Extreme precipitation in the southern US Great Plains in the spring of 2015: mechanisms and prediction

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Overview

During May of 2015, the southern US Great Plains and adjacent Gulf Coast region experienced more than twice the long-term mean precipitation, making it the wettest May since 1895. We investigate the physical mechanisms associated with this event using a suite of large-ensemble regional replay AGCM simulations from the NASA-GEOS model. In these simulations, certain regions of the globe are constrained to closely follow observations while the remainder of the domain is free running, allowing for the isolation of the remote regions that were important for the event. The AGCM results (and supplemental analysis with a stationary wave model) suggest that the extreme southern US precipitation was linked in part to positive precipitation anomalies in the eastern tropical Pacific via a wave train, which ultimately caused anomalous moisture flux from the Gulf of Mexico. An analysis of Subseasonal Experiment (SubX) model output was conducted to explore the subseasonal prediction skill of the event. Several models, including NASA’s GEOS-S2S model, are able to predict the presence of positive precipitation anomalies in or near the southern US at lead times exceeding 10 days, albeit with errors in the locations and magnitude of the heaviest precipitation anomalies. The prediction skill stems from the ability to reasonably predict the positive tropical Pacific precipitation anomalies and the initiation of the Rossby wave train that is believed to be linked to the event.

1. AGCM analysis

Results:

May 2015 precipitation (shaded, mm/day) and 200mb eddy stream function (contoured every 210 m/s) anomaly

Results:

May 2015 precipitation anomaly (mm/day)

The tropical Pacific is important for inducing a wave train to the US and subsequent precipitation anomalies near the Gulf Coast. Secondary influence from the extratropical North Pacific.

2. Stationary wave model analysis

Results:

May 2015 stationary wave model analysis

Based on a stationary wave model, diabatic heating anomalies in the eastern tropical Pacific provide an important source of forcing for a wave train stretching from the subtropical eastern Pacific to the southern US. Additional evidence that tropical Pacific diabatic heating in May 2015 was important for cyclonic flow in the Gulf of Mexico.

Subseasonal prediction skill in the GEOS-S2S-2 model, May 11-25, 2015

Hypothesis:

Eastern tropical Pacific precipitation anomalies induced a wave train that traveled to the US

Which caused enhanced water vapor transport from the Gulf of Mexico

Moving forward

- Clarify the role of the extratropical upstream forcing (e., over the Pacific) in shaping the circulation pattern over the US. What role did internal variability play?
- Look more closely at subseasonal forecasts. What can we learn from intra-ensemble forecast spread? What causes different anomaly patterns across models/members?
- Examine the event in a broader context. How common are wave trains like that in May 2015? Are such events forecasts of opportunity? How can forecasts be improved?

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https://www.ncei.noaa.gov/access/monitoring/climate-at-a-glance/regional/time-series

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