Validation of AQUA/AIRS Integrated Precipitable Water Vapor Using Ground-based GPS Receivers: Progress Report

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by
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INTRODUCTION

The AQUA/AIRS mission provides observations that contain information about the state of the Earth's surface and atmosphere. These observations are to be sufficient in quality, quantity, and timeliness of delivery to advance the state of the art of numerical weather prediction and the characterization and understanding atmospheric and climate processes. One aspect of AQUA/AIRS to meet these broad objectives is to provide more accurate and higher resolution measurements of atmospheric water vapor profiles than has been available from satellite sensors previously. This investigation is intended to provide accurate measurements correlative closely matched in time and space of the column integrated precipitable water vapor (IPWV) product from AIRS. In addition, it is being used to identify the best radiosonde data to use as the basis for AIRS water vapor profile retrievals.

PROGRESS

The AIRS validation process has been designed to establish in sequence the reliability of

Level 0 data
Level 1 data - radiances
Level 2 data – temperature retrievals
Level 2 data – trace gases (H_20, CO, CO_2, etc.)

The validation of AIRS radiances is a necessary prerequisite to the validation of derived products (Level 2), since high quality, well-characterized radiance measurements are needed as input to the Level 2 retrieval algorithms. Nine months after the launch of AQUA in May 2002, the high radiometric quality of AIRS observations has been established by other members of the validation team, and derived temperature profiles have been assigned a high degree of confidence. Several members of the AIRS science and validation teams (Goldberg, Barnet and others) have begun producing initial AIRS water vapor profiles and IPWV data during the most recent two months. Preliminary intercomparisons of those data with the NOAA GPS IPWV are now underway. Definitive GPS-to-AIRS IPWV intercomparisons await the optimization of AIRS water vapor retrieval algorithms. Care has been taken to prepare for data exchange and rapid analysis once the water vapor product stream is on for full-scale validation. These preparations are described in the following sub-sections of this report.

Data Archival and Exchange

IPWV measurements at 30-minute temporal resolution from the NOAA Forecast Systems Laboratory's network of ~ 200 fixed location GPS receivers continue to be archived on an operational basis, and are available as images or data via the World Wide Web. Moreover, sample GPS IPWV data sets have been transmitted to NASA/JPL and to individual AIRS validation team members upon request in designated formats, typically netCDF or ASCII. Finally, the fixed locations of the GPS receivers (latitude, longitude, and altitude) have been provided the AIRS science and validation team, enabling relevant members to select portions of their data sets (both AIRS and alternate validation measurements) that match the GPS data in time and space.

Analysis Tool Development

Figure 1 (below) shows intercomparisons of the NOAA GPS IPWV values against reasonably coincident ones for the sounder on NOAA Geosynchronous Operational Environmental Satellite (GOES) over the continental United States during the Summer of 2002. Since AIRS IPWV suitable for validation efforts were until recently not available for our use, the GOES data provided a suitable format on which to test and refine data handling and analysis. For example, from Figure 1 it can be seen that the GOES sounder is systematically dry compared to the GPS sensors, even if the horizontal separation of the GOES and GPS footprints is severely restricted (right panel.)

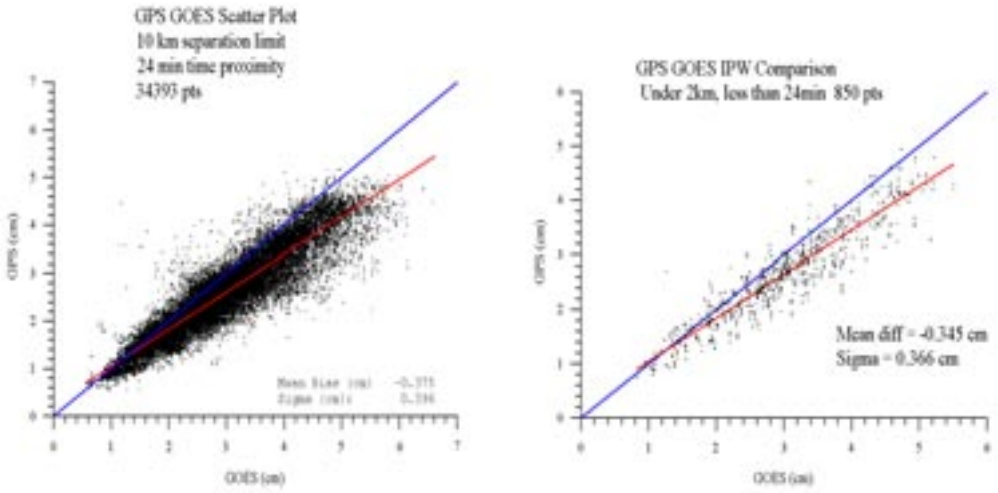

Figure 1.

A similar result is shown in the left panel of Figure 2 (below) for the GPS and GOES IPWV corresponding to the International H_2O (IHOP) Campaign from the summer of 2002. The right panel of Figure 2 shows remarkably good agreement between the GPS and radiosonde IPWV for IHOP, indicating that the dry bias in the GOES retrievals is real. Similar analysis will soon be applied to the AIRS IPWV observations.

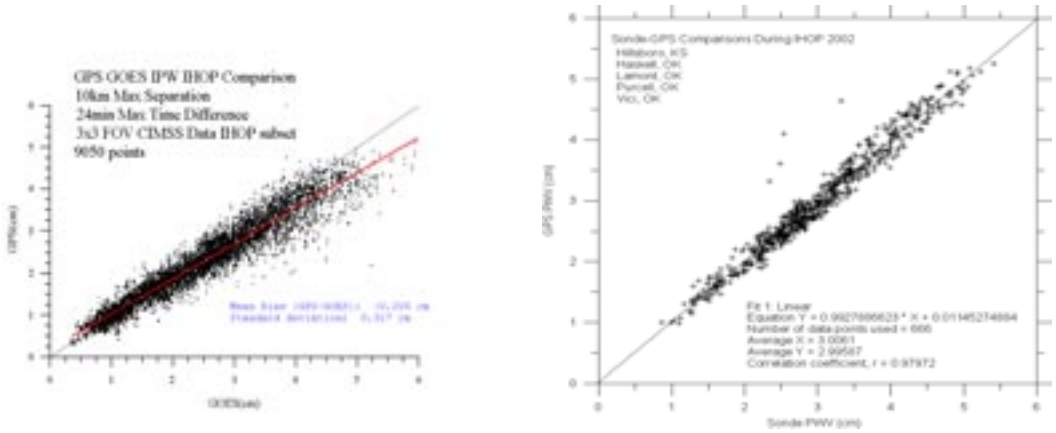

Figure 2.

Interaction with the Scientific Community

In addition to exchanging data with the other members of the AIRS validation and science team, we have actively participated in the weekly teleconferences and team meetings to keep abreast of the status of the AQUA craft, the AIRS instrument, and the production of data products. We have co-authored (Fetzer et al, 2003) a journal article describing (our portion of) the AIRS validation activities. We have described our methodology for validating the AIRS IPWV at a number of scientific meetings and workshops including:

American Geophysical Union (May 2002, Washington DC)
World Space Congress (October 2002, Houston, TX, sponsored by COSPAR)
Optical Society of America's topical meeting on Atmospheric Remote Sensing (February 2003, Quebec City.)

PLANS FOR FUTURE WORK

March 1 – May 31, 2003

In support of the plan for the general release of Level 2 AIRS data, we will complete preliminary statistical intercomparisons of GPS and AIRS IPWV for the continental United States to identify mean and root-mean-square differences in the fashion depicted in Figure 1. We will also define a set of ideal radiosonde stations on which to perform water vapor profile intercomparisons. In addition to these statistical approaches, we will perform a focused case study of the AIRS IPWV over single GPS receiver served by other validation data sources series (the Chesapeake Lighthouse site.)

June 1 – September 31, 2003

Intercomparisons will be extended to longer time series, and refined as re-processed AIRS retrievals are made available. As confidence in the AIRS IPWV data is established, we intend to use the AIRS data as a means of examining those available from a GPS Radio Occultation Sounder, the Challenging Micro-satellite Payload (CHAMP) mission. Currently, intercomparisons of CHAMP water vapor are largely restricted to model analysis (Figure 3, below) or to satellite data far inferior to that from AIRS.

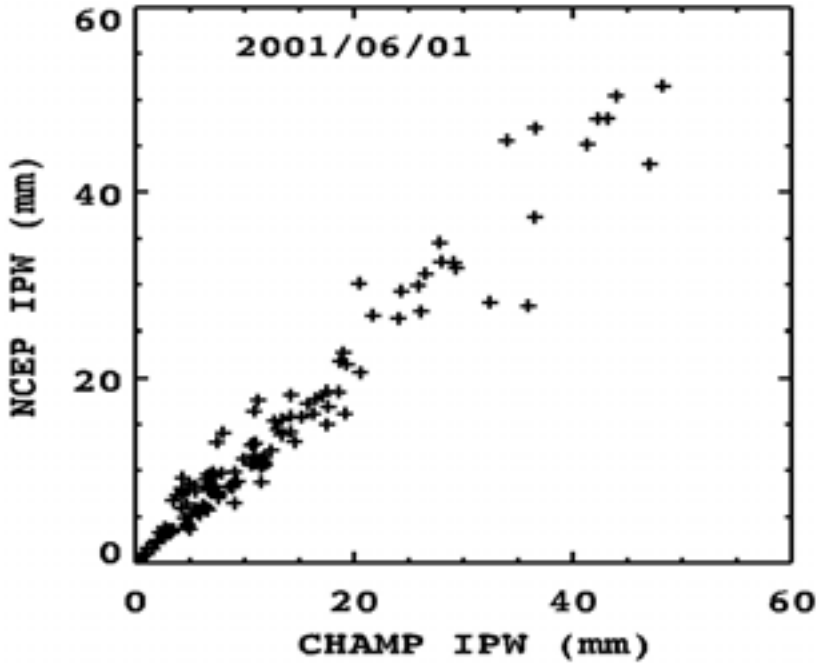

Figure 3