I WANT A RECOUNT.

TIME TO BURN MORE FOSSIL FUELS...

AND YOUR BOOKS.

“SCIENCE”

\[ \frac{x+y}{z\pi} \pm \sqrt{18x^2 - 79w} \]

AL GORE

FED UP CITIZENS

OSCAR

NEWS COLD WAVE STRIKES

I’M WARMING TO THAT IDEA.
Puget Sound, 2045...

Yeah, I miss the salmon, too, but you gotta admit global warming has brought us some cool new species!
Climate Change: Implications for the PNW

Nick Bond
University of Washington
NOAA/PMEL
## Projected Impacts of Climate Change

### Source: Stern Review

<table>
<thead>
<tr>
<th>Global temperature change (relative to pre-industrial)</th>
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<tbody>
<tr>
<td>0°C</td>
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<td>Food</td>
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<td>Water</td>
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<td>Ecosystems</td>
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<td>Extreme Weather Events</td>
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<tr>
<td>Risk of Abrupt and Major Irreversible Changes</td>
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</tbody>
</table>

### Food
- Falling crop yields in many areas, particularly developing regions
- Possible rising yields in some high latitude regions
- Falling yields in many developed regions

### Water
- Small mountain glaciers disappear – water supplies threatened in several areas
- Significant decreases in water availability in many areas, including Mediterranean and Southern Africa
- Sea level rise threatens major cities

### Ecosystems
- Extensive Damage to Coral Reefs
- Rising number of species face extinction

### Extreme Weather Events
- Rising intensity of storms, forest fires, droughts, flooding and heat waves

### Risk of Abrupt and Major Irreversible Changes
- Increasing risk of dangerous feedbacks and abrupt, large-scale shifts in the climate system
Global Climate Change – Questions

- Is climate changing?
- What are greenhouse gases and do we understand their role in climate?
- What is the impact of human activities on greenhouse gas concentrations?
- Can we predict climate change during this century? With what confidence?
Pedersen Glacier, Alaska

Summer 1917
Summer 2005
Northern Hemisphere Extent Anomalies Sep 2013

1981-2010 mean = 6.5 million sq km

slope = -13.7(+/3.0) % per decade
Climate Feedback

- Adding CO2 to the atmosphere warms the planet
- That warming alters other parts of the climate system
- Those changes can further enhance or suppress amount of warming

⇒ Feedback

- Our current understanding of climate feedbacks (water vapor, snow-ice, clouds) is that they tend to enhance the warming due to increased CO2.
Historical Observations in the Pac NW
Figure 2-1. Rising temperatures in the Pacific Northwest. Average annual temperature (red line) shown relative to the 1901–1960 average (indicated by the solid horizontal line). The dashed line is the fitted trend, indicating the +0.13°F/decade warming for 1895-2011. Data source: Kunkel et al. 2013.[2]
1920-2012 Temperature Trends

Squares aren’t significant linear trends; circles are significant at 95%

Abatzoglou et al. 2014 (J. Climate)
Overnight heat events – one where nights stay warm – have increased in frequency in western WA and OR.

No change in daytime events, even though the 2009 event was the 2\textsuperscript{nd} strongest in magnitude on record.

Warm overnight temps in 2009 were particularly remarkable in terms of their duration (8 nights).
Specific Humidity (g/kg) vs. Year

- **Specific Humidity (g/kg)**
- **Year**

**Chart Title:** Summer (Jun-Sep) Average Water Vapor Content at 1000 mb in WA

- **1950 - 2010**
- **8.5 - 10.5**

- **Data Points:**
  - 1950: 8.5
  - 1960: 9.5
  - 1970: 8.5
  - 1980: 9.0
  - 1990: 10.0
  - 2000: 9.5
  - 2010: 9.0
1920-2012 Precipitation Trends

Squares aren’t significant linear trends; circles are significant at 95%

Abatzoglou et al. 2014 (J. Climate)
Potential Evapotranspiration (pET)

Summer Mean Potential ET

ET (in/day)

Year


George Harrah Lind Odessa LeGrow
Predicting the future
Is it liable to warm up faster on the west side or east side of the Cascade Mountains?
Changing Surface Air Temperature – 2050s

Change 1990s to 2050s DJF 2-m Temperature (°F)
Changing Surface Air Temperature – 2090s

Change 1990s to 2090s DJF 2-m Temperature (F)
Temperature Change
NARCCAP, SRES A2
Multi-model mean simulated difference
(2041-2070 minus 1971-2000)

Change
+2.5°F  +6.0°F
+1.4°C  +3.3°C

Annual

Winter

Spring

Summer

Fall
Number of Days per Summer with Max Temp > 90F at Sea-Tac

- 1990s
- 2020s
- 2050s
- 2090s
Projected Change in Ground-Level Ozone, 2090s

Lower Emissions Scenario

Higher Emissions Scenario

parts per billion

-16 -12 -8 -4 0 4 8 12 16

Tao et al.
How is the amount of precipitation liable to change in winter and summer?
Precipitation Changes by Season

- Changes relative to 1970-1999 mean

Wetter winters

Drier summers

(slided adapted from Ingrid Tohver - UW CIG)
Large Drop in Snowpack in the Mountains
Modeled Temperature in the Pac NW
Expectations for the Pac NW

- Variations on time scales of seasons to multiple years will dominate long-term trends for the next 2-3 decades
- Greater increases in minimum rather than maximum temperatures; higher humidity
- Wetter winters and drier summers (probably)
Positive proof of global warming.