The State of the Climate:
Science of Data & Monitoring

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NOAA’s National Climatic Data Center
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The National Climatic Data Center
The world’s largest archive of weather and climate data

- NCDC is located in Asheville, North Carolina
- A place of “active retirement” for weather data of many types
Contents

- About Monitoring
- State of the Climate
  - 2014 Update
- Extremes
Red River, which separates Oklahoma from some other state
Climate Monitoring at NCDC
Climate Monitoring at NCDC
Colleagues from whom I “borrowed” slides today
• Build on established science and datasets
  • Can’t “make it up as we go”
  • Pluses and minuses

• Pursue five facets of data:
  • The observation
  • The difference
  • The unusualness
  • The trend
  • The impact
Haywood Prcp Plot for Athens, GA

Precipitation (in) to Date for ATHENS BEN EPPS AP, GA
Jan 1 through Oct 31. Period of record is 1946 through 2014

NOAA's National Climatic Data Center

1961-2010 Normal underlined in dark grey
2014 period in NOAA Lite Blue
Haywood Tavg Plot for Fresno, CA

Average Temperature (F) to Date for Fresno, CA
Jan 1 through Oct 31. Period of record is 1948 through 2014

NOAA’s National Climatic Data Center

1961-2010 Normal underlaid in dark grey
2014 period in mint
State of the Climate in 2013
Source: State of the Climate in 2013

- 425 authors
- 57 countries
- 24th annual SoC report

Countries contributing author
Countries contributing a chapter editor
Surveys state and behavior of physical climate system: the “annual physical” of the climate system

Does not pursue attribution, forecasts, scenarios, or projections

Most downloaded article among AMS journals

**State of the Climate**
- Updated: annually
- Focus: physical status of the climate and ability to observe it

**U.S. National Climate Assessment**
- Updated: 4 yrs
- Focus: observed change, projected U.S. impacts, readiness of adaptation and mitigation

**IPCC Assessment Report**
- Updated: 6–7 yrs
- Focus: synthesize scientific understanding
Increasing GHG Concentrations

- Global mean CO$_2$: 395.3 ppm (+2.8 ppm from 2012)
  - Mauna Loa Obsvy: 400 ppm on 9 May 2013
  - AMJ 2014: >400 ppm

- Global mean CH$_4$: 1814.1 ppb (+5.7 ppb from 2012)

- Global mean N$_2$O: 325.9 ppb (+0.9 ppb from 2012)

- Additional radiative forcing from GHGs above preindustrial times now 2.92 W m$^{-2}$, a 34% increase since 1990
GHG Concentrations: The Long View

- Carbon Dioxide (CO₂)
- Methane (CH₄)
- Nitrous Oxide (N₂O)

Source: 3rd US National Climate Assessment, 2014
The 2013 annual global temperature (land and ocean) was among six warmest years on record.
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Global Sfc Temperature: 2014 update

Annual Global Temperature (Combined Land & Ocean)

1880-2014 Trend: +1.2°F per century
1998-2014 Trend: +1.0°F per century

* - 2014 assumes Jan-Sep anomaly

Anomaly (°F) relative to 20th Century Average

with linear best-fit trend since 1998 in purple

NCDC / NESDIS / NOAA
http://www.ncdc.noaa.gov/
In the past *half century:*  
Arctic air temperature increased at **0.72°F / decade**  
Land surface temperatures increased at **0.43°F / decade**  
Sea surface temperatures increased at **0.22°F / decade**
# 2014 Global Temperature Horse Race

<table>
<thead>
<tr>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>+0.9</td>
<td>+0.8</td>
<td>+0.7</td>
<td>+0.6</td>
<td>+0.5</td>
<td>+0.4</td>
<td>+0.3</td>
<td>+0.2</td>
<td>+0.1</td>
<td>+0.0</td>
<td>-0.1</td>
<td>-0.2</td>
</tr>
</tbody>
</table>

NOAA's National Climatic Data Center
This plot created 08:07 EDT Oct 20, 2014
2014 Global Temperature Horse Race

Year-to-Date Global Temperature
for 2014 and the five warmest years on record

- 2014
- 2010 (+0.66°C)
- 2005 (+0.65°C)
- 1998 (+0.64°C)
- 2013 (+0.63°C)
- 2003 (+0.62°C)
2014 Global Temperature Horse Race

Year-to-Date Global Temperature
end of year scenarios for 2014 vs. the five warmest years on record

If each month from October through December matches ...

the 2014 end-of-year outcome will be:

... its warmest on record: +0.70°C (warmest on record)
... its 3rd warmest on record: +0.68°C (warmest on record)
... the average of its 10 warmest: +0.67°C (warmest on record)
... its 21st century average: +0.66°C (tied, warmest on record)
... its 10th warmest on record: +0.65°C (tied, 2nd warmest on record)

Difference (°C) from 20th century average

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

2014
2010 (+0.66°C)
2005 (+0.65°C)
1998 (+0.64°C)
2013 (+0.63°C)
2003 (+0.62°C)
Global Temperature Update: 2014

Land & Ocean Temperature Percentiles Jan–Sep 2014
NOAA’s National Climatic Data Center
Data Source: GHCN–M version 3.2.2 & ERSST version 3b

[Map showing temperature percentiles around the world]

- Record Coldest
- Much Cooler than Average
- Cooler than Average
- Near Average
- Warmer than Average
- Much Warmer than Average
- Record Warmest
11 Indicators of a Warming World

The stratosphere (up here!) is cooling

Adapted from State of the Climate in 2009
Upper Ocean Heat Content: 2013

![Graph showing the heat content anomaly from 1993 to 2013 for different data sources. The graph plots the heat content anomaly (in 10^21 J) over time, with error bars indicating variability. The data sources are CSIRO/ACE CRC, PMEL/JPL/JIMAR, NODC, and Met Office.](image-url)
N.H. Snow Cover Extent: Trends

Northern Hemisphere 30-year Monthly Snow Cover Extent Trends
Period Analyzed: July 1984-June 2014

Trend (percent of average)

Data provided by the Rutgers Global Snow Lab
Glacier Mass Balance: 1989-2013
Fig 5.20 from State of the Climate in 2013

Permafrost temperature (°C) at 20m for continuous permafrost stns in AK
Fig 5.27a from State of the Climate in 2013
Recognizing it is difficult-to-impossible to connect single events with long-term climate change, this is one pretty doggone emblematic situation worth noting as we gaze at our future.
- Strongest wind speeds assigned to tropical cyclone
- High intensity at such low latitude (~5°N)
  - cf. Bopha 2012
- Record-setting intensity at landfall
- “Extremes” intensity overall in the basin
likely influenced by La Nina dominance during period

Commonwealth Scientific and Industrial Research Organization (CSIRO, the national science agency of Australia)
2013 MSL anomalies
Fig 3.28 from *State of the Climate in 2013*
SSH section: Merrifield et al. (2014)
Also, Poverty
Extremes in the US

Climate Extremes Index:
http://www.ncdc.noaa.gov/extremes/cei
Relationship between weather & climate

Literature Review: Stallone et al. (1976)
Relationship between weather & climate

Literature Review: LeBron et al. (2012-14)
- Kinda impulsive
- Short attention span
- Very sensitive to his environment
- Prone to occasional extreme behavior, given the “right set of ingredients”
- Forgets quickly, “moves on”
- Let’s call this kid weather
Climate and Extreme Weather

- Still impulsive
- Still responds mostly to his immediate environment
- Still spends months at a time hanging out with influential friends “La Nina” and “El Nino”
- But seems to be getting into weird situations more often

- The drivers of his individual days are mostly similar
- The trajectory of his life has changed
Climate and Extreme Weather

- Still can’t predict the outcome on November 14, 2015
- We may try to attribute today’s particular behavior to “parenting”, but very hard to do definitively.
- But we can surely notice trends
- There will be changes, even some positives and opportunities
- People around him will choose to ignore, adapt to, or mitigate these changes

• This guy gets blamed for almost everything, but hard to prove any single thing beyond a reasonable doubt
Current State of Scientific Knowledge

4 BAMS workshops/papers

**Summary of Extreme Wx and Cx**

- **Most obvious changes:**
  - **Big Heat:** Is increasing, and is expected to continue
  - **Big Rain:** Is increasing, and is expected to continue (w/ regional patterns)
  - **Big Cold:** Is decreasing, and is expected to continue

- **Less obvious changes:**
  - **Big Drought:** increased in recent decades, but other periods have been worse. Western US has seen and expected to see more. Elsewhere, stay tuned
  - **Hurricanes:** no consensus on frequency. Some agreement that intensity will continue to skew up. *Sea level is rising*, this is a factor
  - **Big Snow:** Expect regional and timing shifts, however not yet evident in the data.
  - **Ice Storms:** Expect regional and timing shifts, however the data are not in condition to assess and no trends evident
THANK YOU