Development and Testing of a Layer Precipitable Water Product to Aid Forecasting of Heavy Precipitation and Flooding†

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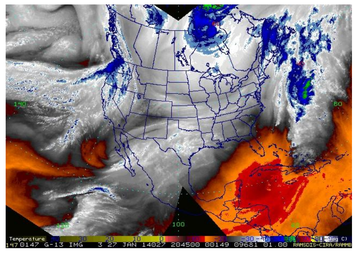
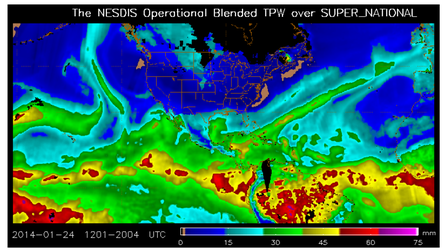
The Problem

Forecasters have long used precipitable water products to aid forecasting of heavy precipitation and flooding, especially along the west coast of continents, where atmospheric rivers make landfall. Two of the most common products are GOES water vapor imagery, which shows mid- to upper-level water vapor, and total precipitable water products from polar-orbiting microwave sensors, which allow the detection of total column water vapor through clouds. A deficiency of these products is that they contain little information about the vertical distribution of the water vapor.



GOES 6.7 μm water vapor imagery. Shows clouds and high-level moisture.



Blended TPW includes microwave observations from NOAA, DMSP, GPS, METOP, and GOES satellites, but contains no information about the vertical distribution of the water vapor.

An Opportunity

Recent instruments and techniques, such as NOAA's Microwave Integrated Retrieval System (MIRS) and NASA's Atmospheric Infrared Sounder (AIRS), allow the retrieval of water vapor profiles. We have developed a four-layer precipitable water product (surface to 850 hPa, 850 hPa to 700 hPa, 700 hPa to 500 hPa, and 500 hPa to 300 hPa), which we call Layer Precipitable Water or LPW:

$$LPW \equiv \int_{p_{top}}^{p_{bottom}} q \frac{dp}{g},$$

where p is pressure, q is mixing ratio, and g is gravity. We also calculate another product we call Layer Relative Humidity or LRH:

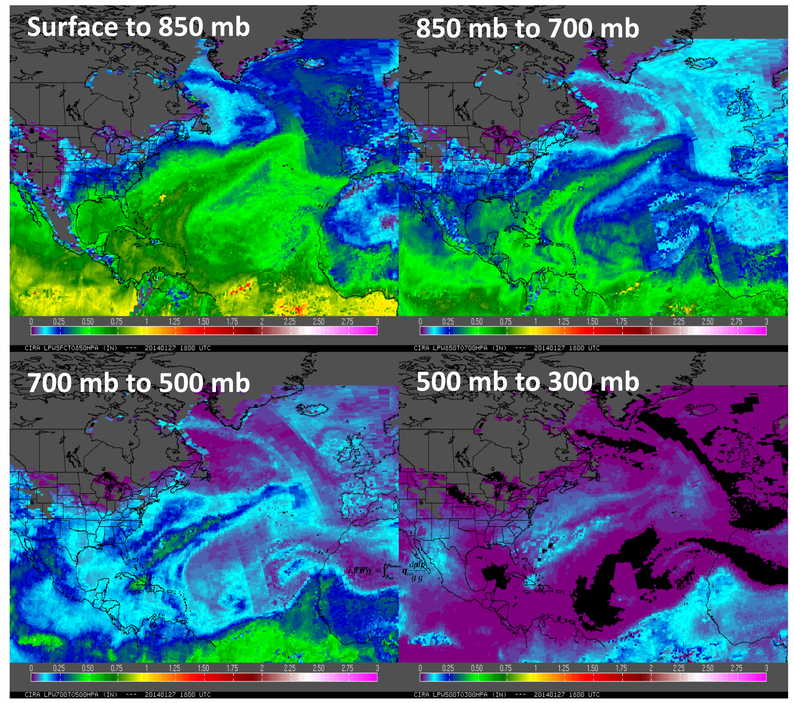
$$LPW_{sat} \equiv \int_{p_{top}}^{p_{bottom}} q_{sat}(p, T(p)) \frac{dp}{g},$$

$$LRH \equiv \frac{LPW}{LPW_{sat}},$$

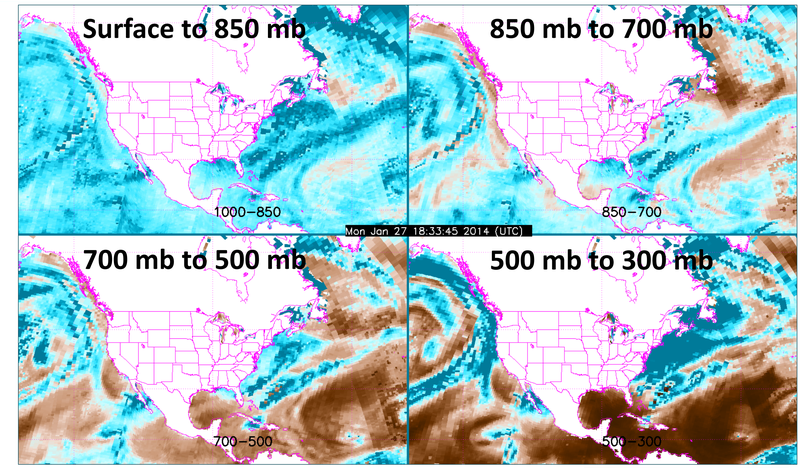
where T is the absolute temperature and the subscript sat indicates saturation values. The products are produced at 3 h intervals from MIRS and AIRS retrievals; they cover the Earth from 71°N to 71°S. They are available in real time in AWIPS format, so that forecasters can easily access the products.

Although moisture retrievals have been available for some time, layer moisture products have not previously been routinely available to forecasters.

Example Products



Layer Precipitable Water from SPoRT. Five polar satellites (NOAA-18 & 19, Metop-A, DMSP F-18 and NASA Aqua) are blended together every three hours.

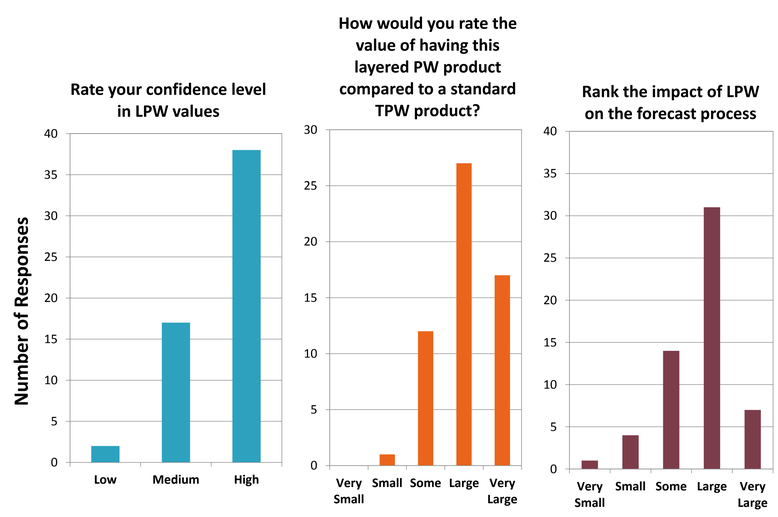


Layer Relative Humidity from CIRA.There are currently no RH retrievals over land from the MIRS system.

View Real-Time LPW Animations
http://cat.cira.colostate.edu/LPW_Animations

Product Testing

The LPW product (but not the LRH product) was converted by SPoRT into AWIPS format for testing by NWS forecasters on the U.S. West Coast, in Alaska, and in Puerto Rico in two observation periods in the spring and summer of 2013. Forecasters were asked several questions about the LPW product. A paper detailing the results is forthcoming. Briefly, preliminary overall results are presented below.



Summary and Recommendations

Forecasters generally had high confidence in the LPW product, thought it added value to the standard TPW product, and reported that it had a large impact on the forecast process. One forecaster in Puerto Rico wrote, "Overall, this product to me is of great value and should be made operational." Another forecaster who was using the product for multiple events at once was specifically pleased with the appearance of the product, saying the "visual quality is alone a help on a busy shift."

We recommend that:

1. Steps be taken toward operationalization of the LPW product.
2. Other layer moisture products, such as LRH, be similarly tested.
3. The LPW product be tested by NHC forecasters during the 2014 Atlantic hurricane season.

More Information

- This work was supported by NASA ROSES grant NNX11AL77G to CIRA/Colorado State University.
- We thank the NWS forecasters who ***volunteered*** their time to assess the LPW product.
- The first two authors wish to thank NASA's SPoRT Center for converting the LPW product into AWIPS format, getting it to forecasters, and organizing the assessment.
- http://cat.cira.colostate.edu/LPW_Poster

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