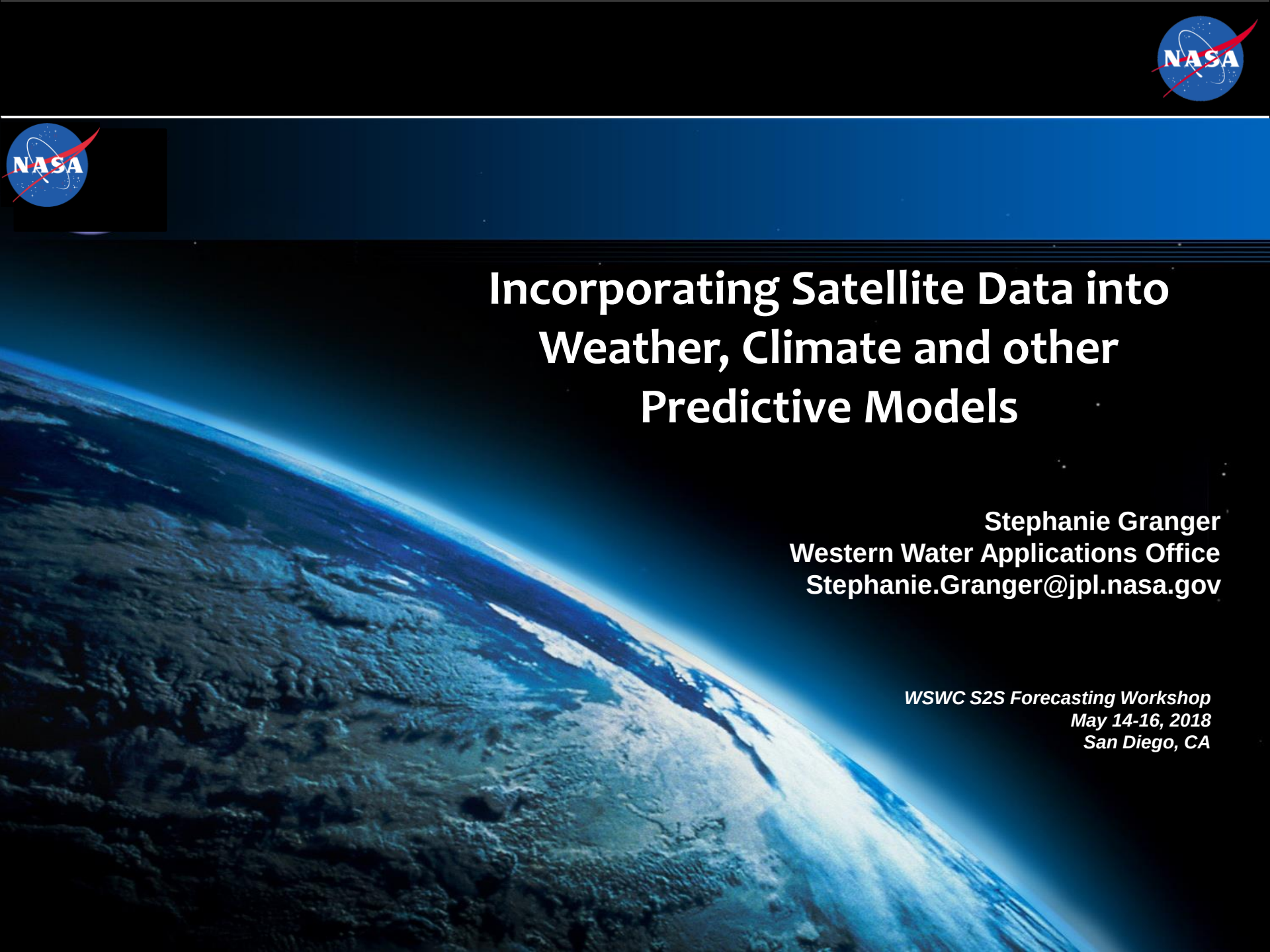


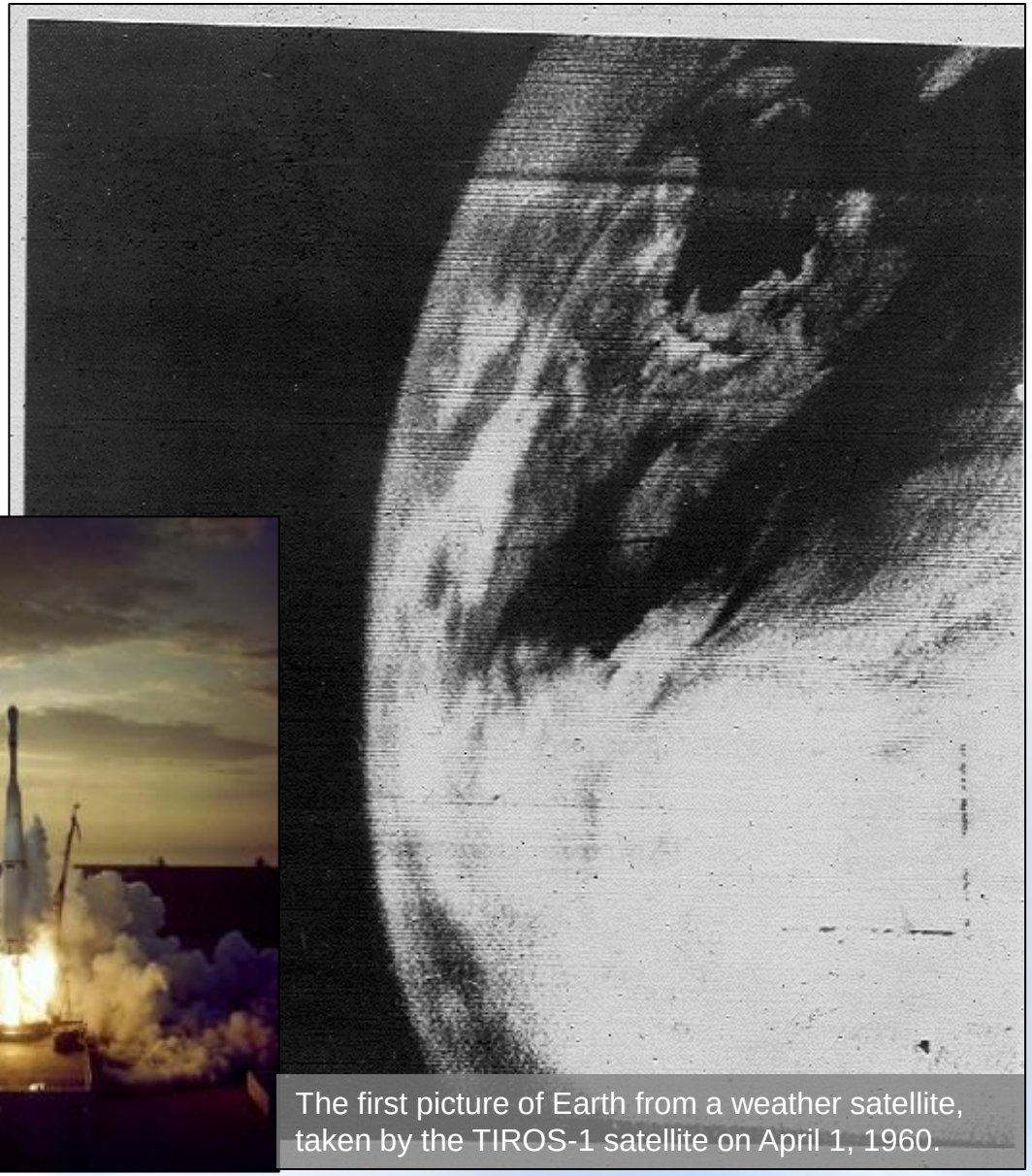
Incorporating Satellite Data into Weather, Climate and other Predictive Models

Stephanie Granger
Western Water Applications Office
Stephanie.Granger@jpl.nasa.gov

WSWC S2S Forecasting Workshop
May 14-16, 2018
San Diego, CA

TIROS: The First Successful Weather Satellite

- **TIROS-1 launched April 1, 1960**
- **Provided the first accurate weather forecasts based on data from space**
- **Led to: TIROS satellite series; Nimbus-series; Geostationary Operational Environmental Satellites (GOES); NOAA Polar Orbiting Satellites; and more**

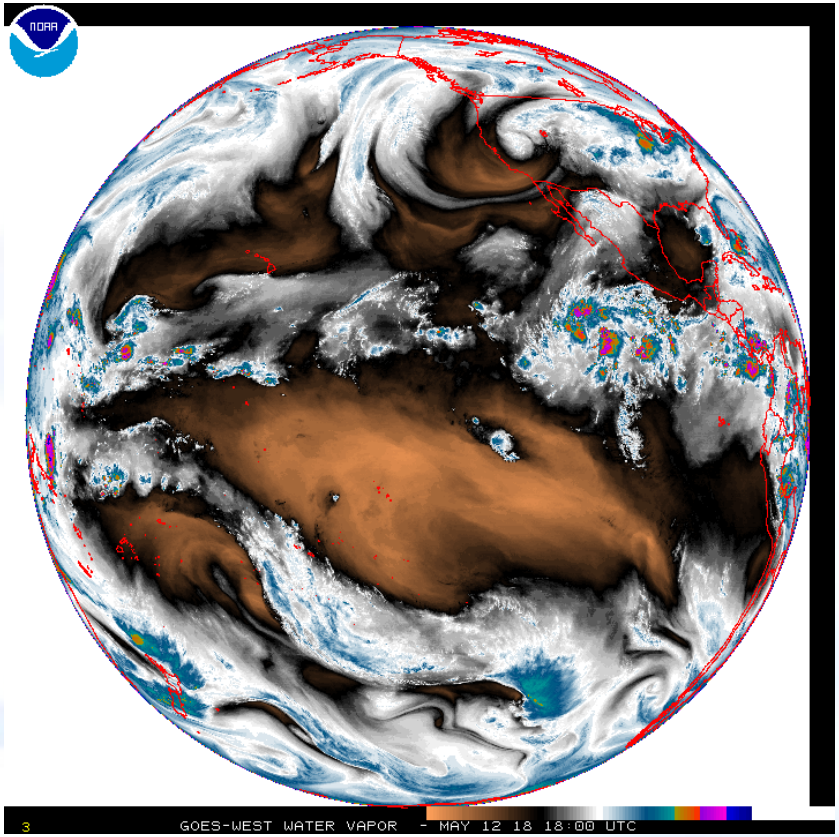


The first picture of Earth from a weather satellite, taken by the TIROS-1 satellite on April 1, 1960.

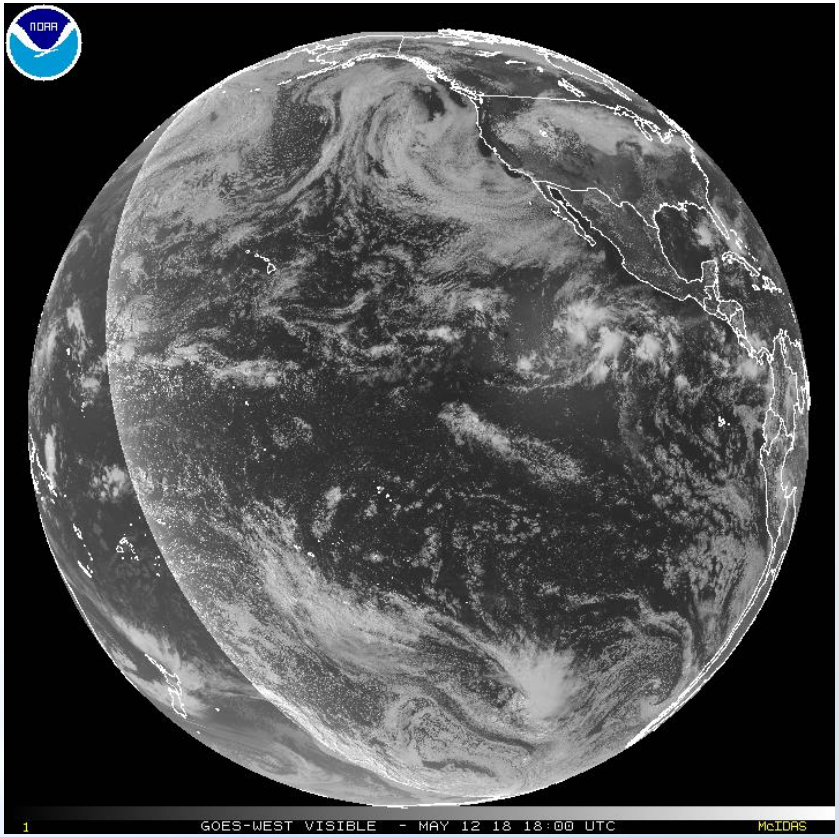
GOESS

NOAA GEOSTATIONARY SATELLITE SERVER

Water Vapor - 5/12/2018



Visible – 5/12/2018

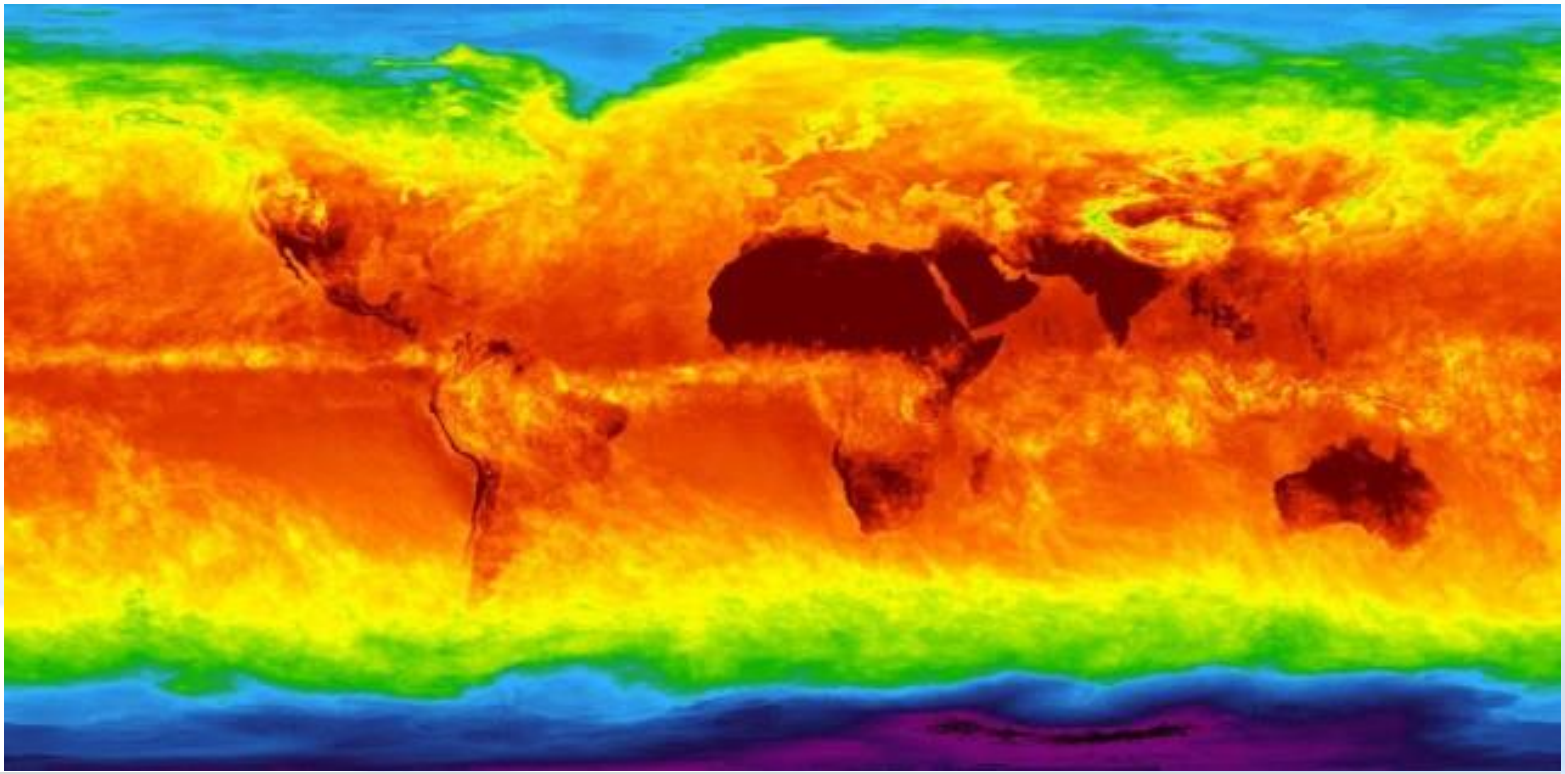


http://www.goes.noaa.gov/goesfull.html


JPSS-2 (NOAA)
Formulation
Implementation
Primary Ops
Extended Ops
NI-SAR
PACE
SWOT
TEMPO
GRACE-FO (2)
ICESat-2
CYGNSS
SAGE III (on ISS)
SMAP
OCO-2
TRMM
QuikSCAT
SORCE
EO-1
Landsat-7
(USGS)
ACRIMSAT
Aquarius
Terra
Suomi NPP
(NOAA)
Aqua
CloudSat
Landsat-8
(USGS)
CALIPSO
Aura
GRACE (2)
OSTM/Jason 2
(NOAA)
GPM

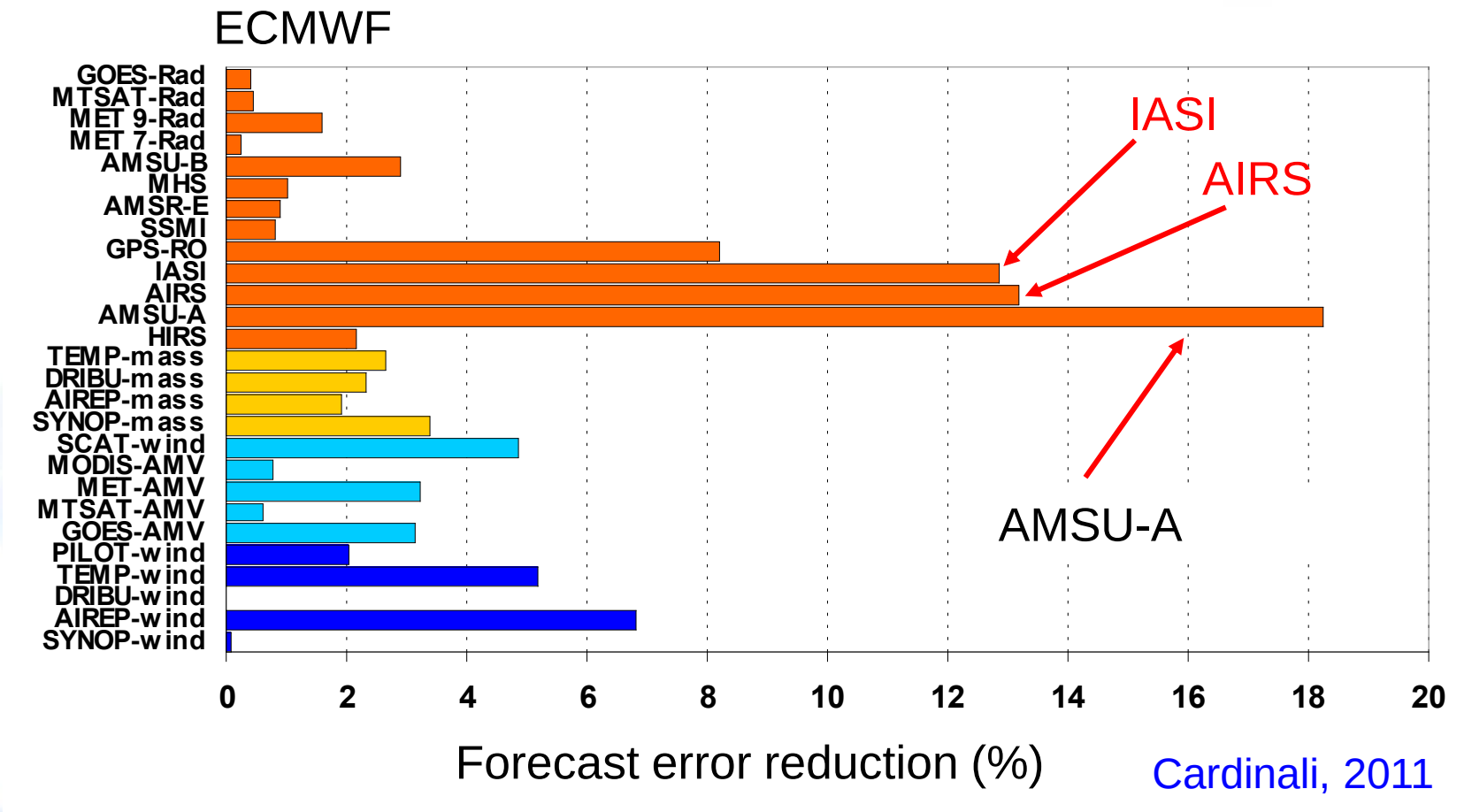
Advanced InfraRed Sounder (AIRS)

- Launched in 2002 aboard Aqua spacecraft
- Multi-agency team: NASA and NOAA
- Suite of sensors: AIRS, AMSU-A, HSB
  - Temperature, Relative Humidity, Water Vapor, Clouds, CO, O3, CO2, others
- AIRS continues to provide a valuable record for weather and climate



https://airs.jpl.nasa.gov

AIRS and Weather Prediction



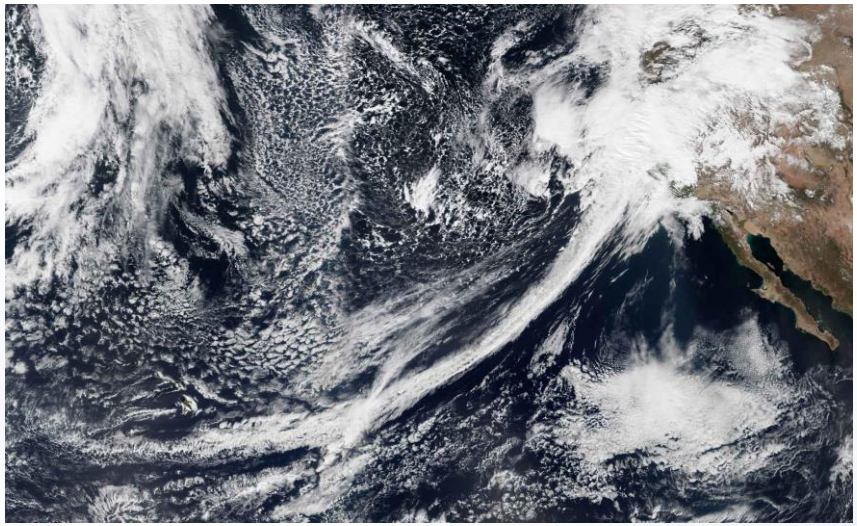
The AIRS suite of sensors has played a significant role in improving forecasts over the last 15 years

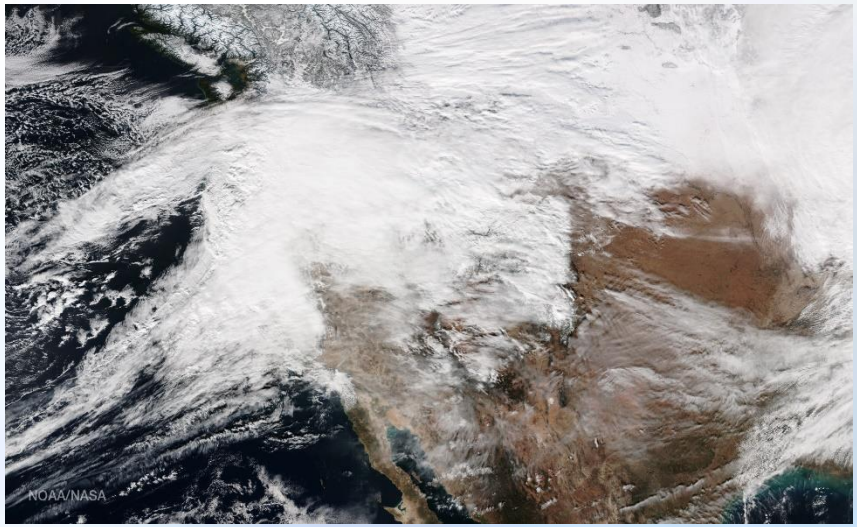
JPSS – Suomi NPP

THE NEXT GENERATION

Joint Polar Satellite System (JPSS) – Suomi National Polar-orbiting Partnership (NPP)

- A collaborative program between the NOAA and NASA.
- New generation polar-orbiting operational satellite system.





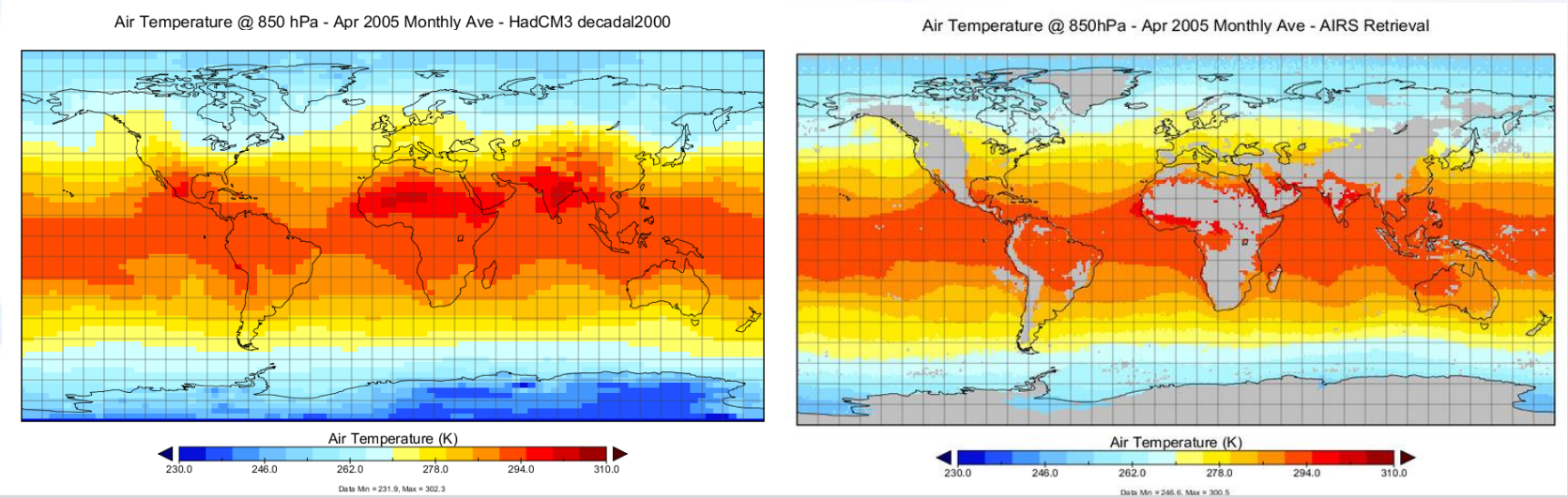
http://www.jpss.noaa.gov/mission_and_instruments.html

Center for Climate Sciences

IMPROVING CLIMATE MODELS

Climate Model Improvement: NASA/JPL Center for Climate Sciences

- The Center for Climate Sciences at JPL bridges the gap between satellite data and climate models
  - Conducts several projects including Obs4MIPs
- Obs4MIPs
  - How do we improve the predictive skill of climate models?
  - Collaborative project with Program for Climate Model Diagnosis and Inter-comparison (PCMDI) at LLNL
  - Prepares and hosts global satellite datasets in the same format as the CMIP5 outputs to easily compare CMIP model outputs to observations.
  - Includes observational datasets from NASA, NOAA, DOE and ESA



https://climatesciences.jpl.nasa.gov/index.html

SPoRT

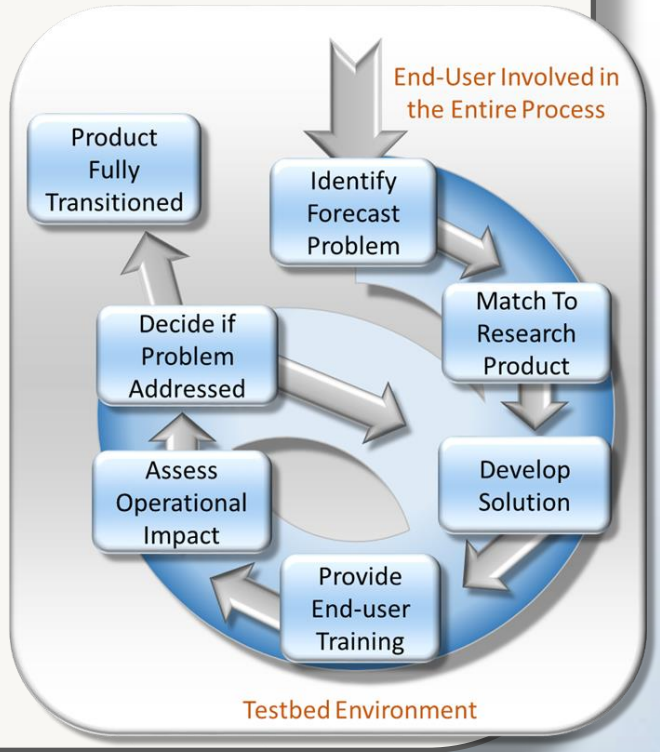
SHORT-TERM PREDICTION RESEARCH AND TRANSITION

Short-term Prediction Research and Transition (SPoRT)

- **SPoRT is focused on transitioning NASA observations and research capabilities to the operational weather community to improve short-term weather forecasts on a regional and local scale.**
- **Uses experimental modeling systems that are modeled after operational systems**
- **Proven paradigm for transition of research and experimental data to "operations"**

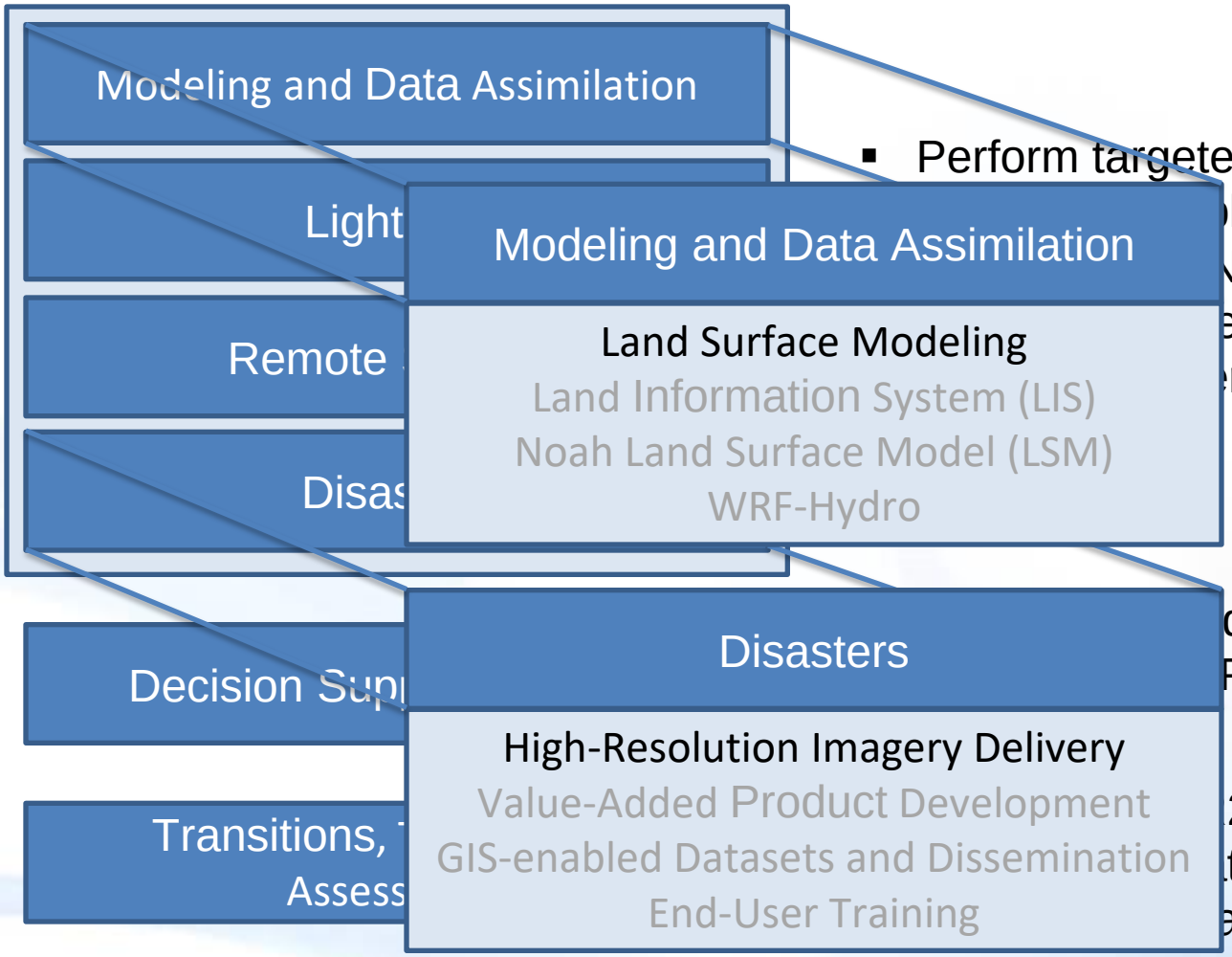
Benefits

- demonstrate capability of NASA experimental products for operations, applications, and societal benefit
- prepares forecasters and modeling systems for use of data from next generation of operational (e.g., JPSS, GOES-R)



Website: http://weather.msfc.nasa.gov/sport/
Blog: https://nasasport.wordpress.com/ Twitter: @NASA_SPoRT
Facebook: NASA SPoRT Center

SPoRT Areas of Expertise



- Perform targeted research
  loit unique
  NASA satellites
  es to solve
  r forecasting

  duct dissemination
  PS II, N-AWIPS,

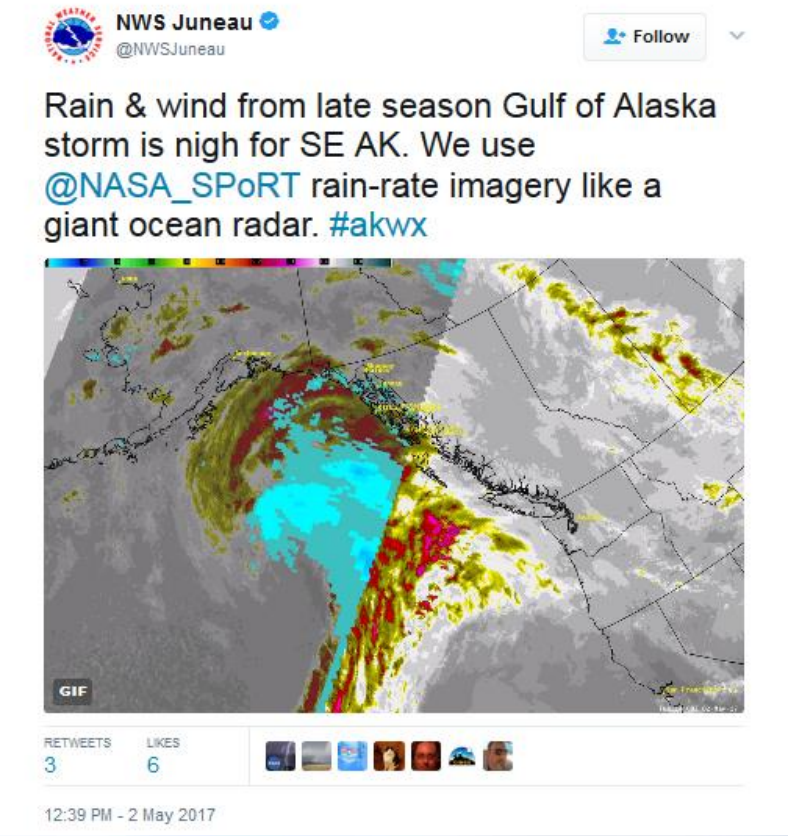
  2O/O2R paradigm for
  ta and obtaining
  ack from NWS
  forecasters

GPM

GLOBAL PRECIPITATION MEASUREMENT MISSION

GPM data used by Alaska National Weather Service Forecasting Office

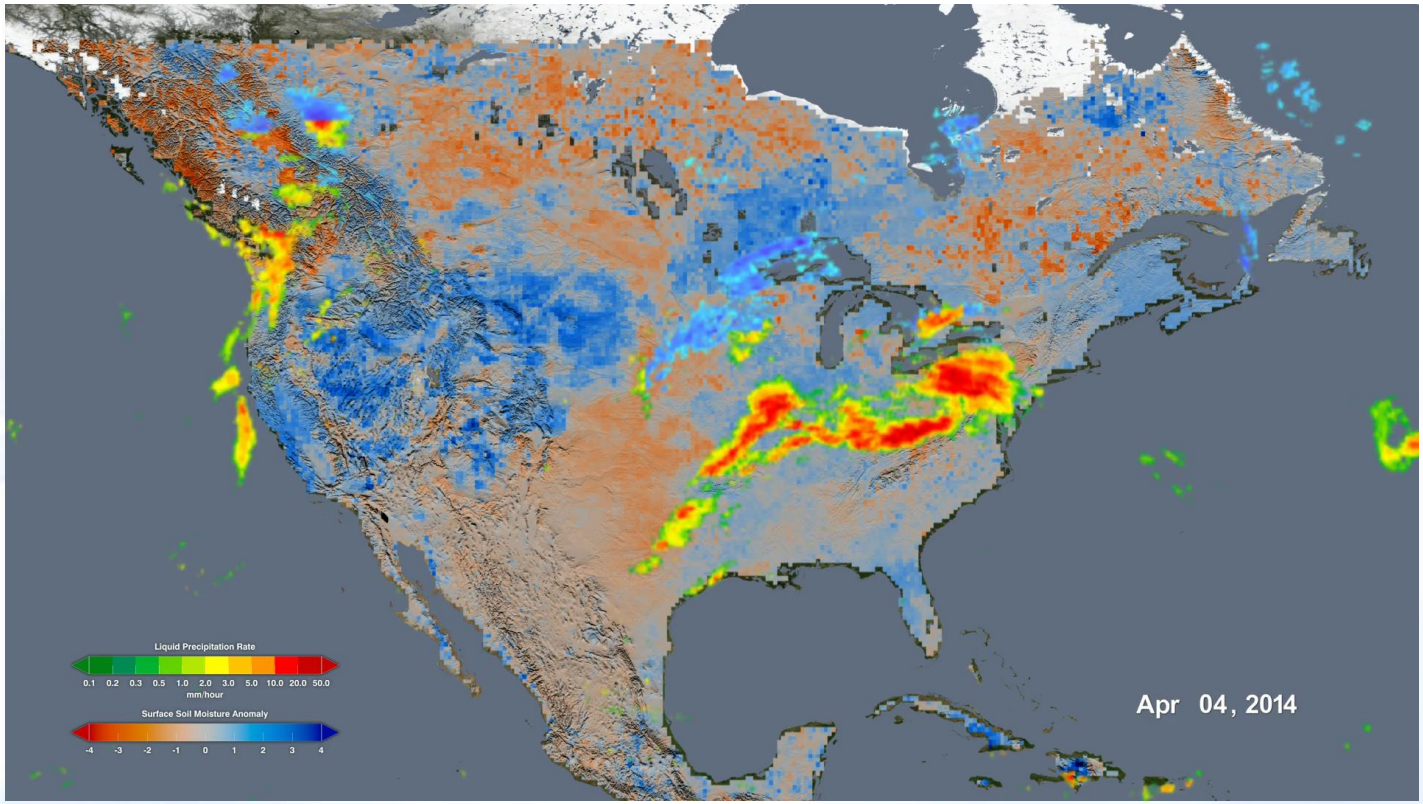
- Global Precipitation Mission (GPM) rain rate products are routinely ingested by the NWS office in Juneau, AK.
- The NASA SPoRT team:
  - Provides the GPM retrievals directly to their AWIPS decision support system (shown in the tweet); and
  - Provided training and assessment of the products to demonstrate applications in southeastern Alaska.
- Data from the Global Precipitation Measurement (GPM) Microwave Imager (GMI) is provided to NOAA's National Hurricane Center through NASA's Short-term Prediction Research and Transition (SPoRT) Center.

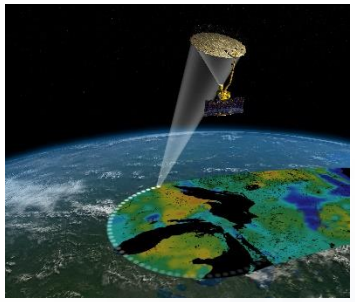


Credit: Anita LeRoy (MSFC/UAH), Matt Smith (MSFC/UAH), Frank LaFontaine (MSFC/Raytheon), Brad Zavodsky (MSFC), and NWS Juneau

https://www.nasa.gov/mission_pages/GPM/overview/index.html

Monitoring Precipitation and Soil Moisture





Soil Moisture Active Passive Mission

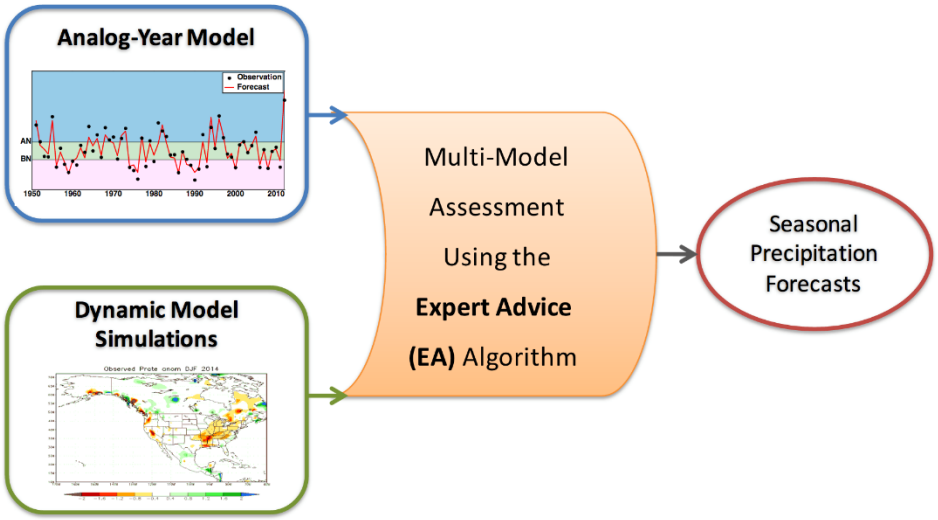
Global Precipitation Measurement Mission, Core Observatory

NASA Applied Science

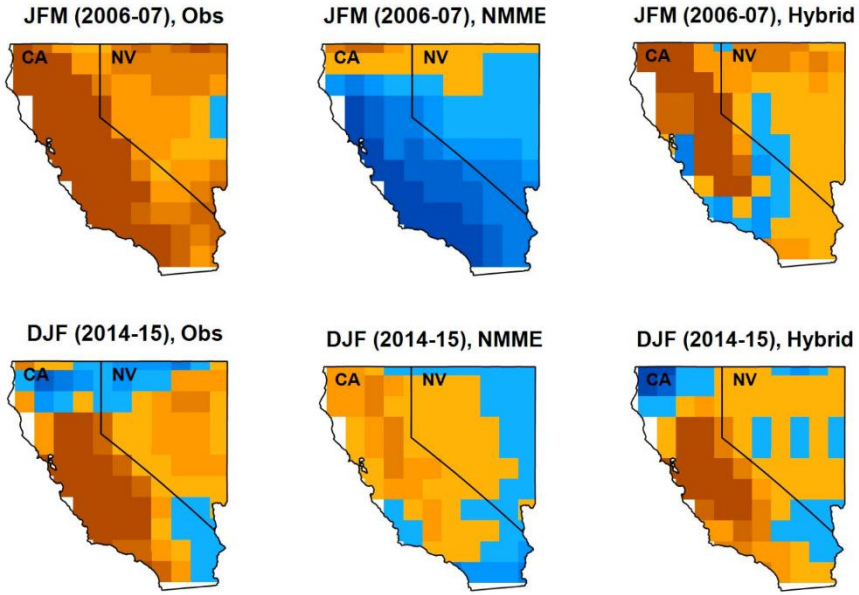
WATER RESOURCES PROGRAM

Seasonal Forecasting of Precipitation

Combining Analog-Year Model with Dynamic Model Simulations



Examples of Seasonal Forecast Results



Amir AghaKoucak, UC Irvine

Advancing Water Supply Forecasts in the Colorado River Basin for Improved Decision Making

Gerald Day, RTI International

Highlight: GPM Satellite Precipitation

- Passive microwave sensors consistently underestimate snow season precipitation in the Colorado River Basin (CRB)
- The rain/snow seasonal biases of 19 sensors were estimated by comparison with gauge observations for the period Oct 2001 – Sep 2017
- The CRB-GPROF retrieval was updated to provide estimates of bias-corrected precipitation estimates by sensor operationally
- CRB-GPROF precipitation estimates are being validated by comparison with PRISM and IMERG estimates (Figure 3)

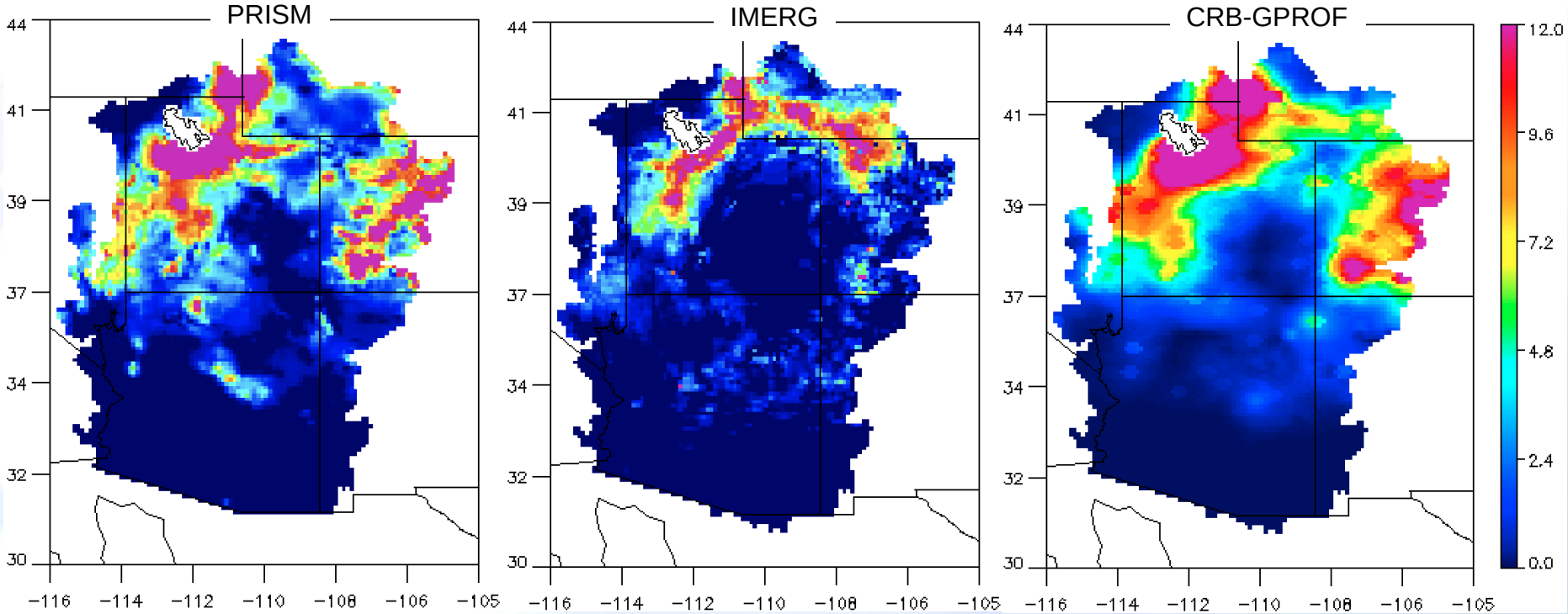


Figure 3 PRISM (left), IMERG (center), and CRB-GPROF (right) precipitation for 10 May 2015

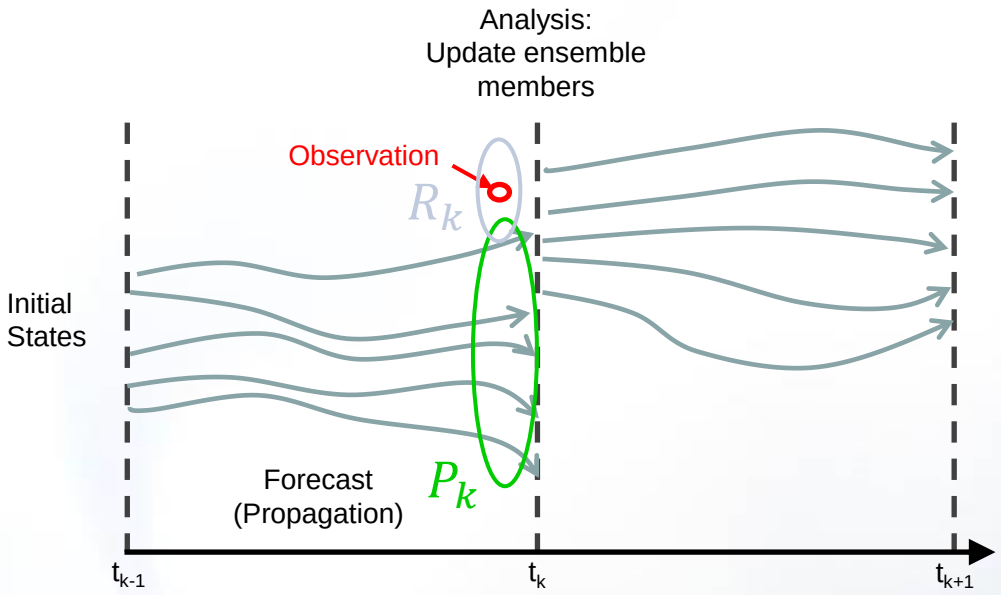
Advancing Water Supply Forecasts in the Colorado River Basin for Improved Decision Making

Gerald Day, RTI International

Highlight: Snow Data Assimilation

Goals:

- Use snow water equivalent (SWE) measurements from SNOTEL stations and MODIS Snow Covered-Area and Grain size retrieval algorithm (MODSCAG) product to create ensemble of gridded "observed" SWE.
- Use ensemble of gridded "observed" SWE to update spatially-distributed SWE states in HL-RDHM using an Ensemble Kalman Filter.
- Evaluate whether there are improvements to water supply forecast performance.



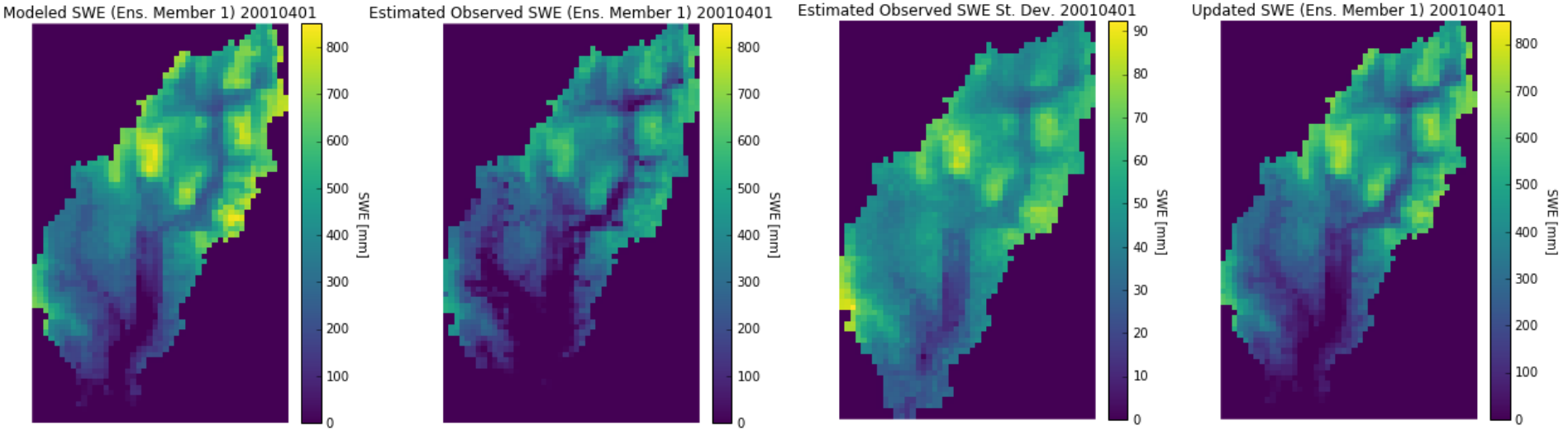


Figure: Modeled SWE (left), estimated observed SWE and estimated observed SWE standard deviation (middle two figures), and updated modeled SWE after application of the Ensemble Kalman Filter for a single ensemble member on a single forecast date (April 1, 2001).

Summary

- NASA has 50+ year history developing and applying space-based observations to advance weather and climate forecasts and predictions.
- Long tradition of collaboration and partnership with NOAA and other federal agencies
- Global Earth observations from NASA, NOAA, and other federal agencies are key to climate model improvement.
- Multiple examples of methods and tools for comparison with model results and assimilation into regional models.
- Applied Science Program supports projects with significant potential to improve regional/local prediction of hydrologic and meteorological variables critical for water management.

Acknowledgements

Many thanks to:

- Amir AghaKouchak, UCI
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- Forrest Melton, NASA-ARC
- Joao Teixeira, NASA-JPL
- Duane Waliser, NASA-JPL
- Brad Zavodsky, NASA-MSFC

Questions?

Thank you!

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