Key Federal Research and R2O to Improve Forecasts – A NASA Perspective

(not necessarily *the* NASA perspective)

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The R side of R2O

- Mostly NASA supports research using its satellite, field program, and related data, and observationally-driven modeling, with some of that suitable for subsequent transition to operations
- Example: Haiyan Jiang's JHT project (next session) grew out of work supported by NASA programs (New Investigator Program, Hurricane Science Research Program, Precipitation Science)
- Some satellites provide real-time data, R2O components
- Data Assimilation (particularly GMAO)
- Separate support for transition of results to operations (esp. JCSDA, SPoRT, associated competitive programs – NDOA)

Impacts of GPM Microwave Imager (GMI) on forecasts of Hurricane Arthur in GEOS-5

GEOS-5: 3-hr forecast of surface rainrate (mm/hr)

Without GMI Assimilation | With GMI Assimilation
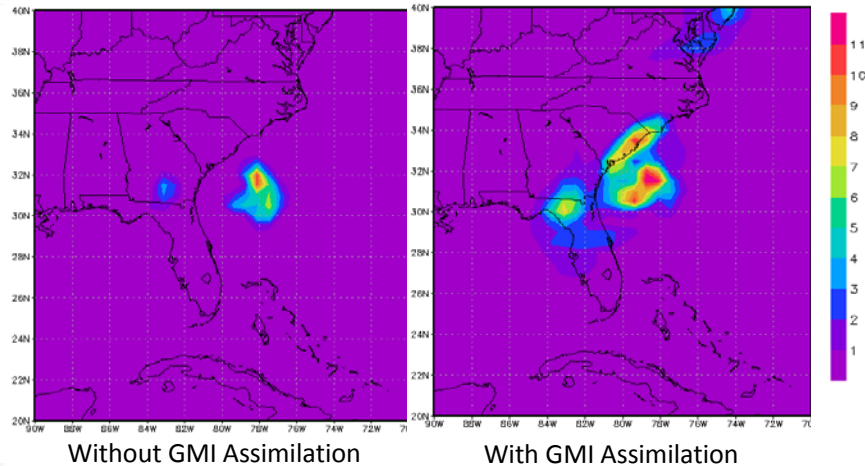
This work required substantial extensions to the GEOS-5 system, including the forward model used to compute ice- and water-cloud affected radiances from the forecasts, extension of GSI control vector, etc.

Results indicate substantial improvements to the cloud and precipitation fields associated with Hurricane Arthur. Demonstrates GMAO's role in early implementation of NASA observations into the GSI analysis

Title	Institution	PI
Assimilation of all-sky satellite radiances from CrIS and GPM: from research to operations	National Center for Atmospheric Research (NCAR)	Josh Hacker
Assimilation and evaluation of MISR cloud tracked winds with GEOS-5 operational data assimilation system	Jet Propulsion Laboratory (JPL)	Junjie Liu
Preparatory work for assimilation of precipitation-affected GPM observations into Numerical Weather Prediction model	Atmospheric & Environmental Research (AER)	Jean-Luc Moncet

External Research Projects call in NASA ROSES–FY16 under the "NASA Data for Operation and Assessment (NDOA)" program element

Passive Microwave Imagery in N-AWIPS and AWIPS-2 for NHC

- **SPoRT provides multispectral imagery (originally developed at NRL) from passive microwave instruments in NHC decision support tools**
- **GPM constellation intercalibrated brightness temperature observations from the Goddard Precipitation Processing System (PPS) are now available to forecasters**
  - Allows forecasters to view these products alongside other operational data
  - Forecasters commonly use these products for determining strongest convection in tropical systems (red) and for pinpointing the location of the center of circulation

GMI 89GHz RGB imagery product 1 October 2015 2101 UTC
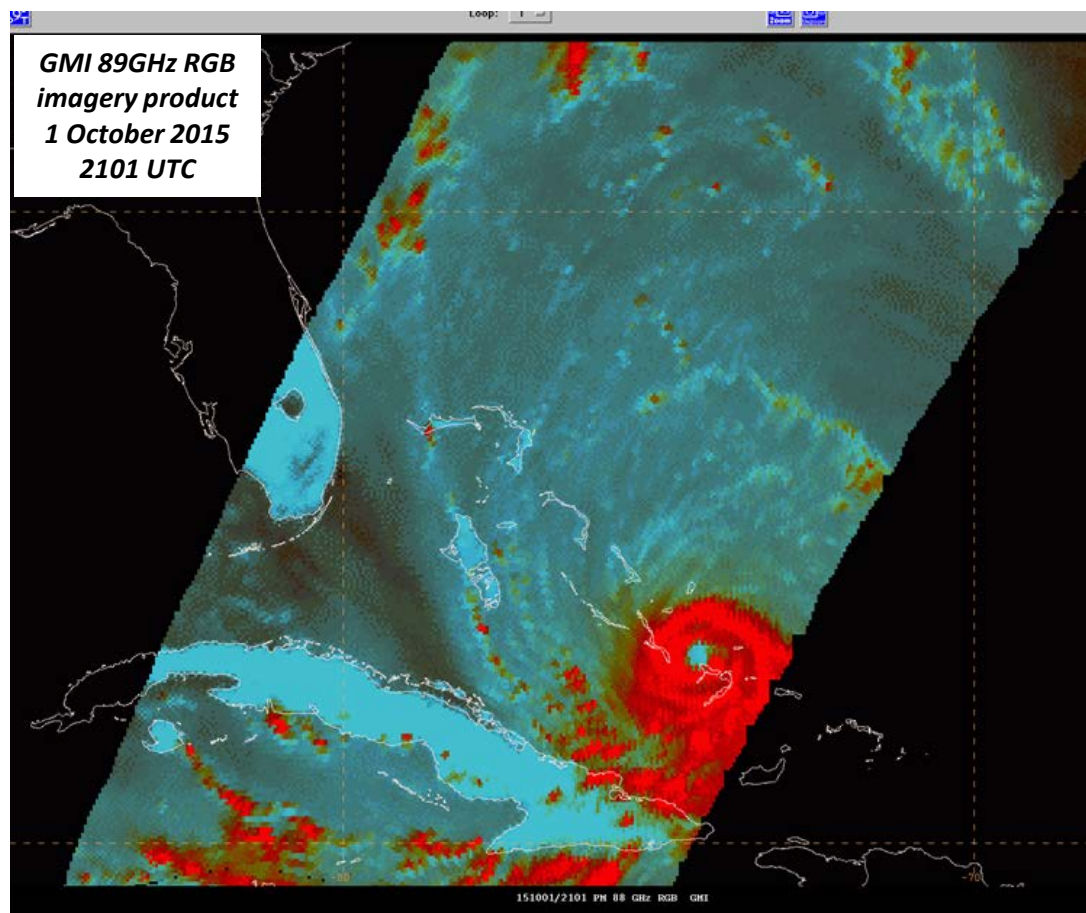
Hurricane Joaquin is captured by the GPM Microwave Imager (GMI) as it passes near the Bahamas; image is shown in N-AWIPS as would be viewed by an NHC forecaster.

Courtesy Frank LaFontaine, Kevin McGrath (NASA MSFC SPoRT / Raytheon and Jacobs)

SPoRT

VIIRS Day Night Band observations for tracking impacts to power grids

- Pre- and post-storm imagery are combined to determine areas where the brightness of city lights has been reduced (orange areas in image on the right)
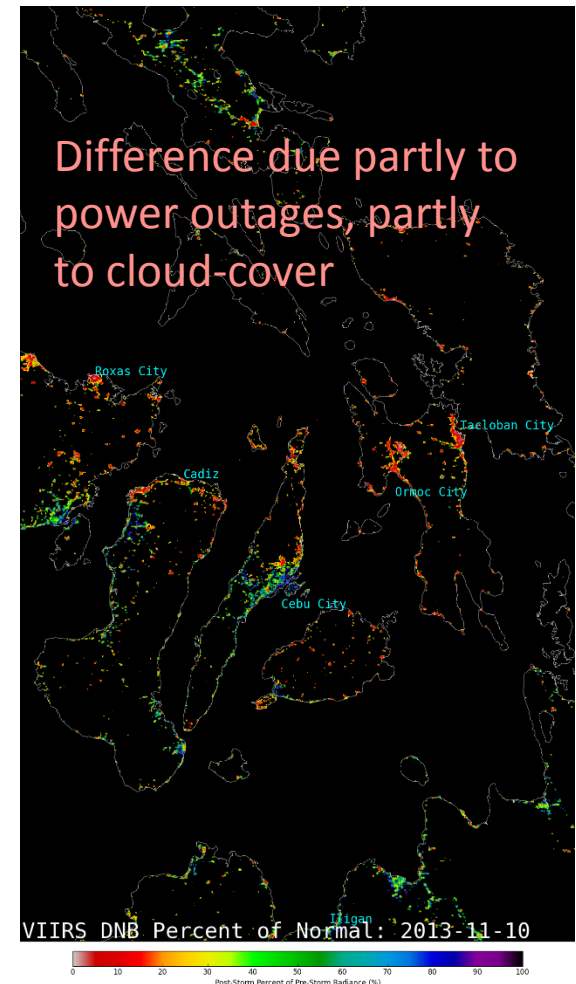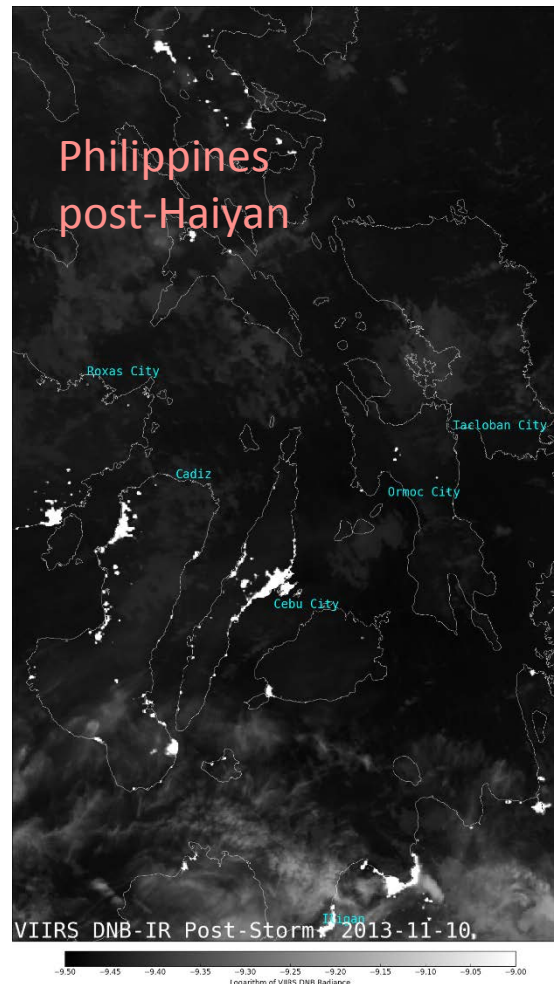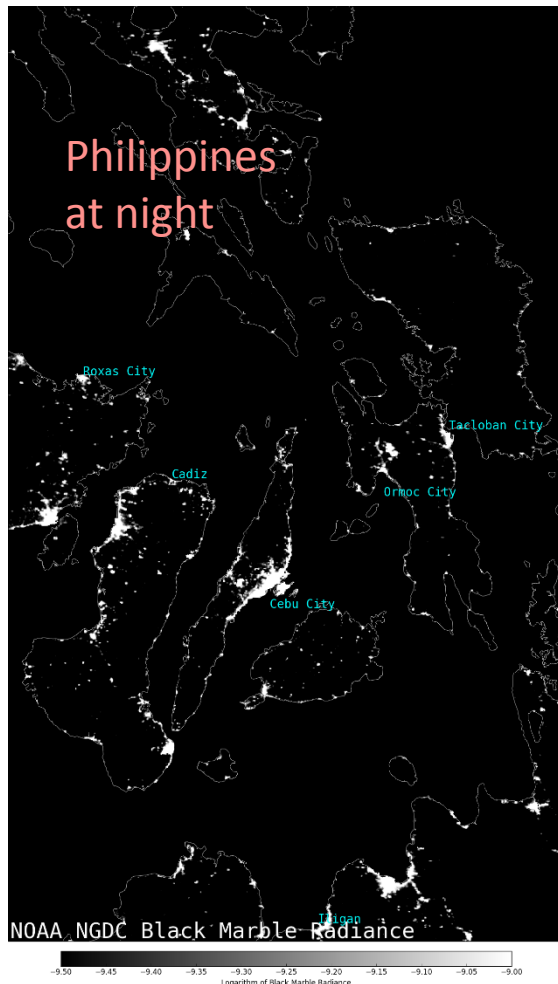

NOAA/NGDC Black Marble global lights, post-typhoon lights and cloud cover, and difference imagery over the Philippines following Super Typhoon Haiyan. The Black Marble serves as pre-event "normal" light in this example, but not in more recent applications. Courtesy Lori Schultz (NASA MSFC SPoRT / University of Alabama – Huntsville)

Post-Sandy Power Outages

- **Use of VIIRS Day Night Band observations for tracking impacts to power grids following land-falling storms**
  - Pre- and post-storm imagery are combined to determine areas where the brightness of city lights has been reduced (yellow areas in image on the right)
- **Studies have been done with Superstorm Sandy (2012) and Hurricane Issac (2012) to identify outages and track recovery**
- **Used by emergency responders to allocate resources following Sandy; products available for future events as directed by NASA HQ**
- **Work continues to develop automated algorithms to detect and track recovery**
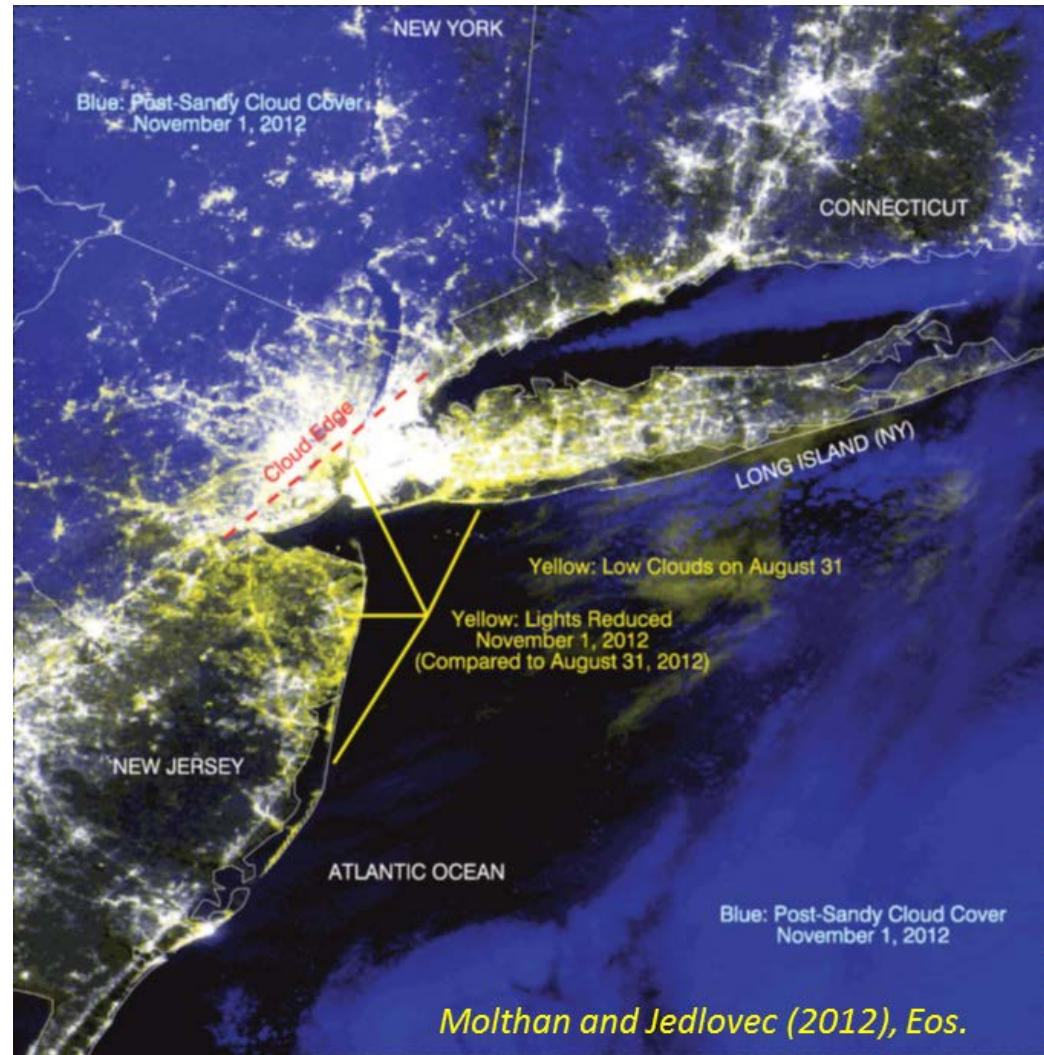
VIIRS DNB RGB product from 1 November 2012 shows continued power outages along the Jersey Shore and Long Island following Superstorm Sandy
*Courtesy Andrew Molthan, NASA MSFC SPoRT*

Satellite Signatures in Extratropical Transition

- **SPoRT is funded by the JPSS Proving Ground to investigate multispectral imagery and retrieved temperature, moisture, and ozone profiles for extratropical transition**
    - Multispectral imagery can be used to monitor the influence of dry stratospheric air (red/orange) during extratropical transition
    - Soundings from the NOAA Unique CrIS ATMS Processing System (NUCAPS) are used in conjunction with the multispectral imagery to better understand the vertical structure of the atmosphere; here to investigate their utility for anticipating stratospheric drying in the complex extratropical transition environment
    - Collaboration with NOAA National Centers, AOML Hurricane Research Division, and University of Maryland Baltimore County
    - Product demonstration with NOAA National Centers planned for August-October 2016

Courtesy Emily Berndt, NASA MSFC SPoRT / University of Alabama - Huntsville

MODIS Air Mass RGB image 1829 UTC 4 July 2014

MODIS Air Mass RGB imagery and NUCAPS soundings showing intrusion of dry air into Hurricane Arthur (2014) as it transitioned to an extratropical storm
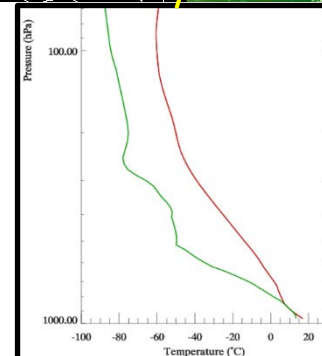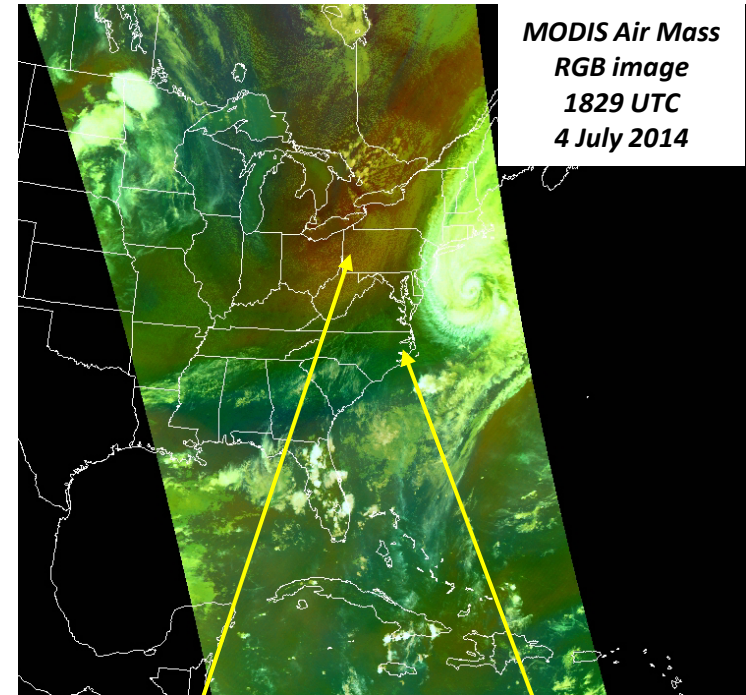
Red/Orange region shows dry upper-levels
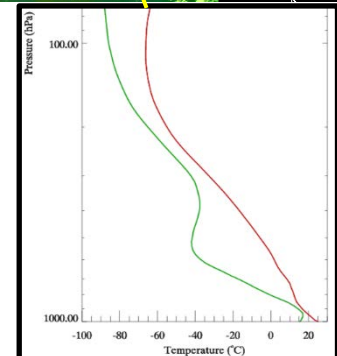
Blue/Green region shows moist upper-levels

NASA Data for Operation and Assessment (in ROSES 2016)

2.1 Operational Short-term (0-48 h) Weather Prediction

- transitioning existing near real-time data products into operational environments or developing algorithms, methodologies, and processes in NOAA/NWS WFO or NCEP operational environments to accept Suomi NPP (S-NPP), Global Precipitation Measurement (GPM), Soil Moisture Active Passive (SMAP), and International Space Station (ISS) Lightning Imaging Sensor (LIS) data

2.2 Joint Center for Satellite Data Assimilation

- 1. Developments to facilitate assimilation of all sky radiances in the infrared and microwave and improve their impact on NWP.
- 2. CRTM (http://www.jcsda.noaa.gov/projects_crtm.php) improvements for cloudy radiance data assimilation, both scientific and computational algorithms, that will increase accuracy and efficiency (especially scattering) are of interest.
- 3. Research and development of a module to perform 4-dimensional localization of ensemble covariances in model space for the 4D hybrid data assimilation systems used at JCSDA especially at NASA and NOAA. This module should work for multiple models and allow for coupled atmosphere-ocean systems.
- 2-year awards, ~$100-150 K per year
- **Proposals due May 20**; NOI due March 15, but late NOIs can be accepted
- Google **NASA ROSES2016**