Title: A link between the hiatus in global warming and North American drought

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Publication: Submission to Journal of Climate

Date: Feb 25, 2015

Key Findings:
We use a suite of GFDL climate models to explore physical reasons for the observed hiatus in global warming and any associated climatic impacts. We find:

(1) Persistently strong easterly winds in the tropical Pacific from 2002-2013 initiate a series of changes in the ocean-atmosphere system that can explain most of the observed hiatus in global warming.

(2) These strong winds also appear to create conditions that lead to prolonged drought over the southwestern U.S. over the last decade.

(3) Our model results suggest that the majority of the drought over the southwestern U.S. over the last decade is due to these enhanced winds. If these winds are due to natural variability of the climate system, then the drought is also largely due to natural variability.

Overview of research:
We use three GFDL climate models (CM2.1, CM2.5_FLOR, CM2.5_FLOR_FA) to study the mechanisms behind the hiatus in global warming over the last decade and their possible relationship to southwestern US drought. By modifying the winds in the model to reproduce the observed winds only in the tropical Pacific, we can show that these changing winds can drive both the hiatus in global warming and drought conditions over the southwestern US (see figure below). If the observed wind changes are a result of natural variability, this suggests that both the hiatus and the drought over the southwestern US are the product of natural variability of the climate system. If, however, the observed wind changes are a response to changing radiative forcings, this would have important implications for future climate in the southwestern US. We use additional experiments to show that southwestern drought over the next decade will be strongly influenced by the behavior of the winds in the tropical Pacific. Further, we use idealized experiments to show that this mechanism for producing a hiatus is self-limiting, and only persists for a decade or two in our models.

Relevance to NOAA Science:
Understanding the physical mechanisms leading to prolonged drought over the US is a key NOAA goal. This study suggests that a majority of the drought in the southwestern US over the last decade is the result of persistent anomalous wind conditions in the tropical Pacific, and is likely due to natural variability.

Relevance to society:
Potential future changes in water resources are an immense societal challenge. Improving our ability to understand observed changes is a vital contribution towards gaining confidence in our ability to
reliably project future changes. The knowledge that a majority of the observed drought is likely due to natural variability could have important implications for water resource and infrastructure planning.

![Observed and model simulated change in annual mean precipitation](image)

The figure above shows changes in precipitation, calculated as annual mean precipitation for the period 2002-2012 minus the annual mean precipitation for the period 1979-2000. The units are mm of precipitation per day.

Shown in the upper left (panel a) are the results from observations, showing relatively drier conditions (yellow to brown shading) over much of the western U.S. for the 2002-2012 period. The other three panels (b-d) show results from various GFDL models when we insert into the models the unusually strong easterly winds that were observed in the tropical Pacific over the 2002-2012 period. All three models reproduce the observed drying over the western U.S. in response to the observed stronger easterly winds in the tropical Pacific. These same simulations also reproduce the hiatus in global warming in response to these wind changes.