Science and Technology Infusion Climate Bulletin
NOAA's National Weather Service
38th NOAA Annual Climate Diagnostics and Prediction Workshop
College Park, MD, 21-24 October 2013

Climate Mean, Variability and Dominant Patterns of the Northern Hemisphere Wintertime Mean Atmospheric Circulation in the NCEP CFSv2

Peitao Peng and Arun Kumar
Climate prediction Center, NECP/NOAA, College Park, Maryland
Bhaskar Jha
INNOVIM, LLC, Greenbelt, Maryland

ABSTRACT

In this study, the climate mean, variability, and dominant patterns of the Northern Hemisphere (NH) wintertime mean 200 hPa geopotential height (Z200) in a CMIP and a set of AMIP simulations from the NCEP CFSv2 are analyzed and compared with the NCEP/NCAR reanalysis. For the climate mean, it is found that a component of the bias in stationary waves characterized with wave trains emanating from the tropics into both the hemispheres can be attributed to the precipitation deficit over the Maritime continent. The lack of latent heating associated with the precipitation deficit may have served as the forcing of the wave trains (Fig. 1).

For the variability of the seasonal mean (Fig. 2), both the CMIP and AMIP successfully simulated the geographical locations of the major centers of action, but the simulated intensity is generally weaker than that in the reanalysis, particularly for the center over the Davis Strait-southern Greenland area. It is also noted that the simulated action center over Aleutian Islands was southeastward shifted to some extent. The shift was likely caused by the eastward extension of the Pacific jet. Differences also existed between the CMIP and the AMIP simulations, with the center of actions over the Aleutian Islands stronger in the AMIP and the center over the Davis Strait-southern Greenland area stronger in the CMIP simulation.

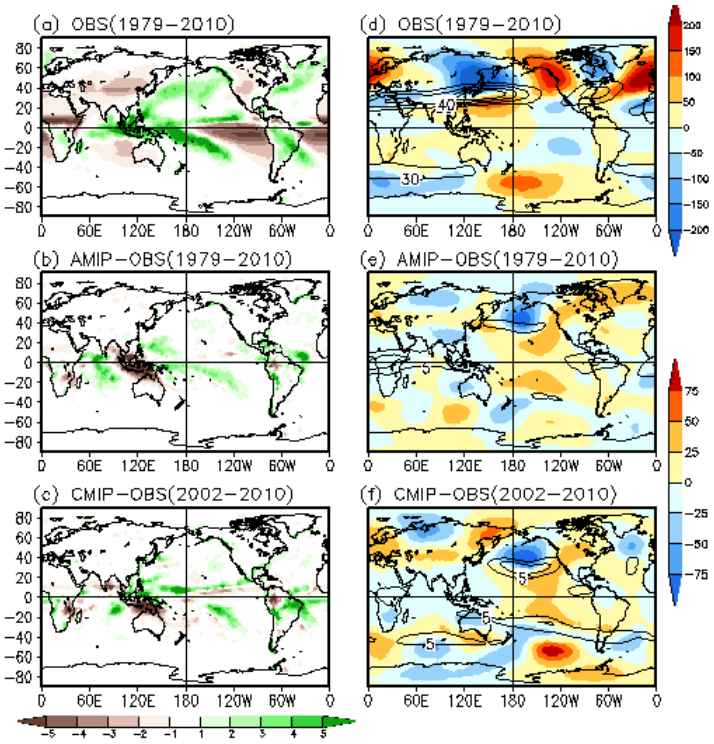

Fig. 1 Climate mean of the zonally asymmetric DJF precipitation rate (mm/day) (left column) and eddy 200 hPa height (m) (right column): The upper row is for the climate of observation over 1979-2010, the middle row is for the bias of AMIP runs from the observation over the same period, and the bottom row is for the bias of CMIP run over 2002-2010. The contours with the height fields are the climate mean of 200 hPa zonal wind (U200) in observation (panel d) and model bias for AMIP and CMIP runs (panel e and f). With m/s unit, the contour levels for U200 climate are 30, 40, 50 and 60, for U200 bias are 5, 10, and 15.

Correspondence to: Peitao Peng, Climate prediction Center, NECP/NOAA, College Park, Maryland;
E-mail: peitao.peng@noaa.gov.

In the mode analysis, the El Nino-Southern Oscillation (ENSO) teleconnection pattern (Fig. 3) in each dataset was first removed from the data, and a rotated EOF (REOF) analysis was then applied to the residual. The purpose of this separation was to avoid possible mixing between the ENSO mode and those generated by the atmospheric internal dynamics. It was found that the simulated ENSO teleconnection patterns from both model runs well resembled that from the reanalysis, except for a small eastward shift. Based on the REOF modes of the residual data, six dominant modes (Figs. 4-6) of the reanalysis data had counterparts in each model simulation, though with different rankings in explained variance and some distortions in spatial structure. By evaluating the temporal coherency of the REOF modes between the reanalysis and the AMIP, it was found that the time series associated with the equatorially displaced North Atlantic Oscillation (ED_NAO) in the two datasets were significantly correlated, suggesting a potential predictability for this mode.

This paper has been submitted to the Climate Dynamics and in revision.

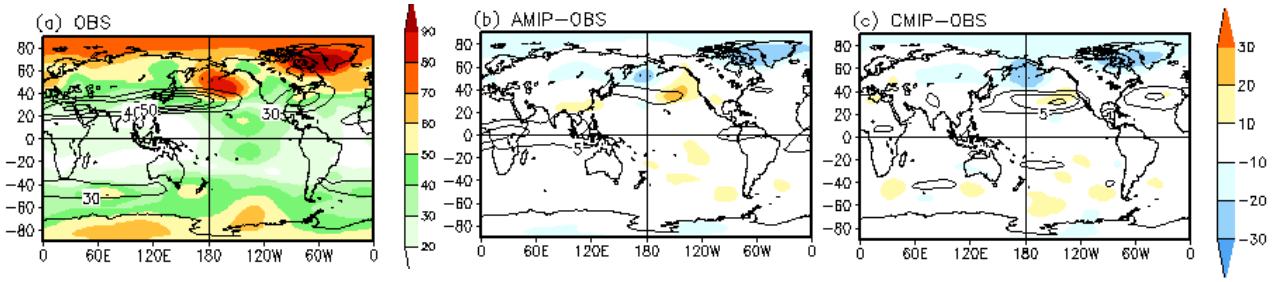

Fig. 2 Standard deviation of DJF mean Z200 (m): (a) total quantity of the observation; (b) AMIP run minus observation; (c) CMIP simulation minus observation. The contours, with the same levels and unit as that in Fig. 1, are for the corresponding climate mean U200. The results are based on the data from the whole period of each dataset.

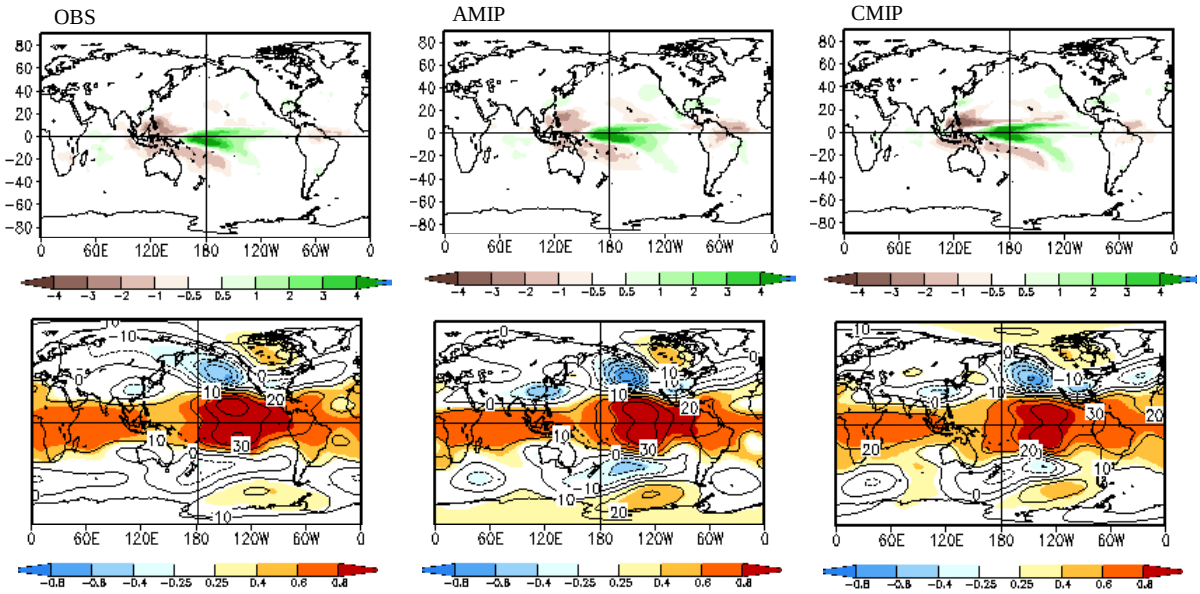

Fig. 3 Regression patterns of DJF mean precipitation rate (mm/day) (upper row) and 200 hPa height (m) (lower row) to the Nino3.4 SST index for observation (left column), AMIP data (middle column), and CMIP data (right column). For the height patterns, the contours are for regression and shading for correlation, with contour interval of 10m, and shaded areas passing the 95% significant level. The data periods are the same as that in Fig. 2.

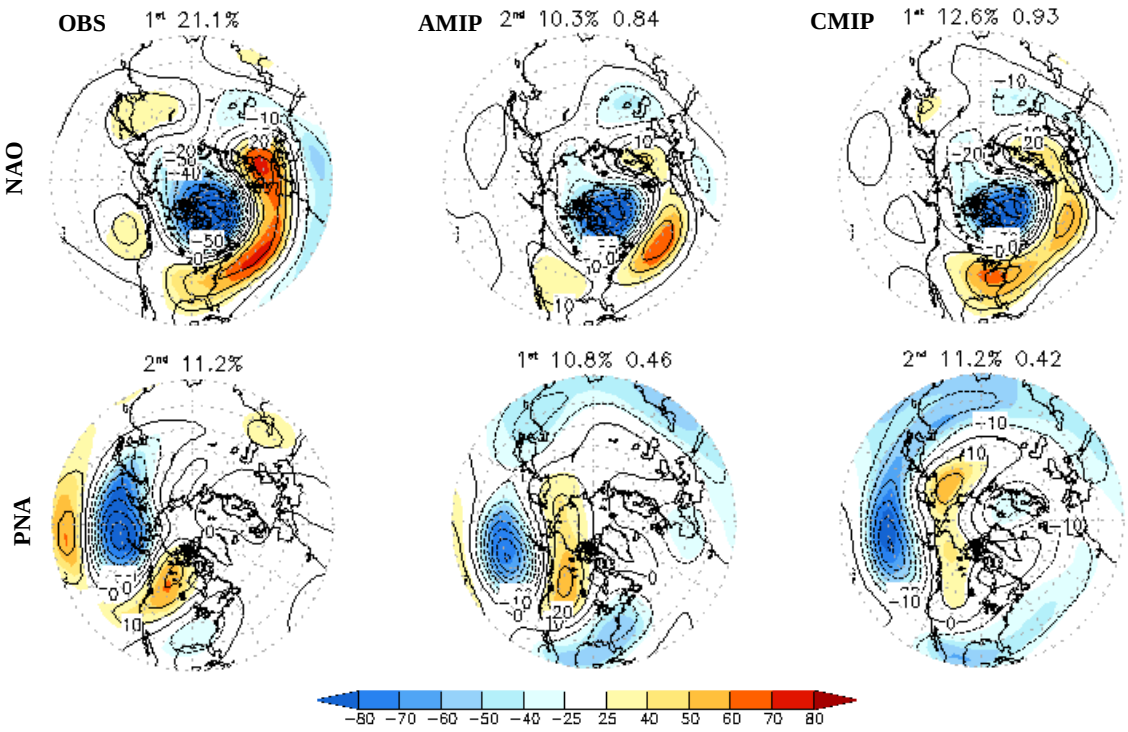

Fig. 4 NAO (upper row) and PNA (lower row) patterns of DJF Z200 for the observation (left column), AMIP runs (middle column) and CMIP run (right column). The patterns are obtained by regressing/correlating Z200 total fields to the rotated principal components (RPCs) of the Z200 residuals (with ENSO related variability removed) over the NH domain (20ºN-90ºN). The contours with interval of 10 m are for regression, and shading (%) for correlation. On the top of each penal, the numbers give the ranking, explained variance (%), and the spatial correlation between the pattern from model and that from observation, respectively.

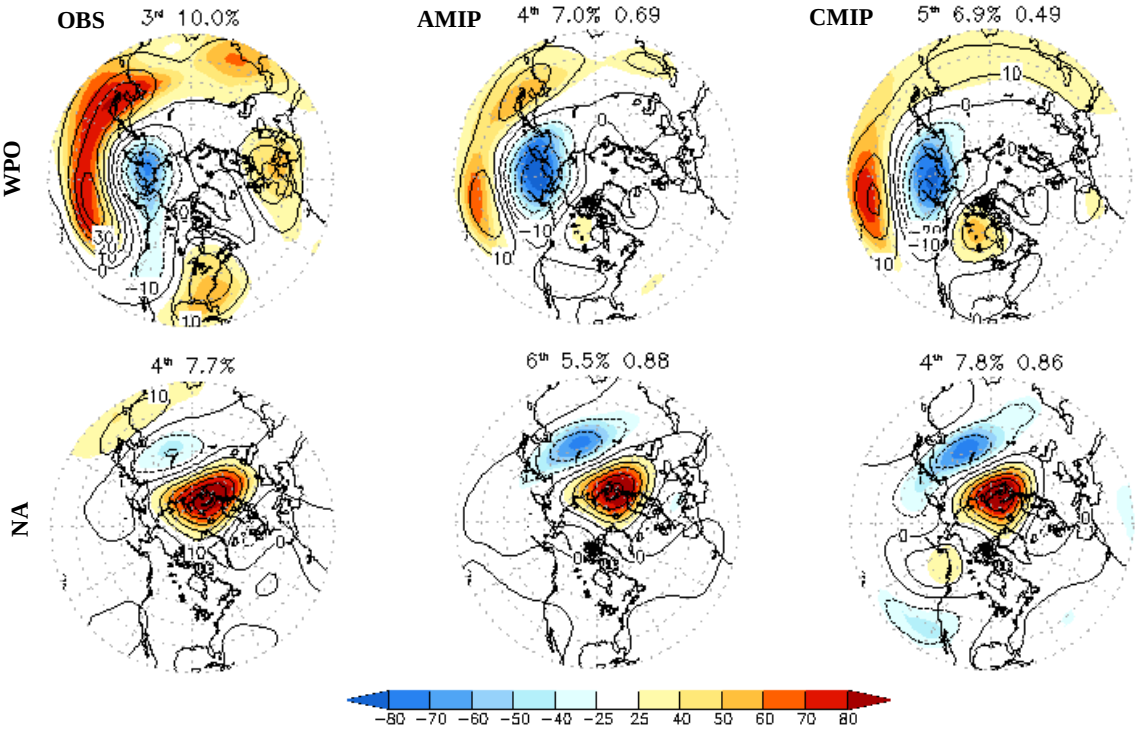

Fig.5 As in Fig.8, but for WPO and NA patterns.

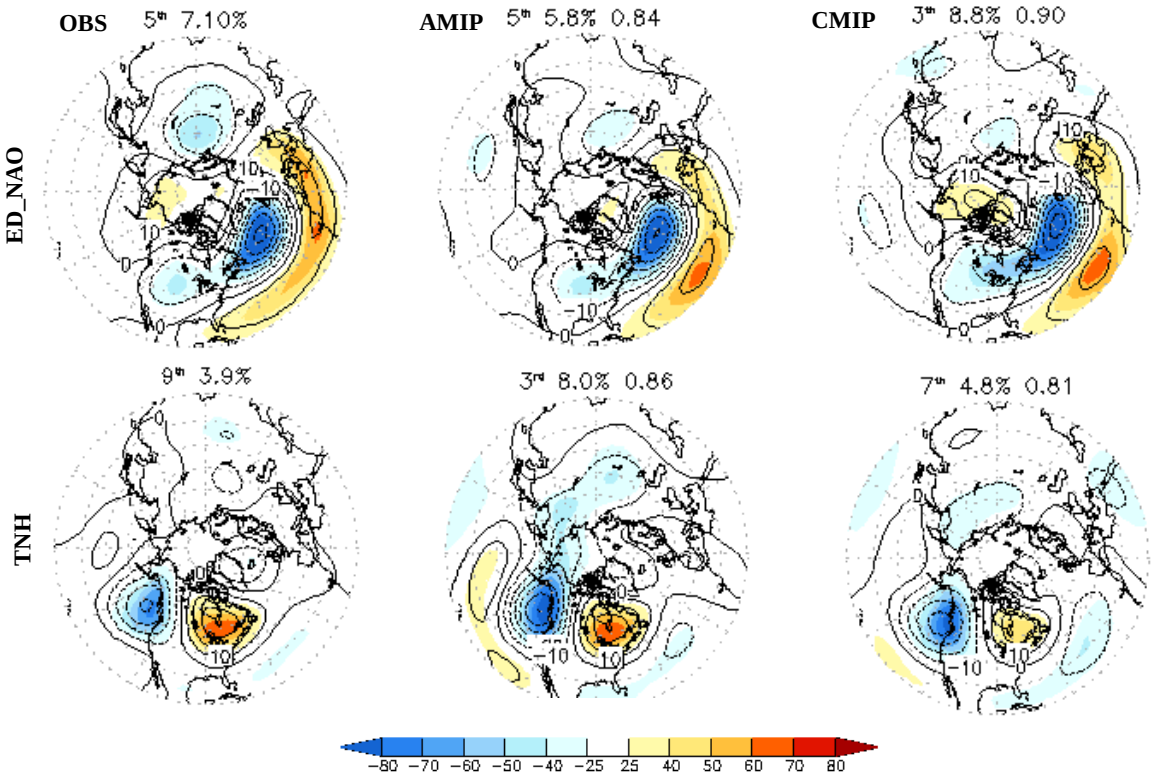

Fig.6 As in Fig.8, but for ED_NAO and TNH patterns.