NESDIS Operational Blended Products

Limin Zhao and Ralph Ferraro
NOAA/NESDIS OSPO and STAR

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Outline

- Attributes of Blended Products
- Current Operational Capability
- Data Access
- Looking Forward

Attributes of Blended Products (1/2)

- **Unified products**
  - From multiple resources, satellites/sensors/algorithms
    - Could also include in-situ data
  - Much better spatial and temporal resolution than any individual L2 product
  - Best analysis from available individual L2 products
- **Value added L3 product**
  - With quality dependency on the L2 products used
- **Highly desirable by NESDIS operations and end users**
  - Optimizes computer resources for both producer and user
  - Puts quality burden of L2 products on producer not user

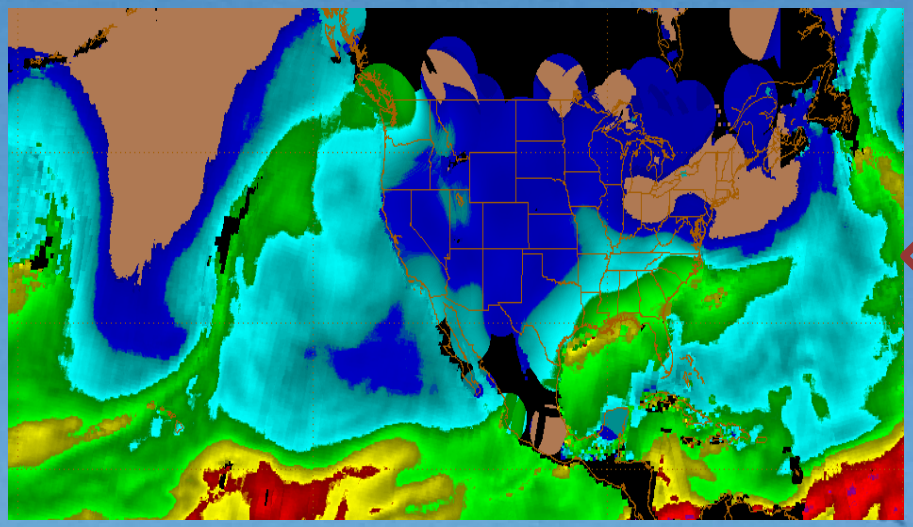
Attributes of Blended Products (2/2)

- **Common Features**
  - Normalization Process
    - Each L2 could have different attributes
      - » Native spatial resolution; Latency; Observation frequency; Scan geometry/biases, etc
    - Generally, each L2 is "adjusted" to a reference
      - » Highest quality L2, independent data, human eye (IMS), etc.
    - End usage also dictates how the normalization is done
      - » AWIPS/image products; Input to NWP or Hydrological Models; Global vs. Regional
  - Merging Algorithm
    - Overlay
      - » Latest; closest; most accurate
    - Average
    - Weighting Function
      - » Error attributes; Time latency, etc.

Current NESDIS Operational Capability - Overview

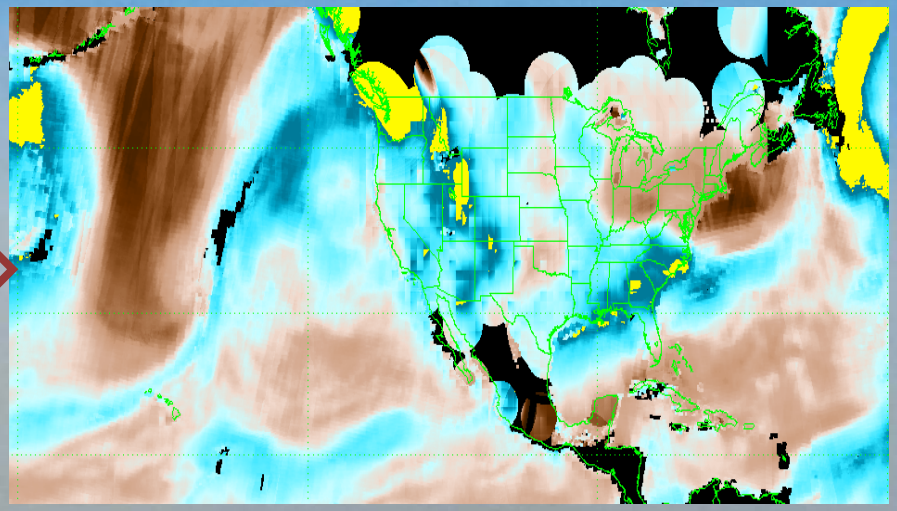
Applications	Satellites/Sensors	Products
bTPW - Blended Total Precipitable Water	NOAA-18, NOAA-19, Metop-A and Metop-B, GOES-W/-E, GPS-Met, DMSP F18	Global TPW map
bRR - – Blended Rain Rate	NOAA-18, NOAA-19, Metop-A and Metop-B, DMSP F17	Global Rain Rate map
eTRaP - Ensemble Tropical Rainfall Potential (eTRaP)	NOAA-18, NOAA-19, Metop-B, DMSP 17&18, GOES-W/-E, Meteosat-8, Meteosat-10, Himawari-8	Ensemble forecast of 6~24-hour rainfall potential for tropical systems
SMOPS - Soil Moisture Operational Products System	Metop-A/-B, SMOS, SMAP, GPM	Global soil moisture map
GHE - Global Hydro-Estimator	GOES-W/-E, Meteosat-8, Meteosat-10, Himawari-8	Global rainfall estimate with different temporal scale
Blended SST – Blended Sea Surface Temperature	Metop-B/AVHRR, S-NPP/VIIRS, GOES-E&-W/Imager, Meteosat-10/SEVIRI and Himawari-8/AHI	Global Sea Surface Temperature
GBBEPx - Blended Global Biomass Burning Emissions Product from MODIS and Geostationary Satellites	GOES-E&-W/Imager, EOS-Terra/MODIS, EOS-Aqua/MODIS	Daily global biomass burning emissions
MTCSWA - Multiplatform Tropical Cyclone Surface Wind Analysis	NOAA-15, NOAA-18, NOAA-19, Metop-A, S-NPP	Six-hourly estimates of tropical cyclone wind fields
TOAST – Total Ozone Analysis	NOAA-19/SBUV-2 and Metop-B/TOVS	Global ozone map
Enhanced TOAST – Enhanced Total Ozone Analysis	NOAA-19/SBUV/2 and S-NPP/CrIS	Global Ozone map
IMS – Interactive Multi-sensor Snow and Ice Mapping System	NOAA-18&-19, Metop-A, S-NPP, Aqua/TERRA, Radarsat-2, Meteosat-10, Himawari-8, DMSP, GOES-E&-W	Snow and Ice cover maps for the Northern Hemisphere

Blended TPW Products Suite



Blended TPW – Merges TPW from AMSU, SSMIS, ATMS, AMSR2, GMI, GOES Sounders and GPS-Met into a unified resource to provide forecasters no-gap TPW coverage over globe and serves as a very helpful tool for forecasters to identify conditions that could result in heavy precipitation and subsequent flooding.

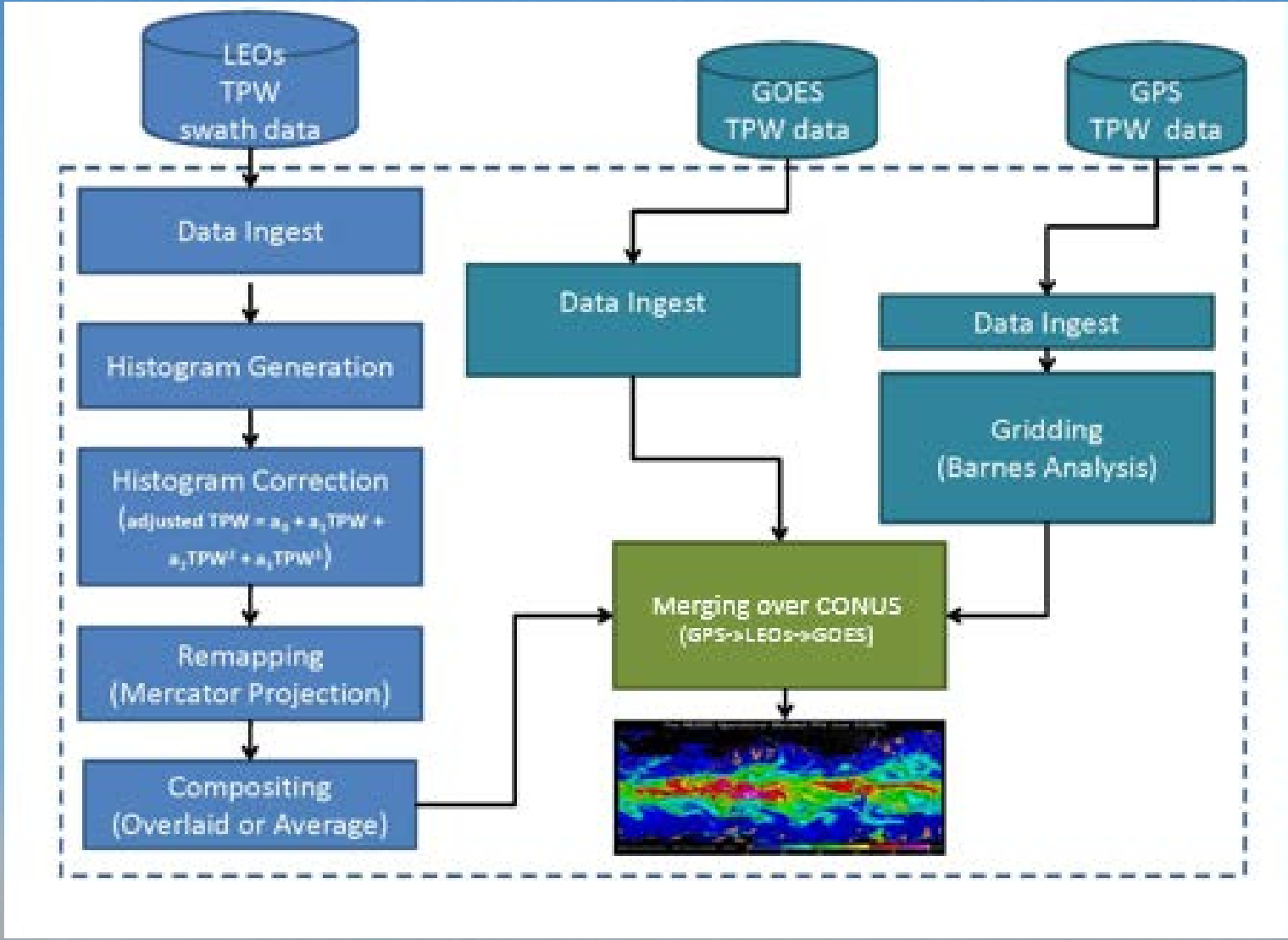
Percent of Normal TPW – Compares the blended TPW with the NVAP (NASA Water Vapor Project) weekly mean. It helps forecasters quickly see areas where active weather is occurring and assess the severity of the situation. For instance, the "Yellow" areas indicate TPW > 200% of the weekly mean, and usually are potential threat areas



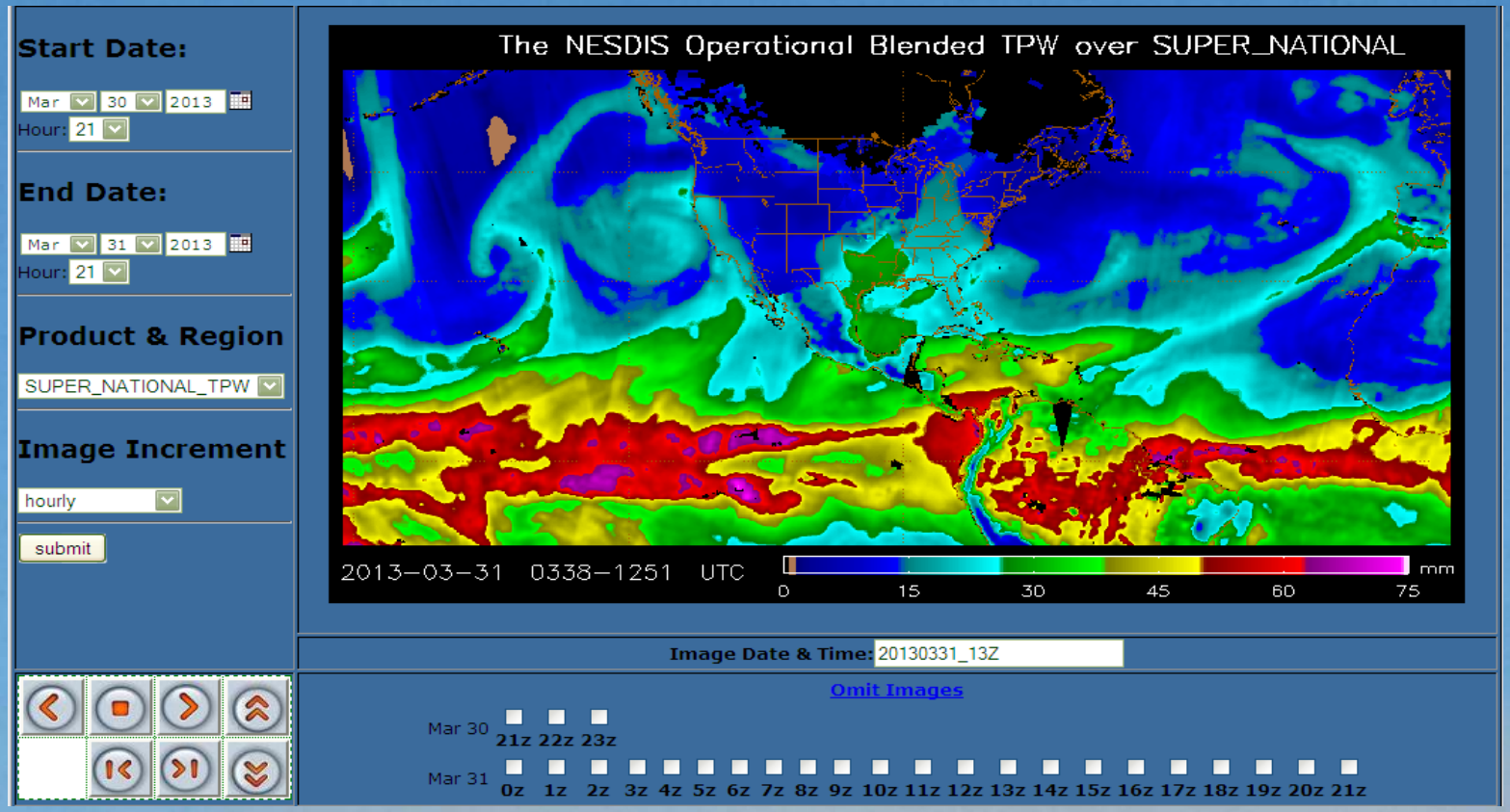
Blended TPW Products

- **Product**
  - Unified, meteorologically significant TPW maps, which merges the TPW retrievals from various satellites/algorithms to provide a global coverage.
- **Current Status**
  - **Operational:** since March 09, 2009
  - **Over Ocean**
    - TPW from NOAA-15, -18, -19 and Metop-A/-B, F17, F18, S-NPP, GCOM-W1, GPM
  - **Over Land**
    - GPS-Met over CONUS, Alaska and Hawaii – primary data source over CONUS
    - MIRS TPW from N18, N19 and Metop-A/-B, F17, F18, S-NPP, GPM over CONUS when GPS is not available, and also over other Landmasks
    - GOES over CONUS, and part of east pacific ocean – used to fill the hole when no GPS and MIRS TPW are available
  - **Products:** *TPW, Percentage of Normal TPW; 16x16km*
  - **Formats:** HDF-EOS, McIDAS area and AWIPS; netCDF4 in near future
  - **Data Access:** DDS/PDA, ADDE and AWIPS
  - **The imagery products are also available on the Internet through:** http://www.ospo.noaa.gov/Products/bTPW/index.html
  - **POCs**: Limin Zhao and Ralph Ferraro

Blended TPW Products - Algorithm



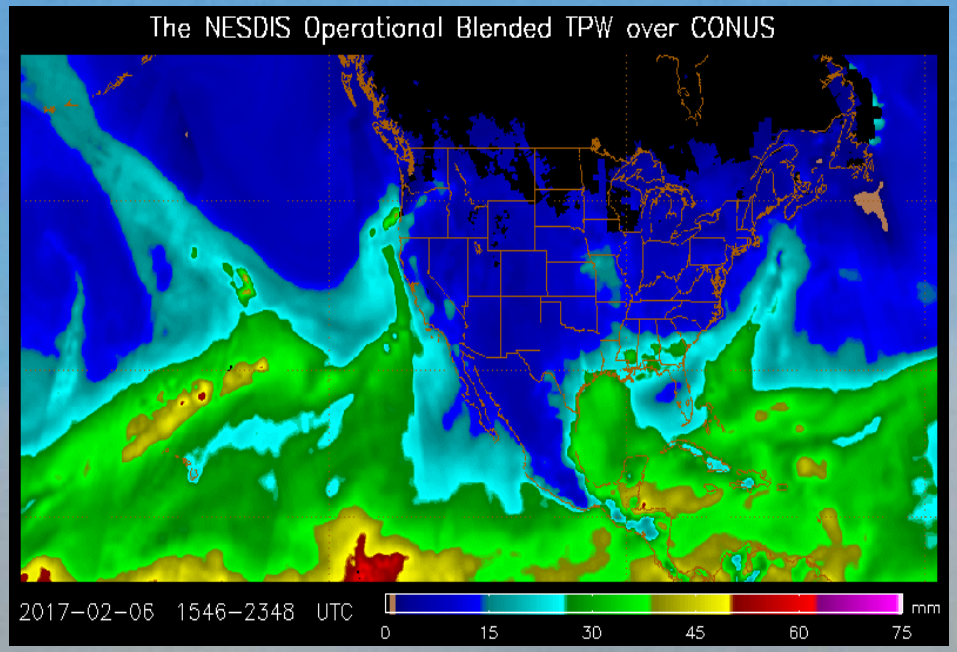
Blended TPWs – Animation Tool

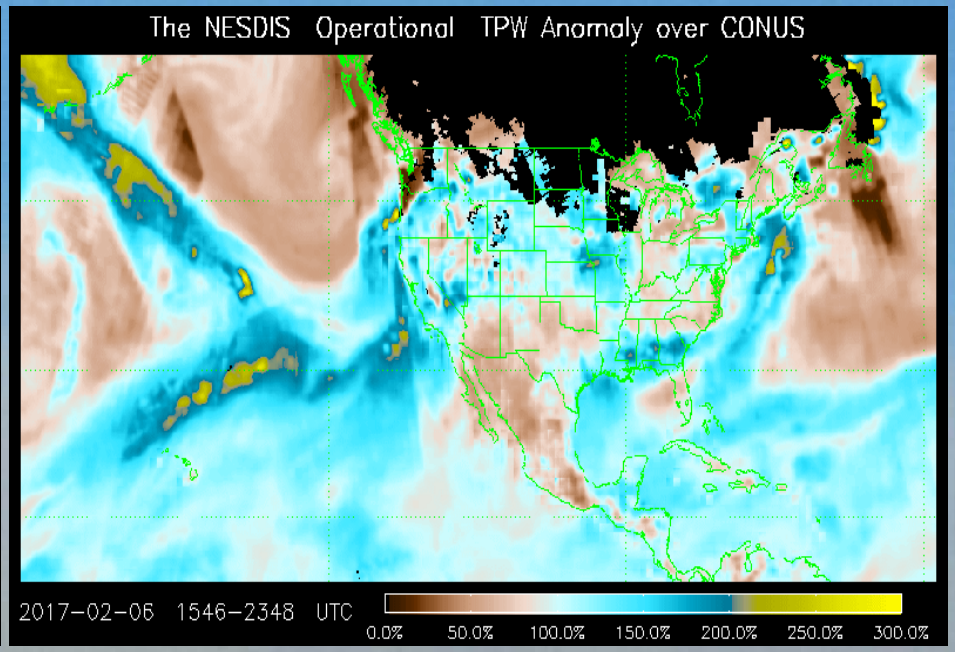


Animation – Near-real time loops of blended TPW and PCT available at: http://www.ospo.noaa.gov/bTPW
Regions – 16 area of interest regions for zooming in details
Image Interval – 1 hour, 3, 6, 12 and 24 hours
Historical Data – up to three months

Example of Blended TPWs

The blended TPW has been used, together with the percentage of normal TPW, by satellite analysts and forecasters to improve analysis and prediction of heavy precipitation and flash flood, and also monitoring the "atmospheric rivers" (ARs). Here shows the animation of bTPW and PCT for a heavy rain event during Feb 6~9, 2017, when an atmospheric river event brought a prolonged period of moderate to heavy rain to portions of northern California on Feb 6. That rain, combined with snowmelt in some areas, brought flooding and several mudslides to parts of California and Nevada.





(Animations credited to Nancy Merckle)

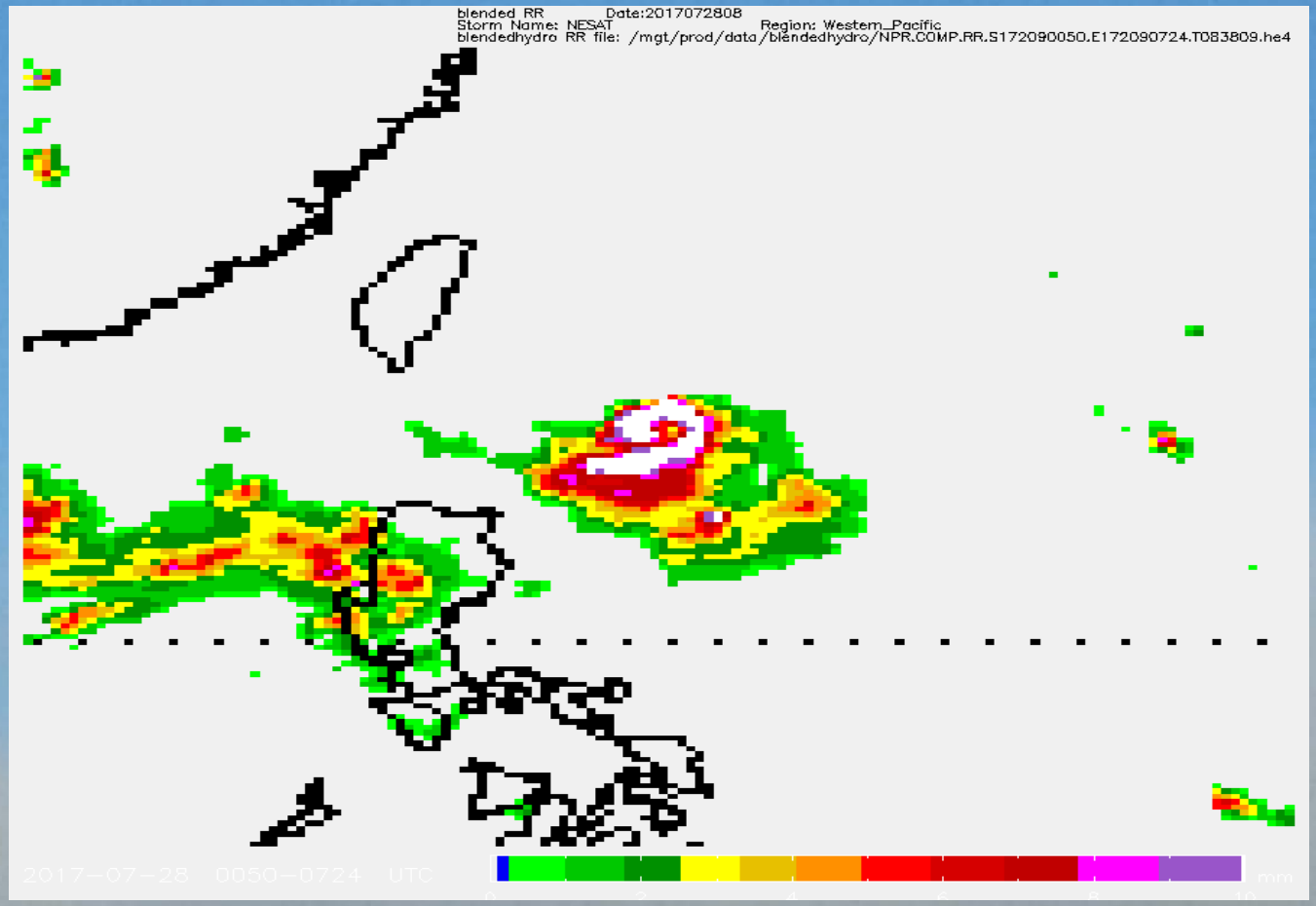
Blended RR

- **Product**
  - **Unified global rainfall rate map generated from multi-satellites and multi–algorithms**
  - **With the same approach as that of blended TPW**

- **Current Status**
  - **Operational:** since September 18, 2012
  - **Data Sources:**
    - AMSU RR from N18, N19 and Metop-A/-B
    - SSMIS RR from FNMOC F17 and F18
    - ATMS RR and GMI RR from MiRS
    - GCOM-W1 RR from GAASP/GPROF
  - **Products:** Rain Rate; 16x16km
  - **Formats:** HDF-EOS, McIDAS and AWIPS; netCDF4 in near future
  - **Data Access:** DDS/PDA, ADDE and AWIPS
  - The imagery products are also available on the Internet through: http://www.osdpd.noaa.gov/Products/atmosphere/brr
  - **POCs**: Limin Zhao and Ralph Ferraro

Blended Rain Rate

Here shows the animation of blended RR for Typhoon NESAT, which swept across Taiwan on 2017 July 29, injuring more than 80 people, forcing the capital to shut down essential services and knocking out power to hundreds of thousands of homes. The blended RR provided a more timely and frequently update on the rainfall dumped by NESAT.



Data Access

- **Real-time data access to ESPC DDS/PDA through Data Access Request(DAR):**
  http://www.ospo.noaa.gov/Organization/About/access.html

- **Historical data access through NOAA/CLASS/NCDC**:
  http://www.class.ngdc.noaa.gov/saa/products/welcome

- **Imagery Products through Internet:**
  bRR - *http://www.ospo.noaa.gov/Products/atmosphere/brr*
  bTPW - *http://www.ospo.noaa.gov/bTPW*
  GHE - *http:// ://www.ospo.noaa.gov/Products/atmosphere/ghe*
  eTRaP - *http://www.ssd.noaa.gov/PS/TROP/etrap.html*
  SMOPS - *http://www.ospo.noaa.gov/Products/land/smops*
  Blended SST – http://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html
  GBBEPx – http://www.ospo.noaa.gov/Products/land/gbbepx/
  MTCSWA – *http://www.ssd.noaa.gov/PS/TROP/mtcswa.html*
  TOAST – *http://www.ospo.noaa.gov/Products/atmosphere/toast/index.html*
  Enhanced TOAST – *http://www.ospo.noaa.gov/Products/atmosphere/etoast/index.html*
  IMS - *http://www.natice.noaa.gov/ims/ims_1.html*

- **Questions/Comments:** *Limin.Zhao@noaa.gov*

Looking Forward (next year or so)

- Integrate the data from S-NPP (for some products that haven't done so yet) and JPSS-1
- Integrate the data from GOES-R as they become operational
- Update the merging algorithm to implement more quality controls and to count the error statistics from each retrievals
- Newest product for operational consideration - Layered Blended TPW

Discussion Topics/Ideas….

- Should there be a ‘recipe’ we develop that
  - Defines approaches to be considered when developing new blended products
  - The recipe needs to account for latency requirements
    - There will not be a ‘one size fits all’ because of this
  - Consider the final end user
    - NWP, forecaster, global monitoring, etc.
- How do we incorporate blended products within the evolving Enterprise Approaches?
- How does reprocessing of L2 factor in?

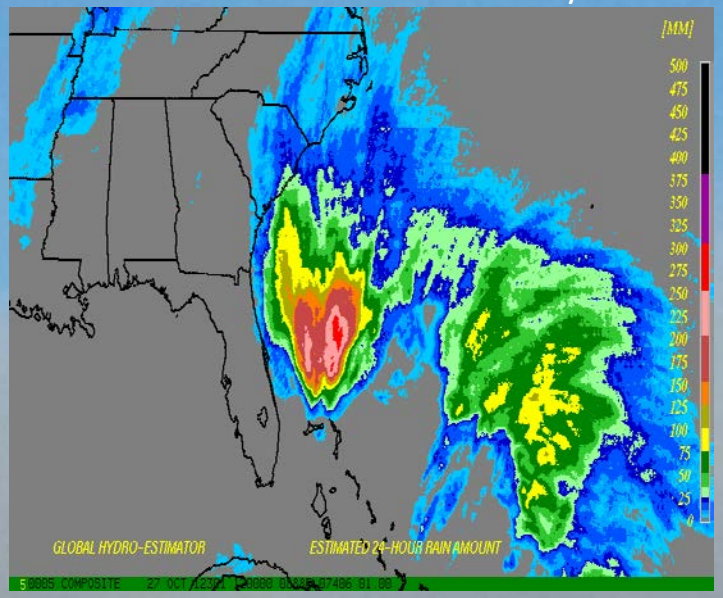
Backup Slides

Additional examples of blended products

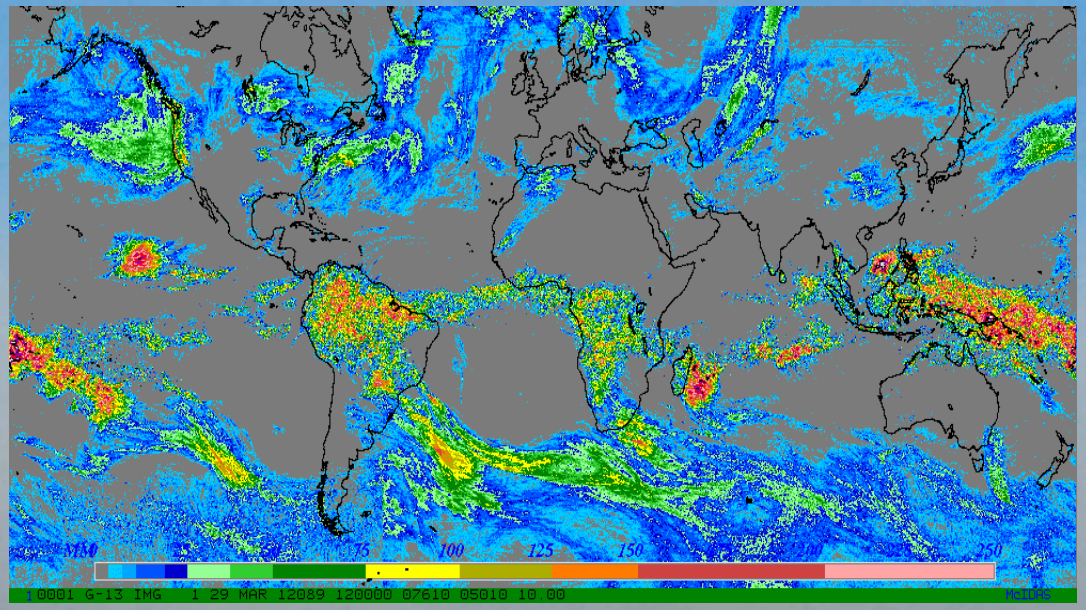
GHE

- **Products:**
  - Global rainfall maps generated from multi-geo-satellites
- **Data Source:** GOES-W/-E, Meteosat-8, Meteosat-10, Himawari-8
- **Products:** *Instantaneous rain rate, 1 hour, 3 hour, 6 hour, 24 hour and also multi-day rainfall accumulation; 4x4 km*
- **Format:** GRIB1, McIDAS area and netCDF4
- **Web Link:** http://www.ospo.noaa.gov/Products/atmosphere/ghe
- **Data Access POCs:** Limin Zhao and Bob kuligowski

24-hour Rainfall Total - Sandy

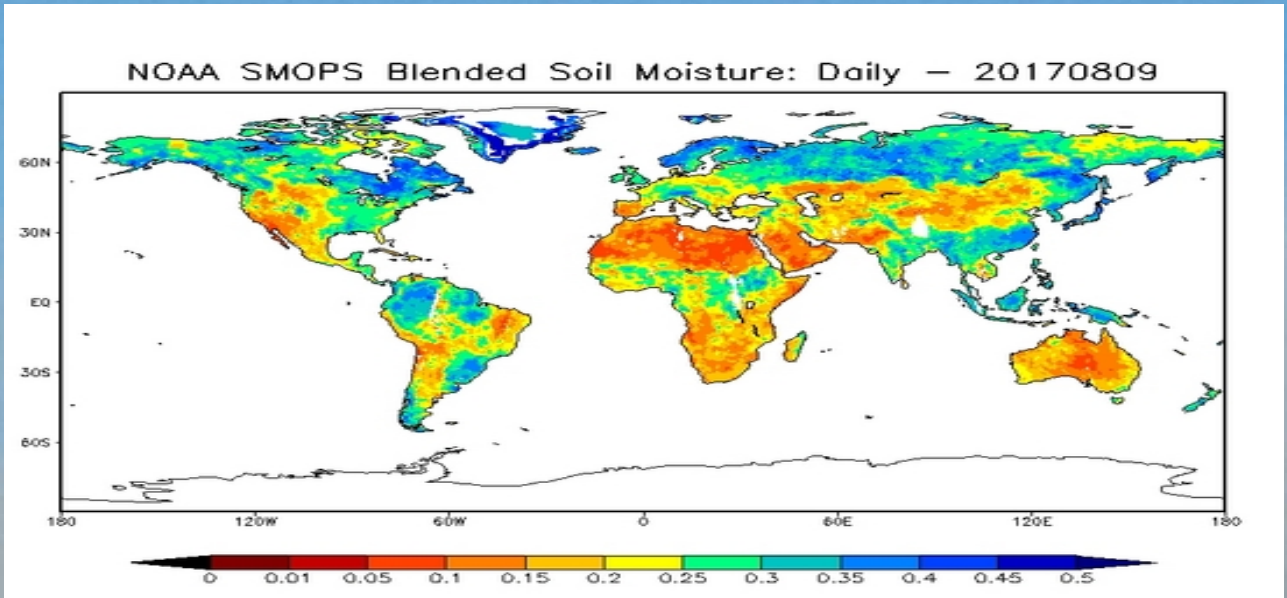


5-Day Rainfall Total



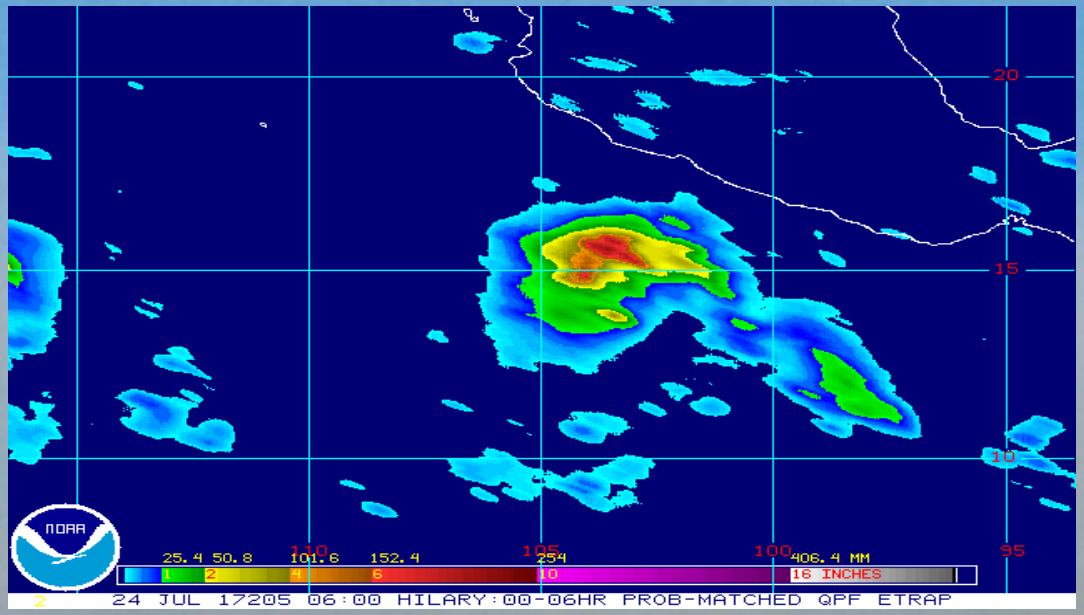
SMOPS

- **Products:**
  - Global soil moisture map generated from multi-satellites and/or –algorithms
- **Data Resource**
  - Metop-A/-B, SMOS, SMAP, GPM
- **Products:** 0.25x0.25 degree; 6 hourly, Daily
- **Format:** GRIB2 and netCDF4
- **Web Link**
  - http://www.ospo.noaa.gov/Products/land/smops
- **Data Access POCs:** Limin Zhao and Xiwu Zhan



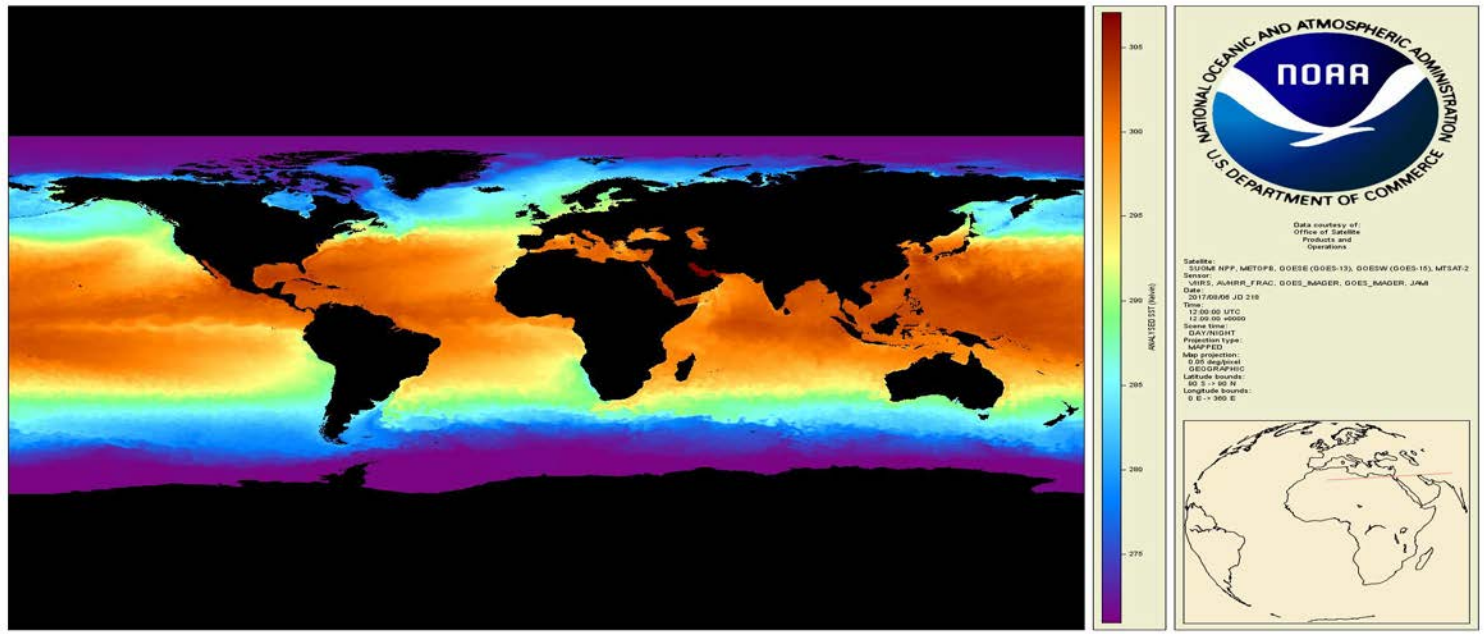
eTRaP

- **Products:**
  - **Ensemble forecast of 6~24-hour rainfall potential for tropical systems based on extrapolation of satellite-derived rainfall rates along predicted storm track**
- **Data Resource**
  - Rainfall Rate from N18, N19 and Metop-A/-B, F17, F18, GOES-W/GOES-E, Meteosat-8, Meteosat-10, Himawari-8
- **Products:** *Probability (PoP), Prob-Matched QPF (PMQPF)*
- **Format:** ASCII, McIDAS and gifs
- **Web Link:** http://www.ssd.noaa.gov/PS/TROP/etrap.html
- **Data Access POCs:** Liqun Ma and Bob kuligowski



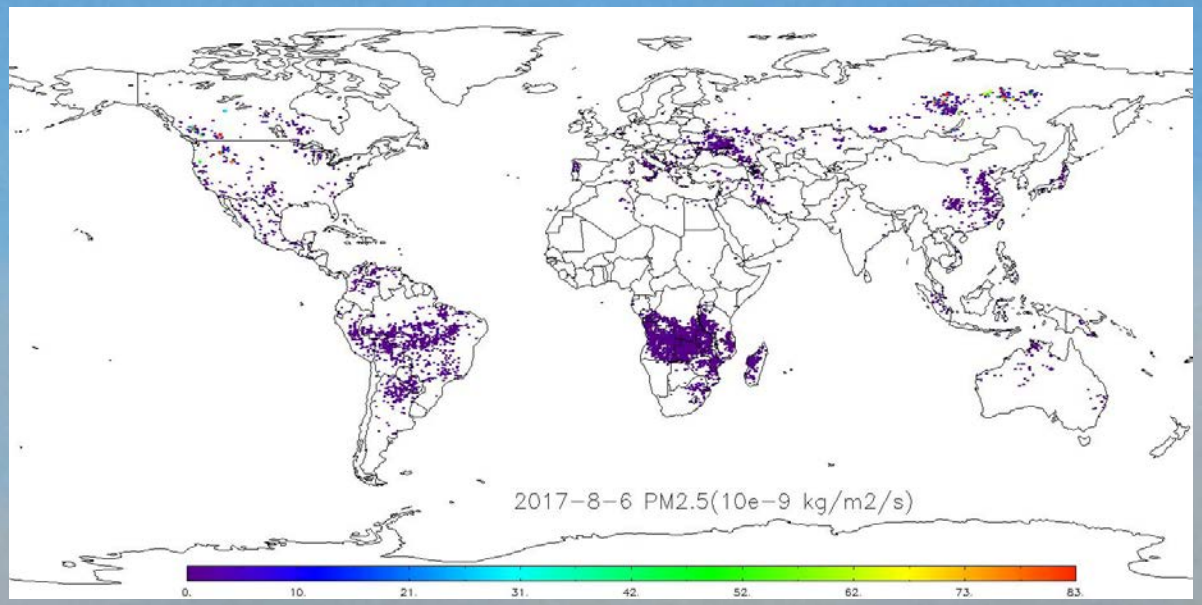
Blended SST

- **Products**
  - Blended SST combines polar-orbiting and geostationary data to provide daily global fields of sea surface temperature on a 0.05° (~5 km) grid for a range of applications in climate, ecosystems, weather, and mesoscale oceanography.
- **Data Resource**
  - Metop-B/AVHRR, S-NPP/VIIRS, GOES-E&-W/Imager, Meteosat-10/SEVIRI and Himawari-8/AHI
- **Format:** netCDF4, hdf4 (will be terminated soon)
- **Web Link:** http://www.ospo.noaa.gov/Products/ocean/sst/contour/index.html
- **Data Access POCs:** John Sapper and Eileen Maturi



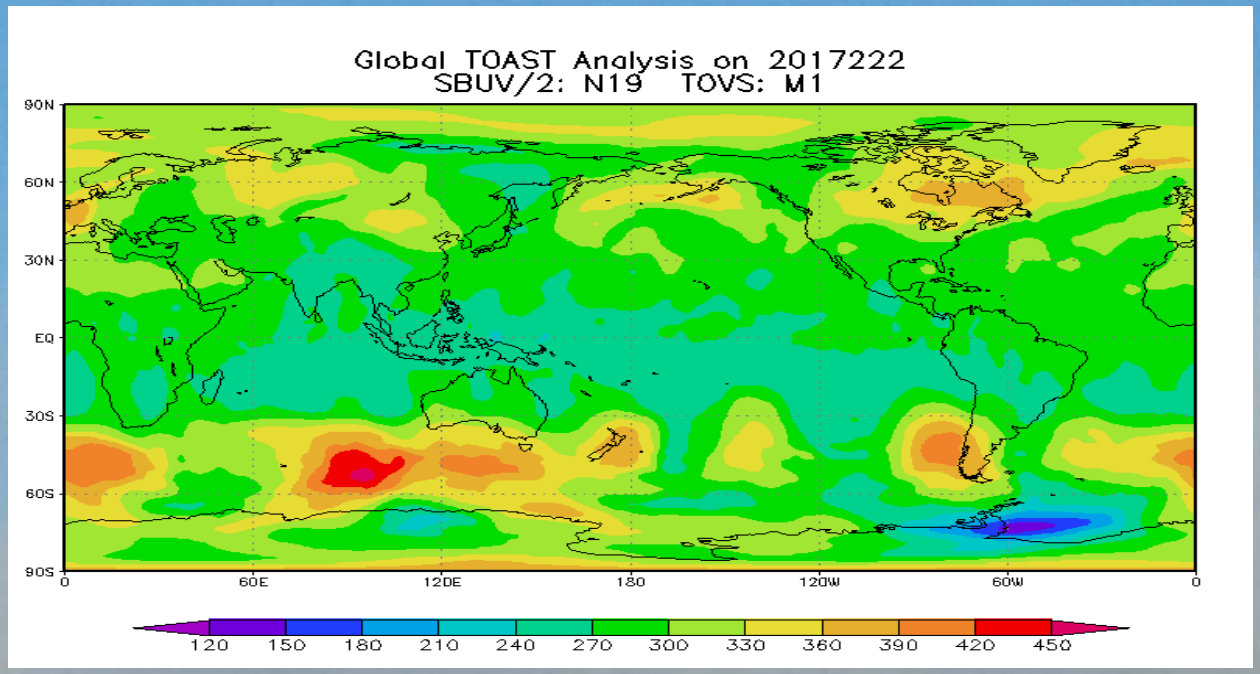
Blended Global Biomass Burning Emissions Product

- **Products:**
  - The GBBEPx produces daily global biomass burning emissions (PM2.5, BC, CO, CO2, OC, and SO2) released from wildfires using fire wildfires power retrieved from MODIS and Geostationary Satellites.
- **Data Resource**
  - GOES-E&-W/Imager, EOS-Terra/MODIS, EOS-Aqua/MODIS
- **Format:** netCDF4, PNG
- **Web Link:** http://www.ospo.noaa.gov/Products/land/gbbepx/
- **Data Access POCs:** Hanjun Ding and Shobha Kondragunta



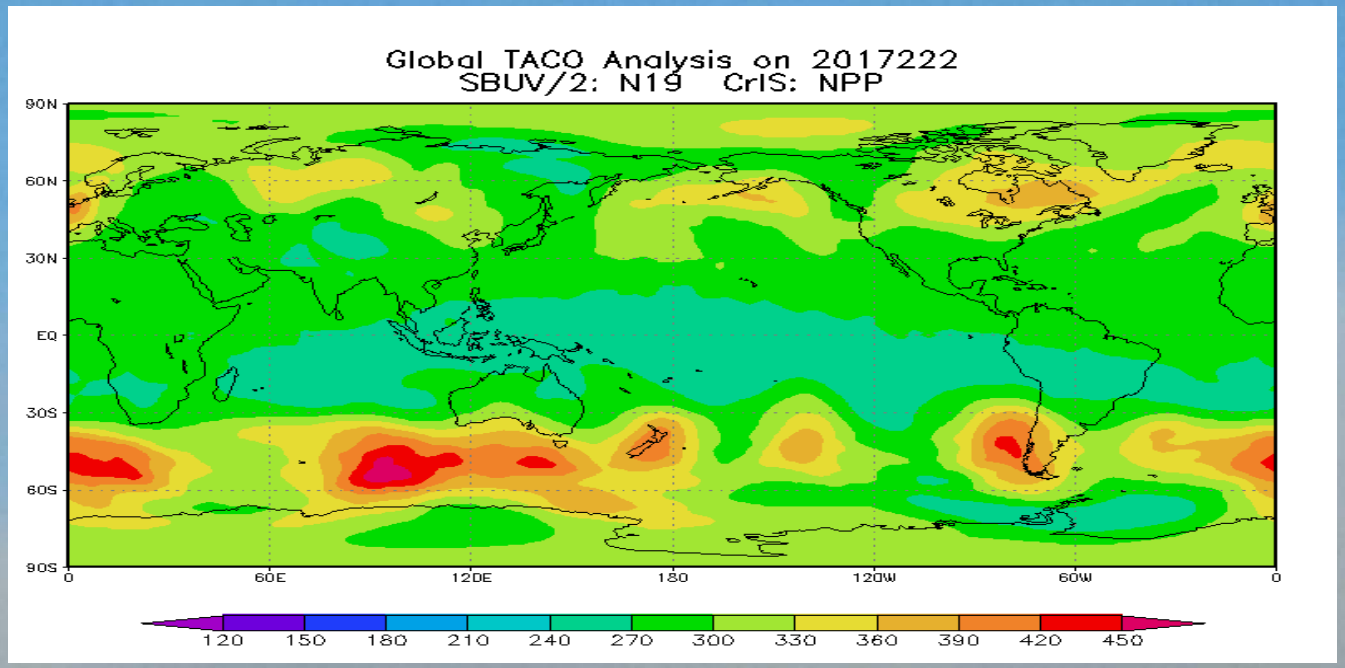
TOAST

- **Products:**
  - Near real-time operational ozone maps generated by combining TOVS (MetOp-B) tropospheric and lower stratospheric (4 to 23 km) ozone retrievals with SBUV/2 (N19) spatially smoothed mid-to-upper stratospheric (24 to 54 km) layer ozone retrievals.
- **Data Resource**
  - NOAA-19/SBUV-2 and Metop-B/TOVS
- **Format:** GRIB, PNG
- **Web Link:** http://www.ospo.noaa.gov/Products/atmosphere/toast/index.html
- **Data Access POCs**: Vaishali Kapoor and Larry Flynn



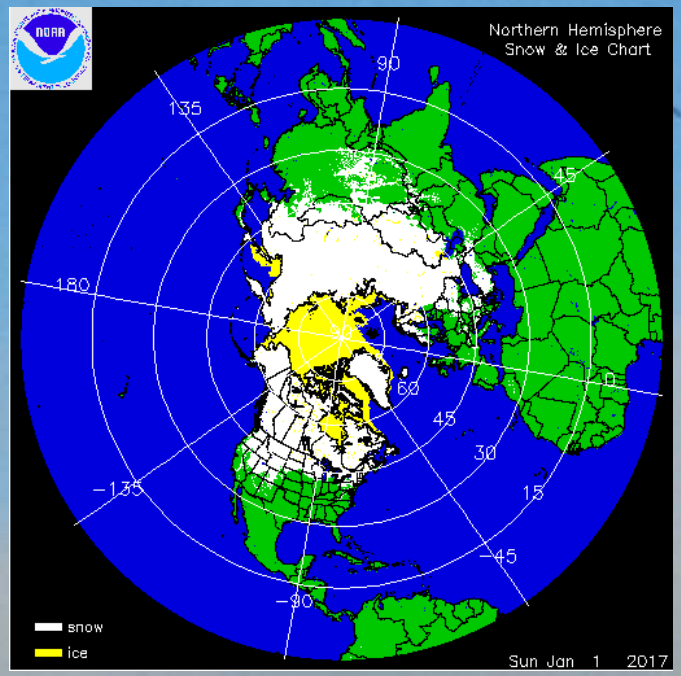
ETOAST

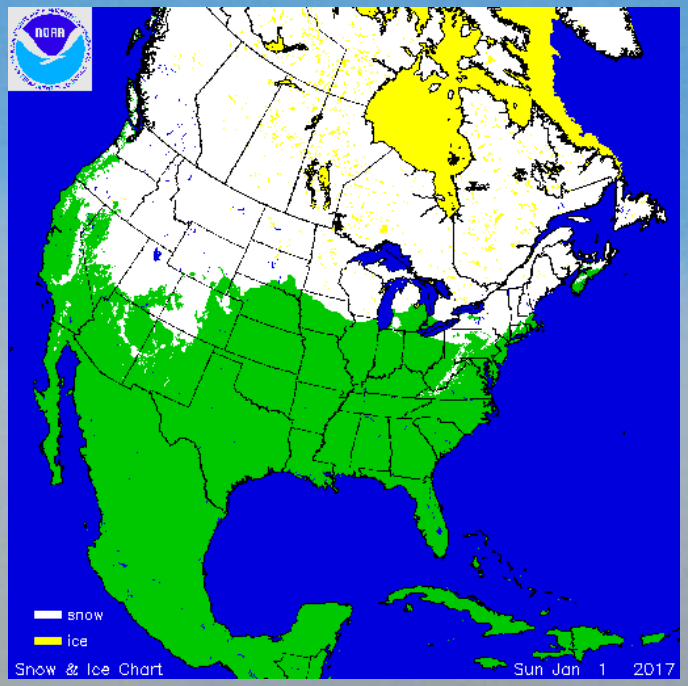
- **Products:**
  - Near real-time operational ozone maps generated by combining UV and IR ozone retrievals generated using Total Ozone Analysis of Cross-track Infrared Sounder- CrIS (NPP) and Solar Backscatter UltraViolet Version 2 - SBUV/2 (N19), which is an enhancement to TOAST with a new algorithm.
- **Data Resource**
  - NOAA-19/SBUV/2 and S-NPP/CrIS
- **Format:** GRIB, PNG
- **Web Link:** http://www.ospo.noaa.gov/Products/atmosphere/etoast/index.html
- **Data Access POCs**: Vaishali Kapoor and Larry Flynn



IMS

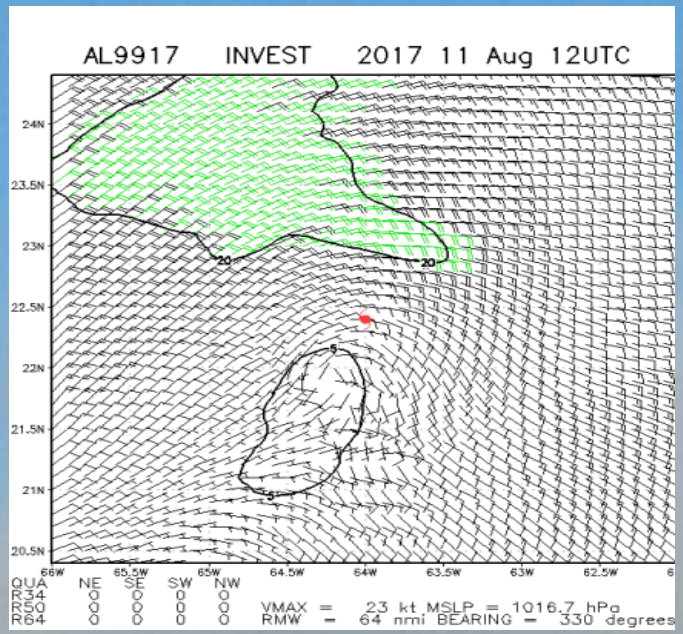
- **Products:**
  - Snow and Ice cover maps for the Northern Hemisphere derived from a variety of data products including satellite imagery and in situ data.
- **Data Resource**
  - NOAA-18&-19, Metop-A, S-NPP, Aqua/TERRA, Radarsat-2, Meteosat-10, Himawari-8, DMSP 15, GOES-E&-W
- **Format:** ASCII and PNG
- **Web Link:** http://www.natice.noaa.gov/ims/ims_1.html
- **Data Access POC:** Sean Helfrich

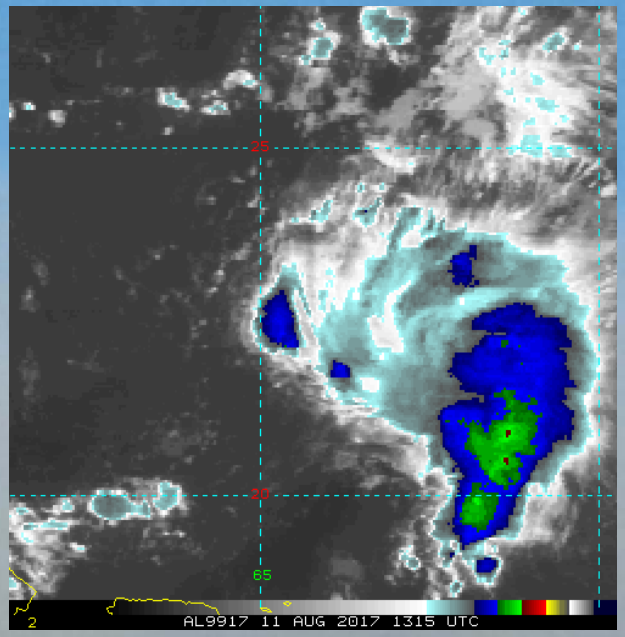




MTCSWA

- **Products:**
  - Six-hourly estimates of tropical cyclone wind fields based on a variety of satellite based winds and wind proxies.
- **Data Resource**
  - NOAA-15, NOAA-18, NOAA-19, Metop-A, S-NPP
- **Format:** ASCII and PNG
- **Web Link:** http://www.ssd.noaa.gov/PS/TROP/mtcswa.html
- **Data Access POCs:** Liqun Ma and John Knaff





Thank You