Inter-comparison of precipitable water observed by GPS and AIRS in the Maritime Continent - Preliminary results -

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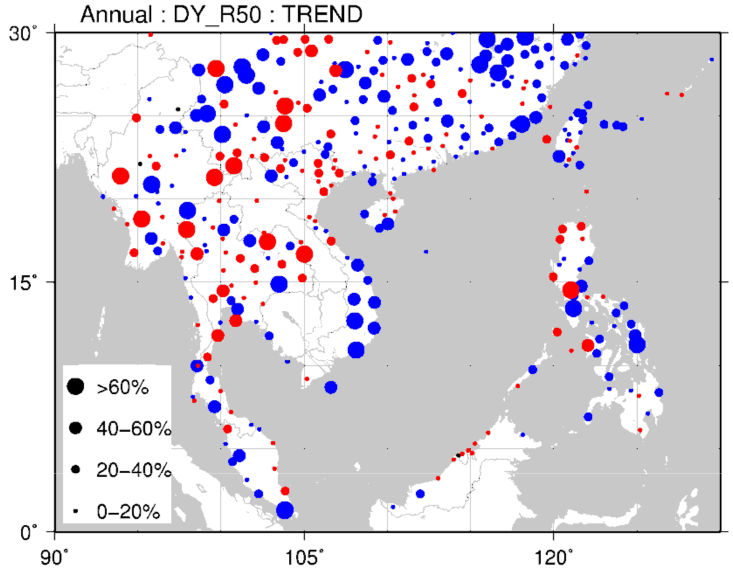
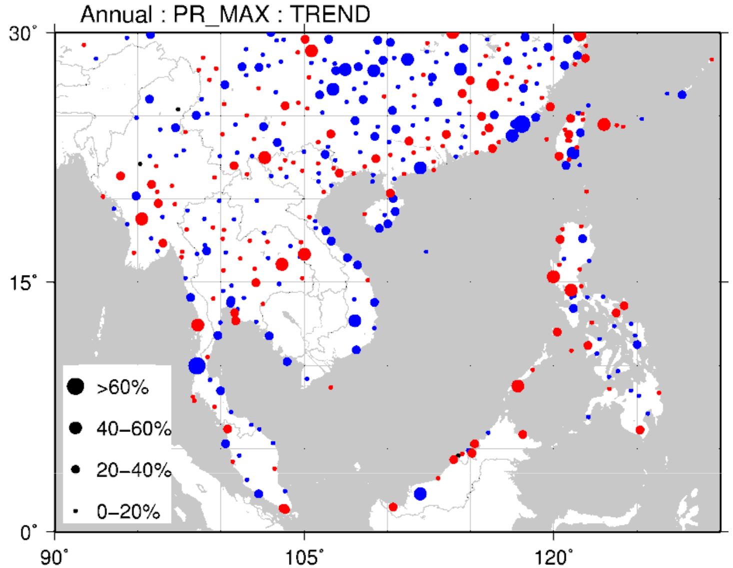
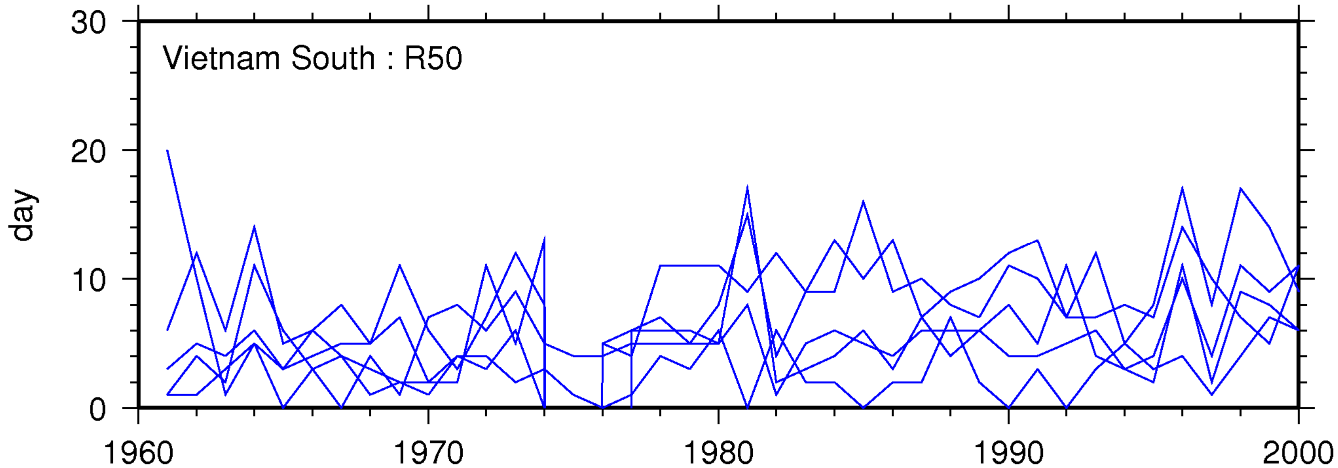
Day(Pr>50), Ann. Max 1-day PRCP





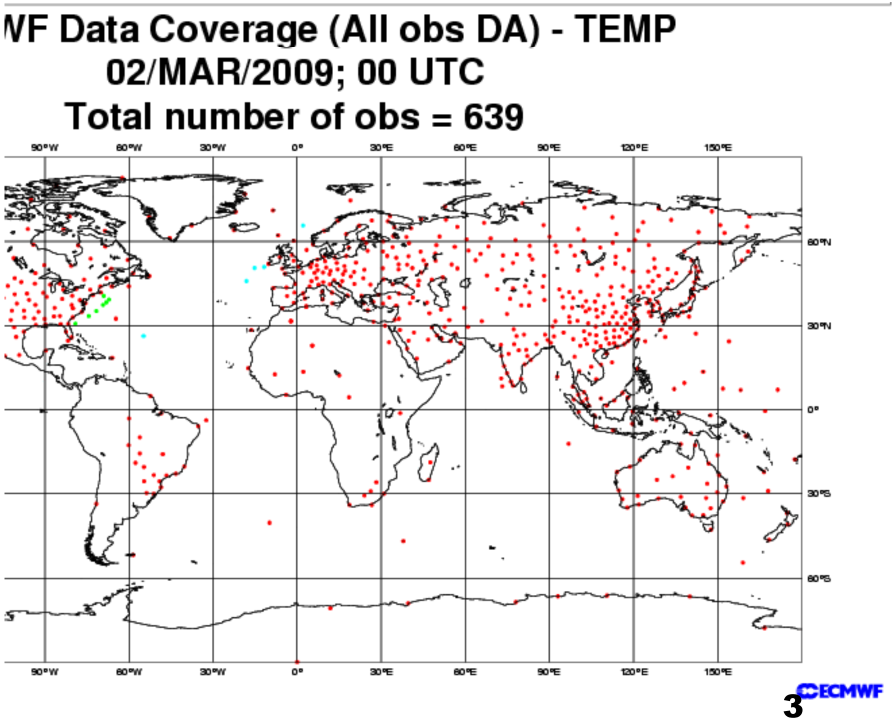
Number of PRDAY > 50 mm

Annual Max of 1-day PR



Precipitation and Forecast

- Precipitation characteristics has been changed with increasing trends of heavy precipitation in some area of SE Asia.
- For more accurate precipitation forecast in SE Asia,
  - Radiosounding were limited over the ocean.
  - Satellite data is very useful.
    - Visible/infrared imager
    - Microwave sounder
    - Microwave radiometer
    - Infrared sounder
    - Etc….



Auqa

Launch : May 4, 2002

Sensors :

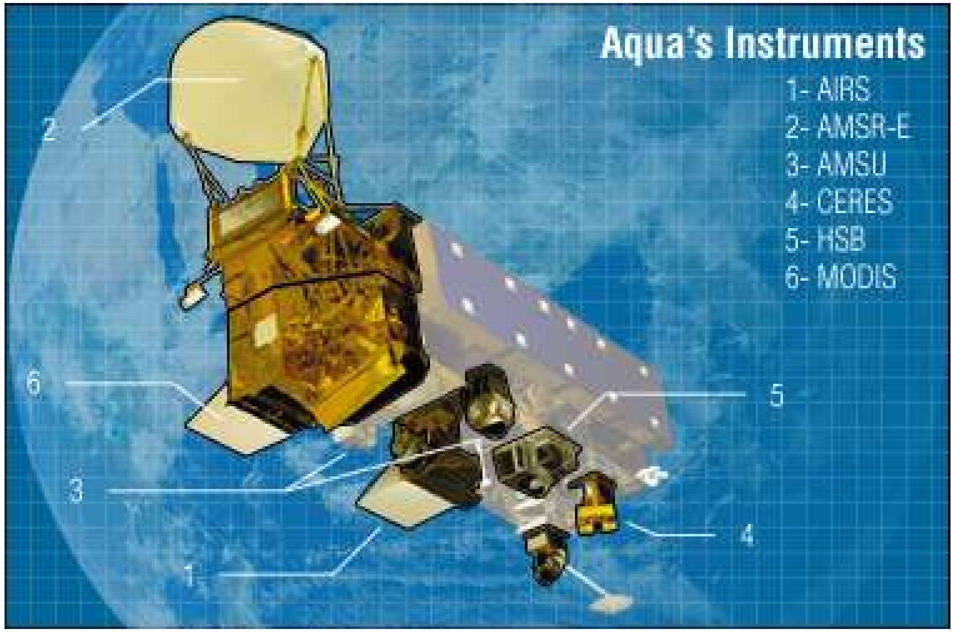
- **AIRS**
- AMSU-A
- HSB
- AMSR-E
- MODIS
- CERES

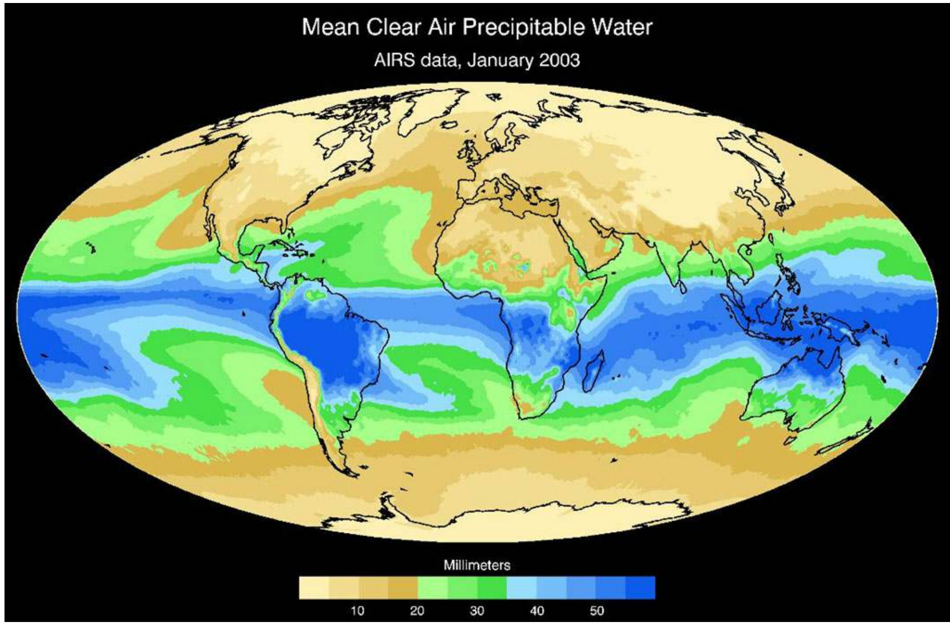
Eq. Crossing time

- ~13:30LT
- ~01:30LT

AIRS:

Profile of T,RH,CW…

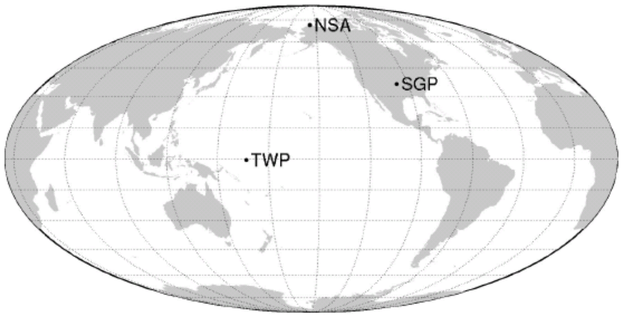


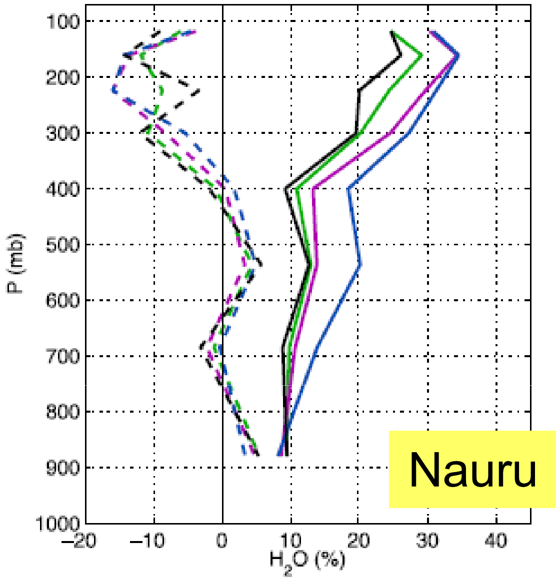


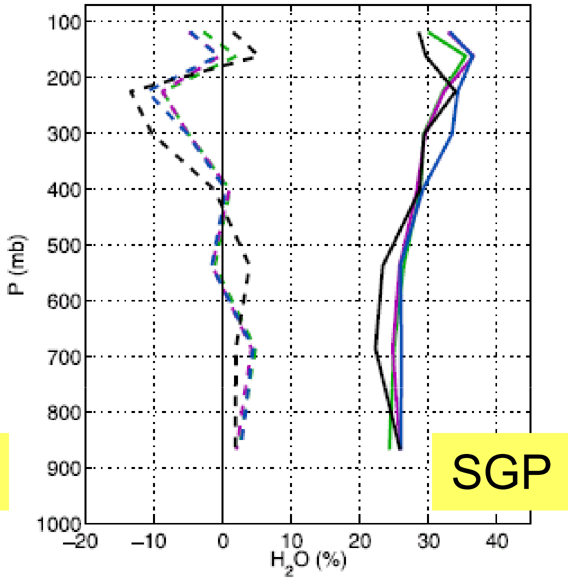
AIRS Humidity Validation with RAOB

AIRS vs Special launch of RAOB

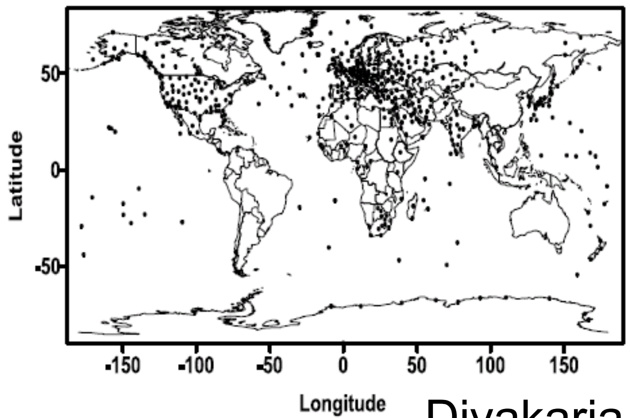
Tobin et al. (2006)







AIRS vs Operational RAOB



Divakaria et al. (2006)

100(AIRS-RAOB)/RAOB

Dash = Bias
Solid = RMSE

RMSE >> BIAS

- **Operational RAOB were limited for overpass of Aqua.**
- **RAOB have some deficiency of humidity observation.**

AIRS PWV Validation with GPS

Another source of water vapor measurement

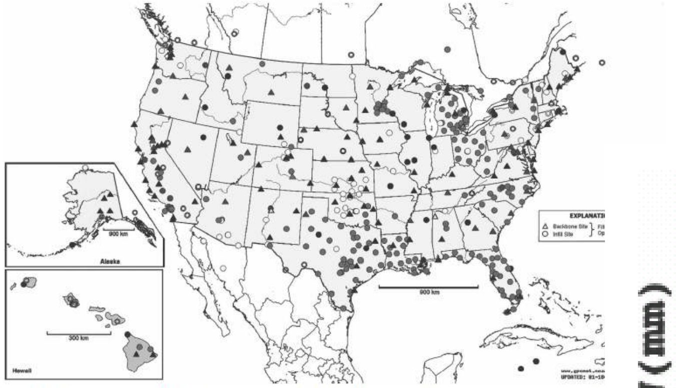


FIG. 1. The distribution of GPS stations operated by NOAA/ESRL to provide IPW in near–real time over CON
Hawaii. Backbone sites (triangles) are operated by U.S. federal government agencies, including NOAA, the U.S. Co
Corps of Engineers, and the U.S. Department of Transportation. Infill sites (circles) are operated by state and lo
agencies, universities, and the private sector and SuomiNet. Filled triangles and circles represent sites that are already o
open symbols represent planned sites.

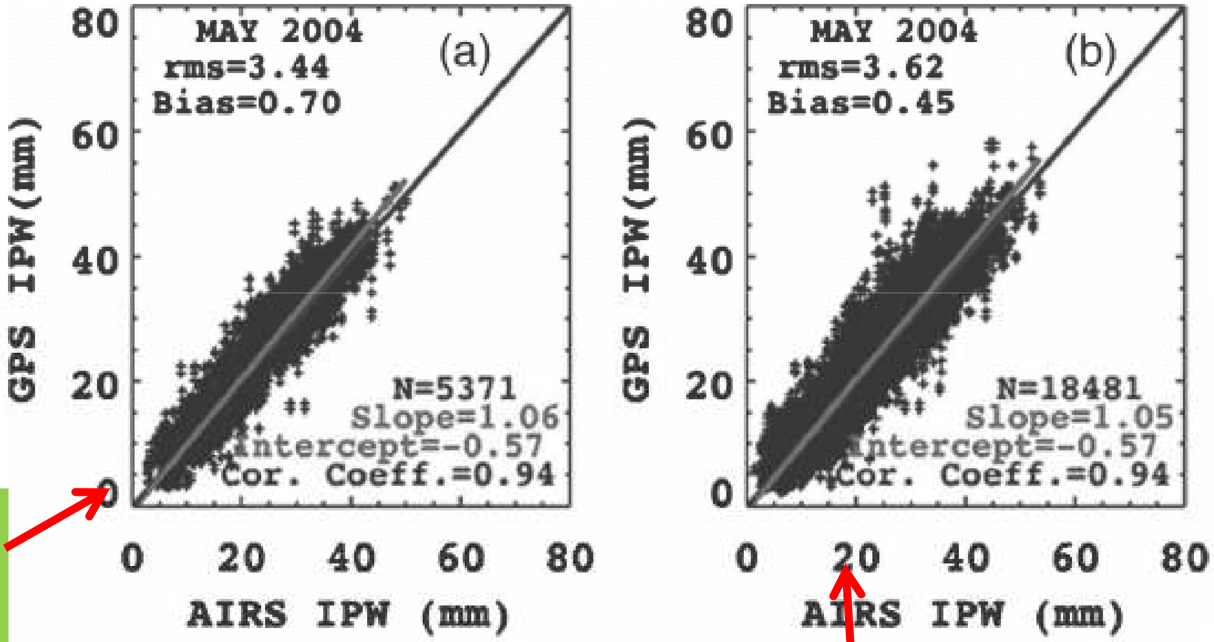


FIG. 2. Scatterplots of GPS and AIRS IPW over CONUS for May 2004 with AIRS data flagged (a) QBOT=0 and (b) QMID=0. Data pairs occur within ½° latitude and longitude and within a half hour of each other. Gray lines denote the best fit to the data determined through rotated linear regression.

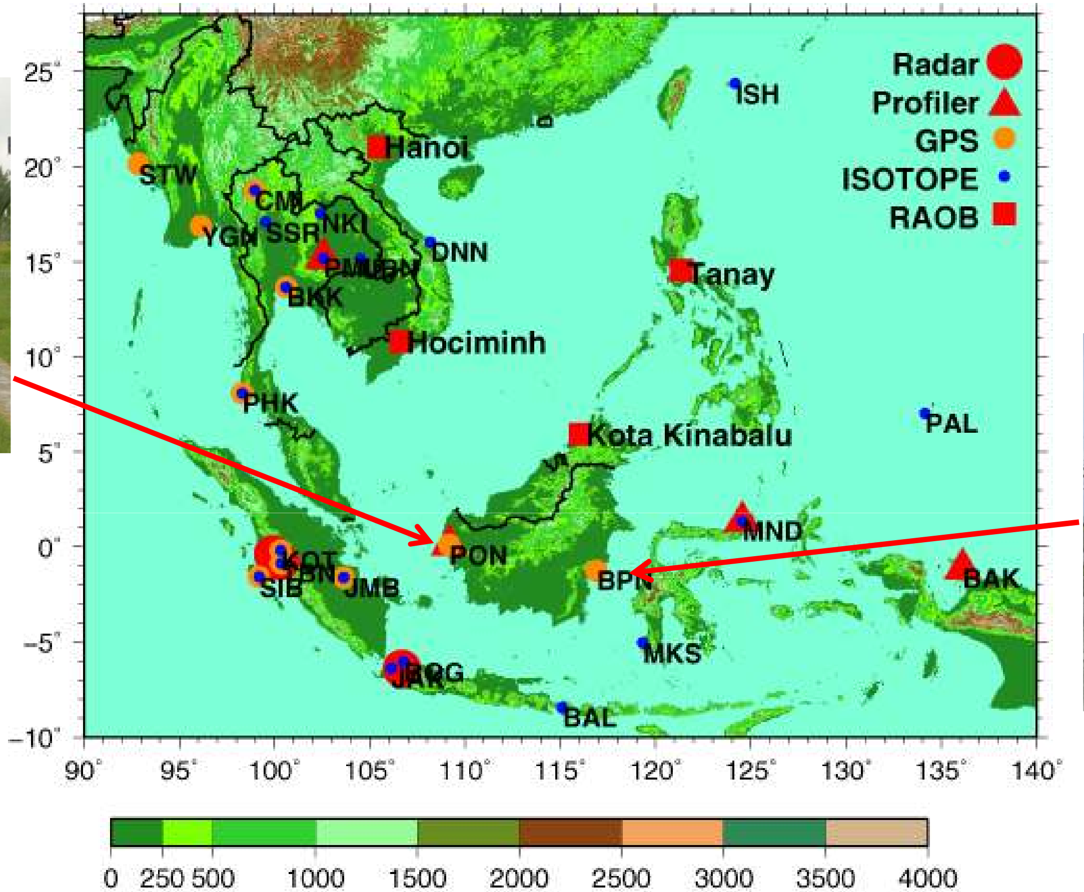
QBOT=0
Lower level temperature
Retrieval was good.

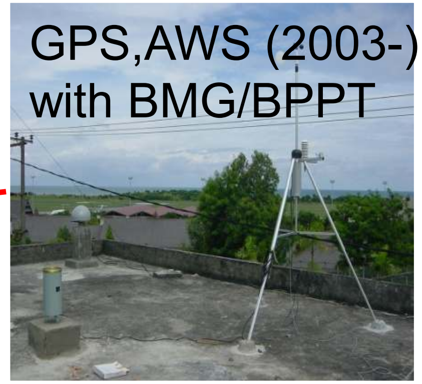
QMID=0
Mid Trop temperature
Retrieval was good.

Rama Varma Raja et al. (2008)

PWV = Precipitable Water

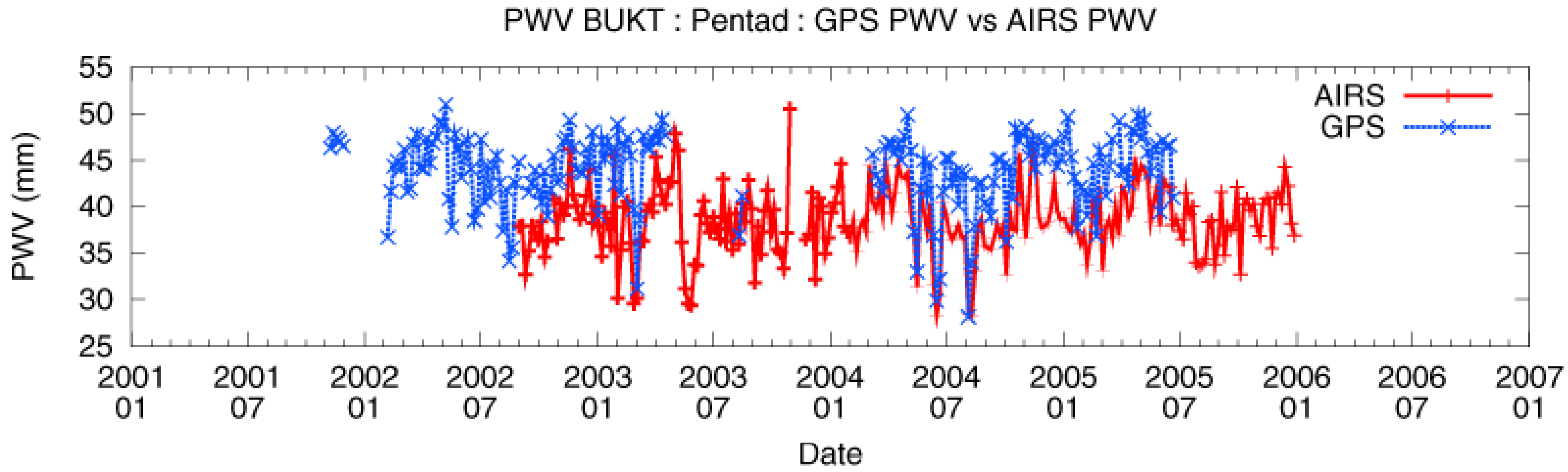
GPS receiver deployed by IORGC

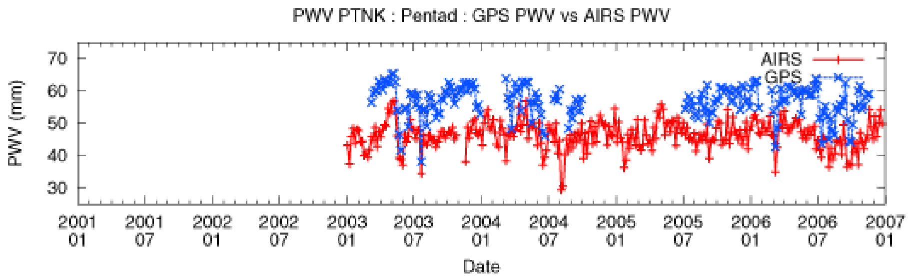


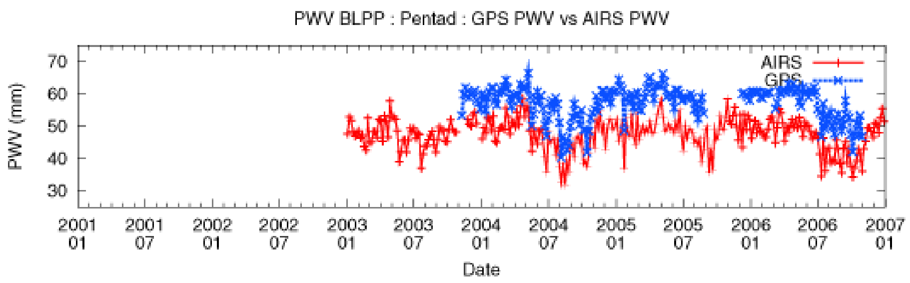


CODE	Station	Lat	Lon	Hight
BUKT	GAW Kototabang	100.318	-0.202	848.683
PTNK	BMG Siantan	109.191	0.075	3.157
BLPP	BMG Balikpapan	116.897	-1.260	29.411

PWV time series at three GPS sites



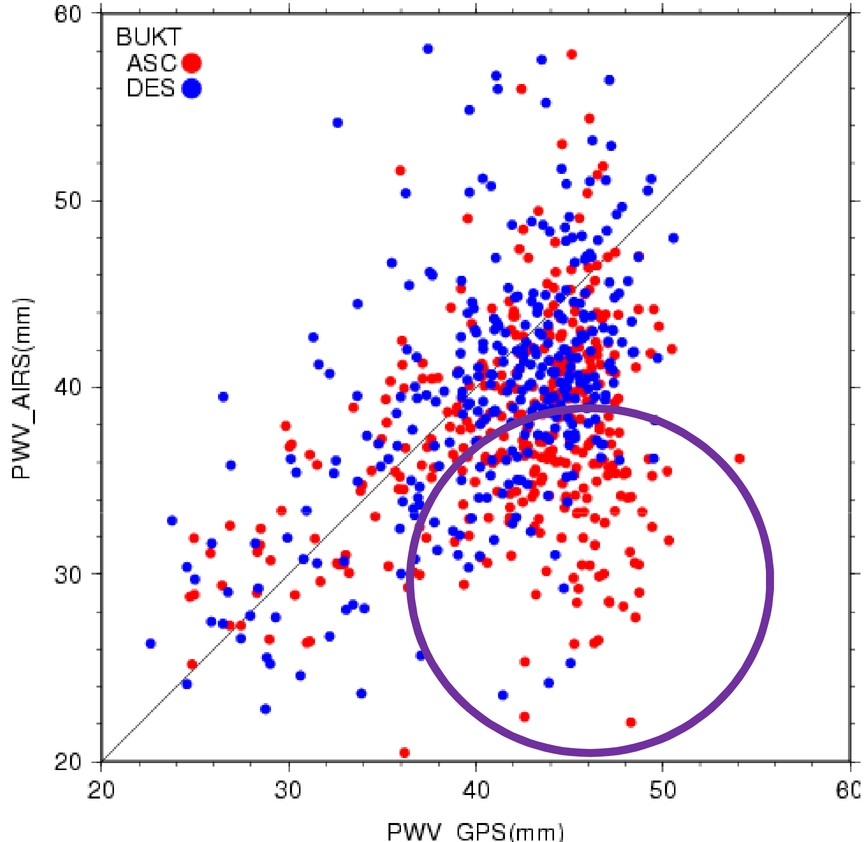


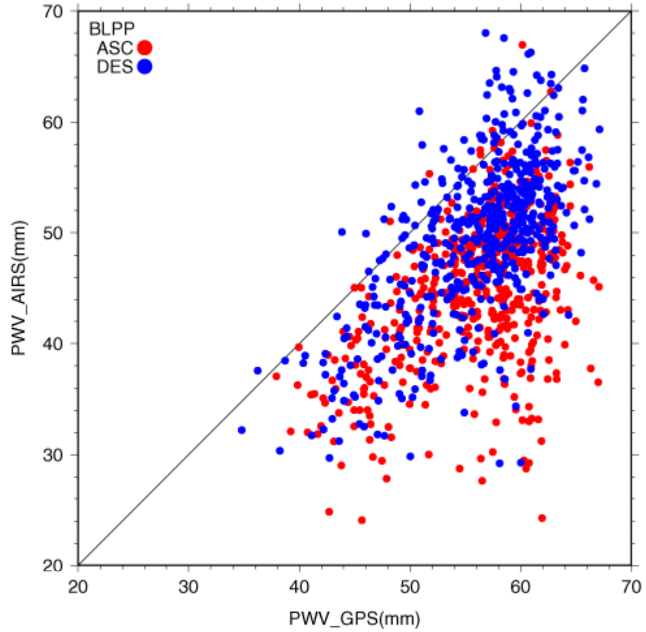


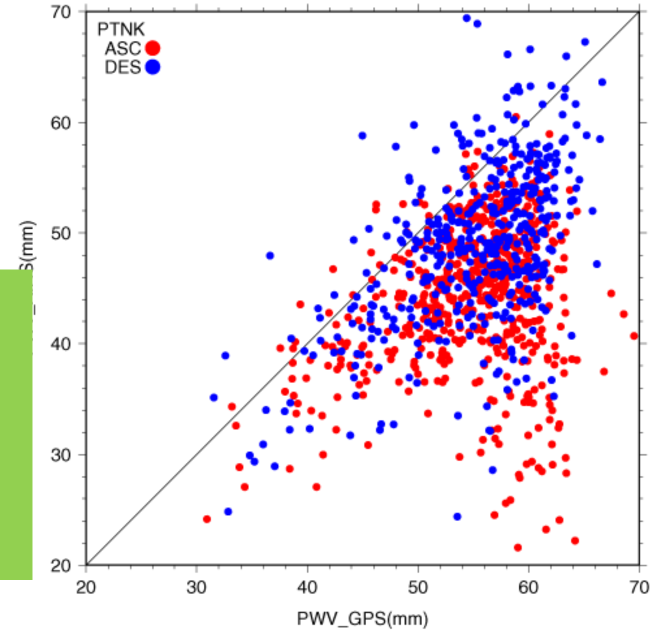
- Seasonal variation was similar each other.
- Dry events well captured.
- AIRS PWV tends to drier than GPS PWV.

AIRS Level-3 AIRX3STD.005 (daily)

Scatter diagram of PWV







- There are many observation with low AIRS PWV when GPS PWV larger than 40 mm.
- Low AIRS PWV is larger in daytime overpass.
- Underestimation of PWV is evident in BLPP and PTNK.

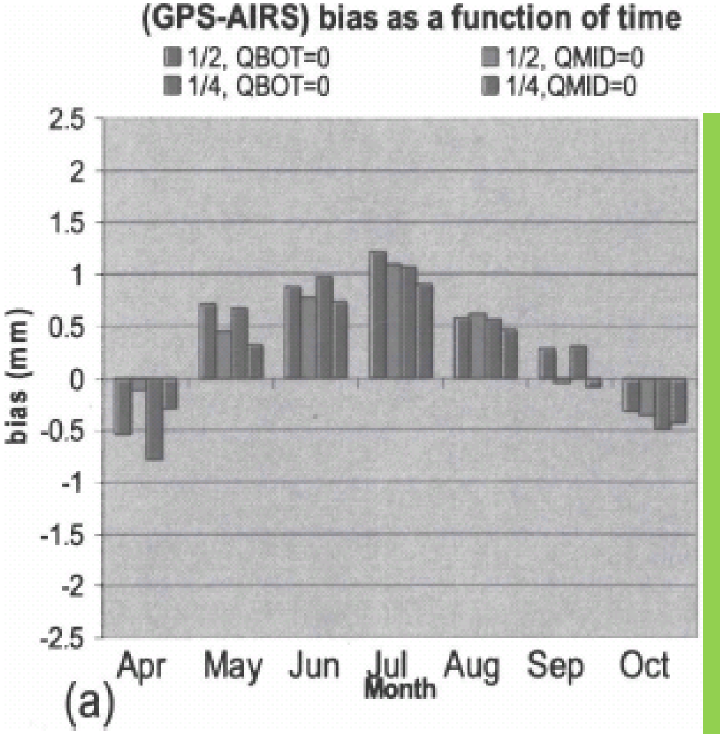
Statistics

Station	Time	Num	GPS Mean(std) (mm)	AIRS Mean(std) (mm)	COR	BIAS (mm)	RMSE (mm)
BUKT	Day	351	42.2(5.4)	37.4(5.8)	0.301	**-4.7**	0.4
	Night	321	41.4(5.6)	39.8(6.6)	0.524	-1.3	0.3
BLPP	Day	515	56.0(5.5)	44.9(6.7)	0.470	**-11.1**	0.6
	Night	510	56.1(5.7)	49.5(7.4)	0.633	**-6.6**	0.4
PTNK	Day	587	54.8(5.9)	44.1(6.6)	0.215	**-10.7**	0.5
	Night	438	55.1(6.4)	48.8(7.6)	0.549	**-6.3**	0.4

- COR were larger in the nighttime observation.
- COR were less than that in CONUS.
- BIAS were more than 10% of GPS mean PWV.
- BIAS in the Maritime Continent were larger than that in CONUS.
- RMSE in the MC were smaller than that in CONUS.

BIAS >>>>> RMSE

Discussion (1)



Rama Varma Raja et al. (2008)

- Bias shows seasonal Variation.
- Positive bias appeared in warm season, and negative bias observed in cold season.
- These are depend on the retrieval algorithms.
  - Conservative approach.
  - Dry season => tend to overestimate
  - Warm season => underestimate

In the Maritime Continent, mean temperature is higher, and moister than mid-latitude => PWV underestimate?

Discussion (2)

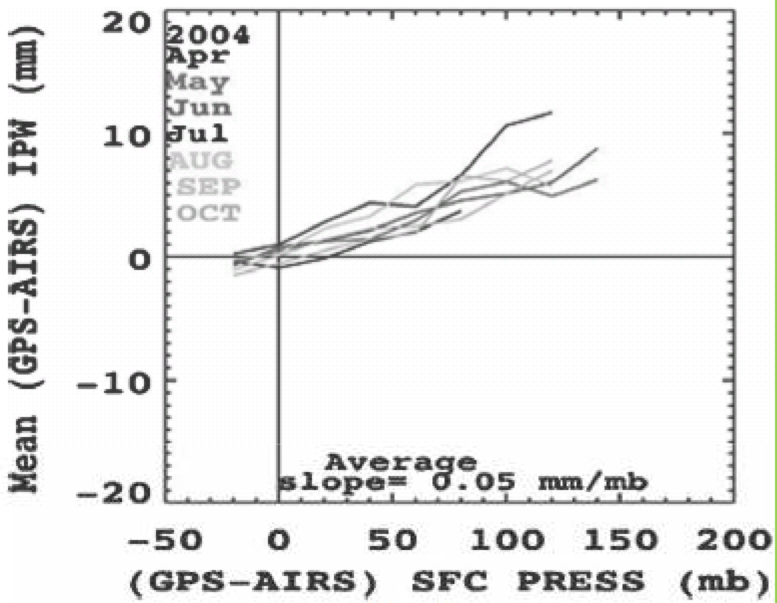


FIG. 7. The mean (GPS–AIRS) IPW difference plotted as a function of the corresponding surface pressure differences. It can be noted that there is a near-linear tendency for the mean IPW difference to increase with increasing surface pressure differences. The average slope for the whole period of analysis is 0.05 mm mb^{-1}. The AIRS quality flag used here is QBOT = 0, which is the stricter of the two quality flags provided.

Rama Varma Raja et al. (2008)

Impact of surface pressure

- Psurf@GPS –Psurf@AIRS
- PWV difference become large, when P difference become large.

- Interpolation of NCEP GSF surface pressure to AIRS FOV have some impact.

- BUKT = Mountain area
- PTNK/BLPP = Coastal area

- Are there any impact of GFS Psurf interpolation error?
- Diurnal tide may have some impact on AIRS PWV retrieval?

Summary

- AIRS PWV retrievals were compared with GPS PWV in the Maritime Continent.
- Seasonal variation of AIRS PWV were similar with that of GPS PWV over the three GPS sites.
- However, **AIRS PWV tends to have negative bias**. Negative bias of ascending node was larger than that of descending node.
- When GPS PWV was larger than 40 mm, AIRS PWV of ascending orbit show large underestimation.
- Dry bias of AIRS PWV in moister condition is similar with results of Rama Varma Raja et al. (2008). However, the orbit dependence of bias was not found in the previous study.
- We will continue inter-comparison study with AIRS Level-2 data.