extent in 1979 and 2000

In 2007 a record low
Observed changes in natural systems (20th century)

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Observed 20th Century Changes (cont’d)

The growing season has lengthened 1-4 days per decade during the last 40 years in the Northern Hemisphere, especially at northern latitudes – earlier spring & later fall

Plant and animal ranges are shifting northward and to higher elevations

The frequency of coral bleaching is increasing, particularly during El Niño events

Mid-elevation mountain snowpack is in decline and melting earlier. Glaciers are in widespread retreat.
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www.usbr.gov

K. Wattenmaker, firepix.blm.gov
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**CO₂ Emissions in the 21st Century**

*IPCC Emission scenarios* based on economical and technological assumptions about global society
CO₂ Emissions in the 21st Century

Green Scenario (550 ppm)
CO₂ Emissions in the 21st Century

Green Scenario (550 ppm)

Business-as-usual Scenario (750 ppm)
CO₂ Emissions in the 21st Century

A1FI “Aggressive” Scenario (900 ppm)

Business-as-usual Scenario (750 ppm)

Green Scenario (550 ppm)

Fig. 4. A composite CO₂ record over six and a half ice age cycles, back to 650,000 years B.P. The record results from the combination of CO₂ data from three Antarctic ice cores: Dome C (black), 0 to 22 kyr B.P. (6, 7) and 350 to 650 kyr B.P. (this work including data from 31 depth intervals over time span V of [11]; Vostok (dotted) 0 to 420 kyr B.P. (8, 7) and Taylor Dome (light green), 20 to 62 kyr B.P. (6). Black line indicates 25 kyr B.P. (7) and 400 to 650 kyr B.P. (10) Blue line indicates 60 kyr Vostok, 0 to 420 kyr B.P. (7).
Global Warming Predictions

2070-2100 Prediction vs. 1960-1990 Average

Based on HadCM3

Temperature Increase (°C)

0 1 2 3 4 5 6 7 8

“Business as usual” scenario; one model (HadCM3)
Projected rate of warming: \(~0.5^\circ F\) average (0.2-1.0°F) per decade through at least 2050 (compared to 0.15°F/decade over 20th century)

Warming is expected across all seasons with the largest temperature increases likely in summer (June-August)

More detail on the CIG scenarios is available at: http://www.cses.washington.edu/cig/fpt/ccscenarios.shtml
“Downscaled” temperature data for a low-to-medium climate change scenario.
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IPCC 2007 report
Examples of some projected regional impacts of North America

• Decreased snowpack, more winter flooding and reduced summer flows, and competition for water resources.

• Moderate climate change is projected to increase yields of rain-fed agriculture by 5 to 20%, but with variability among regions.

• Major challenges are projected for crops that are near the warm end of their suitable range or which depend on highly utilized water resources.
Glacier retreat in Rocky Mountains and North Cascades

Shepard Glacier
Glacier National Park
• Most PNW stations show a decline in snow water equivalent

• Numerous sites in the Cascades with 30% to 60% declines

• Similar trends seen throughout the western United States - 73% of stations show a decline in April 1 snow water equivalent
Spring snowpack is projected to decline as more winter precipitation falls as rain rather than snow, especially in warmer mid-elevation basins.

Snowpack will melt earlier with warmer spring temperatures.
Trends in Spring Runoff

Peak of spring runoff is moving earlier into the spring throughout western US and Canada

- Advances of 10-30 days between 1948-2000
- Greatest trends in PNW, Canada, and AK
- >30% of trends are statistically significant at the 90% level, especially in the PNW

Wildfires accelerate 1970 – 2003 with early snowmelt, longer, drier summers


Large Forest Wildfires in Years with Early Spring

percent change scaled by forest area

200,000 ha  100,000 ha

Tree mortality resulting from insect outbreaks

Southwestern US

British Columbia

Photo by Craig Allen - USGS

© Parks Canada/Ross MacDonald/KNP/2004

October 2004, Sylvan Pass, Yellowstone NP
Conclusions

1. There is an increase in global temperatures due to human-caused increases in greenhouse gases.

2. In the last century the average global temperature has risen with 1.3°F.

3. Future predictions for the PNW say that temperature will increase around 5°F in the PNW by 2100.

4. The impacts of the temperature increase in the PNW will affect agricultural and natural systems.
For more information...

University of Idaho Fall Seminar Series on Climate Change and Idaho

Variety of topics:
- snow
- fish
- fire
- insects
- C sequestration
- etc.

Seminars recorded, available for viewing from WWW

www.webpages.uidaho.edu/~jhicke/courses/cc_fall07.htm
More information on PNW climate impacts and planning for climate change is available from

The Climate Impacts Group
www.cses.washington.edu/cig

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Information on Idaho climate change is available at
http://groups.google.com/group/idahoclimatetchange
Or contact Dr. Jeffrey A. Hicke (jhicke@uidaho.edu),
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