# Impact of AIRS Thermodynamic Profiles on Precipitation Forecasts for Atmospheric River Cases Affecting the Western United States

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## Atmospheric Rivers

Atmospheric rivers are transient, narrow regions in the atmosphere responsible for the transport of large amounts of water vapor. These phenomena can have a large impact on precipitation. In particular, they can be responsible for intense rain events on the western coast of North America during the winter season.

## AIRS

The Atmospheric Infrared Sounder (AIRS) is a radiometer aboard NASA's polar-orbiting *Aqua* satellite. It measures infrared radiation in 2378 frequency bands ranging from 3.7 to 15.4 microns. AIRS has a cross-track scanning geometry, observing 90 fields of view per scan, with a resolution of 13.5 km at nadir and a swath width of about 1600 km. The observed top-of-atmosphere radiation is dependent on atmospheric temperature and the concentration of water vapor and other constituents of the atmosphere. Through an inversion process, profiles of temperature and water vapor are retrieved from AIRS radiometric observations. Since clouds are opaque to infrared radiation, profiles cannot be retrieved inside or below clouds, but useful retrievals can be obtained above clouds (as well as information on cloud top properties).

The *Aqua* satellite (from airs.jpl.nasa.gov).

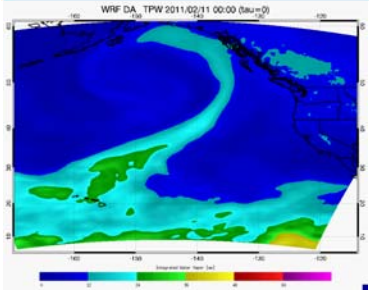
## Hypothesis

The Global Forecast System, an analysis and prediction system based on WRF and run operationally by (?), routinely assimilates AIRS radiances. However, these radiances are used only in cloud-free areas, Data from precipitating areas will not be used since they are obviously cloudy, and other areas which are important in the formation of convection may also be missed due to cloudiness. Since AIRS can retrieve useful information on temperature and moisture above clouds, we expect that using the available profile data in cloudy regions can augment the currently utilized observations and improve WRF model analyses and forecasts.

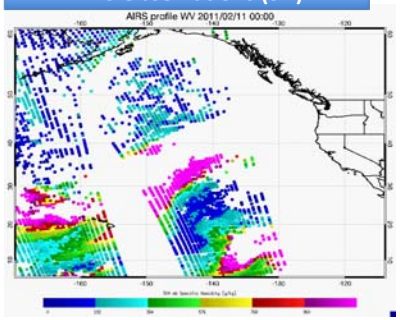
## Experiment

We test the impact of assimilating AIRS temperature and humidity profiles above clouds, using the three-dimensional variational Gridpoint Statistical Interpolation (GSI) data assimilation system to produce a new analysis. Forecasts of WRF initialized from the new analysis are compared to control forecasts without the additional AIRS data. WRF and GSI configurations are based on those used in the GFS. We verify the forecasts by comparison to the CIRA Total Precipitable Water product and to profiles from dropsondes deployed during the Winter Storms and Pacific Atmospheric Rivers (WISPAR) field campaign. We focus on some cases where atmospheric rivers caused heavy precipitation on the US West Coast.

## Initial Field (TPW)

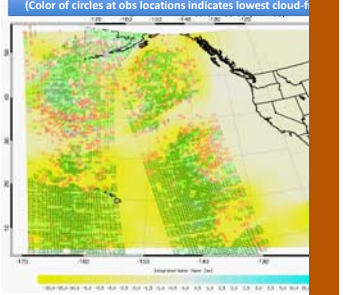


## AIRS Observations (SH)



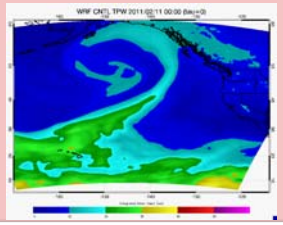
## TPW Increment

(Color of circles at obs locations indicates lowest cloud-fi

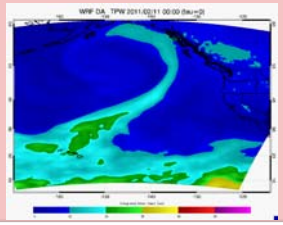


a) WRF Total Precipitable Water at initial analysis time, control run. b) AIRS specific humidity (at ??? level). c) Total precipitable water assimilation increment due to AIRS profile assimilation (yellow shading) and locations of AIRS observations (small circles, colored according to lowest cloud-free level).

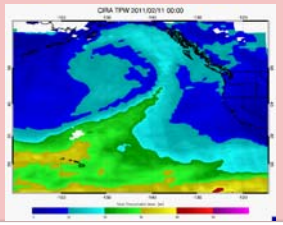
## Ctrl field (forecast)



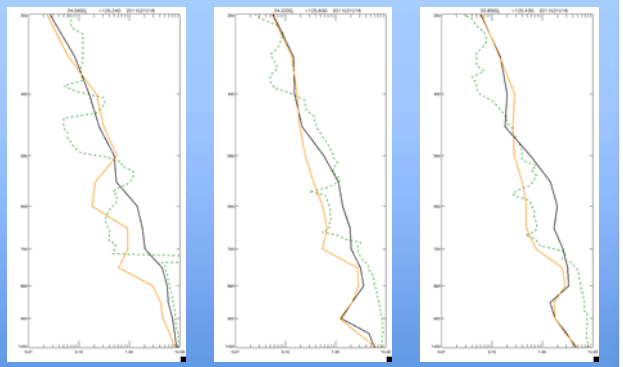
## AIRS DA field (forecast)



## CIRA TPW field



## Validation vs. Dropsondes



**Control (black) and Assimilation Run (orange) profiles of forecast (tau=18 h) specific humidity at dropsonde locations, along with dropsonde-measured profiles (green, dashed). For the 8 dropsondes on this date, assimilation of AIRS 3D profile changes the mean error from XX to YY and the rms error from JJ to KK.** ***(actual values to be inserted here)***

## Validation against CIRA TPW

## References

AIRS
CIRA product
Field experiment?
GSI
WRF