The CIRA Advected Layer Precipitable Water (ALPW) Product and Applications to Help Forecast Hazardous Precipitation Events

Sheldon J. Kusselson[1],John M. Forsythe[1], Stanley Q. Kidder[1], Andrew S. Jones[1], Ed Szoke[1], Dan Bikos[1], Chris Gitro[2], Michael Jurewicz[2] and Dan Leins[2]

[1]*Cooperative Institute for Research in the Atmosphere, Colorado State* [2]*NOAA/NWS*

CIRA ALPW products are currently produced hourly and distributed to 23 NWS WFO's and NWS/NCEP NHC, WPC, OPC and NESDIS SAB. Satellite inputs currently are S-NPP, NOAA-19/20, MetOp-A/B, and DMSP F17/18 MiRS Retrievals

John.Forsythe@colostate.edu

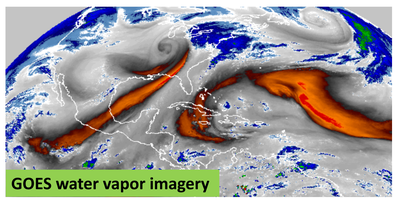
View near-realtime animations at: http://cat.cira.colostate.edu/sport/layered/advected/LPW_alt.htm

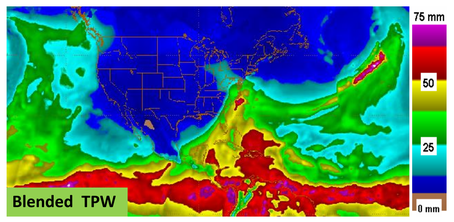
Sheldon.Kusselson@colostate.edu

What Do Forecasters Currently Use Operationally to Analyze Water Vapor?

Analyzing the distribution of water vapor from observations is a key component of the forecast cycle. Both integrated (total precipitable water - TPW) and vertically resolved fields are necessary, depending on the particular forecast challenge. Typically, National Weather Service (NWS) forecasters rely on a few standard tools for this task. There are currently no observing systems within the NWS region of responsibility that provide hourly, vertically resolved, land and ocean, clear and cloudy sky moisture soundings for weather forecasting. A 4-D water vapor product can be applied to many forecasting problems. It can be used to assess the depth of an "atmospheric river" of moisture to determine how much of it will make it over coastal mountains to affect the Cascades of Washington and Oregon or Sierra Nevada of California. A favorable amount of mid-level moisture can be the difference between just an ordinary heavy precipitation event and an extraordinary or historic event, like seen twice since 2016 around Ellicott City, MD. Upper level moisture above 500 hPa can also be useful to predict whether cirrus clouds will form or persist and impact high or low temperature forecasts. An experimental Advected Layered Precipitable Water Vapor (ALPW) product supported by the JPSS Proving Ground is assisting forecasters in this process.

Blended, layered water vapor products fill a void in observations to provide vertical structure



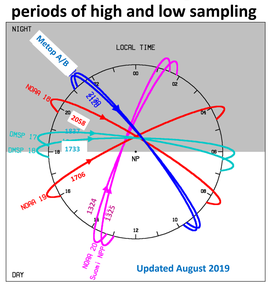


NOAA OFFICE OF SATELLITE AND PRODUCT OPERATIONS — 1800 UTC 15 November 2018

How is the Blended ALPW Product Created?

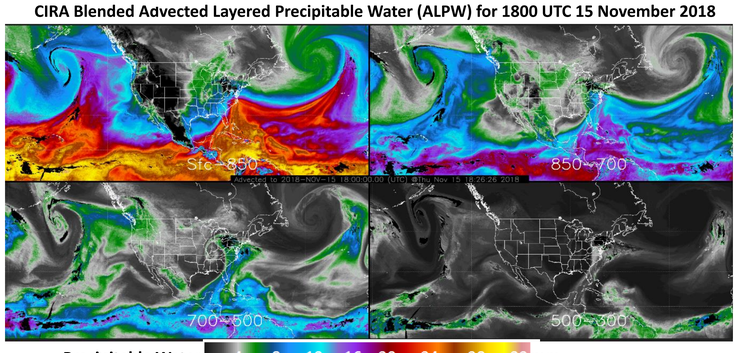
Satellite inputs currently are Suomi-NPP, NOAA-19/20, MetOp-A/B, and DMSP F17/18 MiRS Retrievals

Local equator crossing times, periods of high and low sampling



- Water Vapor profiles created by the NOAA operational Microwave Integrated Retrieval System (MiRS) retrievals from seven spacecraft received at CIRA. Typical latency is 1.5 to 3 hours.
- Four layers of precipitable water created (surface-850, 850-700, 700-500 , and 500-300 hPa).
- Advection of satellite moisture based on GFS model winds to shorten latency and smooth features.
- Satellites overlaid every three hours (36h loop) and every hour (12h loop) in a revolving composite to create animations.
- Product routed in AWIPS-2 and N-AWIPS format to 23 NWS WFOs, WPC via CIRA and SAB, NHC via NASA SPoRT (thank you!).

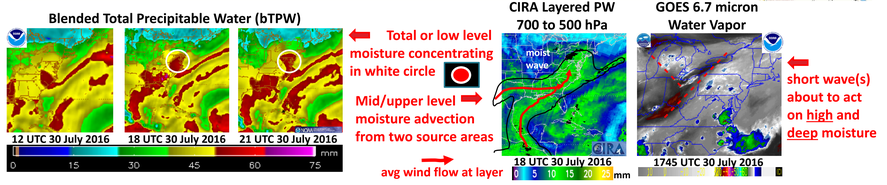
CIRA Blended Advected Layered Precipitable Water (ALPW) for 1800 UTC 15 November 2018



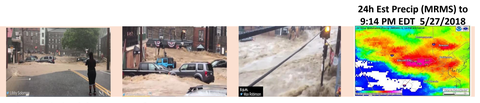
Training Forecasters on Use of Blended TPW and ALPW With Reinforcing Case Study Examples

The Virtual Institute for Satellite Integration Training (VISIT) is a joint effort involving NOAA/NESDIS Cooperative Institutes (e.g. CIRA, CIMSS), the National Environmental Satellite Data and Information Service (NESDIS) and the National Weather Service (NWS). The primary mission of VISIT is to accelerate the transfer of research results based on atmospheric sensing into NWS operations through distant education techniques. Everybody, including those outside government, can take part in the learning here. Many have taken part in both the live and online "ALPW Product" training at: *http://rammb.cira.colostate.edu/training/visit/training_sessions/advected_layer_precipitable_water_product/* . Many hazardous weather case study events are presented during these sessions, so forecasters can understand the products and how to use them. Reinforcing case studies examples using applications have also been well received. A few cases are provided below.

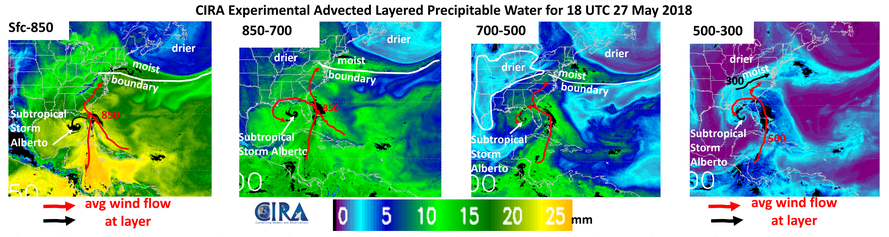
Ellicott City, Maryland Flood #1 (July 2016)



Ellicott City, Maryland Flood #2 (May 2018)

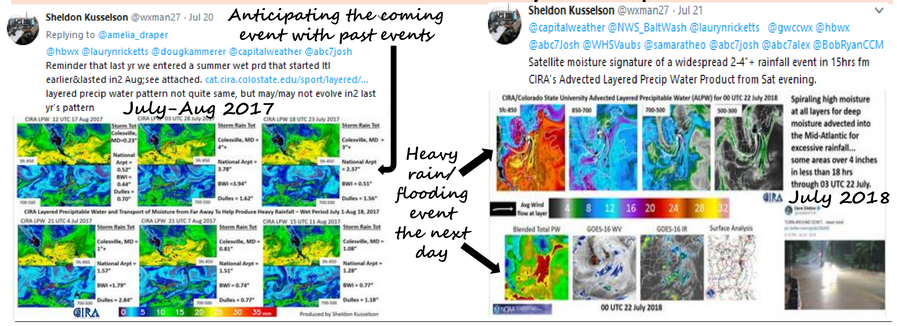


CIRA Experimental Advected Layered Precipitable Water for 18 UTC 27 May 2018

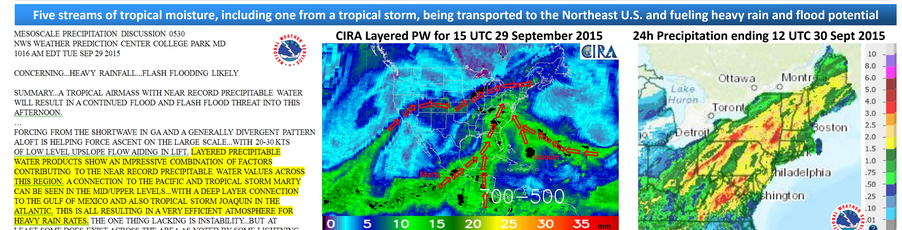


A relatively high concentration of moisture at 4 layers from Subtropical Storm Alberto into the Southeast U.S. Some of the same high moisture was also interacting with an analyzed boundary/front (west to east oriented concentration of higher moisture) to help produce a second 1000-year flood in three years in Ellicott City, Maryland.

Social Media – Use of Blended TPW and Advected Layered Precipitable Water in DC Area

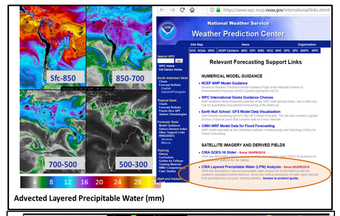


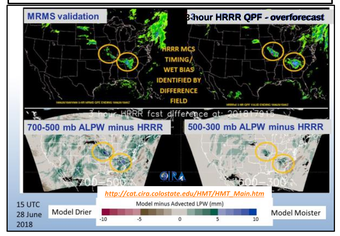
Five streams of tropical moisture, including one from a tropical storm, being transported to the Northeast U.S. and fueling heavy rain and flood potential

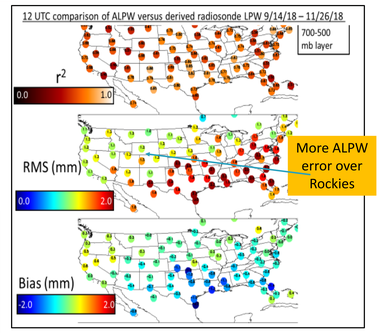


What Research is in Progress?

- Comparison of the ALPW to coincident radiosondes
- Comparison of HRRR model derived 3 hour forecast LPW to ALPW
  - Evaluated at the WPC FFaIR experiment in summer 2019
- Adding new geographic regions, such as the South America sector shown below and used by the NCEP WPC International desk.







Can ALPW be used to tell whether the model is too moist or dry? Is this reflected in QPF?

from 2018 FFaIR experiment at WPC

Summary:

- The ALPW product is widely used by forecasters to track long-distance transport of water vapor which can be a precursor to heavy precipitation and flooding. Commonly used in WPC Mesoscale Precipitation Discussions.
- ALPW is independent of the model moisture fields and thus can be used for comparison to models. Work in progress to see if this is useful for QPF.
- A lead forecaster at NWS WFO Tucson mentioned, "we look at the ALPW product religiously, especially during the Southwest Monsoon season".
- Another WPC forecaster said, "I always value the ALPW when it comes to diagnosing eastern tropical Pacific mid/upper level moisture tongues that lift northeast across the central/southern Plains and Midwest. These streams of enhanced moisture can play key seeder-feeder roles in rainfall efficiency of mid-latitude convection well east of the Continental Divide, and will definitely alter the static stability of the vertical column".
- WPC forecaster looks at the 700-500 ALPW for narrow PW plumes at that layer; he mentioned, "you don't need as much CAPE/instability to get good convection over an area on downwind side of 700-500 moisture plume".
- CIRA and CIMSS are working on adding advection technology and GOES-TPW data to the operational blended TPW product (from Sheldon Kusselson's Wednesday morning NWA talk). If ALPW becomes operational, it will give forecasters a consistent set of satellite-derived water vapor analysis tools.

More details:

Forsythe, J. M., S. Q. Kidder, K. K. Fuell, A. LeRoy, G. J. Jedlovec, and A. S. Jones, 2015: A multisensor, blended, layered water vapor product for weather analysis and forecasting. NWA Journal of Operational Meteor., Vol. 3, No. 5, 41- 58.

LeRoy, A., K. K. Fuell, A. L. Molthan, G. J. Jedlovec, J. M. Forsythe, S. Q. Kidder, and A. S. Jones, 2016: The operational use and assessment of a layered precipitable water product for weather forecasting. NWA J. Operational Meteor., Vol. 4, No. 2, 22-33.

Gitro, C. M., M. L. Jurewicz, S. J. Kusselson, J. M. Forsythe, S. Q. Kidder, E. J. Szoke, D. Bikos, A. S. Jones, C. M. Gravelle, C. Grassotti, 2018: Using the multisensory advected layered precipitable water product in the operational forecast environment: NWA Journal of Operational Meteor., Vol. 6, No. 6, 59-73.

VISIT Advected Layered PW Training at: http://rammb.cira.colostate.edu/training/visit/training_sessions/advected_layer_precipitable_water_product/ .

National Weather Association Monthly (November, 2018) Webinar titled, "Using the Multisensor Advected Layered Precipitable Water Product in the Operational Forecast Environment" at: https://bit.ly/2P5mbSZ .

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