

Abstract

This poster presents the evaluation of the S-NPP TPW Level-2 and 3 products with TPW data from ground-based and satellite-based measurements. The goal of the Suomi NPP VIIRS Moisture Project is to provide total column water vapor (TPW) properties from merged VIIRS infrared measurements and CrIS plus ATMS water vapor soundings to continue the depiction of global moisture at high spatial resolution started with MODIS. While MODIS has two water vapor channels within the 6.5 μm H₂O absorption band and four channels within the 15 μm CO₂ absorption band, VIIRS has no channels in either IR absorption band. The VIIRS/CrIS+ATMS TPW algorithm being developed at CIMSS is similar to the MOD07 synthetic regression algorithm. It uses the three VIIRS longwave IR window bands in a regression relation and adds the NUCAPS (CrIS+ATMS) water vapor product to compensate for the absence of VIIRS water vapor channels. Level-3 global 0.5° daily and monthly mean data products were developed by using a gridding software (called Yori) developed at UW-Madison SSEC. The development of Yori is framed by NASA VIIRS Atmosphere SIPS. The Level-3 products have been processed from May 2012 to December 2016.

Comparison to MWR and GPS measurements

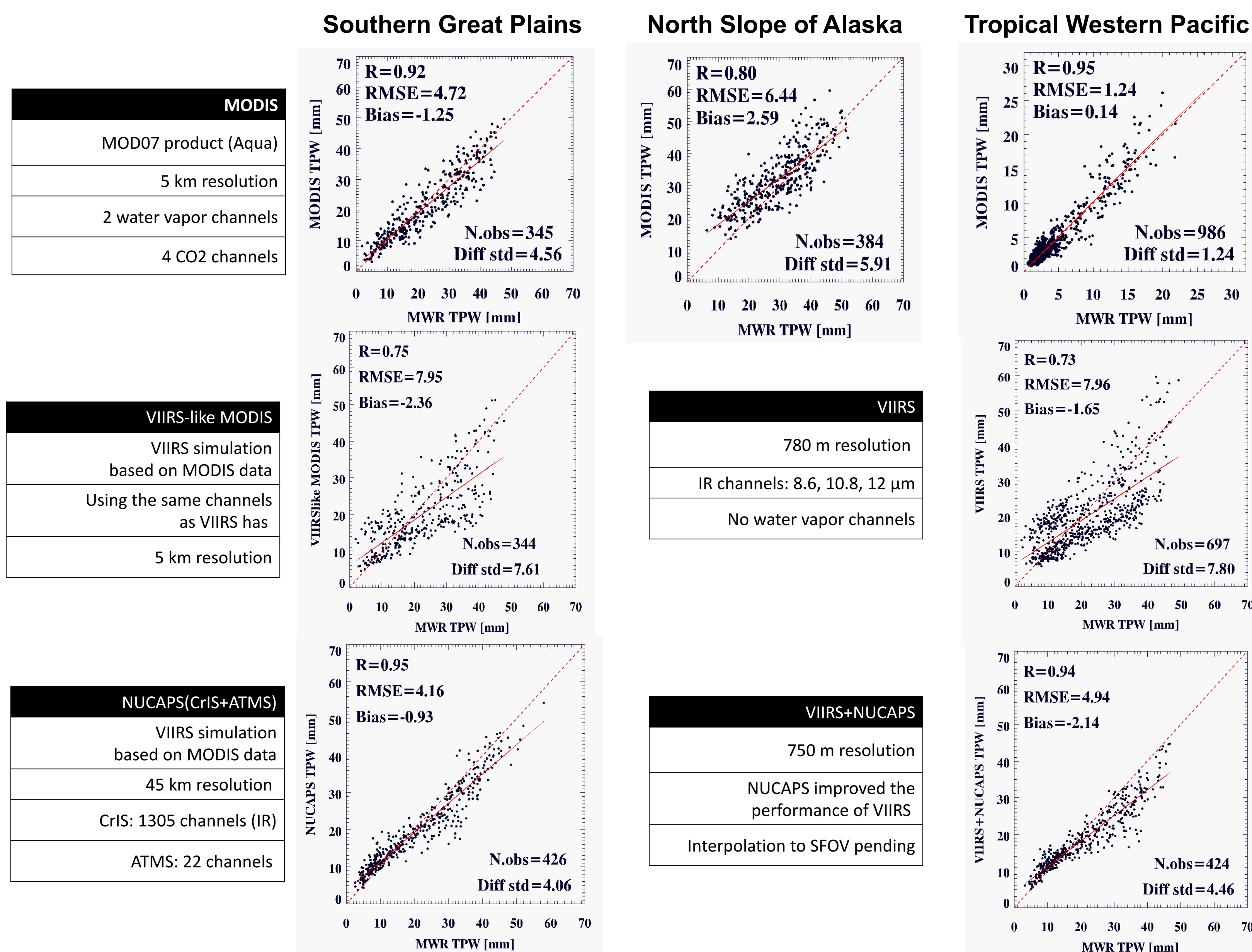


Table 1 Comparison of the characteristics of the Aqua MODIS (MYD07) and the VIIRS NUCAPS data products

Characteristics	MODIS (MYD07)	VIIRS (+CrIS/ATMS)
Spectral Bands	Uses 11 CO ₂ , H ₂ O, and IRW bands between 4.5 and 14.5 μm	Using bands M14, M15, M16 & TPW derived from CrIS/ATMS
Spatial Resolution	5km : 5x5 1km average	5km: 7x7 750m average
Spatial Coverage	Global (clear sky)	Global (clear sky)
Cloud Mask	MOD35 Cloud Mask	MVCM (750m)
Ancillary Data	GDAS (1° x 1° res)	CFSR (0.5° x 0.5° res)
Forward Model	CRIM V2.1	CRIM V2.1
Algorithm	Statistical Regression	Statistical Regression
Time Coverage	2000 -	2012 -

Table 2 Final statistics of the VIIRS algorithm

FINAL STATS	MODIS 5km		VIIRS 750m		NUCAPS 45km		VIIRS+NUCAPS	
	SGP MWR	GPS	SGP MWR	GPS	SGP MWR	GPS	SGP MWR	GPS
Number of obs.	345	63 565	697	169 927	426	66 705	424	
bias	-1.25	0.89	-1.65	0.99	-0.93	-0.28	-2.14	
RMSE	4.72	4.63	7.96	6.86	4.16	4.33	4.94	
Std.dev	4.56	4.17	7.8	6.51	4.06	4.16	4.46	

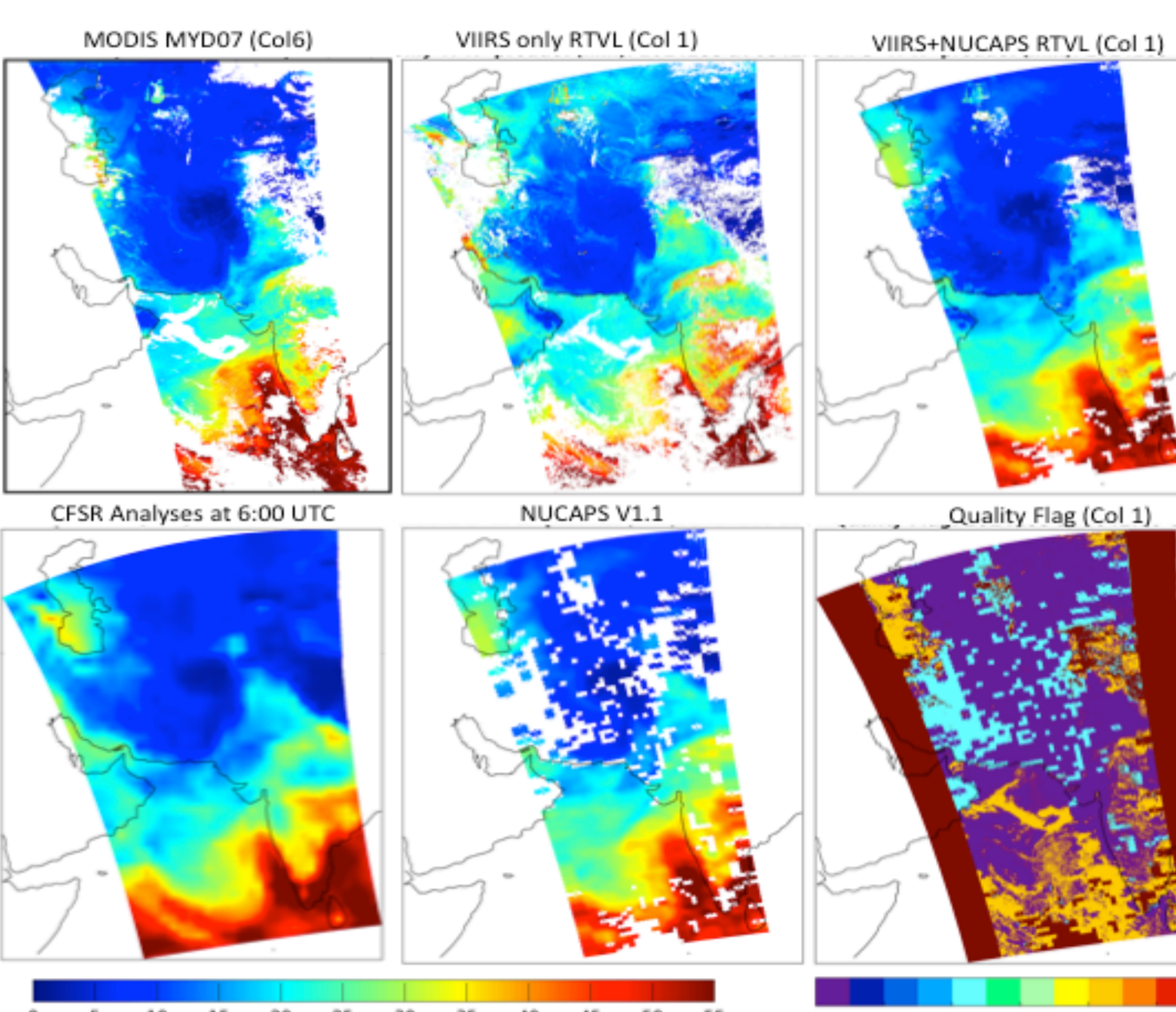


Figure 1 TPW comparison on 15 October 2014 at ~08:50 UTC (top left) Aqua MODIS MYD07. (top middle) VIIRS only (top right) VIIRS plus NUCAPS retrievals, (bottom left) NUCAPS only (bottom left), CFSR TPW analyses, (bottom middle) NUCAPS v1.1 TWP, (bottom right) quality flag.

Note the better coverage and improved quality for VIIRS plus NUCAPS with holes filled compared with VIIRS alone, NUCAPS alone, and even MODIS.

Level-3 Global daily and monthly 0.5 degree gridding

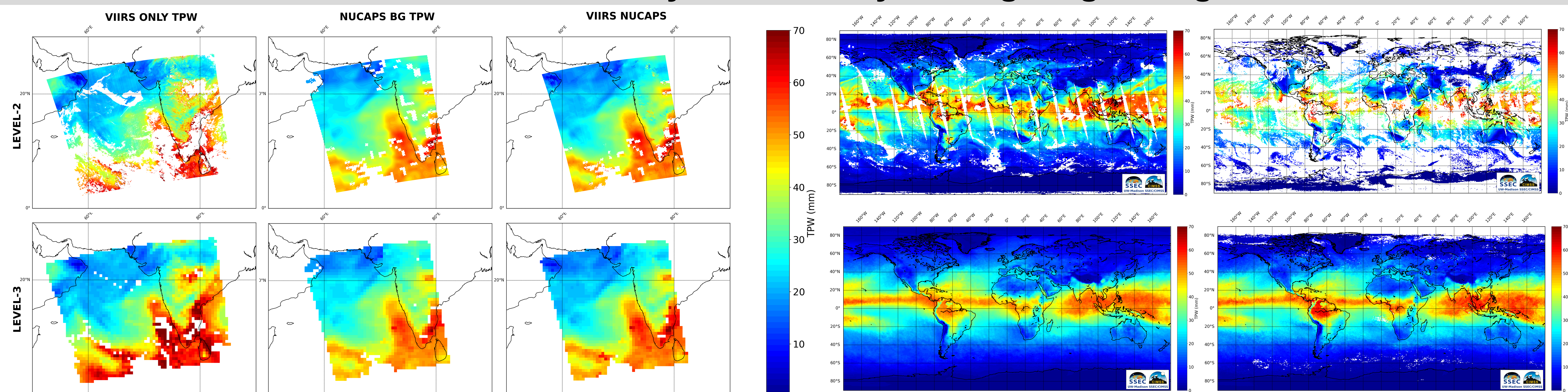


Figure 2 Processing a VIIRS TPW granule to a gridded granule (15 October 2014 at ~08:50 UTC).

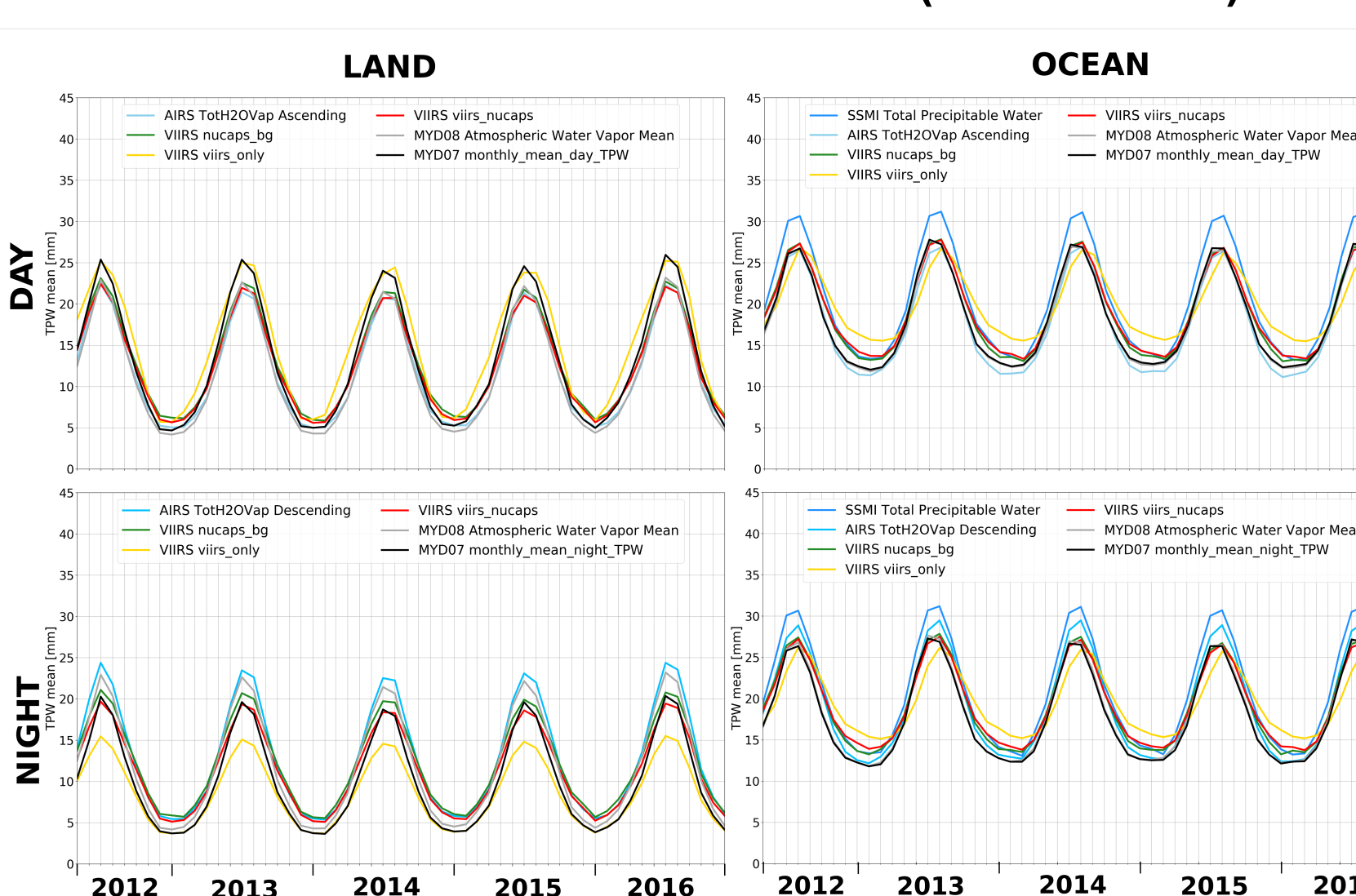
Figure 3 Daytime Daily (Oct 15, 2014, top panels) and monthly (Oct 2014, bottom panels) mean 0.5 degree gridded VIIRS/NUCAPS (left) and AQUA/MODIS MYD07 (right) TPW products.

Zonal monthly mean cross-comparisons of different TPW products

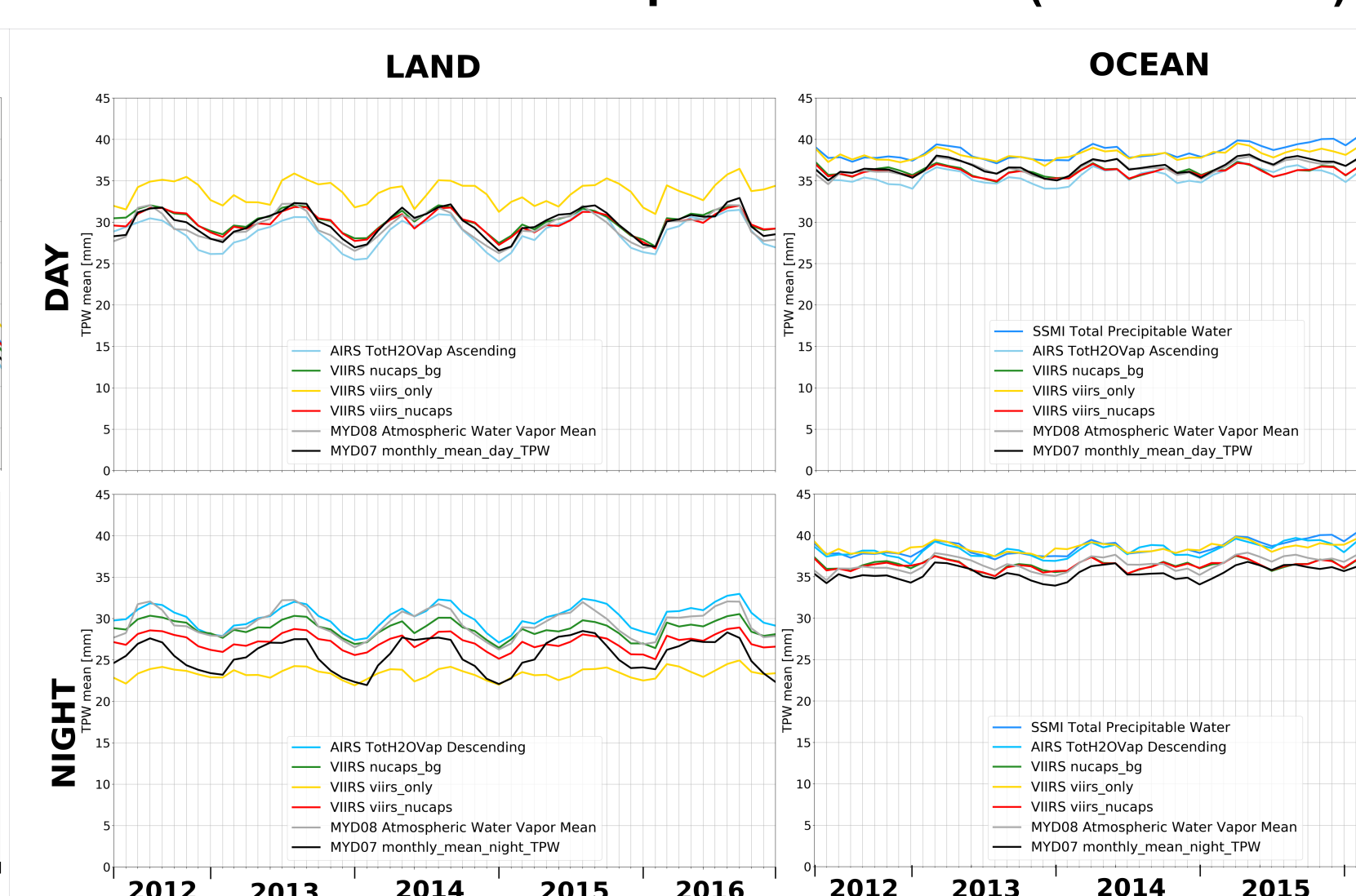
Table 3 TPW Products used for the zonal cross comparison

TPW data product	Res.
VIIRS ONLY (day / night)	0.5°
CrIS + ATMS NUCAPS BG (day / night)	0.5°
VIIRS + CrIS + ATMS VIIRS NUCAPS (day / night)	0.5°
AIRS3STM TotH2Ovap_A, TotH2Ovap_D	1°
MYD08_M3 Atm. Water Vapor	1°
MYD07_L3 TPW (day / night)	0.5°
SSMI TPW	1°

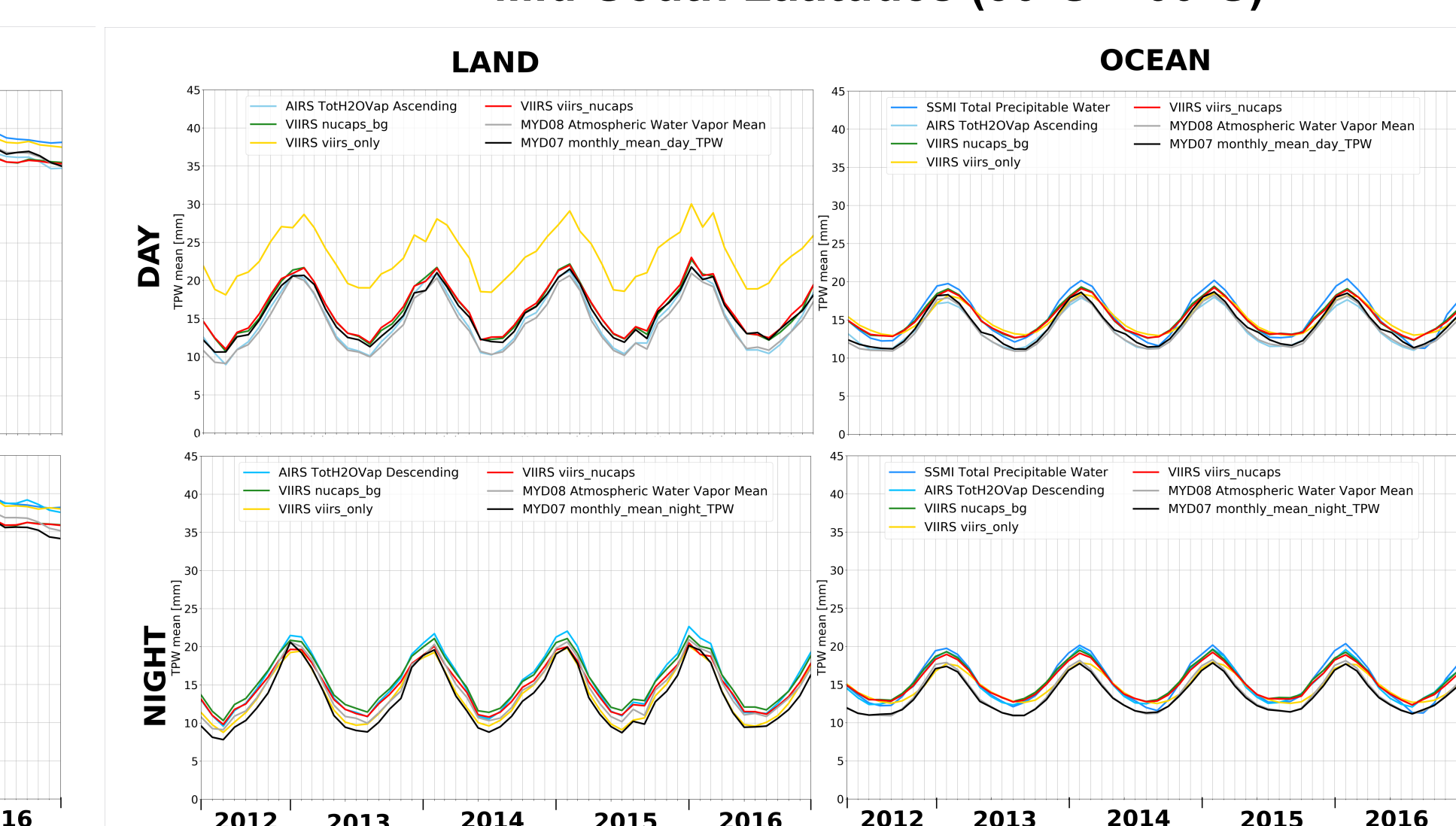
Mid-North Latitudes (30°N – 60°N)



Tropical Latitudes (30°N – 30°S)



Mid-South Latitudes (30°S – 60°S)



Comparing to MODIS/Aqua (MYD07 day/night)

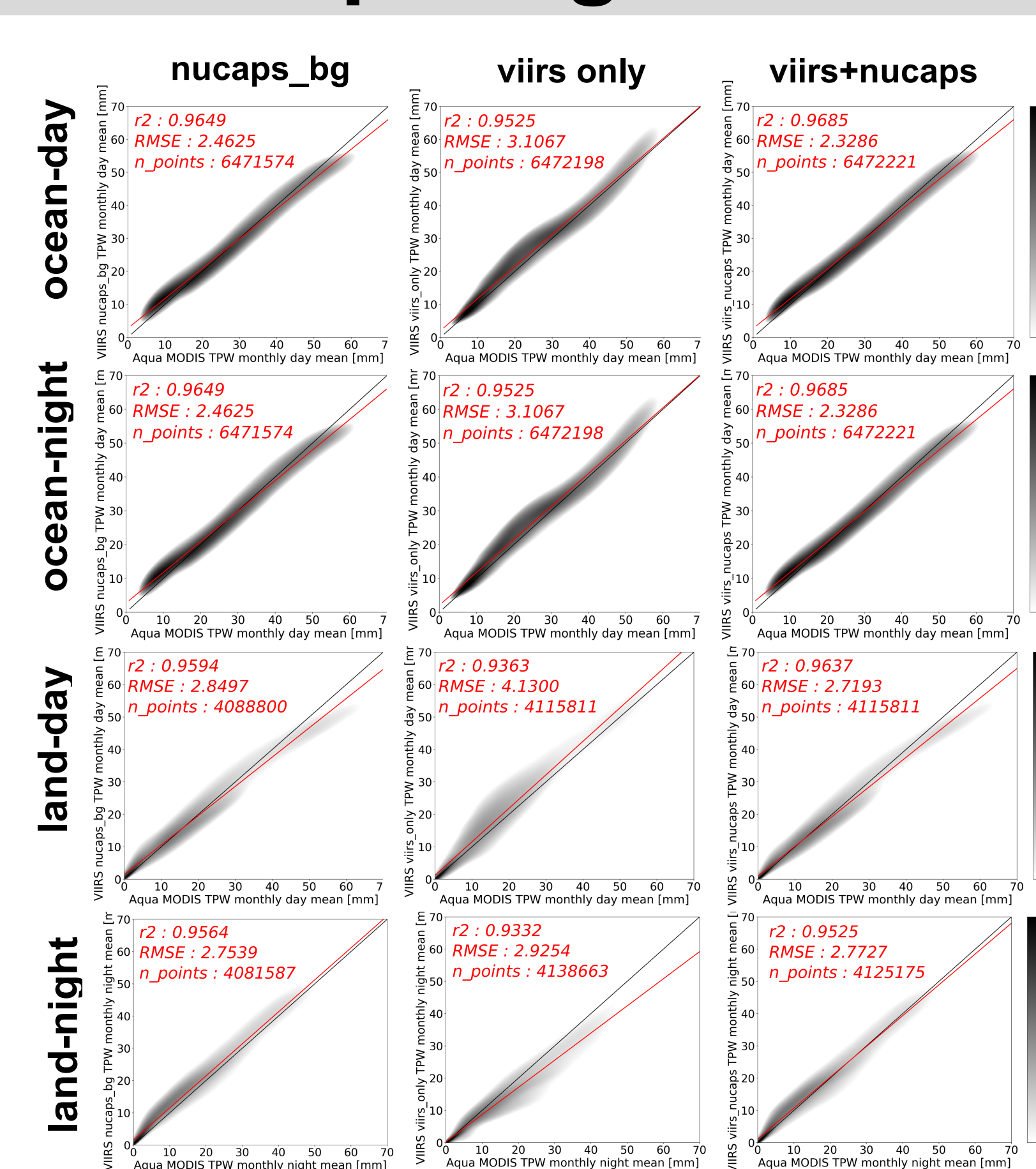


Figure 8 The scatter plots show the day, night, ocean and land separated relationship between the Level-3 MYD07 (x-axis) and the Level-3 NUCAPS, VIIRS-only and VIIRS NUCAPS data products.

Figure 7 (right)

The Land/Water and the Latitudinal Zones used for the cross-comparison. The Land/Water Mask used for the zonal subsetting was derived from the SSM/I dataset.

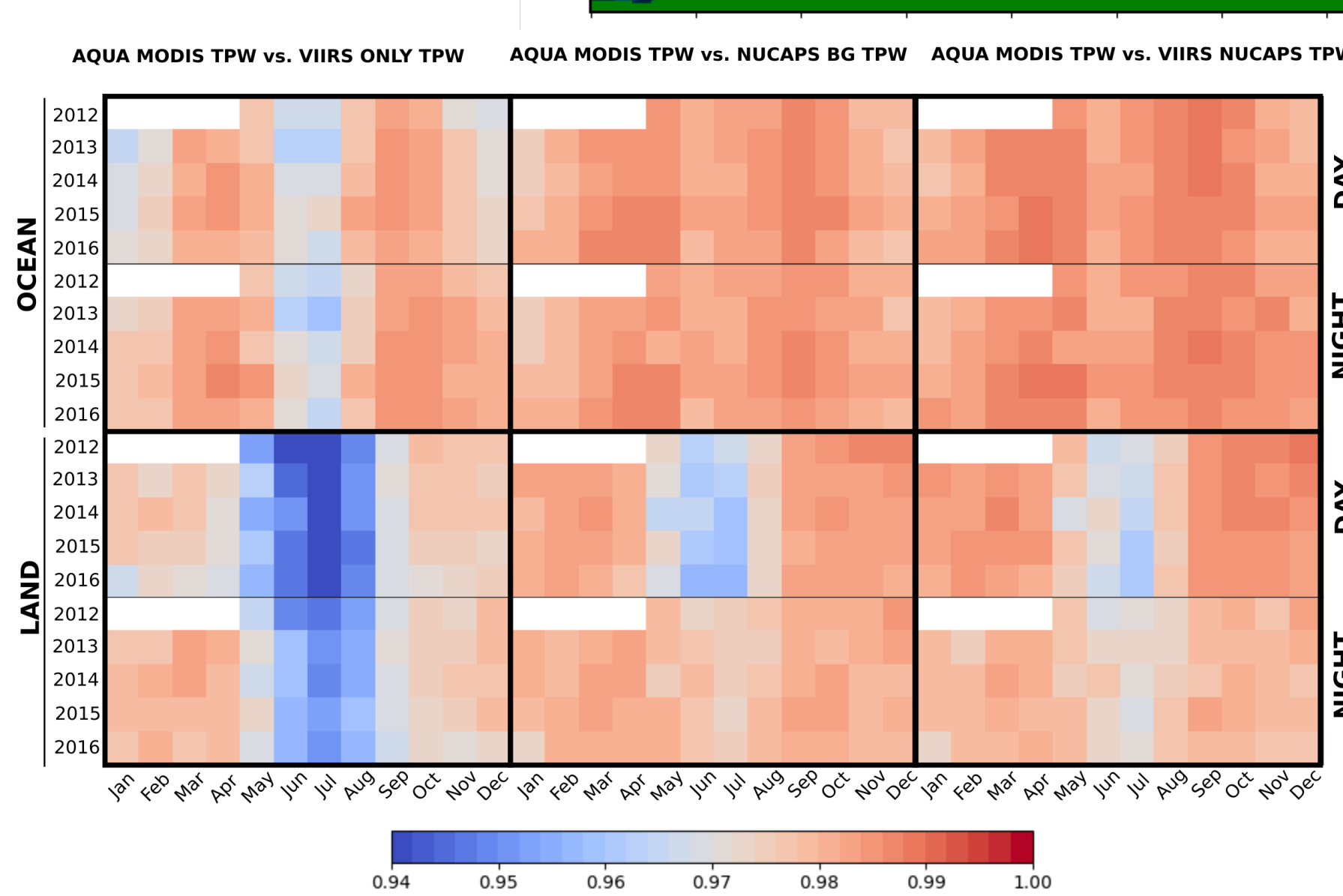


Figure 9 The correlation table shows the relationship between the Aqua MODIS and VIIRS-only (left blocks), NUCAPS (middle blocks) and VIIRS+NUCAPS (right) monthly mean Level-3 data products, separated by day, night, ocean and land.

Conclusions and Future Plans

- The Level-2 6-minutes and 750 m spatial resolution VIIRS TPW product file includes the collocated NUCAPS background TPW, the VIIRS-only TPW, and VIIRS+NUCAPS TPW with a quality flag.
- The Level-3 VIIRS TPW products are daily and monthly means aggregated to 0.5 degree spatial resolution separated by day and night.
- The Level-3 products have been processed for data between May 2012 and December 2016.
- The Level-2 and Level-3 comparison with Aqua MODIS showed that VIIRS+NUCAPS TPW quality is better than VIIRS or NUCAPS alone. Values missing in the NUCAPS alone due to surface emissivity issues are filled by using VIIRS alone values. Values missing in VIIRS and MODIS alone due to interference by non-precipitating clouds are filled by using smoothed NUCAPS values.
- The VIIRS+NUCAPS combined TPW algorithm is producing near-MODIS quality TPW in the comparison between 2012-2016 with r2 values greater than 0.95 over land and ocean both day and night.

In the future, we are planning to

- improve the VIIRS TPW by radiance fusion from CrIS or product fusion (Weisz et al., 2017) and
- making some refinements like updating the forward model from CRTM to RTTOV; increasing viewing angle categories; Investigate the retrieval noise occurring over land at cloud edges. update the IR emissivity data base (from UW BFemis to CAMEL).

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