STATE OF THE CLIMATE **IN 2013 Special Supplement to the** Bulletin of the American Meteorological Society Vol. 95, No. 7, July 2014



# State of the Climate in 2013

Kathryn Sullivan, Ph.D., Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator

**Thomas R. Karl**, L.H.D., Director, NOAA's National Climatic Data Center, and Chair of the Subcommittee on Global Change Research

**Jessica Blunden**, Ph.D., Scientist, ERT Inc., Climate Monitoring Branch, NOAA's National Climatic Data Center

Martin Jeffries, Ph.D., Arctic and Global Prediction Program Officer, Office of Naval Research

James Renwick, Ph.D., School of Geography, Environment and Earth Sciences, Victoria University of Wellington (New Zealand)

# What is the Importance of this Report?

- This is the 24th annual State of the Climate report
- Surveys the changing state and behavior of the physical climate system every year: an annual "score card" or "annual physical" of the climate system
- Does not pursue "attribution" or contain forecasts, scenarios, or projections
- Last year's report remains the most downloaded article of the last 12 months among all AMS journals

The State of the Climate report is one of several distinct climate assessments All are based upon peer-reviewed science, but serve unique purposes



# State of the Climate

- Updated: each year
- Focus: physical status of the climate and ability to observe it



#### U.S. National Climate Assessment

- Updated: 4 years
- Focus: observed changes, projected impacts to U.S., readiness of adaptation and mitigation



#### IPCC Assessment Report

- Updated: 6–7 years
- Focus: synthesize scientific understanding



# **Global Scope; Global Authorship**

- The climate system is large, diverse, and complex
- So too is the authorship of the State of the Climate
- Many scientists from many disciplines fit the pieces together:
  - Dozens of essential climate indicators, extreme weather and climate events, historical context













NOAA's National Climatic Data Center 3

# **Content in the Report**

### The report monitors and analyzes:

- Dozens of climate indicators across land, sky, sea, and ice
  - Mostly global in scope; useful for examining big-picture changes to climate system
- Major climate zones and regions
  - Important places within the climate system: Arctic, Antarctic, the Tropics, individual countries
- Important climate phenomena
  - Extreme and notable events; large-scale climate patterns such as El Niño

- There is a rising need and data available to examine variables that affect dayto-day life
  - Analyzing warm days and nights in recent decades



#### % of Warm Days

#### % of Cool Nights





## **Continued Increase in Greenhouse Gases**



- Additional radiative forcing from greenhouse gases above preindustrial times is now 2.92 W m<sup>-2</sup>, a 34% increase since 1990
- CO<sub>2</sub> contributes to about 2/3 of this forcing

- Global mean carbon dioxide (CO<sub>2</sub>) reached 395.3 ppm, a 2.8 ppm increase from 2012
- Mauna Loa Observatory reaches 400 ppm on May 9, 2013 for first time in history
- Global mean methane (CH<sub>4</sub>) reached 1814.1 ppb, a 5.7 ppb increase since 2012
- Global mean nitrous oxide (N<sub>2</sub>O) reached
  325.9 ppb, a 0.9 ppb increase since 2012





## 2013: Global Surface Temperature Among Six Warmest on Record

Four major independent datasets show 2013 between second and sixth warmest since records began in 1880, depending on the dataset





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## 2013: Oceans Warm; Key Indicators Reach New Records



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Global Mean Sea Level





## Continued Signals of a Warming World in the Cryosphere: Glaciers

#### Careser Glacier, Italy Change from 1933 to 2012





Preliminary data suggests that 2013 will be the 23rd consecutive year of negative glacier ice loss



## Continued Signals of a Warming World in the Cryosphere: Permafrost





Record high permafrost temperatures in 2013 at 20-m depth at some stations on the North Slope of Alaska and in the Brooks Range



## Snow Cover Over Land and Arctic Sea Ice

- Record low May Eurasian snow extent: 27% below 1981–2010 average
- N. American June snow extent: 34% below 1981–2010 average
- N. Hemisphere June snow extent: declining at a rate of -19.9% per decade



- Minimum Sept. sea ice extent:18% below 1981–2010 average; 6th lowest in the satellite record (1979–2013)
- Sept. Arctic sea ice extent: declining at a rate of -13.7% per decade





# **Arctic Air Temperature**

- 2001–13 was ~1°C (1.8°F) warmer than 1981–2000 average
- Arctic-wide annual surface temperature was seventh warmest since 1900
- Air temperature is rising in all seasons, most pronounced in autumn and winter
- Warming is greater in Arctic compared to lower latitudes (Arctic Amplification)

Arctic Amplification: difference in surface air temperature (departure from 1948–2013 average) between Arctic and midlatitudes





## Summer 2013 in the Arctic

Fairbanks, AK: Record 36 days with maximum air temperatures of 27°C or higher

Chukchi and East Siberian Seas: lower than average SST due to later and less extensive sea ice retreat



(b) Chukch Sea Sea ice Sea *Sea ice minimum extent* Kara Sea Barents Se Barents Se SST, Aug.

Eastern Arctic Summer: 1–3°C warmer than 2007–12 average

Barents, Kara, and Laptev Seas: SST higher than average due to earlier sea ice retreat

Surface melt extent on the Greenland Ice Sheet was much lower in 2013 than in 2012 due to cool, northerly airflow Summer 2013: 1–3°C cooler than 2007–12 average from Greenland across a large swath of the Arctic

# Antarctic Sea Ice and Inland Temperature Extremes

- Maximum Sept. sea ice extent: 5.2% above 1981–2010 average; record highest in the satellite record (1979–2013)
- •Sept. Antarctic sea ice extent: increasing at a rate of **1.01% per decade**.
- All-time daily high reached on October 1, 2013: 7.56 million square miles



Sea Ice Extent Sept. 2013



- Amundsen-Scott South Pole station record high annual temperature of -47°C (-53.3°F); records date to 1957
- Many locations in Antarctic interior set record high temperatures during August and September

## **Extreme Event: Spring Flooding in Europe**



- Major rivers flooded
  - Danube, Rhine, Elbe
    - > Highest levels for 100–500 years in places
- 24 deaths
- Billions of U.S. dollars in damages



### **Extreme Event: Super Typhoon Haiyan**







- Estimated 6,300 deaths and 1,000 still missing
- Sustained winds 196 mph at peak
  - Strongest estimated at landfall
- Storm surge 6–9 meters
- Left 2 million people homeless



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# Extreme Events: East Asia Heat, Drought, Floods in Summer 2013



- Warmest summer on record in China, Japan, and South Korea
- Southern China drought (damages estimated at \$7.7 billion U.S. dollars)
- Heavy rains, Jul–Aug, China/Russia (damages estimated at billions of U.S. dollars and over 100 fatalities)



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# **Extreme Event: Heat in Australia**

- Warmest year on record for Australia since records began in 1910
- September max temp anomaly +3.4°C: highest recorded for any month on record



#### Heat wave: January 1–18

#### Maximum temperature departure from 1961–90 average



#### Highest reported temperature





#### State of the Climate in 2013

# State of the Climate in 2013

- The 2013 annual global temperature across land and ocean surfaces was among the six warmest years on record
- Several important indicators set new records or were near record levels during the year:
  - Greenhouse gas levels
  - Ocean heat content
  - Sea level
  - Glacier ice loss
  - Permafrost temperatures
  - Late spring Northern Hemisphere snow cover extent
  - Antarctic sea ice extent
- The Arctic continued to warm faster than the rest of the globe
- Notable extremes occurred across the globe, including heat waves, droughts, floods, and intense tropical cyclones







# For More Information



### Link to Full Report and Today's Presentation:

http://www.ncdc.noaa.gov/bams-state-of-the-climate/2013.php

**Report Highlights:** 

http://www.climate.gov/news-features/understanding-climate/state-climate-2013-highlights

NOAA's National Climatic Data Center: <a href="http://www.ncdc.noaa.gov">www.ncdc.noaa.gov</a>

#### U.S. Office of Naval Research Arctic and Global Prediction

**Program:** <u>http://www.onr.navy.mil/en/Science-Technology/Departments/Code-32/All-Programs/Atmosphere-Research-322/Arctic-Global-Prediction.aspx</u>

#### Victoria University of Wellington: http://www.victoria.ac.nz/

Climate Portal: <u>www.climate.gov</u>

Media Contacts:

John.Ewald@noaa.gov, 202-482-3978 (NOAA/Comms)

Katy.Vincent@noaa.gov, 828-257-3136 (NOAA/NCDC)

