1. Introduction

The subseasonal prediction of warm season drought in North America remains a great challenge. The prediction skill of North American warm season drought during warm season, drought development in particular, in current NOAA operational drought forecast system is rather limited. This study attempts to explore processes that contribute to the warm season drought development by focusing on the role of leading modes of subseasonal atmospheric circulation variability. These leading modes are often present in the form of stationary Rossby waves, and have been crucial in the development of many recent short-term warm season climate extremes over North America. Our recent studies have shown that these waves form of stationary Rossby waves, and have been crucial in the development of many recent short-term warm season climate extremes over North America. The leading modes contribute to a number of climate extremes over North America (e.g., 1988, 1998 North American drought).

2. NASA MERRA-2, GEOS-5 AGCM and Experiments

NASA MERRA-2; NASA GEOS-5 AGCM (tag: Ganymede4.0/MERRA-2)

Bias Tendency Correction Approach

Compute 6-hourly climatological analysis tendency terms (relative to MERRA-2) and apply them to model basic state variables within a free-running AGCM.

Standard and Bias Corrected Daily AGCM Hindcasts

- **Standard**: Daily hindcasts from (May 1 - Jun 30) to August 31 for years 1988, 1998, 2000-2015, initialized at 21z of same date from MERRA-2.
- **Bias Corrected**: Same as standard hindcasts except that the model bias is corrected by applying 6-hourly climatological corrections to model basic state variables within the free-running AGCM.

Regional Replay Experiments

- Constrain model basic state variables to be close to those of a reanalysis over select regions.
- Performed two experiments:
  - Tibetan (70°E-110°E; 17°N-50°N), Tropical Atlantic (120°W-0°; 0°-25°N).
  - Each experiment consists of 31 ensemble members respectively for the summers of 1980-2010, initialized from Apr 30 using MERRA-2, and integrated through Sep 2 of the same year.

3. Results

A. Leading Modes of Subseasonal Atmospheric Circulation Variability during JJA

**REOFs**

**REOF analysis of MERRA-2 subseasonal V250mb**

**RPCs**

**Subseasonal anomalies associated with the leading REOFs**

- The leading modes of subseasonal atmospheric circulation variability are guided by mean jet streams.
- These leading modes contribute to a number of climate extremes over North America (e.g., 1988, 1998 North American drought).

B. GEOS-5 Model Bias

- Notable summertime biases in GEOS-5 AGCM (left panels), which are common across many other models (middle panels), include distinct wet biases over the west and central Pacific and west tropical Atlantic, warm biases over much of the NH extratropical land, and a dry bias over the central US. These biases adversely impact the proper representation of stationary Rossby waves and their effects in these models.
- Much of the bias in the GEOS-5 AGCM (relative to MERRA-2) can be removed by using a bias tendency correction approach (right panels).

C. Model Prediction Skill Assessment and Impact of Model Bias

- The rapid drought development from mid-June to mid-July 2012 was associated with considerable eastward propagating wave activities across the north Pacific.
- Correcting the model bias can potentially improve the prediction skill by ~9 days.

4. Summary and Conclusions

- The GEOS-5 AGCM biases in north Pacific jet and tropical convection during warm season, which are common across many other models, limit the model’s capability in properly representing stationary Rossby waves and their effects over North America.
- An objective bias tendency correction approach has been developed to correct much of model bias (relative to MERRA-2) in the GEOS-5 AGCM.
- The bias correction improves GEOS-5 AGCM prediction skill of stationary Rossby waves and surface temperature anomalies over North America, but the skill improvement for precipitation is only marginal.
- The overall modest skill improvement involves the competing influences of the loss of predictability and the time it takes for climate drift to start having a significant impact on forecast skill.
- Future Work:
  - Investigate select climate extreme events, and explore sources of predictability that can lead to enhanced prediction skill; diagnose origin of model biases for model development.