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Using AIRS and AMSR-E to Assess the Precipitable Water Vapor in Global Climate Models (GCMs) with Regional Validation from SuomiNET and NWP Re-analysis

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The water content of the atmosphere is a key climate response to increasing temperatures in global climate model (GCM) simulations. However, recent work has identified large differences among models on seasonal and regional scales. For example, in the CMIP3 AR4 A2 scenario, the NASA GISS model consistently shows nearly three times the water vapor content of the NCAR Community Climate model (CCSM3) during the summer season over North America. To better understand the water vapor feedback in models, observations are needed that provide good spatial and temporal resolution over both ocean and land areas. The AMSR-E sensor on the NASA Aqua platform has produced a long record of PWV over ice-free ocean areas while the Atmospheric Infrared Sounder (AIRS) on the NASA Aqua satellite was the first of a new generation of satellite sensors that provided the capability to retrieve water vapor profiles at high vertical resolution and good absolute accuracy over both ocean and land areas using the same algorithm. The operational follow-on to the AIRS is the Cross-track Infrared Sounder (CrIS) successfully launched on the NPP satellite on 28 October 2011. The CrIS, along with ATMS, will provide the U.S. component of the joint U.S./European operational weather satellite system. The Infrared Atmospheric Sounding Interferometer (IASI) was launched on METOP-A in October 2006 and is currently operated by EUMETSAT. A long record of observations from copies of these sensors is anticipated from this new network of advanced IR sounders. Among other atmospheric observables, the NASA AIRS science team has produced a global dataset of PWV beginning in September 2002 that is approaching ten years in length. In addition, the AIRS radiance data has been used to create a proxy-dataset (nadir only) for the NASA Decadal Survey mission named CLARREO. Atmospheric profiles have been obtained from this CLARREO-proxy data using a new retrieval algorithm that is designed to preserve the trace-ability of the sensor radiances to international standards (SI). This paper investigates the accuracy of satellite retrieved PWV climatology's for use in comparison to climate models. Validation data used is from the ground based GPS network (SuomiNet) and the conventional meteorological network as represented in NWP reanalysis products. The purpose of this study is to first compare the retrievals of PWV from NASA's global gridded satellite products to our independent UW satellite retrievals, as well as compare all the retrievals to ground-based GPS measurements and NWP reanalysis. After assessing the accuracy of the satellite retrievals using ground-truth, over land the NASA's AIRS PWV product as well as our independent retrievals and GPS observations will be used to validate climate model predictions from the Coupled Model Inter-comparison Project (CMIP). Over ocean areas, the AMSR-E observations will replace the ground-based GPS measurements in providing independent measurements for the assessment of GCM model output. Results are presented that highlight the PWV climatology from the satellite sensor data record and quantify the differences and agreement between the satellite retrievals, GPS observations, and model outputs on monthly averages.