Using Ground-based GPS from SuomiNet and NWP Reanalysis for Regional Validation in Europe and North America of PWV from IASI, AIRS, and CrIS for Detecting Extreme Weather Events and Climate Change

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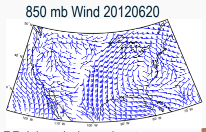
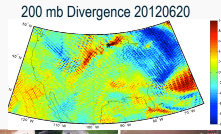
Abstract

The water content of the atmosphere is a key climate response to increasing temperatures in global climate model (GCM) simulations. To better understand the water vapor feedback in models, observations are needed that provide good spatial and temporal resolution over both ocean and land areas. In addition, the IPCC 4th Assessment found that changes in extreme events, such as droughts, heat waves, and flooding, have occurred and the frequency of such events is expected to increase. PWV is a useful parameter for forecasters in determining atmospheric stability and the probability of convection; it is critical for determining the occurrence of extreme weather events. This paper investigates the accuracy of satellite retrieved PWV climatology for use in comparison to climate models as well as the ability to detect extreme weather events. Validation data is from the ground based GPS network (IGS and SuomiNet) and the NWP reanalysis products. PWV retrievals from EUMETSTAT for the IASI will be compared to retrievals done by NOAA, along with NASA AIRS, and NOAA/NASA CrIMSS. In addition, for detecting extreme weather events, UW satellite retrievals using IASI, AIRS, and CrIS radiances will be used. The UW satellite retrievals use a new dual regression retrieval algorithm that is designed to preserve the trace-ability of the sensor radiances to international standards (SI).

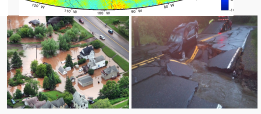
Duluth, MN, USA

Storm Event

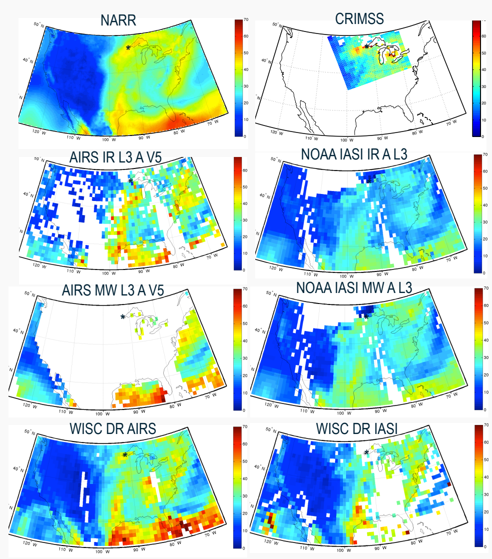




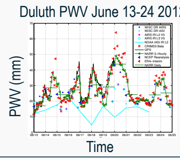
The NARR (above) showed a strong transport of moisture from the Gulf of Mexico to Duluth during June 19th and 20th 2012 when a low pressure system stalled over the area and strong divergence at 200 mb occurred



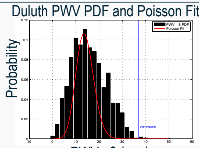
Satellite Observations

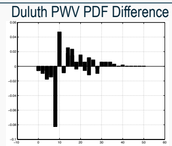


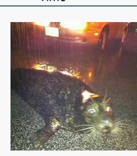
- The panels above show daily PWV (mm) for June 20th 2012.
- The CRIMSS (only one granule) shows the enhanced moisture over the Duluth region on this day whereas the AIRS L3 V5 is missing many points and has relatively lower PWV.
- The figure to the right shows the PWV (mm) on June 13th-24th 2012 for Duluth, MN.



Extreme Event







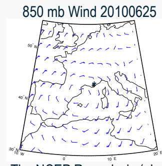
- The PDF of normalized NARR June daily PWV from 1979 is shown left. The red curve represents the Poisson fit to the distribution. This event had was a 5 sigma event
- The PDF difference of the last 10 years-first 10 years of the NARR, shown on the right panel, indicates a shift to higher moisture values.

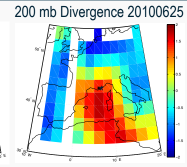
Conclusions

- The Duluth flooding of June 2012 was predominantly caused by strong northward transport of moisture from the Gulf of Mexico.
- This northward moisture transport was well characterized by the NARR and best captured by the Wisconsin Dual Regression of AIRS radiances.
- CRIMSS (ATMS+CrIS combined MW+IR retrievals) shows promising results with PWV values close to those seen by the ground based GPS, where as the AIRS L3 and L2 V5 had a strong dry bias and were lacking spatial resolution.
- PDFs show strong evidence that the Duluth Flood was an extreme event in terms of PWV (5 sigma).

Var, France

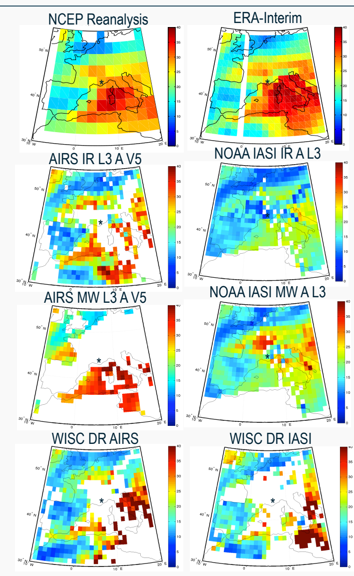
Storm Event

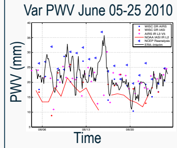




The NCEP Reanalysis (above) showed a strong transport of moisture from the Mediterranean Sea during June 15th and 16th 2010 when a meso-scale cyclone moved across the region bringing strong divergence at 200 mb

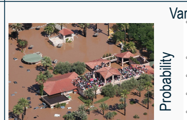
Satellite Observations

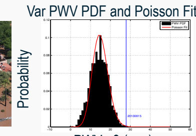


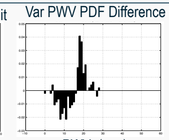


- The panels above show daily PWV (mm) for June 15th 2010.
- CRIMSS not available for this date, but AIRS L3 V5 captures enhanced moisture over the Mediterranean Sea.
- The figure to the left shows the PWV (mm) on June 5th-25th 2010 for the Var region in France.

Extreme Event







- The PDF of normalized NCEP June daily PWV from 1949 is shown left. The red curve represents the Poisson fit to the distribution. This event had was a 6 sigma event
- The PDF difference of the last 15 years-first 15 years of the NCEP Reanalysis, shown on the right panel, illustrates a shift to greater moisture.

Conclusions

- The Var flooding of June 2002 was predominantly caused a cyclone stalled over the region that brought moist air from the Mediterranean Sea to Southern France.
- This transport was well characterized by the NCEP Reanalysis and the ERA-Interim. Near the coast, the NOAA IASI MW L2 product showed the enhanced moisture, whereas the IR product was significantly drier.
- The AIRS L3 V5 product best verify the PWV reanalyses.
- Through PDFs strong evidence exists that the Var Flood was an extreme event for PWV (6 sigma).