State of the Climate in 2011

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Annual *State of the Climate* Report

- 22\textsuperscript{nd} annual *State of the Climate* report
- Surveys the changing state and the behavior of the physical climate system
- Now tracks 43 global-scale climate indicators

378 authors from 48 countries
17 editors on 3 continents
2011: Broader Monitoring of Climate System

• Report added new indicators to better understand changes in the global climate
• Same bottom line conclusion – climate continues to change
La Niña contributed to weather and climate patterns around the world in 2011.
2011: A Year of Extreme Weather and Climate

- Many extreme events occurred at regional and local levels
- La Niña contributed to some but not all of these events
  - Southern United States and northern Mexico: Historic drought
  - Above-average North Atlantic hurricane season
  - Below-average Eastern North Pacific season
  - Brazil: Devastating floods
  - Thailand: Worst floods since 1942
  - United States: Record destruction by tornadoes
  - North Korea: Longest cold snap since 1945
  - Central and southern Europe: Worst heat wave since 2003
  - Australia: Struck by most powerful tropical cyclone, Yasi, since 1918
2011: Long-term Trends Continue

Global average surface temperature was higher than the 1981 to 2010 average

Globally averaged carbon dioxide concentrations in the atmosphere surpassed 390 parts per million for the first time.

Globally averaged heat stored in the top 2,300 feet of the oceans was the highest since records began in 1993.

Four data sets show global surface temperatures continue to rise; temperature has increased at a rate of about 0.31°F per decade since 1980.
Global Temperature Departures in 2011

2011: La Niña in the eastern equatorial Pacific kept global surface temperatures cooler during the year compared with the record warmth of 2010, but still remained above the average of the past 30 years

Long-term trend: Temperatures at the Earth’s surface and lower atmosphere continue to warm, while the stratosphere continues to cool
The Water Cycle in 2011

2011 was wetter than average over land but relatively dry over the oceans.

In 2011, oceans were saltier in already drier areas and fresher in already rainy areas, indicating an increase in the global water cycle.
2011: Arctic Temperatures

• “Arctic Amplification”: Average temperature has increased by about 3.6°F since the mid-1960s, more than 2 times faster than at lower latitudes

• Barrow, Alaska had record 86 consecutive summer days with minimum temperatures at or above freezing

• Record high temperatures were recorded at 20 m below the surface at all permafrost observatories on Alaska’s North Slope

• In March 2011, the lowest ozone concentrations on record led to elevated UV radiation levels at the surface
2011: Arctic Ice

- September sea ice extent was 2\textsuperscript{nd} smallest since the satellite era began
- Old ice (4–5 years) reached record low: 81\% below average

March: when maximum ice extent occurs
September: when minimum ice extent occurs

- Greenland ice sheet: Above-average air temperatures and declining albedo (reflectivity) caused extreme melting and mass loss in 2011
2011: Arctic Vegetation

- Sea surface temperature in the Beaufort, Chukchi, East Siberian, Laptev, and Kara Seas were 2\textsuperscript{nd} warmest on record, behind only 2007.
- Since 1982, tundra greenness has increased by 15.5\% in the North American Arctic and by 8.2\% in the Eurasian Arctic.
State of the Climate in 2011

• Long-term trends show that climate indicators expected to increase in a warming world are continuing to increase and those that are expected to decrease are continuing to decrease.

• The annual global temperature was cooler than in 2010, but was still one of the 15 warmest years on record. The Arctic continues to warm faster than the rest of the globe.

• There were many extreme weather and climate events around the globe in 2011. La Niña contributed to many, but not all, of these events.
Explaining Extreme Events of 2011 from a Climate Perspective

• Determining the causes of extreme events is difficult

• A goal of this paper is to foster the growth of the science

• Cannot say a particular event was or was not caused by climate change

• Can explain how the odds of such events have changed in response to global warming
Texas Heatwave

- By wide margins the hottest and driest growing season on record
- Was associated with La Niña conditions
- Such a heatwave is now about 20 times more likely during La Niña years than in the 1960s
The odds of the cold December 2010 temperatures have halved as a result of human-induced climate change.

The warm November 2011 temperatures are now about 60 times more likely than in the 1960s.
Explaining Extreme Events of 2011 from a Climate Perspective

- Climate change has altered the odds of some of the events that have occurred
- Some have become more likely
- Some have become less likely
- Natural variability also plays an important role
- We hope that this report will help foster the growth of attribution science needed to make assessments such as this more comprehensive

Flooding in Australia

Texas creek bed in drought

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More Information

• “State of the Climate in 2011” report:

• Online Report Highlights:

• BAMS article on *Explaining Extreme Events of 2011 from a Climate Perspective*:

• Slides from today’s webinar: