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Winter 2015/16 Atmospheric and Terrestrial Anomalies over North America: El Niño Response and Role of Noise

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ABSTRACT

In this study, attribution of the possible reasons for the observed 2015/16 winter precipitation anomalies that were opposite to the mean El Niño signal over the southwest North America were analyzed. The analysis focuses on the role of SST forcing and the contributions of atmospheric internal variability based on the ensemble forecasts of hindcasts and real-time forecasts from the NCEP Climate Forecasts System version 2 (CFSv2, Saha et al. 2014). We analyzed first the atmospheric response to forecast SSTs based on ensemble mean, specifically, to examine how well the 2015/16 winter NA atmospheric anomalies were predicted as an ensemble mean atmospheric response and if the pattern of 2015/16 winter anomalies in the forecast ensemble mean has been changed from that of the El Niño composite. Then we assessed the contribution of atmospheric noise based on individual forecast members, specifically, to examine how much the individual forecasts are differed from the ensemble means and if the observed 2015/16 winter atmospheric anomalies were within the envelope of variability in the ensemble forecast.

The results show that the pattern of 2015/16 winter North America atmospheric anomalies as an ensemble mean atmospheric response to SSTs compared favorably with the El Niño composite from the historical period and were much the same as the previous El Niño events of 1982/83 and 1997/98 with similar amplitude of ENSO SSTs. The major features include the 200mb height with sub-tropical Pacific jet toward the southwest NA, and the precipitation with positive anomalies over the southwest NA and negative across

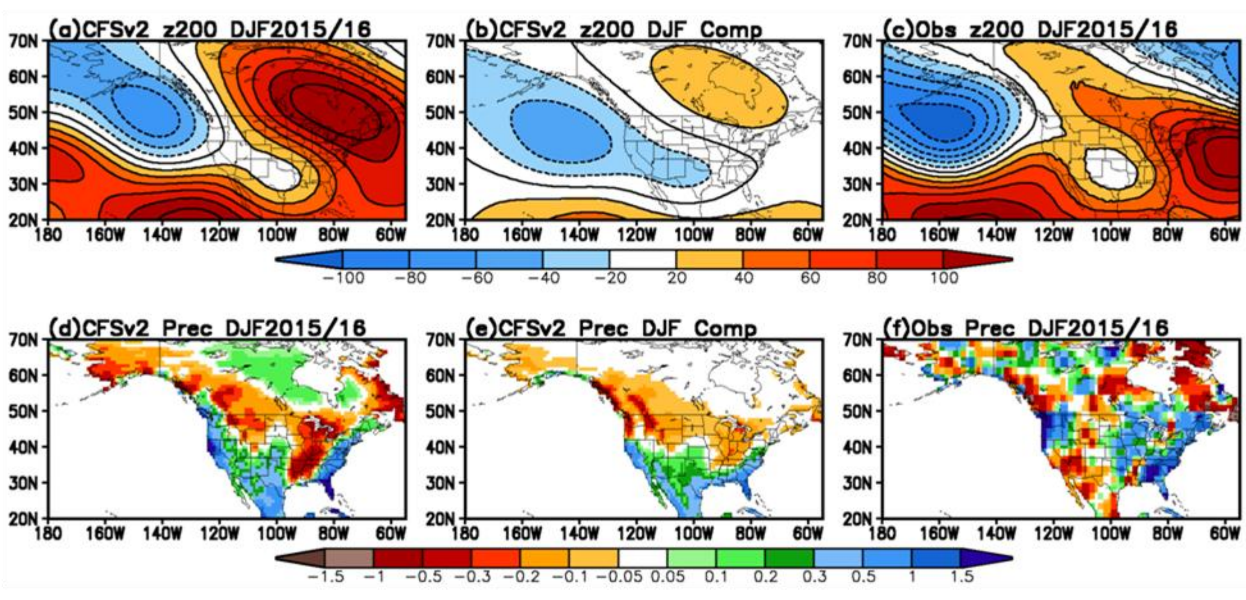

Fig. 1 The z200mb height (a, b, c) and precipitation (d, e, f) anomalies for the CFSv2 forecast ensemble mean of DJF2015/16 (a, d), the El Niño composite based on CFSv2 ensemble forecasts of DJF in1982-2014 (b, e), and the observations in DJF2015/16 (c, f). The unit is in m and mm/day for the 200mb height and precipitation, respectively. The observed precipitation is from (Janowiak and Xie 1999), and 200mb height from the CFSR (Saha *et al.* 2010).

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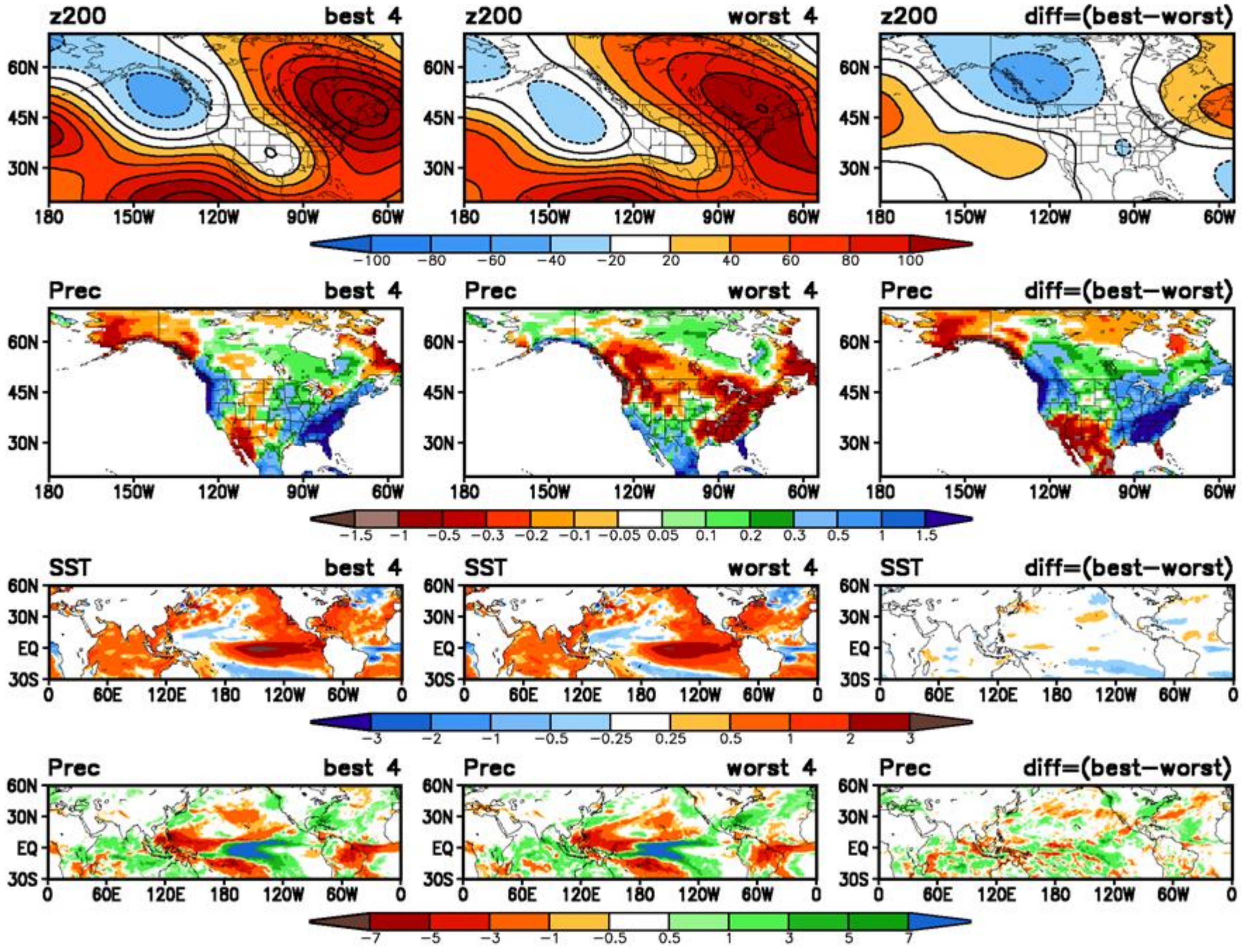

Fig. 2 Average of four best forecast members (the left panels), and four worst forecast members (the middle), and their differences (the right panels) for DJF2015/16 forecasts from CFSv2. The top row is for 200mb height (m) over the PNA; the 2nd row precipitation (mm/day) over North America, the 3rd row SST (K), and the 4th row precipitation (mm/day) over global region from 30°S to 60°N.

the northern NA (Fig. 1). Therefore, the tele-connection pattern and precipitation response pattern in winter 2015/16 had not changed from the mean El Niño signal. The observed negative precipitation anomalies over the southwest NA in DJF2015/16 were not the result of SST forced signal.

However, there are considerable variations in the outcome of 2015/16 winter precipitation over the North America from one forecast to another even though the SSTs are the same. Among the 40 forecasts in the analysis, the average of four members with highest correlation skill with the observation is very different from that of four members with lowest correlation skill with the observation, with their signs of forecasts anomalies opposite of each other (Fig. 2). The observed 2015/16 winter precipitation anomalies were well within the envelope of possible outcomes.

In conclusion, the reason why the observed 2015/16 winter precipitation anomalies over the southwest North America differed greatly from the El Niño composite was mainly due to the large contribution of the atmospheric internal variability (noise) which overwrote the atmospheric response (signal) to the ENSO SSTs. This unpredictable inherently nature of atmospheric variability leads to low predictability and prediction skill for the North America seasonal precipitation.

References

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