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Can regional climate models reproduce observed local extreme temperature and precipitation statistics over the U.S. Pacific Northwest?

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The estimation of changes in local extreme events is crucial to assess the impacts of projected climate change. Global models are powerful tools to study climate change on large scales but their coarse horizontal resolution ($\sim$150-300 km) keeps them from representing local terrain and mesoscale weather systems well. Yet, the interactions of large-scale weather systems with local terrain and mesoscale processes can be important for causing localized extreme weather events. This is especially true for the U.S. Pacific Northwest that includes mountainous ranges and land-sea interface. Recently, Zhang et al. (2009) noted improvement of the regional climate models performance over the large-scale driving data in simulating the observed climatology of precipitation and temperature over the U.S. Pacific Northwest. Here, we build on the analysis of Zhang et al. (2009) and assess the regional models performance over the U.S. Pacific Northwest in terms of extreme weather events. Note that this study is a necessary step towards confident interpretation of the projections of future changes in extreme weather events at the local scale.

In the present work, model simulations are carried out over the U.S. Pacific Northwest for the period 2003-2007 using three regional climate models, the Weather Research and Forecasting (WRF) at 12 and 36-km grid spacing and the Hadley Centre Regional Model (HadRM) at 25-km grid spacing. All three models were forced with the Reanalysis 2 data from the National Centers for Environmental Prediction and National Center for Atmospheric Research (NCEP/NCAR; R2 hereafter). R2 data and model simulations are compared with observed indices of extreme temperature and precipitation over the U.S. Pacific Northwest during 2003-2007 to evaluate whether the regional climate models, when forced by reanalysis, can reproduce local daily temperature and precipitation statistics observed at a station. This approach is motivated by the fact that, for climate impacts applications, the station-level observations provide the closest representation of extreme events of interest.

This study shows that the regional models represent most indices of extreme temperature well. For extreme precipitation, finer grid spacing considerably improves the match to observations. The reanalysis data represent the timing of rain-bearing storms over the U.S. Pacific Northwest well; however, the reanalysis have the worst performance at simulating both extreme precipitation indices and extreme temperature indices when compared to the WRF and HadRM simulations. These results suggest that the reanalysis data, and by extension global climate model simulations, are not sufficient for examining local extreme precipitations and temperatures due to their coarse resolutions. Nevertheless, the large-scale forcing is adequately represented by the reanalysis so that regional models may simulate the terrain interactions and mesoscale processes that generate the observed local extremes and frequencies of extreme temperature and precipitation.

Zhang, Y., V. Dulière, P. Mote and E.P. Salathé Jr., 2009: Evaluation of WRF and HadRM Mesoscale Climate Simulations over the United States Pacific Northwest. J. Climate, 22, 5511-5526.