JPSS Hydrology Products

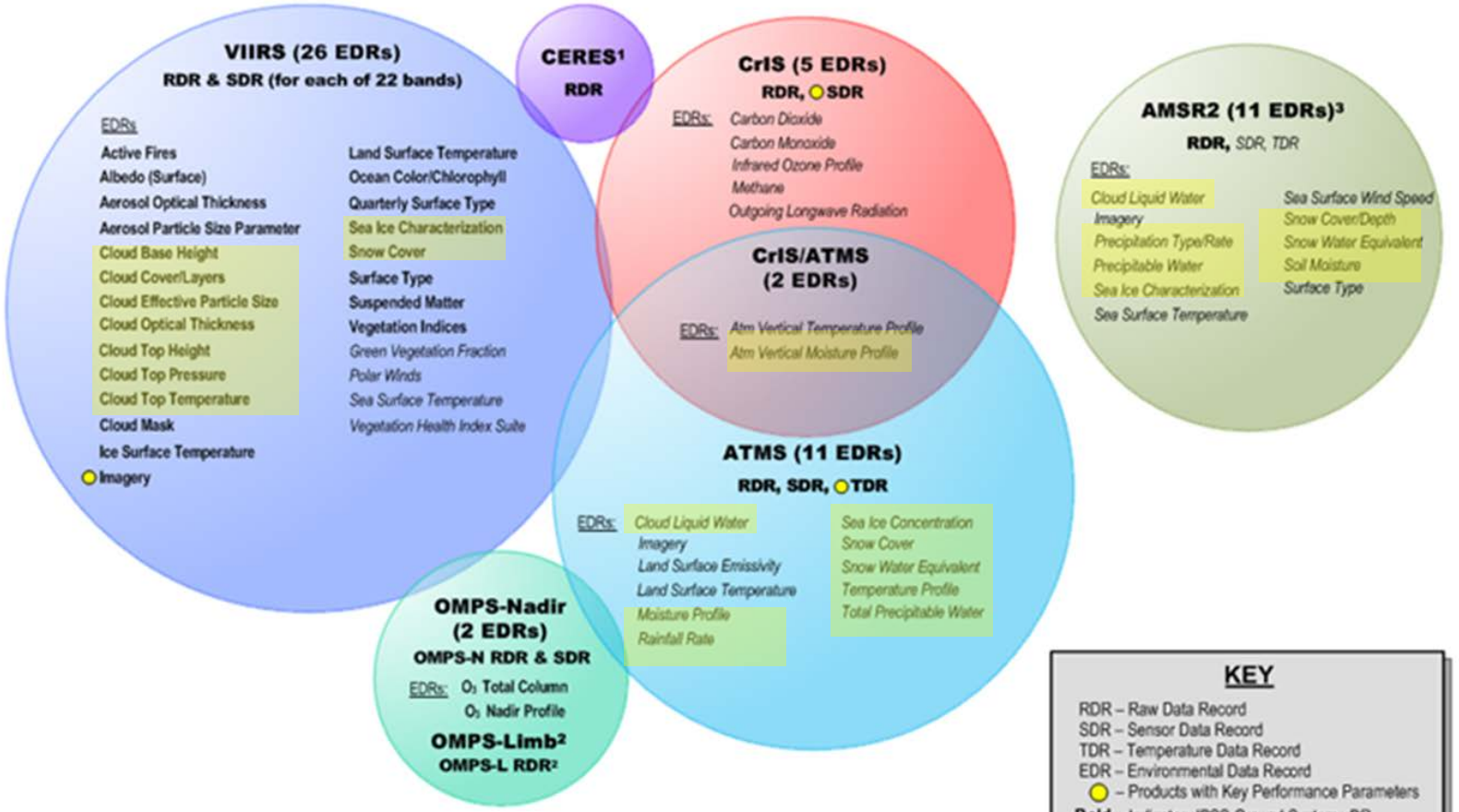
Ralph Ferraro
NOAA/NESDIS/STAR
Ralph.R.Ferraro@noaa.gov

Three Classes of Products

- JPSS Baseline products/systems
  - Primarily from ATMS, AMSR-2, VIIRS
- JPSS/Legacy POES "blended" products
  - Primarily MW driven, includes AMSU/MHS and non-NOAA satellites like GPM
- JPSS Proving Ground Risk Reduction (PGRR) developmental products
  - Enhancements to baseline, could include data fusion with GOES and in-situ
  - Newer, pushing limits of sensor capabilities

JPSS Baseline Hydrology – Very Diverse!

JPSS Program Data Products



Notes:

[1]RDRs for the JPSS-2 Mission are contingent on NASA manifest of the Radiation Budget Instrument (RBI)

[2]Not applicable to JPSS-1; contingent on NASA manifest of OMPS-Limb on the JPSS-2 Mission

[3]Dependent on the Global Change Observation Mission (GCOM) provided by the Japan Aerospace Exploration Agency

The JPSS Program includes Ground System Support for the Metop, DMSP, and GCOM missions

December 18, 2014

This chart is controlled by JPSS Program Systems Engineering

JPSS-P Rev C

Primary Product Systems

(Support S-NPP, POES, JPSS-1, some others…)

- Microwave Integrated Retrieval System (MiRS)
  - http://www.ospo.noaa.gov/Products/atmosphere/mirs/index.html
- Snowfall Rate (SFR)
  - http://www.ospo.noaa.gov/Products/atmosphere/mspps/real_us.html
  - http://www.ospo.noaa.gov/Products/atmosphere/mirs/index.html
- NOAA Operational GCOM-W1 AMSR2 Products System (NOGAPS)
  - http://www.ospo.noaa.gov/Products/atmosphere/gpds/
- NESDIS Operational Soil Moisture Products (SMOPS)
  - http://www.ospo.noaa.gov/Products/land/smops/index.html
- Blended TPW/RR
  - http://www.ospo.noaa.gov/Products/atmosphere/brr/
- Interactive MultiSensor Snow & Ice Mapping System (IMS)
  - http://www.natice.noaa.gov/ims/index.html

JPSS PGRR Hydrology Initiative Projects/Participants

Project details provided in backup slides

Project PI	Project Title
Dave Gochis *(NCAR)*	Applying Snow Products from S-NPP JPSS and SNODAS to Seasonal Streamflow Forecasting at the NWS National Water Center
Huan Meng *(NESDIS/STAR)*	Continued expansion, enhancement and evolution of the NESDIS snowfall rate product to support weather forecasting
Pingping Xie *(NWS/NCEP)*	Reprocessing of JPSS precipitation and OLR products for improved operational climate applications
John Forsythe *(CSU/CIRA)*	Using JPSS Retrievals to Implement a Multisensor, Synoptic, Layered Water Vapor Product for Forecasters
Tony Wimmers *(UW/CIMSS)*	Strengthening TPW visualization in the OCONUS domain with JPSS data products
Tarendra Lakhankar *(CUNY/CREST)*	Validation and Application of JPSS/GCOM-W Soil Moisture Data Product for operational flood monitoring in Puerto Rico
Jerry Zhan *(NESDIS/STAR)*	Enhance Agricultural Drought Monitoring using NPP/JPSS Land EDRs for NIDIS
Andi Walther *(UM/CIMSS)*	Further development of the VIIRS Nighttime Lunar Reflectance-derived Cloud Properties and the Demonstration for their use for Precipitation and Icing Applications

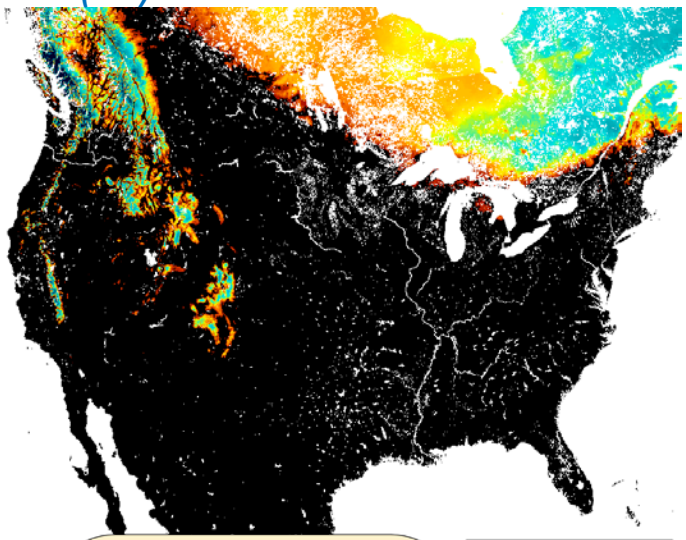
Backup Slides

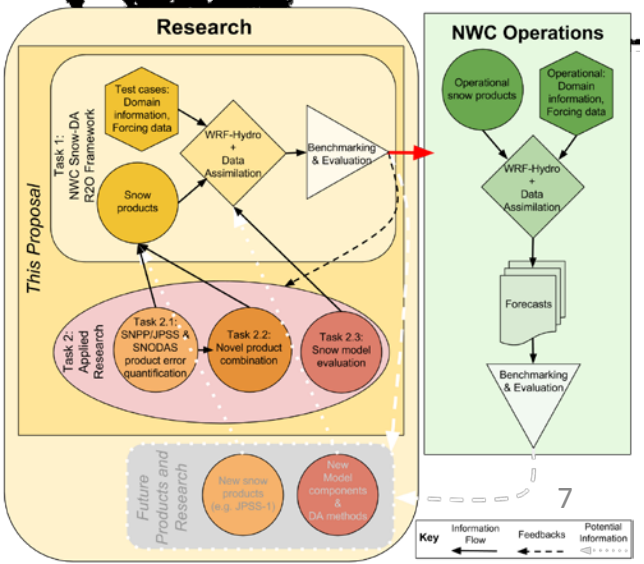
- Hydrology Project Details
- Hydrology Project Case Studies

S-NPP/JPSS and SNODAS Applications to the National Water Model

NCAR (Gochis) – NWC (Cosgrove)
NOAA CREST (Romanov) – NCEP (Ek)

- Objectives
  - Improvement of seasonal streamflow forecasts
    - Assimilation snow observations and SNODAS.
    - Develop error chars of satellite snow obs
    - Combine satellite snow observations
  - Establish and R2O evaluation framework for operational snow products
- Primary sensors involved
  - SNPP satellite:
    - VIIRS snow cover fraction
    - ATMS snow depth and snow water equivalent
  - GCOM-W satellite:
    - AMSR2 snow depth and snow water equivalent
- Primary ground data / ancillary products
  - The SNODAS product & its observations
    - Airborne Gamma
    - Vast point observation data base including SNOTEL, etc.
  - NASA Airborne Snow Observatory
    - LiDAR
    - Hyperspectral (Albedo)
- Targeted end users
  - NWC's National Water Model (NWM)

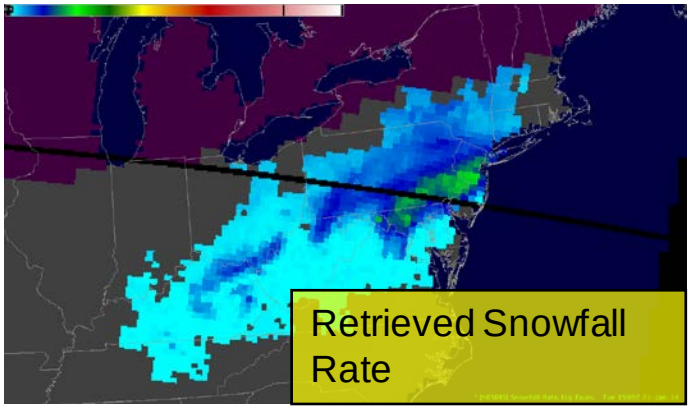


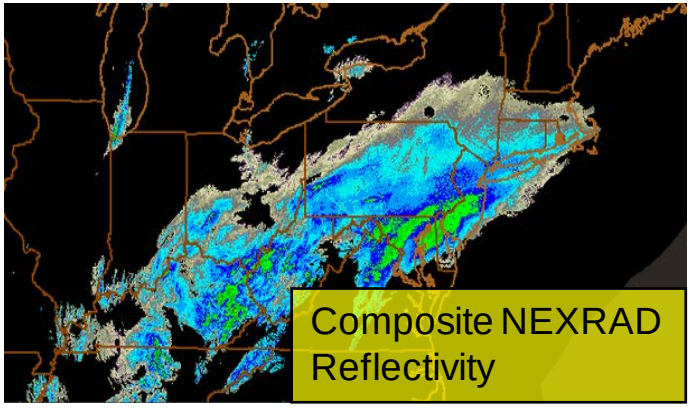


Continued Expansion, Enhancement and Evolution of the NESDIS Snowfall Rate Product to Support Weather Forecasting

H. Meng, J. Dong, C. Kongoli, R. Ferraro, B. Yan, S. Rudlosky, B. Zavodsky

- Objectives
  - An ATMS snowfall rate (SFR) algorithm was developed previously with the support of JPSS PGRR
  - Improve the SFR algorithm for snowfall associated with low cloud and with dominating emission effect
  - Develop SFR algorithms for SSMIS and GMI sensors
  - Develop prototype over ocean SFR algorithm
- Primary sensors involved
  - ATMS (S-NPP, JPSS)
  - MHS and AMSU pair (POES, Metop)
  - SSMIS (DMSP)
  - GMI (NASA GPM)
- Primary ground data
  - NSSL MRMS radar precipitation
  - NCEI QCLCD gauge
- Targeted end users
  - NWS Weather Forecast Offices (WFOs)
  - National Centers (WPC, SPC)
  - Hydrology community (CMORPH, NWC)

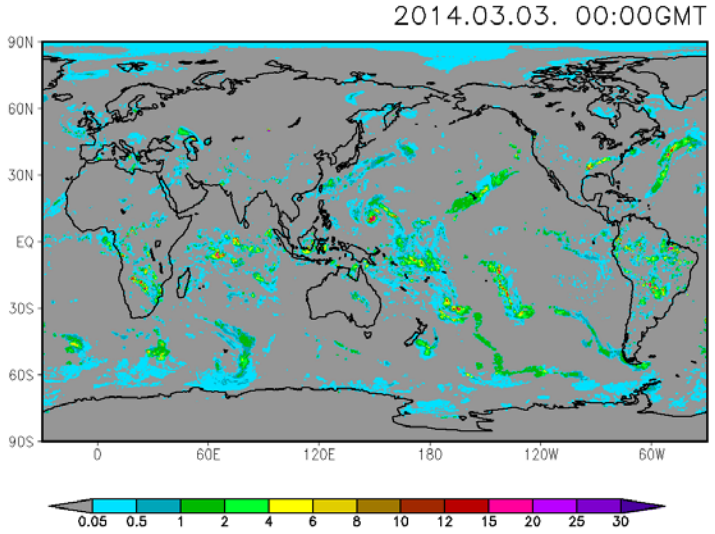




Infusing JPSS PMW Retrievals to CMORPH Precipitation Estimates for Improved Weather, Climate, and Water Applications

P. Xie, R. Joyce, S. Wu and collaborators

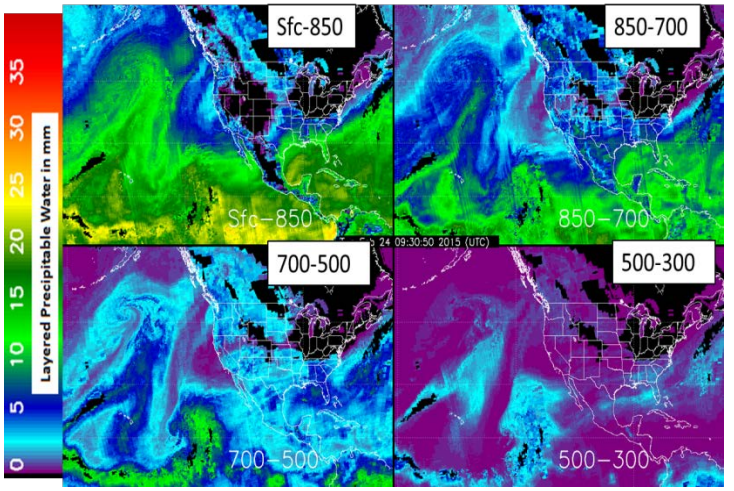
- Objectives
  - *To improve CMORPH integrated precipitation estimates through infusing retrievals from JPSS sensors*
    - Pole-to-pole coverage
    - Snowfall rate representation
    - Improved accuracy / reduced latency
- Primary sensors involved
  - *ATMS, VIIRS*
- Primary ground data
  - Gauge measurements of precipitation
- Targeted end users
  - *NHC, WPC, EMC, CPC and field offices*
  - National / international centers, research institutes, universities, governments, private industries (>100s)



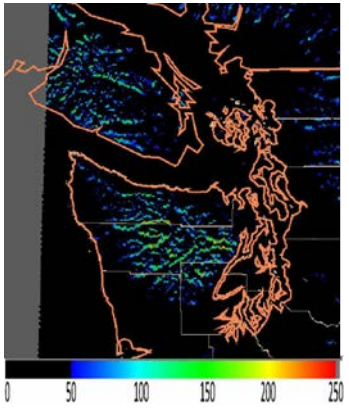
Using JPSS Retrievals to Implement a Multisensor, Synoptic, Layered Water Vapor Product for Forecasters

John Forsythe, Andy Jones, Stan Kidder, Dan Bikos, Ed Szoke
Cooperative Institute for Research in Atmosphere (CIRA),Colorado State University

- Objectives
  - Blend multiple polar soundings of layer precipitable water (LPW) and advect through time to benefit forecasters
  - Update the orographic rain index (ORI)
  - Obtain feedback and develop training materials
- Primary sensors involved
  - S-NPP (ATMS), DMSP F18/~~19~~ (SSMIS), NOAA-18/19 (AMSU-A/MHS), Metop-A/B 9(MHS); all via NOAA MiRS retrieval system.
  - NASA Aqua (AIRS); NUCAPS products
- Primary ground data
  - Radiosondes
  - GFS 0-6 hour forecasts
- Targeted end users
  - National centers (WPC, NHC, SPC, OPC, AWC)



Example of 4-layer blended LPW product produced in near-realtime at CIRA at 0900 UTC 24 February 2015.

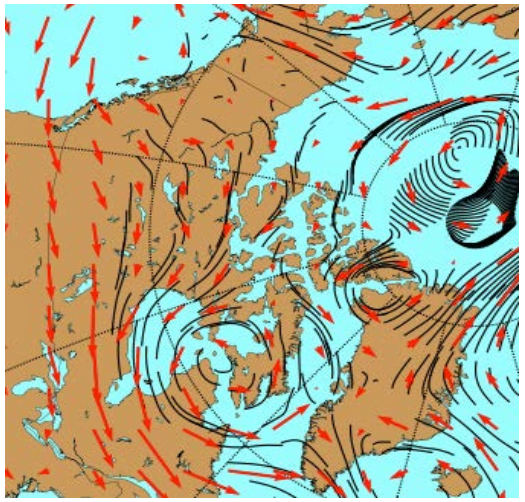


ORI product at 00 UTC 14 Feb. 2010. Units are mm * m/s.

Strengthening TPW visualization in the OCONUS domain with JPSS data products

Tony Wimmers, Chris Velden, Jordan Gerth, Bill Ward, Carven Scott, Kennard Kasper, Xiwu Zhan

- Objectives
  - 1) Add SNPP ATMS and AMSU/MHS to the hourly, morphed-composite MIMIC-TPW product and ready the system for JPSS
  - 2) Streamline the algorithm and extend the product domain to 70°N-70°S
  - 3) Direct all development toward a future merger with the Blended TPW product
- Primary sensors involved
  - SNPP ATMS, AMSU/MHS, SSMIS
- Targeted end users
  - 1) Operational NWS forecasters in the OCONUS domain
  - 2) Tropical weather and tropical cyclone forecasters (NHC, JTWC) and global partners

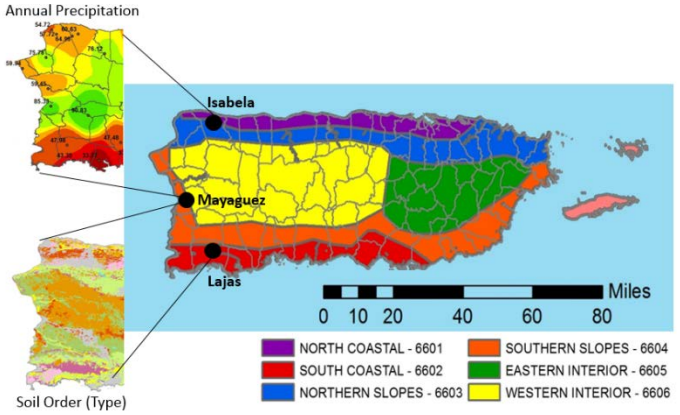


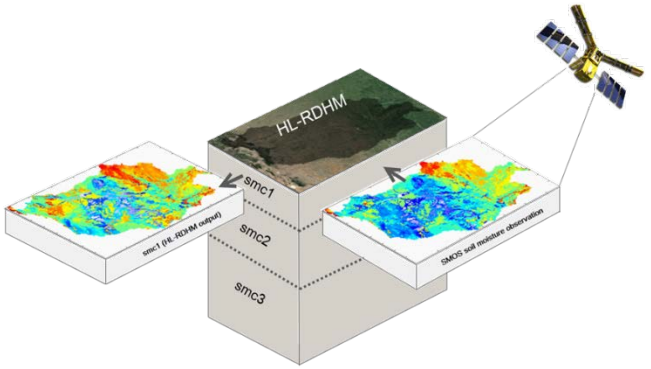
Example of improved data advection scheme
Red: GFS surface winds,
Black: 10-hour Runge-Kutta trajectories used for image morphing of TPW

Validation and Application of JPSS/GCOM-W Soil Moisture Data Product for operational flood monitoring in Puerto Rico

Tarendra Lakhankar, Jonathan Munoz, Reza Khanbilvardi, and Nir Krakauer
Xiwu Zhan, Jorge Rivera-Santos, and Reggina Cabrera (Collaborators)

- Objectives
  - Validation of GCOM-W Soil Moisture Data Product using field measurements
  - Field Experiment using L-band Radiometer for GCOM-W soil moisture
  - Development of framework for GCOM-W soil moisture in Flash Flood Guidance System in Puerto Rico
- Primary sensors involved
  - GCOM-W1/AMSR2
  - SMOS and SMAP
- Primary ground data
  - L-Band dual polarized microwave radiometer
  - Soil moisture, vegetation and ancillary data
- Targeted end users
  - WFO/NWS (San Juan)
  - NESDIS/STAR (Cal/Val)

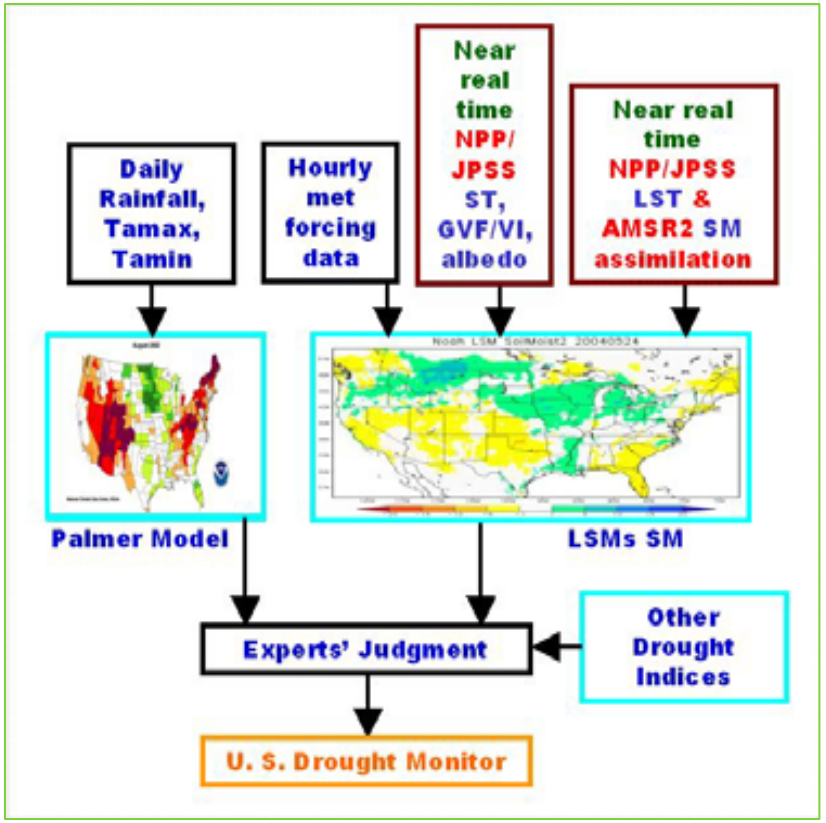




Enhance Agricultural Drought Monitoring Using SNPP/JPSS Land EDRs for NIDIS

X. Zhan, C. Hain, J. Yin, J. Liu, L. Fang, M. Ek, J. Huang, M. Anderson, M. Svoboda

- Objectives
  - Improve current US and global drought monitoring via using near real time SNPP/JPSS land data products
- Primary sensors involved
  - S-NPP/VIIRS
  - GCOM-W1/AMSR2
- Primary ground data
  - Palmer Drought Severity Index
  - In situ soil moisture measurements from USDA SCAN/NOAA CRN ground networks
- Targeted end users
  - NIDIS of USDA, NOAA and USGS
  - NWS-NCEP



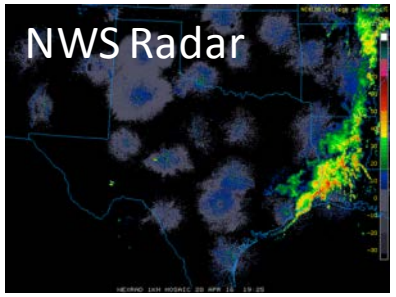
Data flow of Weekly US Drought Monitor (USDM) Generation

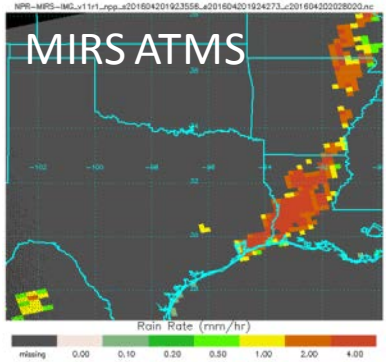
Hydrologic Applications of the VIIRS Cloud Products

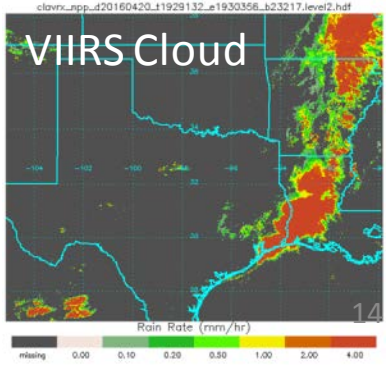
Andi Walther, Andrew Heidinger and Samantha Tushaus

- Objectives
  - Verify the skill in deriving precipitation from VIIRS cloud products and study how they complement other sources (microwave, IR).
  - Explore the accuracy of the cloud water path product from VIIRS and how it can complement that from ATMS (*which lacks coverage over land*)
  - Demonstrate skill with lunar-reflectance to provided unique nighttime ability.
- Primary sensors involved
  - VIIRS including DNB (primary)
  - ATMS (for reference)
- Primary ground data
  - NWS Radar Data
- Targeted end users
  - NWS forecast offices – we think precipitation and water path are better suited for AWIPS displays than the standard cloud optical depth and particle size.

Rain-rates on April 20, 2016 19:30 UTC







Case 1: Atmospheric River, California, January 5 2016

MESOSCALE PRECIPITATION DISCUSSION 0001
NWS WEATHER PREDICTION CENTER COLLEGE PARK MD
544 AM EST TUE JAN 05 2016

AREAS AFFECTED...CENTRAL CA COAST...SRN CA

CONCERNING...HEAVY RAINFALL...FLASH FLOODING POSSIBLE

VALID 051043Z - 051643Z

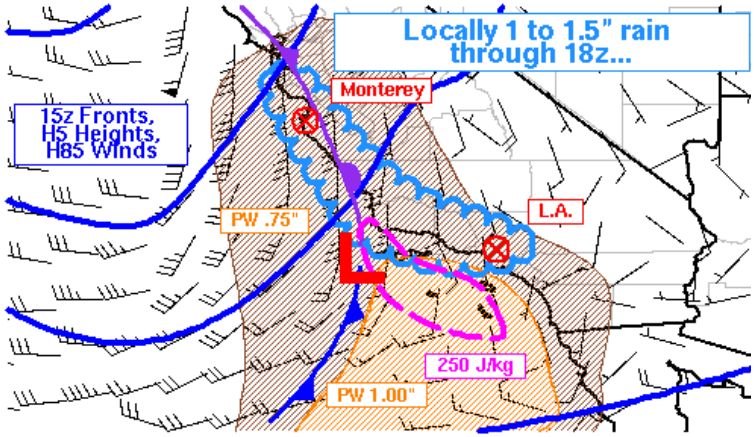
SUMMARY...RAIN RATES WILL INCREASE ALONG THE CENTRAL AND SOUTHERN CALIFORNIA COAST EARLY THIS MORNING...AND HEAVIER RAIN WILL BEGIN TO SPREAD INTO THE L.A. BASIN AROUND 15Z. FLASH FLOODING IS POSSIBLE.

DISCUSSION...STRONG ASCENT WILL ACCOMPANY AN OCCLUDED FRONT COMING ONSHORE ALONG THE LENGTH OF THE CA COAST...AND ASSOCIATED POSITIVE TILT UPPER TROUGH...WITH LATER EMPHASIS FOR HEIGHT FALLS IN THE BASE OF THE TROUGH ALONG THE SOUTHERN CALIFORNIA COAST. ALTHOUGH LIGHTNING HAD NOT BEEN DETECTED AS OF 1030Z...RADAR AND SATELLITE PRESENTATION WAS IMPRESSIVE NEAR AND OFFSHORE OF MONTEREY...WHERE CLOUD TOPS HAD COOLED TO -40C...AND CONVECTIVE RADAR ELEMENTS WERE TRACKABLE...NOT SIMPLY HIGH REFLECTIVITY DUE TO BRIGHT BANDING. SURFACE OBSERVATIONS HAD BEGUN TO SAMPLE HEAVY RAIN AND ACCUMULATIONS EXCEEDING A HALF INCH PER HOUR IN THE BAY AREA.

A FRONTAL PRECIPITATION BAND WILL PROGRESS STEADILY EASTWARD...WITH THE BACK EDGE COMING SOUTH ALONG THE COAST THIS MORNING. EXPECTATIONS PER THE HIGH RESOLUTION MODELS ARE FAIRLY UNIFORM...WITH AREAL AVERAGE 0.50 TO 1.0 INCHES OF RAIN THROUGH 18Z...BUT LOCALLY GREATER THAN 1.5. TOTALS MAY BE ESPECIALLY ENHANCED IN THE SOUTHWARD FACING MOUNTAINS OF SOUTHERN CALIFORNIA...OWING TO S/SW LOW LEVEL FLOW...LONGER DURATION OF BROAD HEIGHT FALLS...AND PROXIMITY TO GREATER PW VALUES NEAR 1.00 INCH ALONG WITH ENOUGH INSTABILITY FOR THE HRRR TO PICK UP ON 250 J/KG. **THE HEAVIER RAIN RATES SHOULD REACH LOS ANGELES BY 15-17Z...AND THE EVENT IS EXPECTED TO CONTINUE INTO THE AFTERNOON FROM THERE SOUTHWARD...WITH MAXIMUM HOURLY RATES APPROACHING 0.75 INCHES. THIS WOULD BE VERY CLOSE TO FLASH FLOOD GUIDANCE VALUES...AND WOULD BE MORE THAN ENOUGH TO CAUSE FLASH FLOODING IN THE MORE SUSCEPTIBLE BURN SCAR AREAS.**

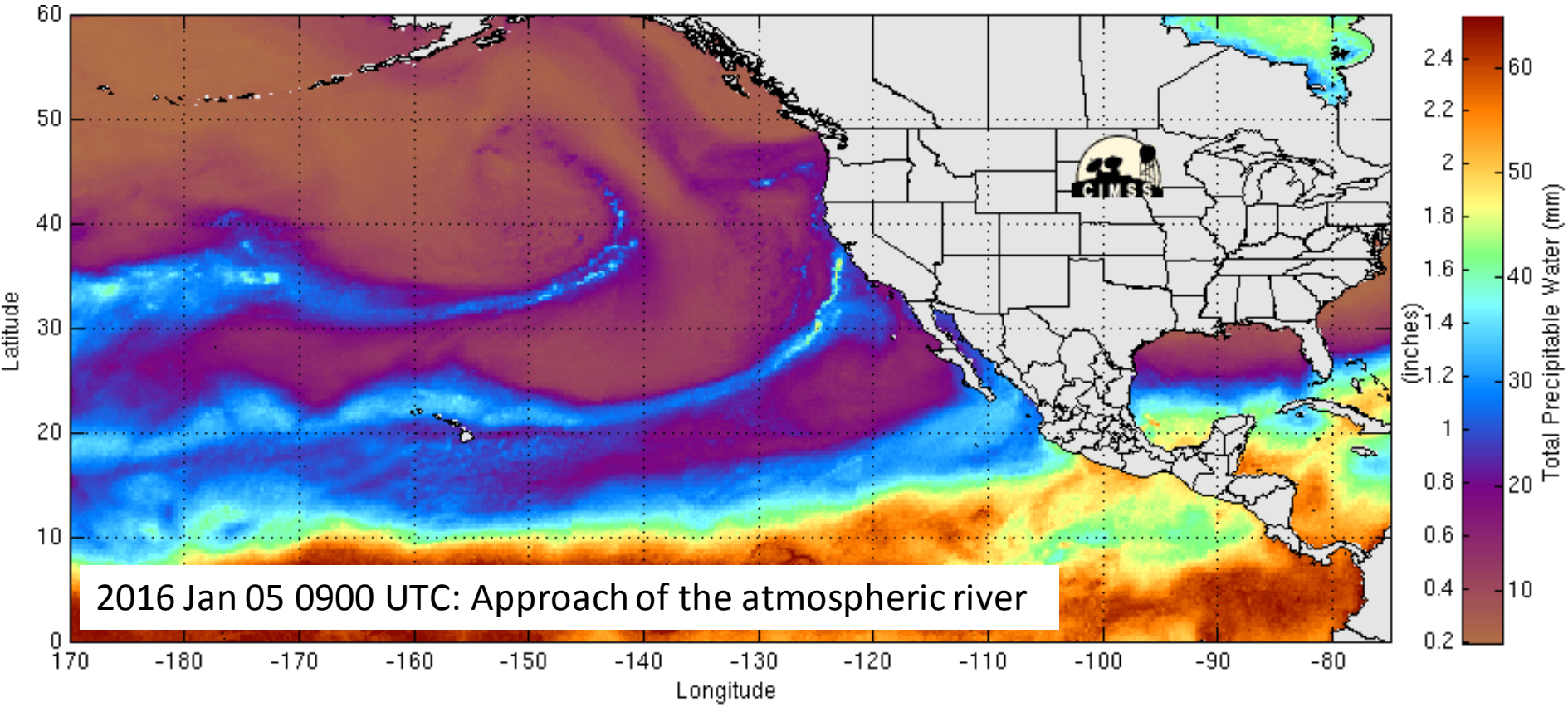
BURKE

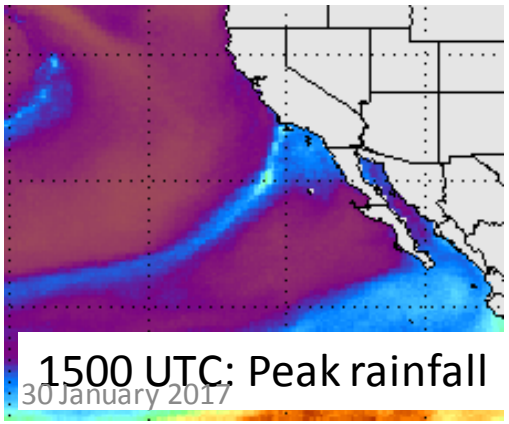
ATTN...WFO...HNX...LOX...MTR...SGX.

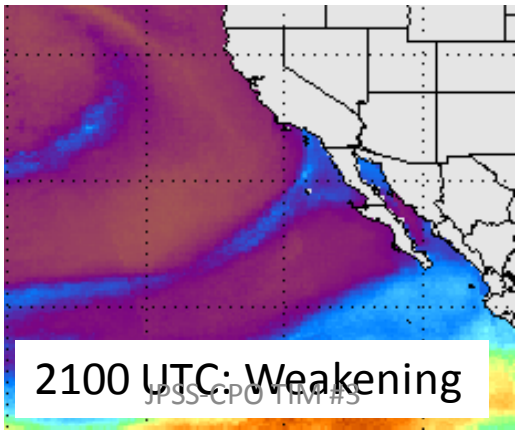


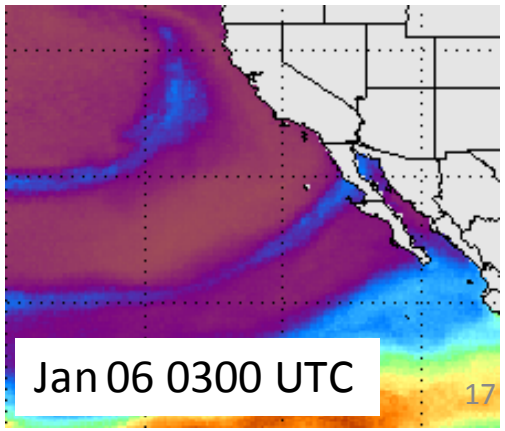
HRW_NMMB_5 850 MB WINDS 160105/0000f007
WPC MPD #0001

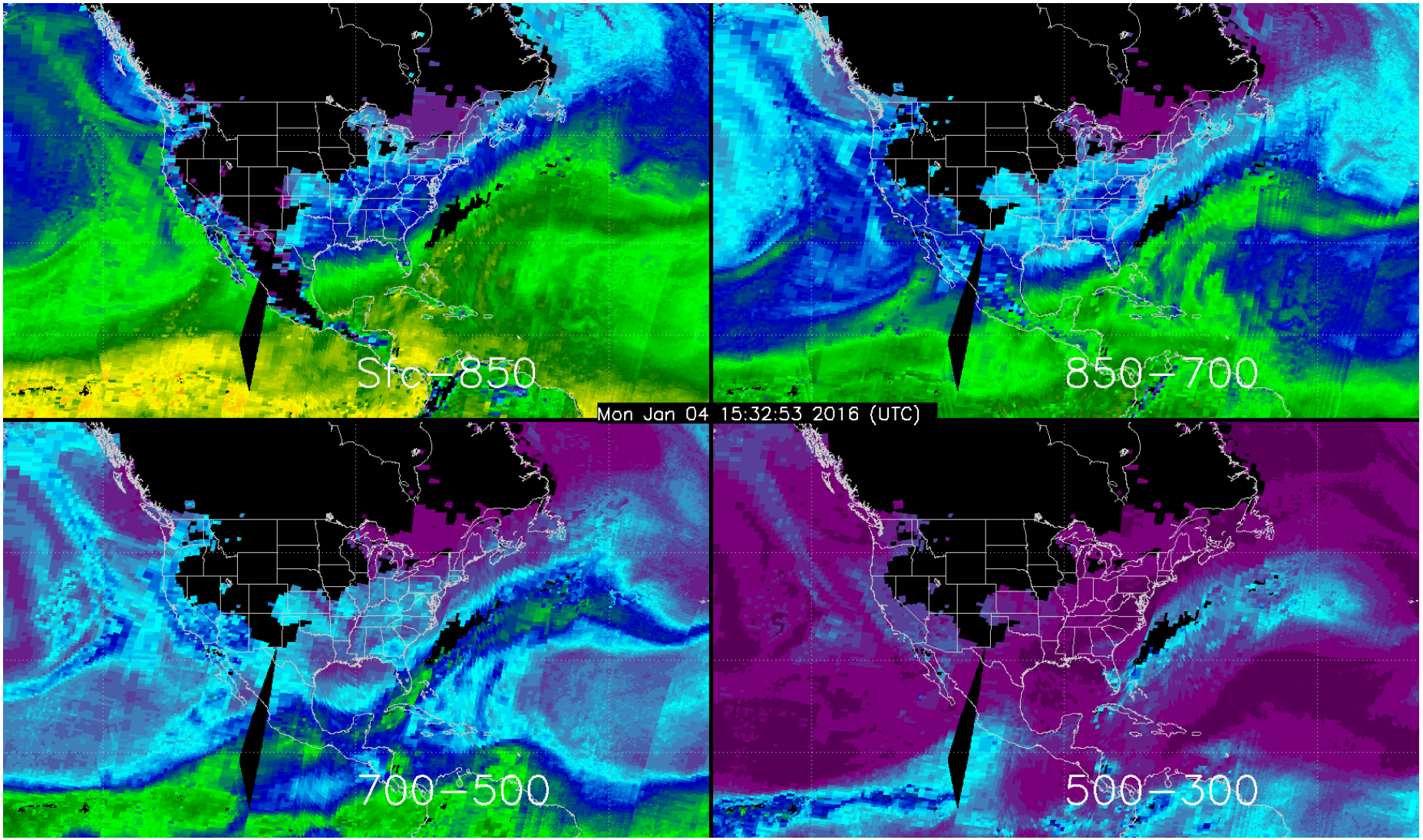
MIMIC TPW


Latitude
Longitude
(inches)
Total Precipitable Water (mm)
2016 Jan 05 0900 UTC: Approach of the atmospheric river

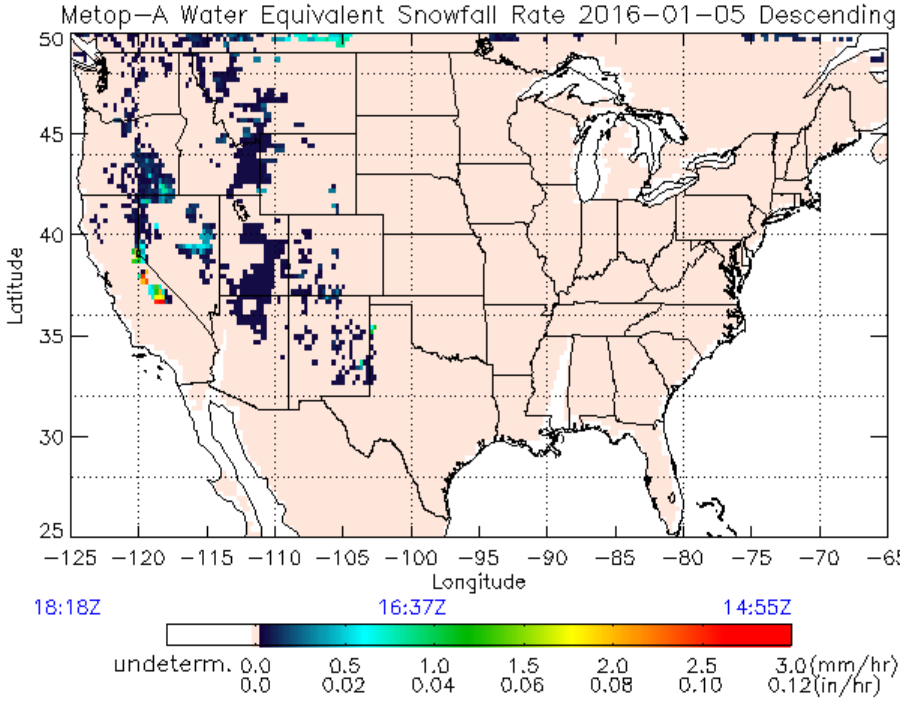

1500 UTC: Peak rainfall

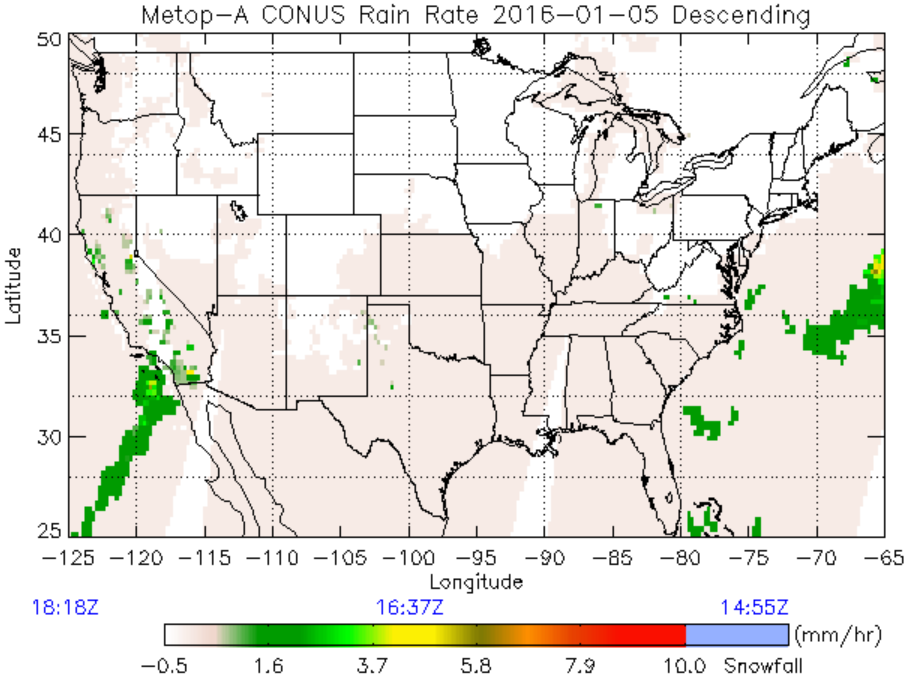

2100 UTC: Weakening


Jan 06 0300 UTC

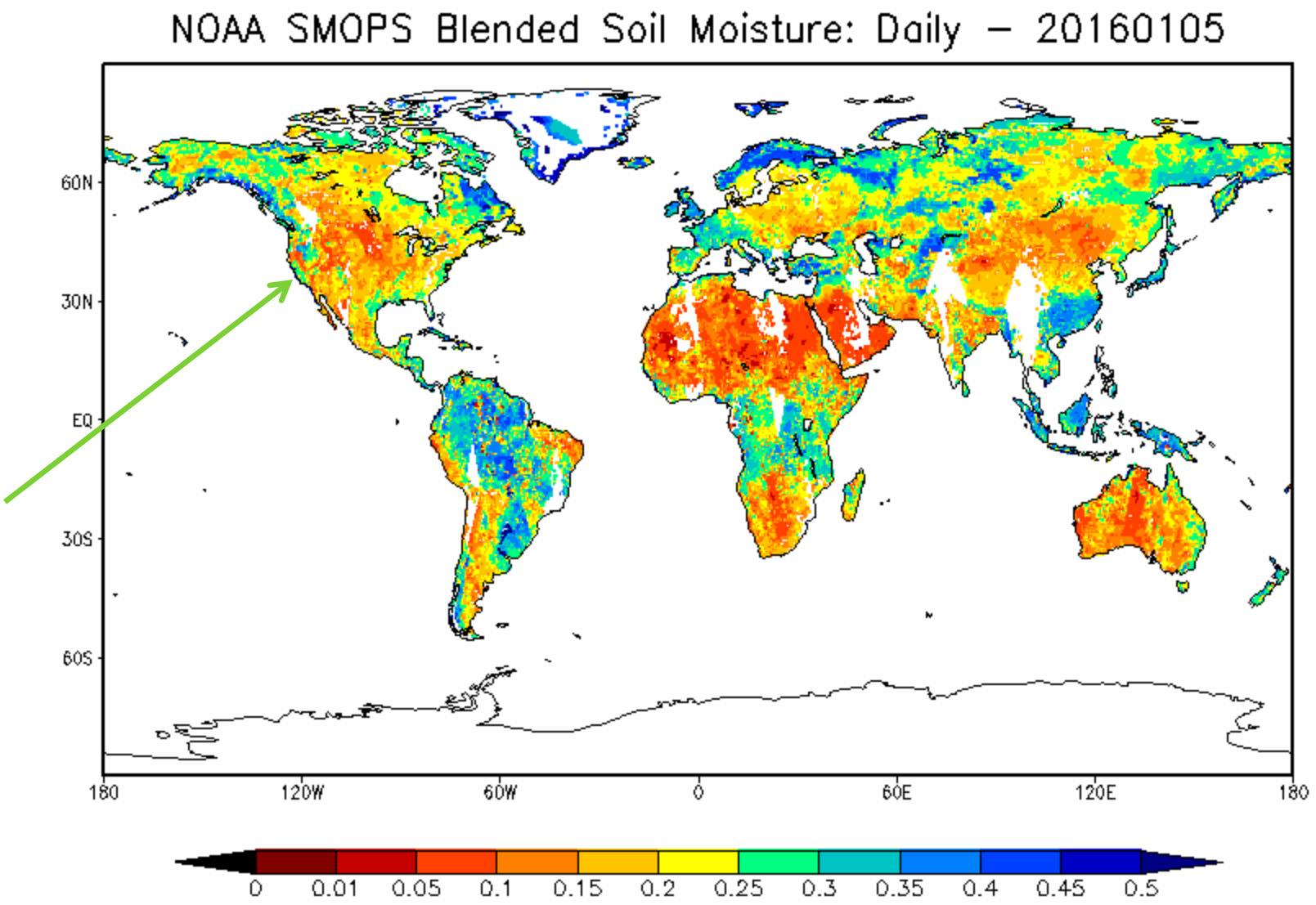


Broad moisture signature at lower layers, small signal above 500 mb





http://www.star.nesdis.noaa.gov/corp/scsb/mspps_backup/sfr_realtime.html

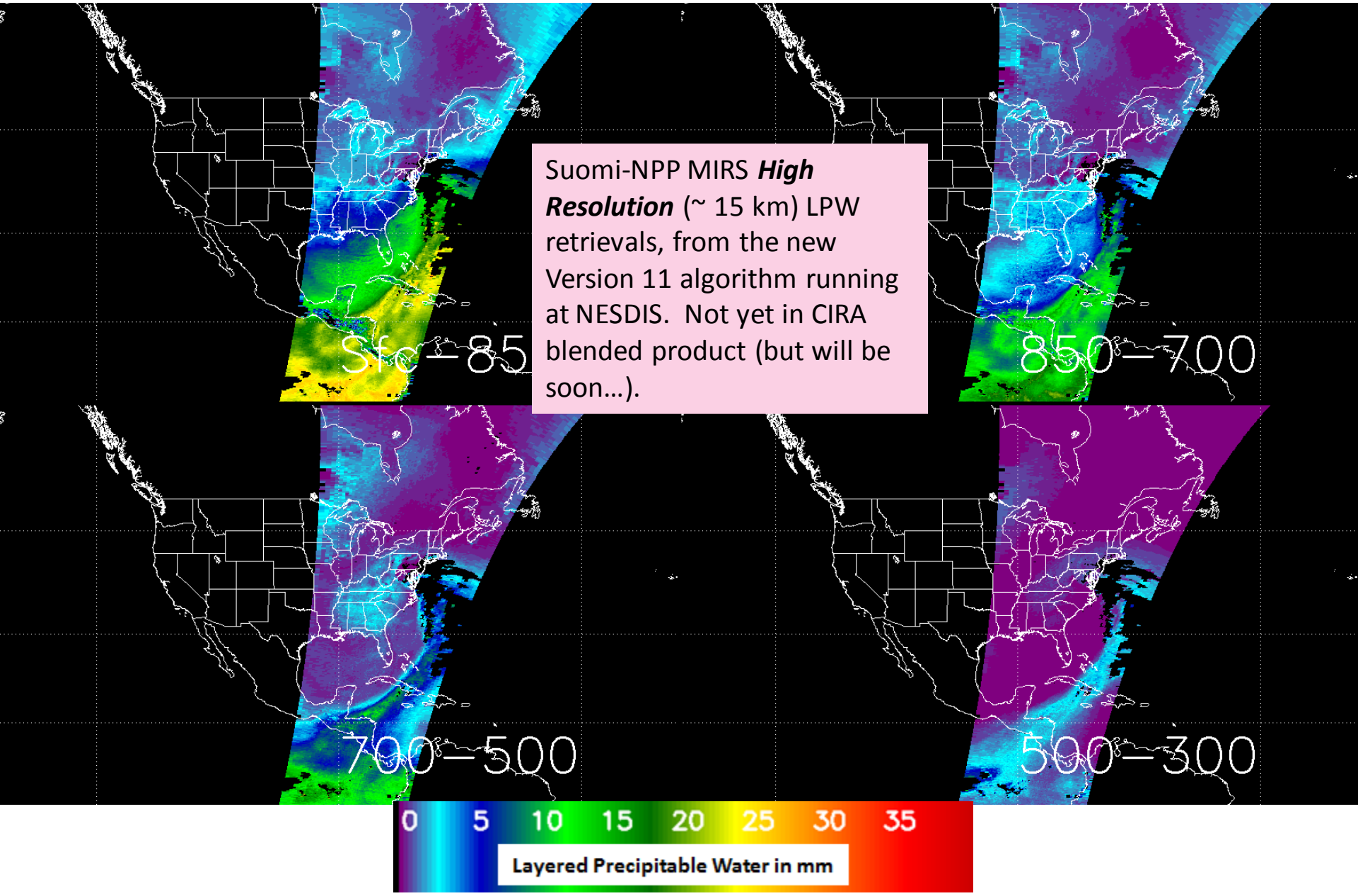

NOAA SMOPS Blended Soil Moisture: Daily – 20160105
60N
30N
EQ
30S
60S
180
120W
60W
0
60E
120E
180
0
0.01
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5

Case 2: East Coast Blizzard of 2016. January 22-23 2016

See also:

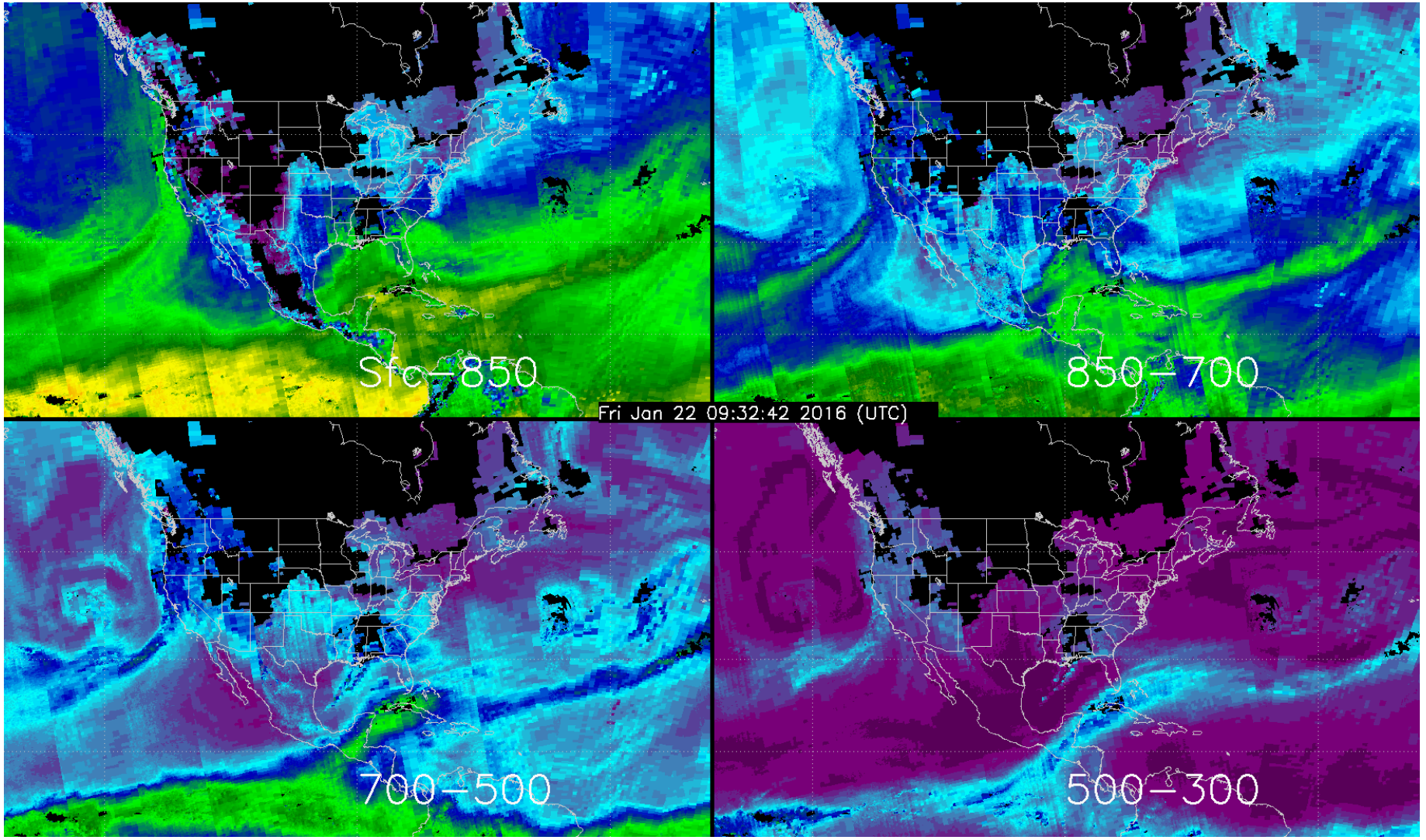
http://www.star.nesdis.noaa.gov/jpss/Blizzard2016.php

East Coast Snowstorm: Layered water vapor: Jan. 23 07 UTC (coastal low was forming at this time)



Suomi-NPP MIRS ***High Resolution*** (~ 15 km) LPW retrievals, from the new Version 11 algorithm running at NESDIS. Not yet in CIRA blended product (but will be soon…).

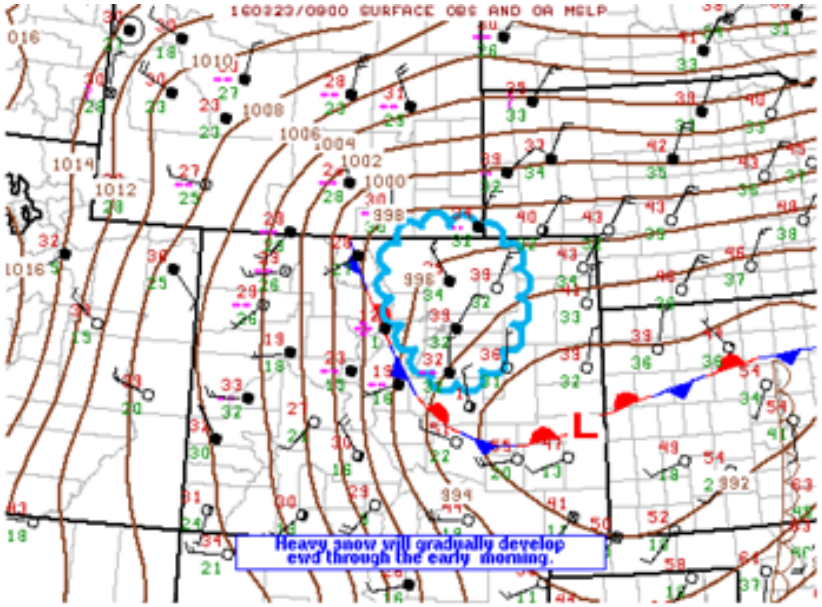
East Coast Snowstorm: Layered water vapor Jan 22, 09 UTC to Jan. 23 18 UTC (NOAA-18/19; Metop-A, -B, DMSP F18) using MIRS V8 (old version). SNPP to be added soon.



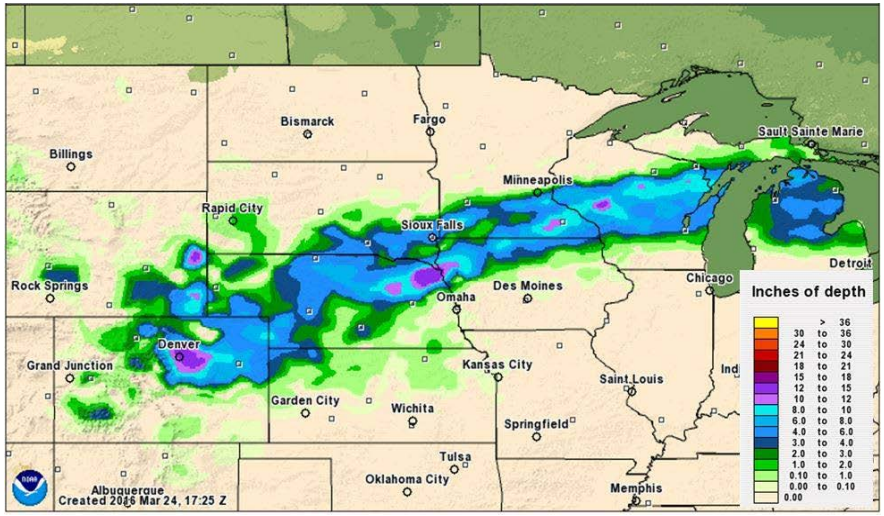
Case 3: Front Range Blizzard
March 23-24, 2016

March 23-24 Front Range Blizzard

- Interesting synoptic event "typical" of transition season snowfall in Front Range
  - Mesoscale features were "atypical" and lead to forecast "bust"
  - Snowfall rates 2-3"/hr occurred
  - Wetness of snow and strong winds caused extensive power outages



SPC MCD #0250



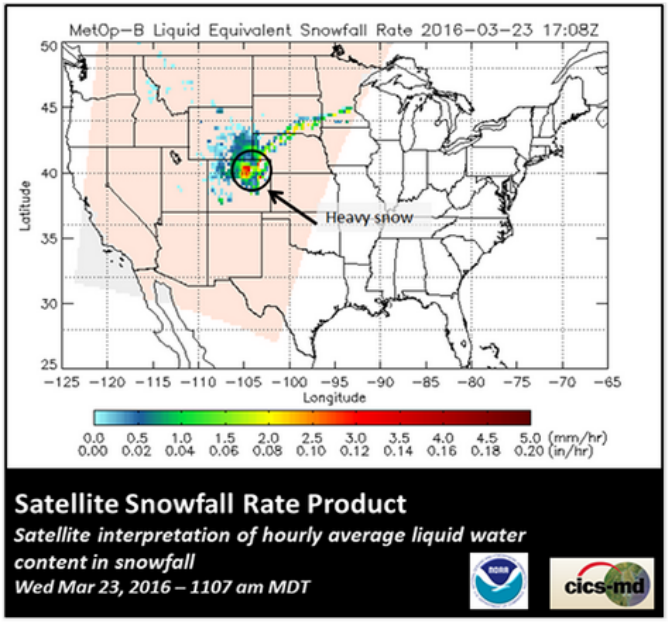
Snowfall Rate Product

Diane Cooper/Sheldon Kusselson

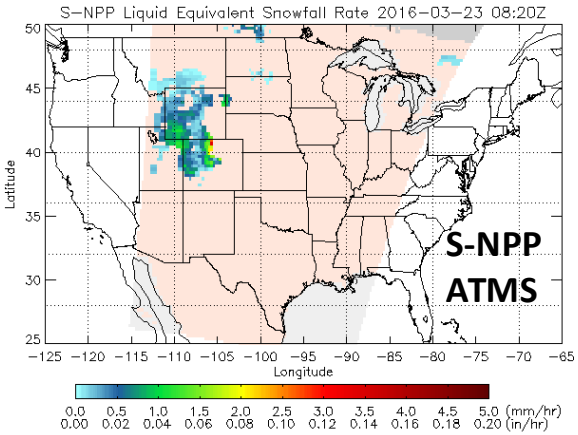
WxIntegrations
March 23 ·

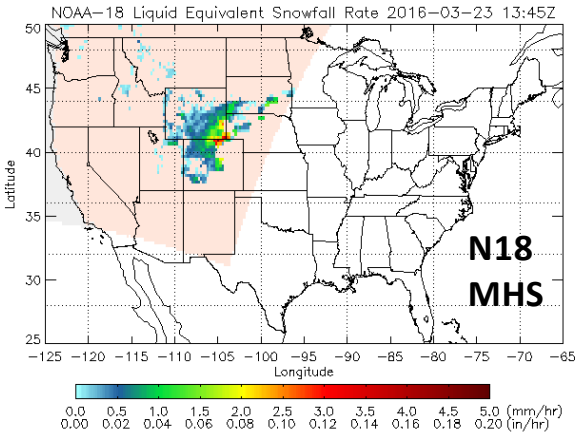
The Colorado Front Range experienced some impressive snowfall rates with the storm this morning. The attached image is the NOAA Satellite Snowfall Rate Product which estimates liquid water content that is in the snow fall. The yellows and brighter reds highlight 0.06 to 0.15 inches of water. Since this was a wet snow, we know the snow ratios were fairly low. Using a ratio of 8 inches of snow to 1 inch of water (8 to 1 ratio) or even a ratio of 10 inches of snow to 1 inch of water (10 to 1 ratio), we can estimate that hourly snowfall rates around 11 am MDT were between 0.5 to 1.5 inches per hour. The snowfall rates were likely heavier in localized areas, but this gives a context of the broader snowfall rates.

While the resolution of the satellite date as is not as fine as radar estimates, it is exceedingly helpful for areas that the radar is blocked such as in hilly or mountainous training or in situations where the radar not seeing the snow.

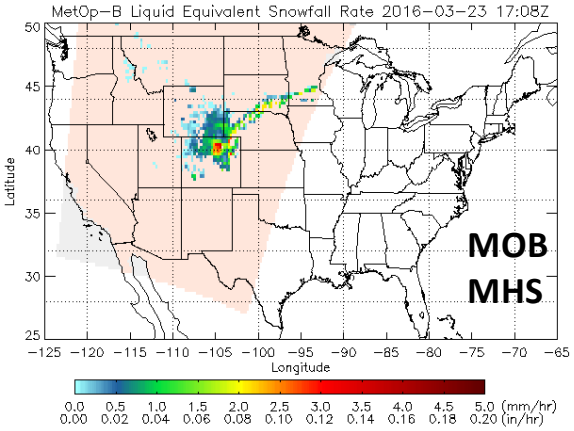


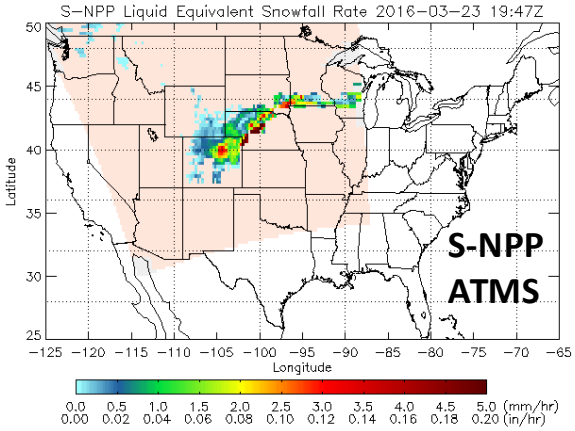
0820 UTC **23 March 2016** **1345 UTC**



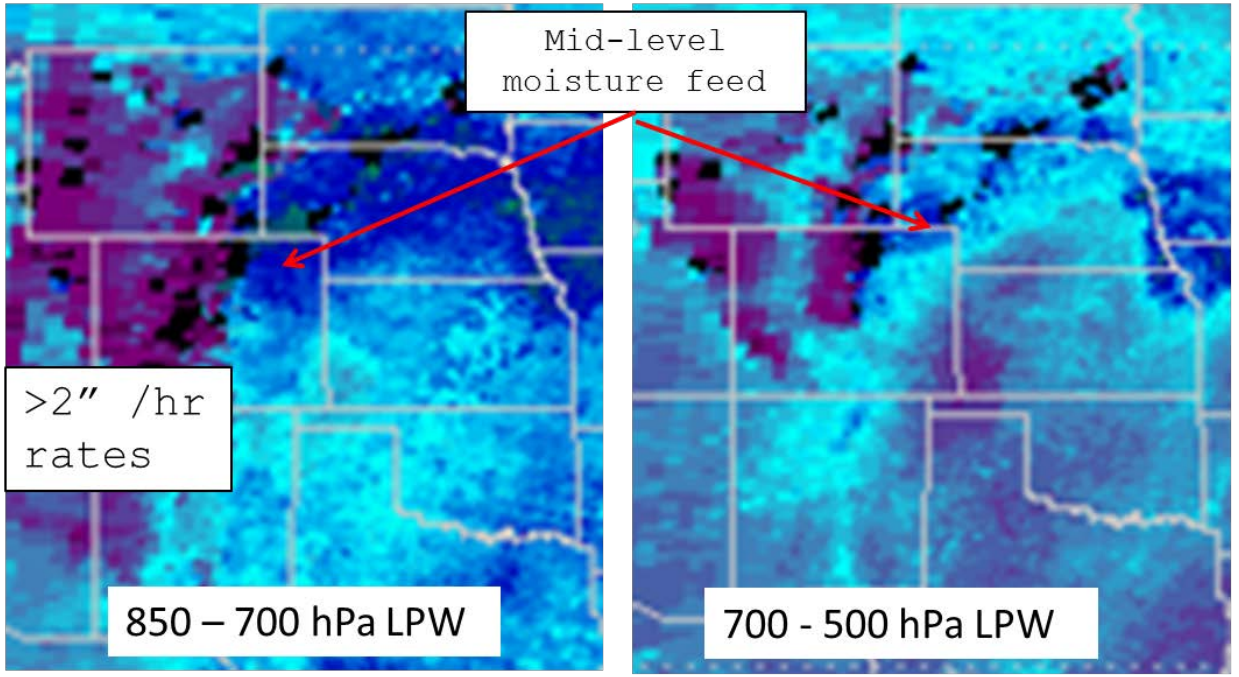


1708 UTC **23 March 2016** **1947 UTC**





Water Vapor Products



CIRA Blended Layered Precipitable Water Vapor merged at 1200 UTC 23 March 2016 [S-NPP MiRS retrievals shown]

Forecast for Fort Collins for 3/23 morning:
4 PM 3/22: Winter Weather Advisory
8 PM 3/22: Winter Storm Warning
4 AM 3/23: Blizzard Warning
Total: 14" of snow in 7 hours, shut down city.