



## Impacts of climate variability over Asia on North American drought development during boreal spring and summer

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International Workshop of First Phase of GEWEX/GASS ILSTSS2S Initiative and TPEMIP December 8-9, 2018

# Motivation

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- This study:
  - explores potential sources of North American drought predictability during warm season
    - Performs case studies to investigate drought causes
  - investigates the impact of model biases

## A Case Study: 2012 US Great Plains Drought



- Developed rapidly, established in 1-2 months
- Was not foreseen in operational seasonal forecasts
- Among the costliest natural disasters in U.S. history

Hoerling et al. (NOAA MAPP, 2013)

#### 2012 US Great Plains Drought: Meteorological Anomalies



## GEOS-5 AGCM regional replay

- Replay technique
  - nudges model atmosphere to be close to that of a reanalysis
- <u>Control</u> ensemble: 31 members (1980-2010)
- Anomaly ensemble: 30 members (2012, add small perturbations)
- Initialized from 30Apr (MERRA-2) and integrated through 31Aug of same year



## GEOS-5 AGCM regional replay

- Replay technique
  - takes advantage of incremental analysis update (IAU) procedure employed in the GEOS data assimilation system to force a model to track a pre-existing analysis
  - can be used to identify and quantify regional errors and their global impacts in climate models



#### Siegfried Schubert, Monday PM (A13O-2690)





- The observed anomalies are in general well captured by the regional replay.
- The simulated anomalies are somewhat weaker and displaced northward.



#### Anomalies: Jun23-Jul10 2012

Model	# Members	Forecast Length	Initialization
CESM-46LCESM1	10	45 days	Every Wednesday 1999-2015
ECCC-GEM	4	32 days	Every 7 days 1995-2014
EMC-GEFS	11	35 days	Every Wednesday 1999-2016
ESRL-FIMr1p1	4	32 days	Every Wednesday 1999-2017
GMAO-GEOS-v2.1	4	45 days	Every 5 days 1999-2016
NCEP-CFSv2	1	44 days	Every 6 hours 1999-2017
NRL-NESM	1	45 days	4 consecutive days each week 1999-2016
RSMAS-CCSM4	3	45 days	Every 7 days 1999-2016

The SubX models have an overall limited skill in predicting the cross-north Pacific wave train and the subsequent 2012 drought development in the U.S. Great Plains.

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## Prediction in Subseasonal Experiment (SubX) Hindcasts

#### Example: GMAO-GEOS-v2.1 (IC: Jun 10, 2012)



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The anomalies over the U.S. Great Plains can be predicted ~3 weeks in advance if a forecasting model captures the cross-north Pacific wave train.

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### **Predictability of the Wave Train and Its Drivers**

#### RCEOF1 of 20-90 day filtered V250mb MERRA-2; 10N-80N; MJJA 1980-2007 Composites of h250mb (contour) and

-1.8 -1.8 -1.4 -1.2 -1 -0.8 -0.4 -0.4 -0.2 0.2 0.4 0.8 0.8 1 1.2 1.4 1.8 1.8





- The leading mode of intraseasonal atmospheric circulation variability during MJJA connects East Asia and North America.
- The drivers of the mode and their predictability are currently under investigation.

### Model Bias (NASA GEOS-5 AGCM, JJAclim)



Correcting model biases (relative to MERRA-2) over Tibet and nearby regions considerably improves the model simulation over north Pacific and North America.

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# Conclusions

- The development of a number of warm season droughts over North America were induced by processes over Asia via cross-North Pacific Rossby waves.
- The main sources of model bias in the NH middle latitudes appear to be over Tibet and nearby regions.
- These results highlight the importance of better understanding and correctly modeling processes over Tibet and nearby regions in order to improve the simulation and prediction of their local and remote impacts, including the warm season drought development over North America.