GOESR3 Periodic Reporting

Reporting Period: July 2017 – December 2017 (1st half of FY17 funding cycle)

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Collaborators / Participants: Andy Edman (NWS Western Region), Limin Zhao (NOAA/NESDIS/OSPO); Mark Klein (NOAA/NWS/WPC), Andrew Orrison (NOAA/NWS/WPC)

Project Title: Using the New Capabilities of GOES-R to Improve Blended, Multisensor Water Vapor Products for Forecasters
Project Number: 444

Executive Summary

The first half-year of this CIRA project saw progress in setting up ingest and processing of the new GOES-16 Total Precipitable Water (TPW) data. Near-realtime animations of the data are online at CIRA, using data processed with the same system as used in NESDIS operations.

Initial results and inspection of GOES-R TPW data and a comparison with GPS TPW stations shows that the data appears to be of high quality. A comparison with Suomi-NPP TPW showed RMS differences of about 3 mm. These are fairly low values and bode well for blending of these data sets. In the upcoming reporting period, the project will participate in the NOAA Hazardous Weather Testbed and distribute an experimental blended TPW product using GOES-16 data.

Progress toward FY17 Milestones

There were two project milestones this reporting period:

Quarter 1: Establish ingest of GOES-R TPW, LPW and cloud mask at CIRA.

This task is progressing on schedule. CIRA set up an ingest machine and account to access the NOAA ESPC Product Distribution and Access (PDA) system. GOES-R CONUS sector TPW retrievals are flowing into CIRA's NESDIS Ingest system in near-realtime, and being moved to other CIRA processing machines for integration with the existing blended TPW product. A minimal subscription initially for only CONUS TPW was set up to develop software and exercise the ingest process. The Legacy Atmospheric Moisture profile, which includes three layers of layer precipitable water (LPW) and cloud mask will be added to the PDA subscription, but those products were not needed in this reporting period.

A near-realtime website, http://cat.cira.colostate.edu/ABI_TPW/ABI_TPW.htm, has been created using the CIRA ingest to animate the CONUS sector TPW. A major achievement this reporting period was to read and map GOES-16 TPW data with the CIRA Data Processing and Error Analysis (DPEAS) system. DPEAS is a critical link to future R2O success as it is also the operational system running at NESDIS OSPO which produces operational blended TPW. In other words, the research system used in this project is also the target operational system for future operational transitions.

In order to handle GOES-16 data, a Fortran 90 module was created to add the ABI Fixed Grid map projection to DPEAS, following the *GOES-R Product Definition and Users' Guide, Volume 5: Level 2+*

Products. A DPEAS module to read the GOES-16 netCDF files was also created. Ingesting GOES-16 into DPEAS enables data fusion with other existing TPW products such as the operational blended TPW, new Microwave Integrated Retrieval System (MiRS) Version 11 retrievals which are not yet operational at OSPO.

An example of GOES-16 TPW mapped to an 11 km resolution Cylindrical Equidistant projection is shown in Figure 1, along with the corresponding NESDIS operational blended TPW product. As a reminder, the operational TPW does not use GOES-16 TPW data.

Initial visual evaluation of the animations and overall quality indicates that the cloud clearing is working well. Such evaluations will continue, as changing seasons and meteorological conditions can present new artifacts in the products. This was noticed in the GOES Sounder data over the past several years by our team, because in spring and summer fair weather cumulus clouds were not detected and negatively impacted the retrieval quality.

Quarter 2: Begin near-realtime collection and matching of GOES-R TPW to GPS and blended passive microwave TPW.

The GOES-R CONUS 5 minute data is being ingested and mapped to the same 16 km Mercator projection as operational blended TPW. CIRA runs a shadow system which creates blended TPW hourly, using the polar orbiting passive microwave retrieval data and Global Positioning System (GPS) data which have accuracy of better than 2 mm in all weather conditions. CIRA ingests GPS data hourly via the MADIS system. An initial comparison of GOES-16 TPW and GPS TPW for 21 hours of February 19, 2018 is shown in Figure 2. The RMS error of the GOES TPW is 2.6 mm, and the bias is 0.2 mm. This is a good start but further evaluations of this type are needed in the coming spring and summer months. A sample question is: Does the GOES-16 retrieval behave differently as the atmosphere becomes more humid, and will there be cloud masking problems with small cumulus clouds?

A comparison of GOES-16 TPW with a time-matched Suomi-NPP swath is shown in Figure 3. The major differences between the two products are the missing data due to clouds in GOES-16 and the regions outside of the S-NPP swath. This initial comparison shows encouraging agreement, with an r^2 value of 0.88 and fairly low RMS and bias values. This example is from daytime, a night time comparison showed similar performance.

Plans for Next Reporting Period

A subscription request for the GOES-16 TPW Full Disk sector will be added to the PDA subscription, to provide TPW every 15 minutes.

Implementation of the Community Radiative Transfer Model (CRTM) to simulate GOES-16 water vapor channels will begin. CRTM has previously been implemented within DPEAS, but only for simulations of microwave radiance. This change will involve adding new instrument configuration calls to CRTM.

Now that the ingest and mapping of GOES-16 TPW to a common projection as the passive microwave and GPS data is complete, comparisons between these datasets can begin in earnest.

Milestones in this reporting period are:
Quarter 3: Begin integration of CRTM with blended water vapor and MiRS temperature profiles.

Quarter 4*:* Add GOES-R TPW to BTPW, Version 3.0, at CIRA. Deliver via CIRA LDM to WPC, NHC and partner WFO's in Western Region in near-realtime. Develop training slides and have telecons with partner offices.

The project will participate in the spring Hazardous Weather Experiment, the satellite proving ground experiment will run the weeks of April 30, May 7, May 14, May 21. CIRA will deliver an experimental version of blended TPW using weighted GOES-16 data and a previously developed blending algorithm. This will provide a first look at how the GOES-16 data, which is only available in non-cloudy regions, meshes with other GPS and microwave data.

Additional Information

1. Interaction with operational partners –

Initial GOES-R plots were shown to Limin Zhao, who is the Precipitation Products Area Lead at NESDIS OSPO.

2. Conference/workshop participation –

John Forsythe attended the AMS Annual Meeting and presented the talk "Tracking Water Vapor with Multisensor Blended Products for Forecasters" in the Satellite Meteorology Conference.

3. Outside project publicity –

N/A

4. Journal articles –

N/A

Key Graphics

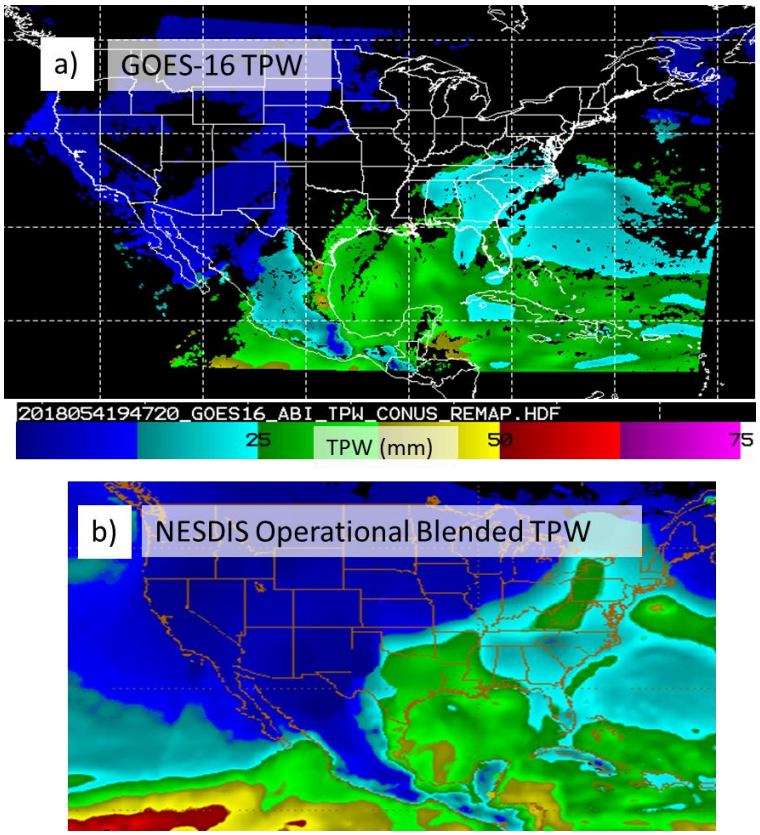

Figure 1: (a) Remapped GOES-16 TPW from 1947 UTC 23 Feb 2018 and (b) NESDIS Operational Blended TPW from 1921 UTC 23 Feb 2018.

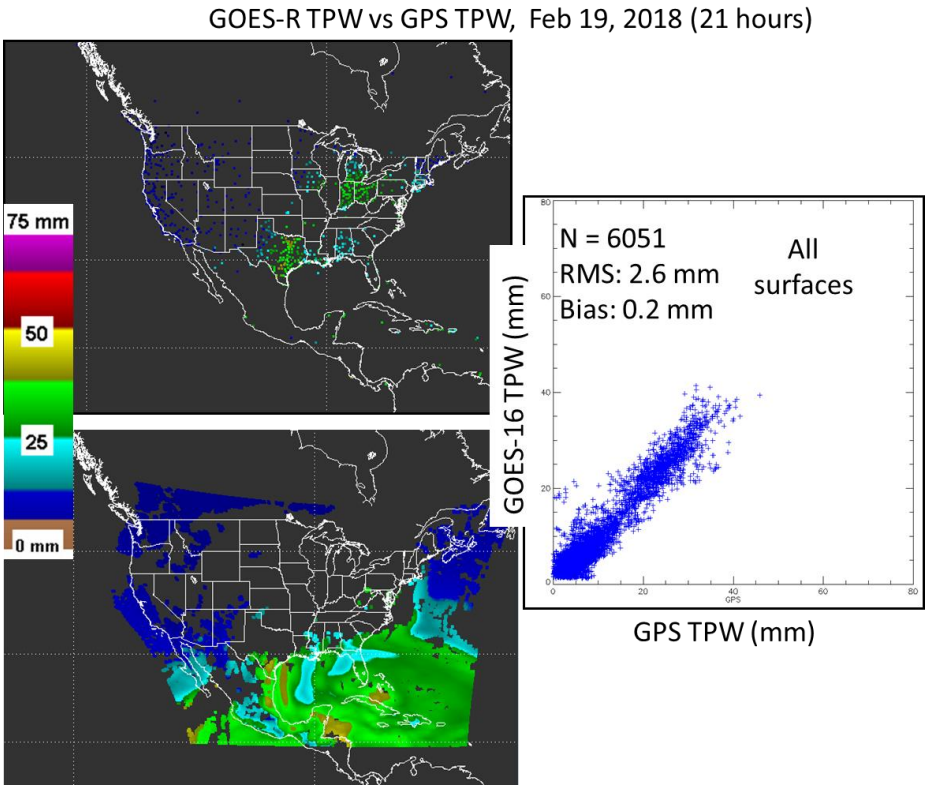

Figure 2: Results of a 21 hour matchup between GOES-16 and GPS stations for Feb. 19. 2018. An example of the GPS TPW and GOES-R TPW from the day is shown as an image, and the scatter plot from the day is also shown.

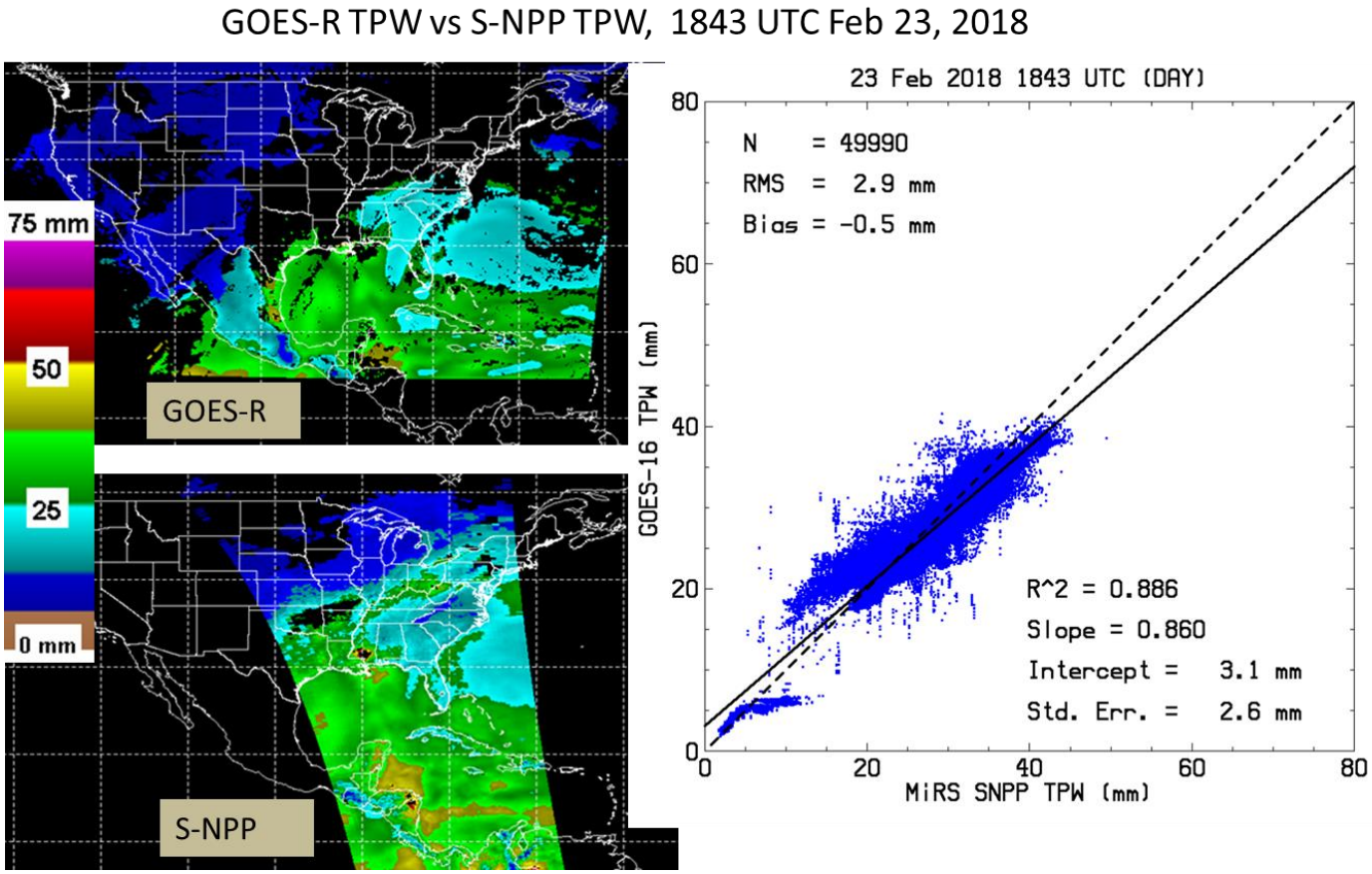

Figure 3: GOES-16 CONUS sector TPW vs Suomi-NPP TPW at the same time on 23 Feb. 2018.