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Coupled GCM SST biases and their effect on regional downscaling efforts

John Mejia[†];
[†] Desert Research Institute, USA
Leading author: john.mejia@dri.edu

This study addresses the impact of Coupled Atmosphere-Ocean General Circulation Models (AOGCMs) near-surface ocean biases on the accuracy of Regional Climate Modeling (RCM) applications. We have analyzed 15 AOGCM model outputs from the World Climate Research Programme's (WCRP's) Coupled Model Intercomparison Project phase 3 (CMIP3). Most of the AOGCMs outputs show subtropical warm SST biases over the eastern oceanic boundaries. In particular, offshore California and Baja California Peninsula the modeled coastal SSTs are higher than observations by ~ 3-5 C with seasonal fluctuations and the warmest biases occurring between May and November. We first show that such systematic SST biases are associated with temperature and precipitation biases over the Great Basin in the western U.S. Additionally, we show that that AOGCM SST biases have a significant impact on simulated regional dynamically downscaled climate parameters. An attempt is made to isolate the atmospheric response to regional SST biases using a regional climate model (RCM) based on WRFV3.1.1 at 36 and 12 km grid size. The RCM was integrated for a period of 1998-2007 using CCSM3 forcing with and without corrections of CCSM3 simulated SSTs. The SST biases are corrected using a quantile-based mapping approach based using the NOAA optimum interpolation (OI) SST. Even though inconsistencies in the evolution of atmospheric processes may have appeared due to the corrected SSTs, this approach allowed us to easily evaluate whether a priori corrections of the SST would significantly affect, locally and remotely, RCM outputs. We characterize the overall impact of such downscaling experiment using mean and extreme event parameters and offer some physical mechanisms to explain the simulated differences. We examine the resultant differences in precipitable water and liquid water path fields as well as the three-dimensional mass and wind fields. Our results show that SST biases impact climate regionally and propagate over western U.S. Our analysis show suggestive physical connections that relate SST biases with storm tracks changes. Issues concerning ensemble climate projections based on dynamical downscaling techniques forced with systematically biased OAGCMs are discussed.