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Validation of regional Global Climate Model (GCM) water vapor bias and trends using Precipitable Water Vapor (PWV) observations from a network of Global Positioning Satellite (GPS) receivers in the U.S. Great Plains and Midwest

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The IPCC Fourth Assessment concluded that increases in global Precipitable Water Vapor (PWV) are expected with rising global surface temperatures. The Global Climate Models (GCMs) used in this assessment provide a way to predict the increase in the atmosphere's total water vapor content and the resulting water vapor feedback, however a validation of the GCM's accuracy at forecasting PWV is needed. We use observations over land in order to verify predictions of climate model water vapor trends on continental regional scales. We show the utility of using PWV observations from the NOAA Wind Profiler Demonstration Network (WPDN) and NCAR SuomiNet networks of ground-based GPS receivers for the regional validation of global climate models. Study regions in the U.S. Great Plains and Midwest highlight the differences among GCM output from the AR4 SRES A2 scenario in their seasonal representation of column water vapor and in the vertical distribution of moisture. In particular, the CSCM3 model is shown to exhibit a dry bias of more than 30% in the summer-time water vapor column while the GISS model agrees well with GPS PWV observations. All models show good agreement in the winter season for the study regions. Comparison of GCM output to the NARR suggests that northward moisture flux from the Gulf of Mexico represents the largest variation from model to model, which may explain the model differences in the U.S. Great Plains and Midwest. A detailed validation of vertical profiles of temperature, relative humidity, and specific humidity confirm that of the GCMs evaluated only the GISS model was able to accurately represent the summer time specific humidity profile in the atmospheric boundary layer and thus the correct total column water vapor. The importance of performing a station elevation correction in the estimation of regional trends from GPS networks was demonstrated in order to avoid introducing artificial trends in the observations. Regional trends using station elevation corrected GPS PWV data from two complimentary networks are found to be consistent with null trends predicted in the AR4 GCM model output for the time period 2000-2009.