Session: C36 Poster: Th58B

Analyzing the Pacific-North American teleconnection pattern and its relationship to climate using RegCM3, a high-resolution regional climate model

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The Pacific-North American (PNA) teleconnection pattern has long been recognized as a robust feature of Northern Hemisphere atmospheric circulation, and more specifically represents the structure of the quasi-stationary wave field over the North Pacific and North America. The general circulation model (GCM), MPI/ECHAM5, and the high-resolution regional climate model, RegCM3, have been used to assess and analyze the influence of the Pacific-North American Index (PNA) on past, present, and future climate and surface hydrology in North America. The model output used for analysis covers 240 years at both T63 grid scale and 50-km resolution following both present climate (20C) and the IPCC A2 climate scenario. The present study will examine the spatial and temporal changes in the PNA pattern and index over the length of the model runs. The PNA index and spatial pattern will be based on the linear pointwise method from Wallace and Gutzler (1981) and a rotated principle component analysis (RPCA) (Barnston and Livezey, 1987). Strong correlations exist between the PNA monthly index and both surface temperature and precipitation in North America (Leathers et al., 1991). Studies have found a shift of the PNA index toward more positive values in recent years, which has resulted in warmer temperatures in the Western half of the United States. These higher temperatures have contributed to more of the precipitation falling as rain rather than snow, as well as increased snow melt and an earlier spring onset (Wallace and Gutzler, 1981; Abatzoglou, 2010; Fauria and Johnson, 2008). In addition, changes in the PNA spatial pattern greatly influence climate in many Midwestern states since the location of the troughs and ridges associated with the 500-mb planetary wave are not consistent. For those regions in the path of variability, specifically many Midwestern states, it could mean the difference between an anomalously warm versus an anomalously cold winter season. Composite maps of both the 500-mb geopotential heights and height anomalies for "extreme" high and low PNA indices will show the height fields for "textbook" positive and negative PNA patterns. Observations show that the PNA index is highly correlated to both surface temperature and precipitation in North America. In order to exhibit these correlations within the models, maps showing the correlations between the PNA indexes calculated from ECHAM5 and climate variables from RegCM3 output will be produced and compared to those from the NCEP/NCAR Reanalysis. These analyses will be performed for "control" and "future" runs, using the 20C and A2 datasets. Changes in the future will be based off of the 1950-2010 climatological base period, as defined by NCEP/CPC. The temporal relationship between the PNA index and various hydrological variables, such as soil moisture and snow pack, will also be investigated. The results from this study will explore the PNA as an important, robust feature in observed atmospheric circulation, which has strong influences over the climate of North America.