Methodology for the Validation of Water Vapor Profile Environmental Data Records (EDRs) From the Cross-Track Infrared Microwave Sounding Suite (CrIMSS): Experience with the DOE ARM Water Vapor Raman Lidar

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Abstract

Water vapor is a key component of the Earth’s hydrology cycle that plays an important role in the intensity of severe weather and hurricanes. Numerical weather prediction models are expected to show improved forecast skill when water vapor remote sensing observations are assimilated from operational weather satellites. Accurate water vapor vertical profiles retrieved from satellite radiances will also provide a valuable climate record for evaluation of MWR reanalysis products and for validating climate models.

NASA and NOAA are operating the NPP satellite with CRIS and ATMS in a PM orbit while the European METOP IASI sensor occupies an AM orbit. Radiance data and products from both of these platforms will contribute to water vapor observations from NPP centers. This paper describes the methodology developed for validation of the water vapor vertical profiles from the CRIS and ATMS (CrIMSS) Environmental Data Records (EDRs). The approach uses ground truth measurements from the Department of Energy Atmospheric Radiation Measurement (ARM) site in Oklahoma and a ground-based Vaisala radiosonde network of ground-based GPS receivers.

Preliminary assessment of this methodology using NASA AIRS L2 retrievals as a proxy for the CrIMSS EDRs have been performed. Results show a dry bias in AIRS L2 version 5 for summer nighttime observations in the Southern Great Plains. This is confirmed using interpolated radiosonde profiles. The result is consistent with Bedka et al. 2020 that showed a similar dry bias in PWV from MWR data. Assessment of CrIMSS EDRs is in progress.

Observations

AirS looks toward the ground through a cross-track rotary scan mirror which provides ±45.5 degrees from nadir) ground crossways along with views to cold space and to on-board spectral and radiometric calibrations sources every scan cycle. The scan cycle repeats every 6.7 seconds. Nearly ground footprints are observed each scan. Use spectrum with all 220 spectral channels at 20.4 ms footprint. A ground footprint 20.4 m. The AIRS L2 resolution is 0.3 km. The AIRS L2 reanalysis products contain atmospheric temperature and moisture profiles from above 5 km down to the surface with a horizontal resolution of about 45 km. The AIRS L2 retrieval product provides nearly complete daily global coverage in ascending (day) and descending (night) modes.

Conclusions

• A methodology has been developed for the validation of CrIMSS water vapor profile EDR products and demonstrated on NASA AIRS L2 data.

• The ARM Raman Lidar at the SGP site has been used to validate the vertical moisture profile of AIRS v5 retrievals for the year 2008.

• A dry bias in the AIRS L2 nighttime PWV in the summer season found by Bedka et al. 2020 is confirmed by the ARM Raman Lidar which identifies the error as confined to the boundary layer.

• This dry bias is further confirmed by comparison to interpolated radiosondes launched at the ARM SGP site in Oklahoma. This method is ready for application to CrIMSS EDR products.

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