GOESR3 Periodic Reporting

Reporting Period: July 2018 – December 2018 (1st half of FY19 funding cycle)

Team Lead: John Forsythe
Team Members: Andrew Jones, Stanley Kidder, Lewis Grasso, Natalie Tourville, Daniel Bikos (Co-Investigators, CIRA, Colorado State University)
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 of the second year of this project saw routine ingest of the GOES-16 Total Precipitable Water (TPW) product at CIRA, and comparisons with satellite microwave and Global Positioning System (GPS) TPW products which are currently used in operational blended TPW. Near-realtime animations of the data are online at CIRA, using data processed with the same data processing system as used in NESDIS operations. A variety of near-realtime GOES-16 TPW and related product animations are available at http://cat.cira.colostate.edu/abi_tpw/ (CONUS) and http://cat.cira.colostate.edu/ABI_TPW_FD/ (Full Disk). This includes an advected TPW product, which is likely the future direction of blended TPW products for forecasters. Advected TPW from polar data with GOES-16 data overlaid will be evaluated in NOAA forecast testbeds in 2019 (Hazardous Weather Testbed (HWT) and Flash Flood and Intense Rainfall Experiment (FFaIR) at WPC)). Routine inspection of the GOES-16 TPW data overlaid onto the advected TPW derived from polar orbiters indicates that the GOES-16 TPW is of high quality, with no obvious artifacts or diurnal biases.

An initial version of a "cloud free water vapor channel" (Channel 09 - 6.9 μm) water vapor radiance data product has been created. Advected layer precipitable water (ALPW) fields are used to drive the Community Radiative Transfer Model (CRTM) and create cloud-free water vapor imagery. Several simulations around tropical cyclones were created, and the product could be promising for detecting whether the atmosphere is dry under a deck of cirrus. This might be particularly useful for tropical wave genesis and short-term tropical cyclone intensity forecasting. Further evaluation is planned during the 2019 hurricane season.

CIRA's production of GOES-16 TPW with advected microwave TPW was used in forecast operations to support the NSF-sponsored RELAMPAGO convective experiment in South America in late 2018.

Progress toward FY19 Milestones

There were two project milestones this reporting period:

Quarter 1: Initial creation of advectively blended TPW.

A near-realtime advectively blended TPW product has been created, and is available hourly for both CONUS and fulldisk domains at http://cat.cira.colostate.edu/abi_tpw/ (CONUS) and http://cat.cira.colostate.edu/ABI_TPW_FD/ (Full disk). An example of the blended product with GOES-16 TPW overlaid is shown in Figure 1.

The project initially planned to participate in the spring Hazardous Weather Testbed in 2018, but due to training and distribution issues, as well as changing product configurations, we did not participate. We plan to participate in this experiment in spring 2019. The next FFaIR experiment will be in June-July 2019 at WPC, and we plan to participate in this as well with the new GOES-16 infused TPW product.

At both of these experiments, forecasters will toggle between the operational blended TPW product and the GOES+Advected product. They will be surveyed on the benefits and deficits of the new product compared to the operational TPW. It is hypothesized that they will find the new product more physically realistic.

Quarter 2: Initial GOES-R radiance simulations in cloudy skies created. Deliver advected TPW to users in AWIPS-II / N-AWIPS format.

This task is proceeding well. Simulations of ABI Channel 09 (6.9 μm central wavelength) versus the observed radiance are shown in Figures 2 and 3 for Hurricanes Hector and Lane, respectively. These cases were chosen as a demonstration because forecasters noted the importance of dry air in their intensity forecasts (Chris Slocum (CIRA), personal communication). The NHC discussions for each system mention the dry air nearby. In the figures arrows indicate dry air (warmer brightness temperatures) in the simulated data while the GOES-15 water vapor data has clouds. This might provide valuable environmental information for hurricane intensity forecasts. These are Version 1.0 simulations, the simulation is being further refined to reduce biases in clear skies.

The radiance simulation now contains all of the necessary state variables to create realistic looking imagery. Further refinements are in progress to reduce biases between the modelled and observed brightness temperature fields. The CRTM configuration for Version 1.0 includes:

- Temperature data from GFS at five fixed pressure levels, + surface. Level, not layer data.
- 300-100 mb mixing ratio estimated at 10% of 500-300 value (poor simulations without this layer).
- Zenith angle effect included
- No aerosols, fixed surface emissivity
- As initial focus is on oceans for NHC, currently no simulations at surface pressure < 850 mb or precipitating regions (black in simulations).

In the next reporting period, the simulations will be activated in near-realtime, which will greatly enable an evaluation of whether this experimental product could have forecast applications.

Plans for Next Reporting Period

Milestones in the next reporting period are:

Quarter 3: Gather comments from forecasters and adjust products accordingly. Finalize advected TPW product and compare to GOES-R TPW. Analyze matchup statistics.

Quarter 4: Characterize errors of advectively blended TPW using GPS and GOES-16.

The project will participate in the spring Hazardous Weather Testbed in spring of 2019. CIRA will deliver an experimental version of blended TPW 9Version 1.0 overlaid GOES-16 data in clear regions. A key feature is that the passive microwave TPW field will be an advected field, versus the swath overlay which is currently in the operational blended TPW. This will give forecasters a look at a new approach to a familiar and widely used product, with GOES-16 inputs. It's worth noting that this approach (GOES TPW is the dominant data when available) is the opposite of the current NOAA blended TPW (GOES is used as a last-ditch hole filler).

Additional Information

1. Interaction with operational partners –

GOES-R plots and updates on the work as needed are provided to Limin Zhao, who is the Precipitation Products Area Lead at NESDIS OSPO. These occur through biweekly telecons related to operational blended product support.

Initial AWIPS-2 test files were sent to the National Weather Center in advance of TPW product evaluation in the 2019 Hazardous Weather Testbed. Minor modifications will be iterated upon (color, map area).

2. Conference/workshop participation –

John Forsythe presented "Using the New Capabilities of GOES-R to Improve Blended, Multisensor Total Precipitable Water Products for Forecasters" at the 15th Annual Symposium on New Generation Operational Environmental Satellite Systems at the 2019 AMS annual meeting.

Sheldon Kusselson presented "Advected Layered and Total Precipitable Water Products and Applications to Forecasting Hazardous Precipitation Events" at the AGU Fall meeting in session IN046 JPSS: Providing Advanced Global Observations to Improve Knowledge and Decisions by a Global Interconnected Community.

3. Outside project publicity –

N/A

4. Journal articles –

N/A

Key Graphics

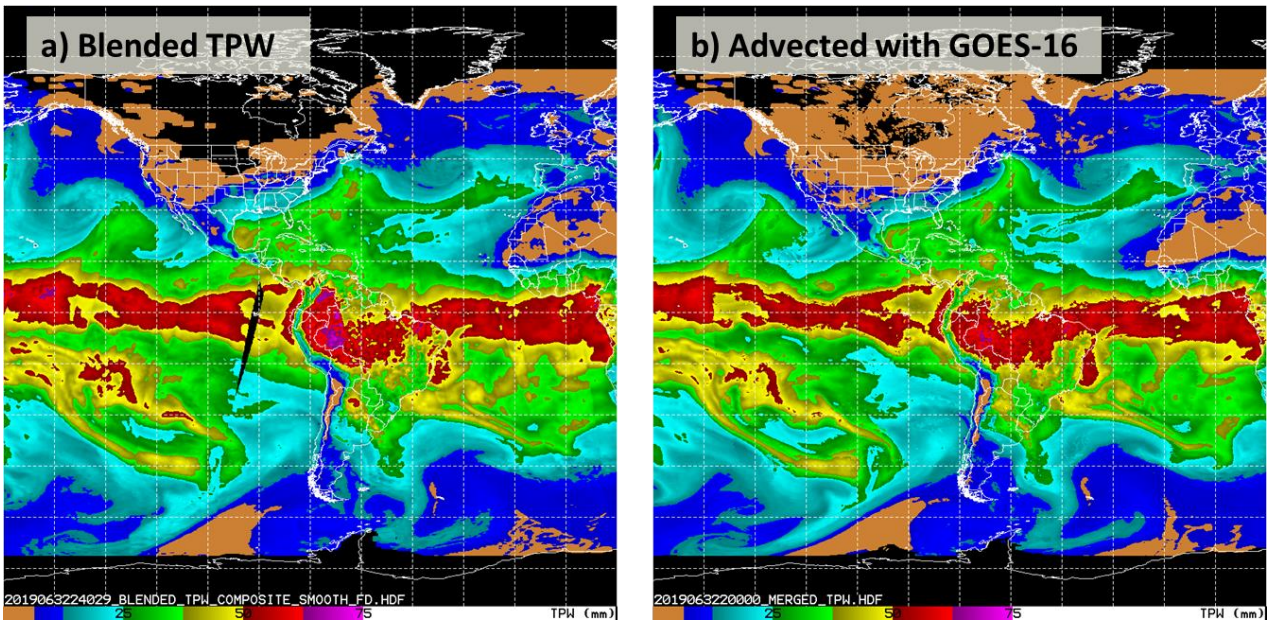
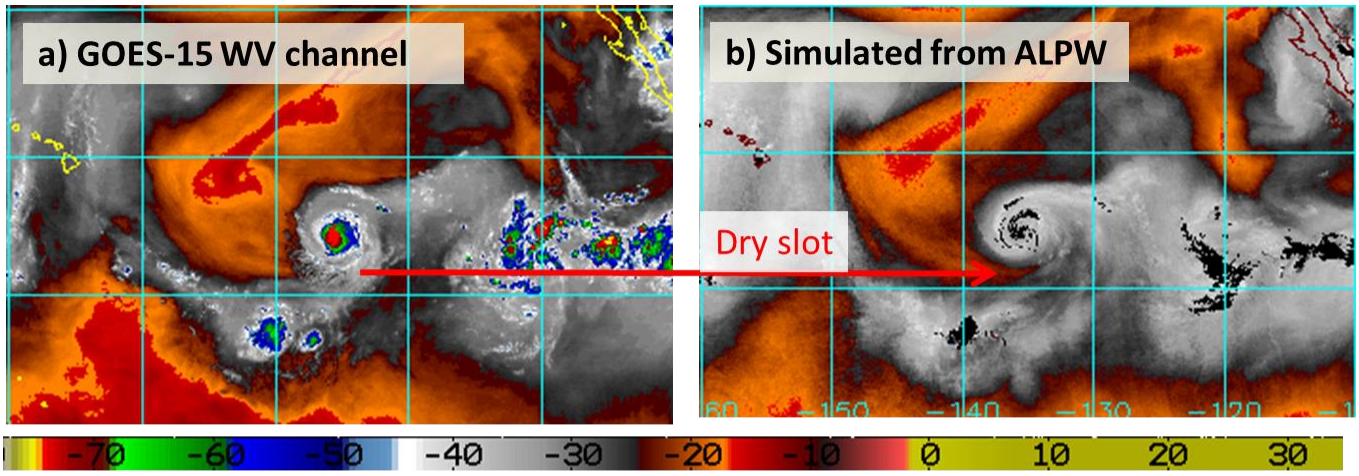


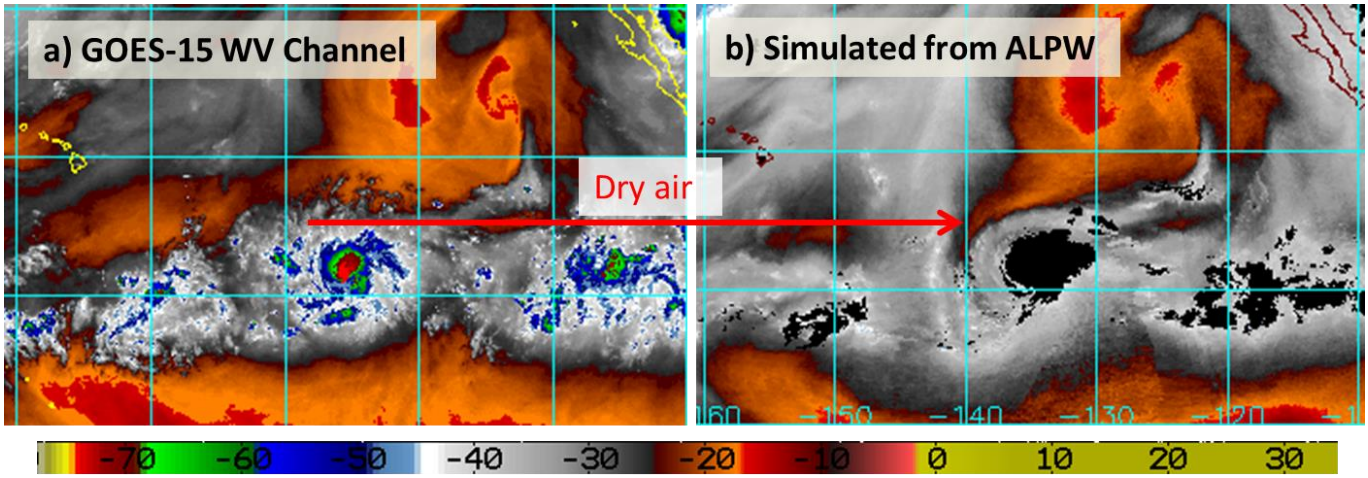
Figure 1: Blended TPW (mm) using a) NOAA operational algorithm (i.e. non-advected) and b) Version 1.0 of new algorithm using advected microwave data with GOES-16 overlaid. 22 UTC 4 March 2019. Notice the increased coverage over snow-covered areas due to GOES-16 TPW data, since the GOES retrieval is not adversely impacted by snow unlike the microwave retrieval.



Aug. 5, 2018 09 UTC Hurricane Hector

Hurricane Hector Discussion Number 19
NWS National Hurricane Center Miami FL EP102018
200 AM PDT Sun Aug 05 2018
…
Outer banding features have become less evident since the previous advisory, and with Hector moving into an increasingly drier airmass, the chances of Hector evolving into an annular hurricane are increasing in the longer term. Although the hurricane will be embedded within a light vertical wind shear environment, marginal SSTs and a much drier airmass characterized by mid-level humidity values less than 40 percent are expected to produce a slow weakening trend throughout the forecast period. The official intensity forecast is a little lower than the previous advisory, and closely follows the intensity consensus models HCCA, FSSE, and IVCN, which all show steady weakening.
…
Forecaster Stewart

Figure 2: a) Observed GOES-15 water vapor channel and b) Cloud-free simulation from ALPW product at 09 UTC 5 August 2018 for Hurricane Hector. NHC discussion noted the dry airmass around the system, and the simulated product shows cloud-obscured dry air on the south side of Hector. Black areas in simulated image are precipitation masked.



August 18, 2018 03 UTC Hurricane Lane

Hurricane Lane Discussion Number 13
NWS National Hurricane Center Miami FL EP142018
800 PM PDT Fri Aug 17 2018
…
The first portion of the intensity forecast is a bit problematic. With the exception of the HMON model, none of the intensity guidance shows much additional strengthening. However, except for the possibility of some dry air wrapping around the west side of the central convection, there is no apparent reason why the current rapid intensification should stop that quickly. The intensity forecast will show 12 h more of rapid intensification, followed by a period of little change from 12-48 h. This portion of the intensity forecast lies above all of the guidance. After 48 h, Lane should start to encounter westerly shear, which should increase by the end of the forecast period and cause the cyclone to steadily weaken. This portion of the intensity forecast lies near or a little above the intensity consensus.
…
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Forecaster Beven

Figure 3: a) Observed GOES-15 water vapor channel and b) Cloud-free simulation from ALPW product at 03 UTC 18 August 2018 for Hurricane Lane. NHC discussion noted the dry air on the west side of the central convection, which is readily apparent in the simulated imagery as compared to the GOES image. Black areas in simulated image are precipitation masked.