NOAA's Activities and Contributions to GPM

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NOAA/NESDIS/STAR

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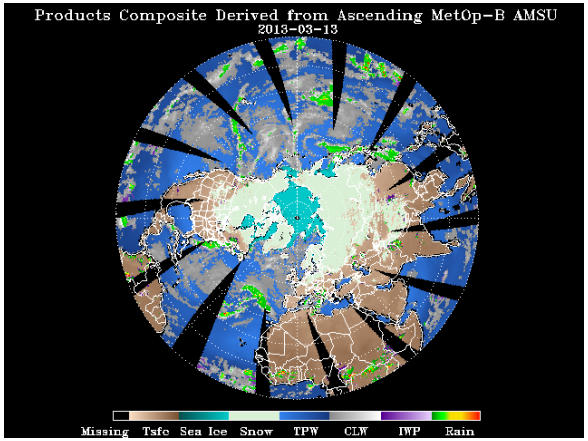
***Includes contributions by other PI's on the PMM Science Team, other NOAA researchers and those at ESSIC/CICS at the University of Maryland**

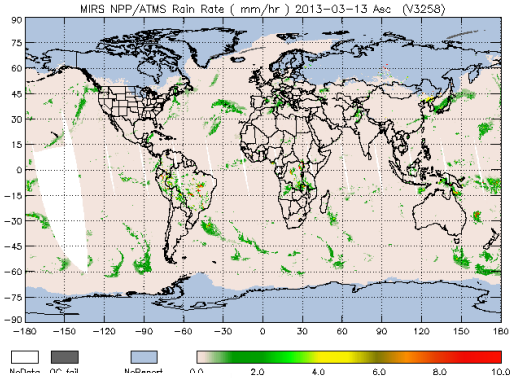
Outline

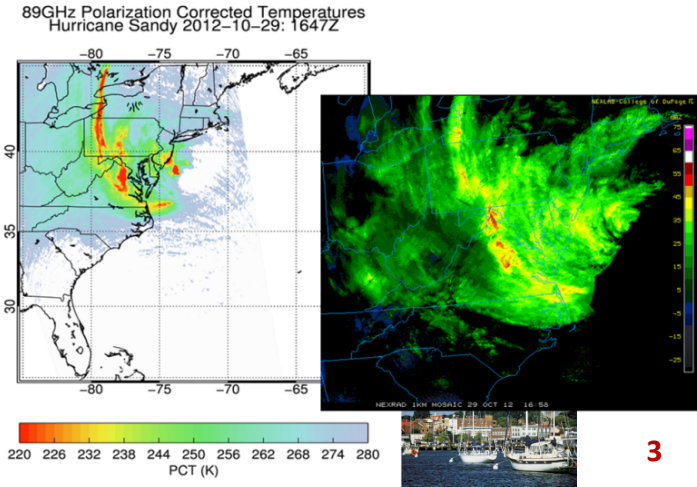
- **Update on Satellite Programs**
  - **POES**
  - **International Partners – JAXA, CNES & ISRO, CMA**
  - **NASA**
- **Science Activities**
  - **PMM Science Team**
  - **AMSU/MHS Snowfall Rates – Operational**
  - **GOES-R and JPSS PGRR Activities**
- **NOAA User Workshops on GPM**
- **Summary and Future**
- **Other meetings of interest**

Update on Operational LEO Satellites

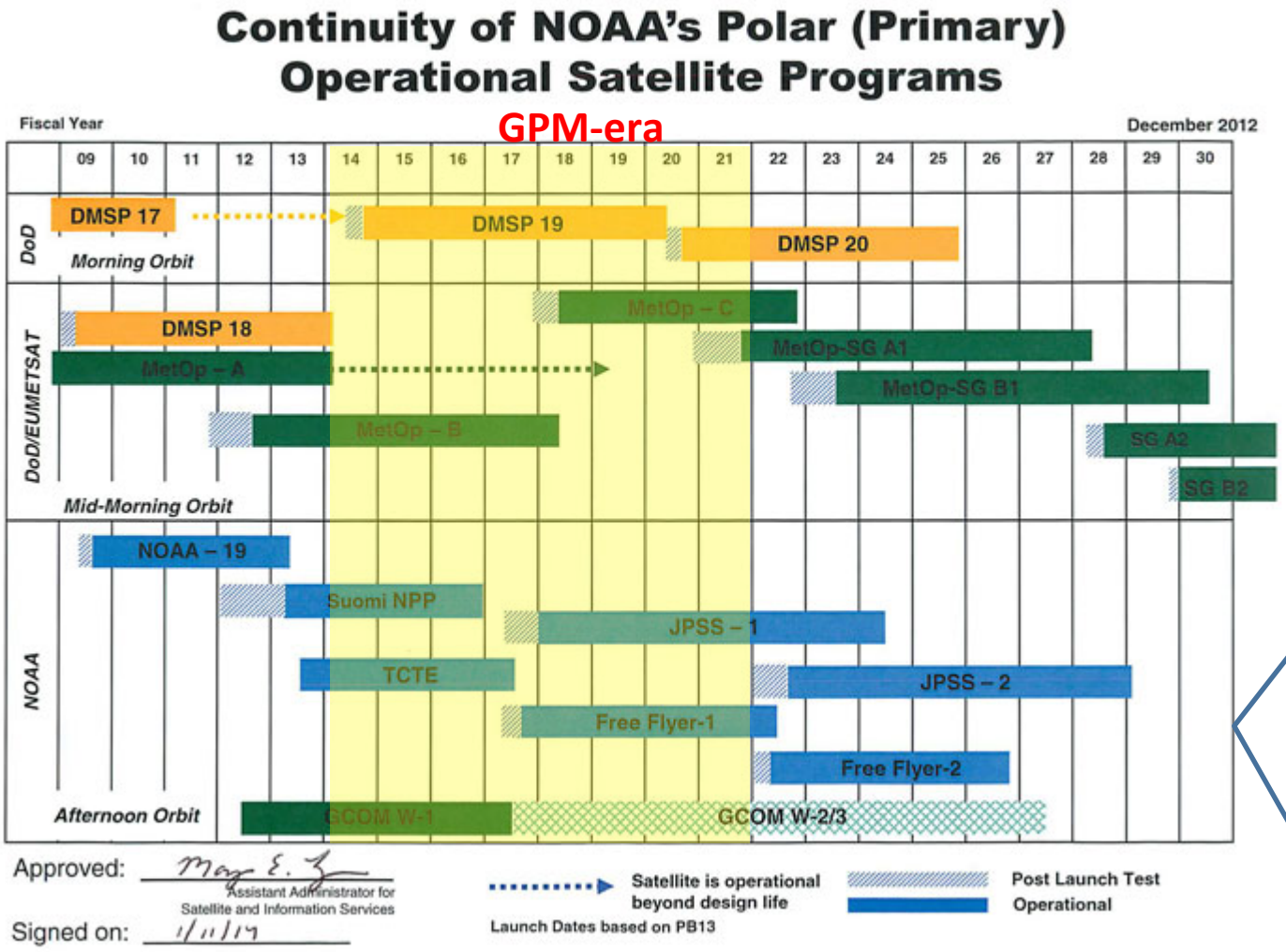
- NOAA/POES (AMSU-A/MHS)
  - NOAA-18, NOAA-19 operating properly
- MetOp/EUMETSAT (AMSU-A/MHS)
  - MetOp-A - is operating properly
  - MetOp-B – launched 9/17/12; becomes operational at NOAA in April 2013
- JPSS (ATMS and JAXA/GCOM-AMSR2)
  - Suomi NPP operating properly (ATMS-degradation?)
    - MiRS precipitation products
  - GCOM-W1 launch 5/18/12
    - NOAA EDR's by 9/2013, including GPROF2010-'b'
- DMSP (SSMIS)
  - SSMIS F-16, F-17 and F-18 still operating
  - F-19 launch ~ mid 2014; F-20 launch ~2020
- JPSS (ATMS)
  - JPSS-1 launch ~2017; JPSS-2 launch ~2022







LEO Flyout Schedule



Free Flyer-1 & 2
Carry Argos-DCS, SARSAT, TSIS (Total Solar Irradiance Sensor)

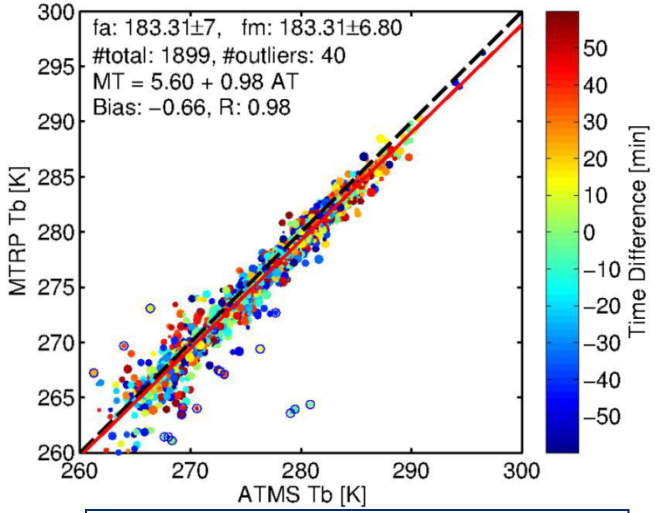
TCTE
Total Solar Irradiance Calibration Transfer Experiment aboard STPSat-3

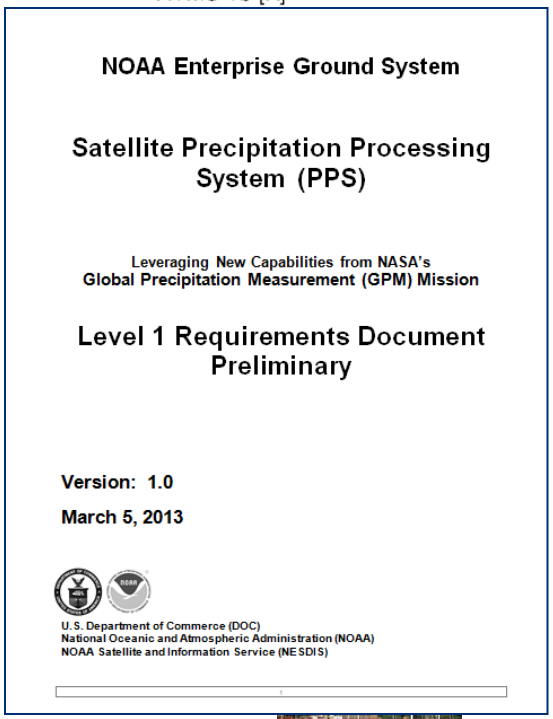
http://www.nesdis.noaa.gov/FlyoutSchedules.html

http://www.jpss.noaa.gov

Partners & Status

- **International:**
  - **India/France - M-T**
    - NOAA's efforts maturing to reformat TB's, generate in-house EDR's (MiRS), distribute across NOAA
  - **China - FY-3**
    - FY-3 data in n.r.t. as JPSS gap mitigation?
- **NASA**
  - **Formal MOU on GPM being worked in legal (summer 2013?)**
  - **R20 Transition Planning**
    - L1RD and CONOPS nearing approval
  - **PMM Science Team**




NOAA Enterprise Ground System

Satellite Precipitation Processing System (PPS)

Leveraging New Capabilities from NASA's Global Precipitation Measurement (GPM) Mission

Level 1 Requirements Document Preliminary

Version: 1.0

March 5, 2013

U.S. Department of Commerce (DOC)
National Oceanic and Atmospheric Administration (NOAA)
NOAA Satellite and Information Service (NESDIS)

Importance of GPM from NOAA's Perspective

- **Continuity for TRMM**
  - GPM-core - higher inclination that TRMM (65 vs. 35 deg.)
  - GPM will have more advanced payloads (GMI vs. TMI; DPR vs. PR)

- **Recent "NOAA Challenge Workshop on Water Cycle" mentions severe observational data gaps; GPM will greatly help!**

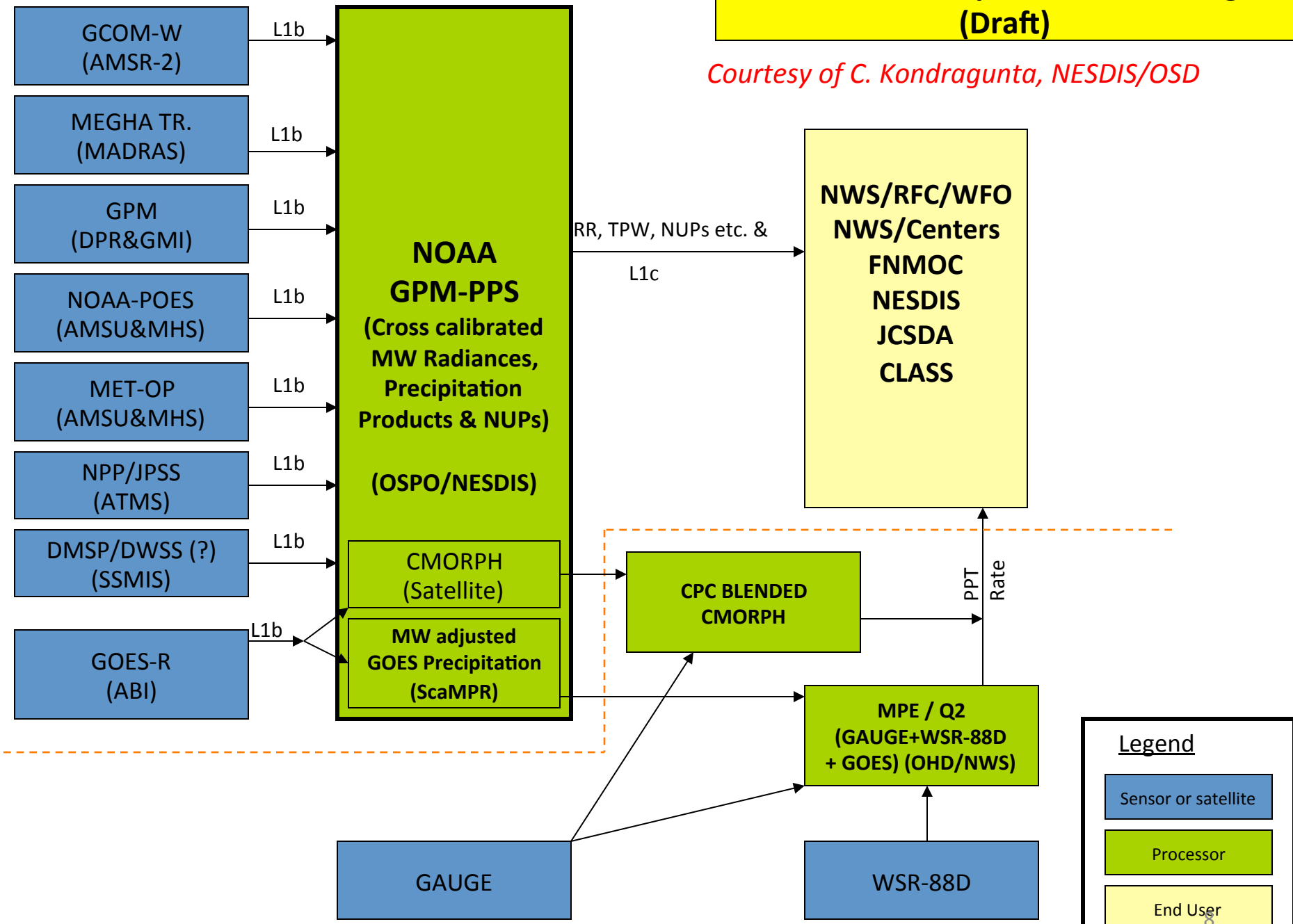
- **Strong connection to several critical NOAA mission goals**
  - NWP
    - Emerging JCSDA theme is regional modeling, cloudy/raining regions
  - Local forecasts and warnings
    - Atmospheric rivers which contribute to flooding episodes
    - Rain rates from off-shore systems (outside of radar range)
  - Hurricane monitoring
    - MW imagery/storm center fixing to improve track forecasts
  - Hydrology/Water Resources
    - Fill in data voids left by radar and gauges
  - Climate
    - GPM-core anchors satellite constellation - high precision sensors & precessing orbit

Importance of GPM from NOAA's Perspective

- GPM is "ripe" for R2O; why?
  - Precipitation Processing System (PPS)
    - NASA- Precip. Research Focus
    - NOAA – 24 x 7 Operations Focus
      - NOAA Unique products – TPW, OWS, AWIPS, …
    - Prototype system to
      - Reduce "stove pipes " and system maintenance cost
      - Anchor for multi-satellite precipitation products
        - » GOES and LEO
      - Anchor for multi-sensor precipitation products
        - » Satellite, radar, gauges
  - L1C (Inter-calibrated radiances)
    - Ideal for climate related activities
    - May benefit NWP data assimilation

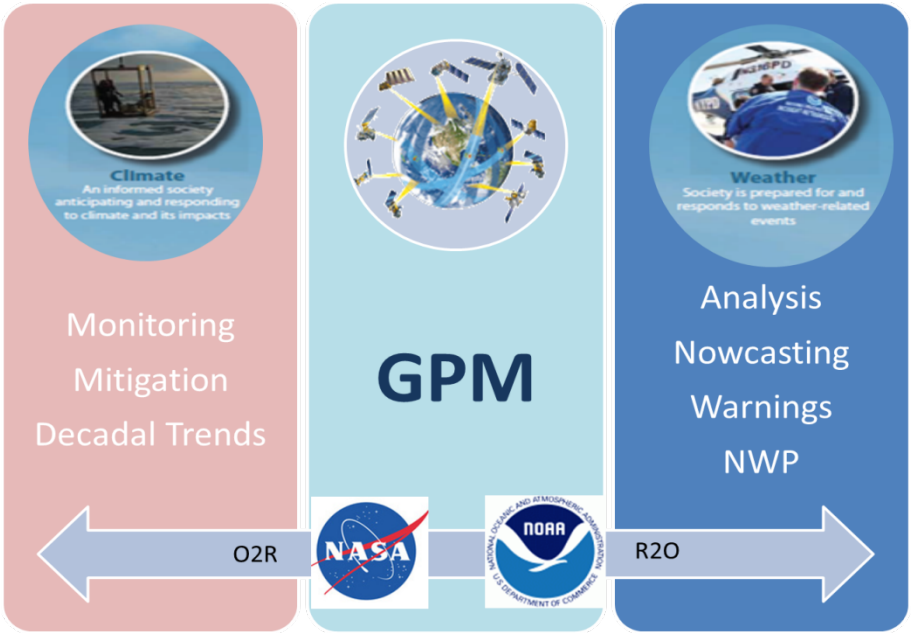
GPM- era Precipitation Processing (Draft)

Courtesy of C. Kondragunta, NESDIS/OSD



Participation on PMM Science Team

- Nine NOAA PI's contributed to successful "Omnibus" no-cost to NASA proposal to ROSES2012
  - NESDIS, NWS, OAR
  - NOAA secured 60% funds in FY13
    - Some projects will be extended into 4th year
- Shows continued interest in GPM at NOAA
  - Four funders within NESDIS
  - Two funders within OAR
  - JCSDA funding
  - Future funders identified
- Please see our posters!



	PRIMARY NASA/ROSES GOALS			PRIMARY NOAA PROGRAMS			
NOAA Lead PI	Algo/prod. val & enhancement	Process Study & Model Development	Applications	Weather, Water, and Climate Applications	Satellite/ Risk Reduction	Testbeds & Proving Ground	NWP
R. Ferraro	X		X		X	X	
P. Xie	X		X	X	X	X	
S. Boukabara	X		X				X
F. Weng		X			X		X
P. Groisman	X			X			
JJ Gourley	X			X	X	X	
R. Cifelli			X	X		X	
Y. Zhang	X	X	X	X	X	X	
Y. Xie			X				X

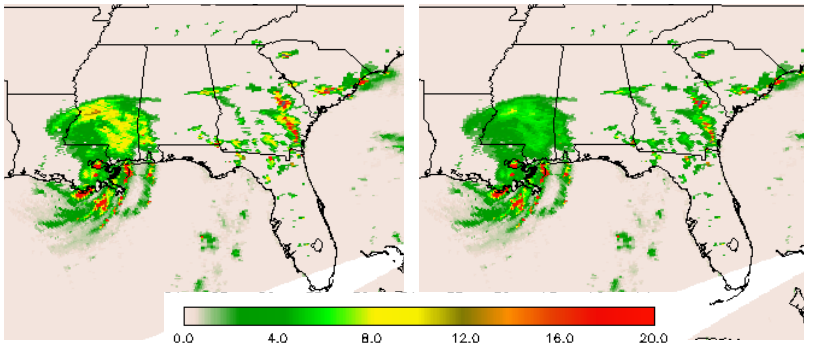
NASA-NOAA Algorithm Synergy & NWP Impact Assessment In support of GPM

S. Boukabara (PI), K. Garrett, V. Tallapragada (co-PI), In-Hyuk Kwon

Contributes to ROSES Focus Area of Algorithm/Product Validation and Enhancement

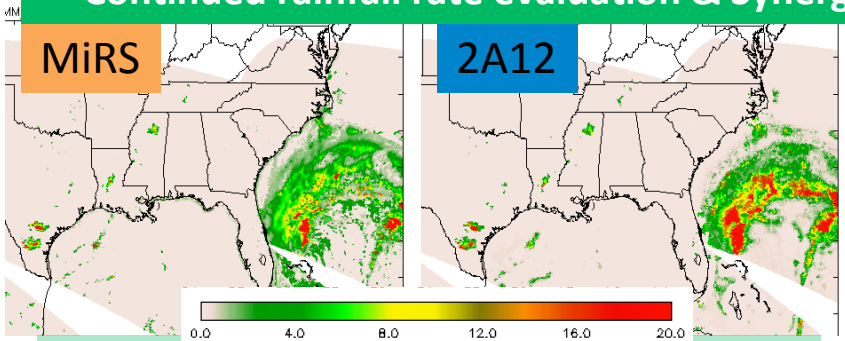
- **Explore synergy between MiRS and GPROF**
  - Utilize GPROF hydrometeor profiles in MiRS
  - Utilize MiRS surface emissivity in GPROF
  - Ensemble MiRS/GPROF: providing RR and Uncertainty
  - Validation of MiRS rainfall rate over snow and ice-covered surfaces
  - Extension of MiRS to snowfall rate
  - Optimization of MiRS rainfall rate with CRTM 2.1 implementation (impact of particle size)
  - "Wet Surface Emissivity" dynamic handling in active regions
- **Improved Data Assimilation Applications**
  - Focus GSI 3DVAR/EnKF for HWRF/GFS extreme events
  - Direct assimilation of rainfall rates and heating rate
  - Improved vortex initialization for tropical cyclones
  - Advanced quality control of GPM data

Implementation of official CRTM 2.1
Sensitivity to Graupel PSD



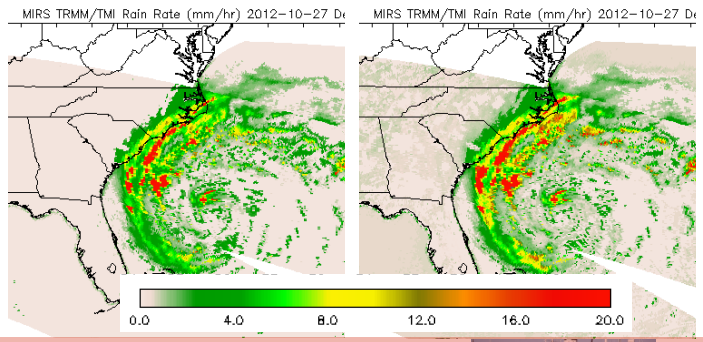
MiRS TMI Rainfall Rate assuming true graupel effective radius (r_e) (left) and 100% increase (error) in graupel r_e (right). Values of RR highly depend on the assumptions made about Dme.

Continued rainfall rate evaluation & Synergy



MiRS TMI Rainfall Rate (left) and TRMM-2A12 Rainfall Rate (right) over Hurricane Sandy

Understand errors due to error in surface emissivity



MiRS Rainfall Rate with emissivity retrieval on (left), off (right) over Hurricane Sandy. False alarms a problem when emissivity not varied.

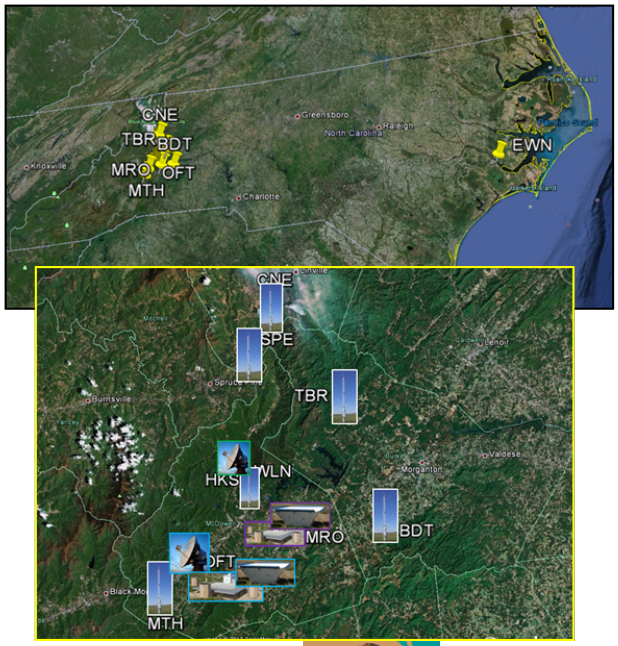
NOAA GPM Proving Ground and Utilization for HMT-SEPS

R. Cifelli, S. Rudlosky, R. Ferraro, P. Xie

Contributes to ROSES Focus Areas of Methodology Development for Improved Applications of Satellite Products

- Extreme precipitation research: event climatology, QPE improvement, forecast challenges, high-impact event case studies
- Research-to-operations transitions focus
- Develop NOAA GPM "Proving Ground" – generate and serve GPM-era products to NWSFO's and NOAA Testbeds for use and evaluation

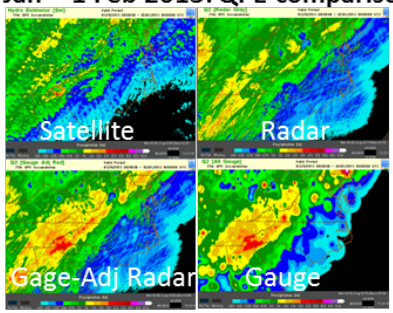
HMT-SE Pilot Study (HMT-SEPS) Deployment:
May 2013 – October 2014



Key research topics:

How can enhanced observations, common/shared precipitation datasets improve QPE?

28 Jan – 1 Feb 2013: QPE comparisons

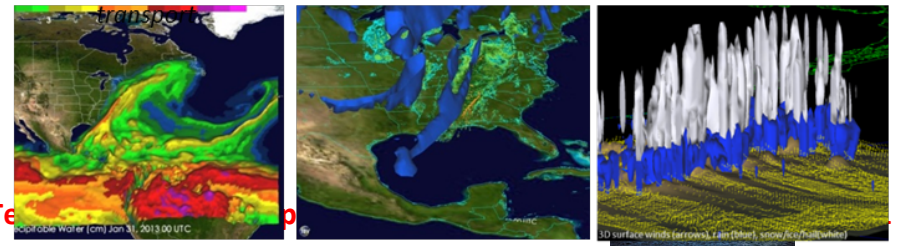


How can enhanced observations, process understanding at all scales improve forecasts, models?

Large-scale moisture transport

Medium-scale focusing factors (e.g., frontal dynamics)

Small-scale processes: Drivers of high-impact, extreme precipitation?

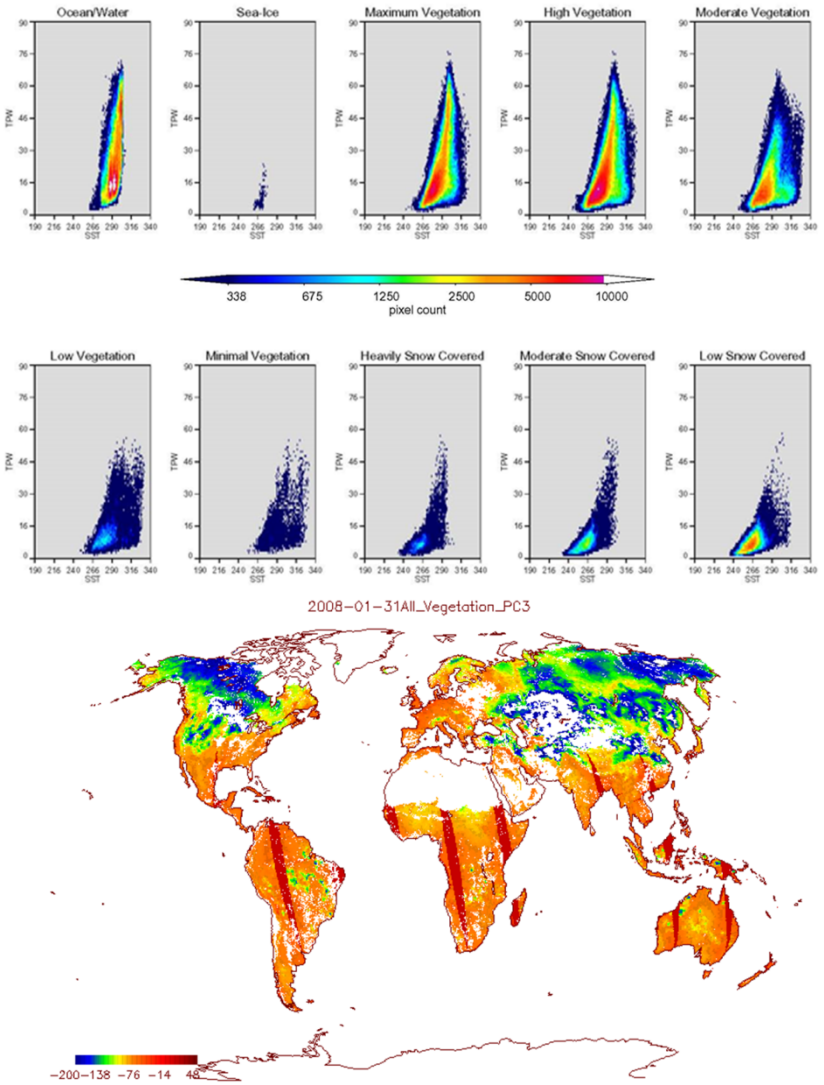


Contributions to the MW-RE Precipitation over Land Algorithm

R. Ferraro, N-Y. Wang, H. Meng

Contributes to ROSES Focus Area of Algorithm/Product Validation and Enhancement

- Three primary objectives:
  - Provide operational NOAA snowfall rates to PMM team
    - Benchmark for GPM Day 1 snowfall rate retrievals?
  - Determine optimal information for GPROF data bases
    - MW HF & sounder emphasis
  - Determine optimal channel weights
    - MW HF & sounder emphasis

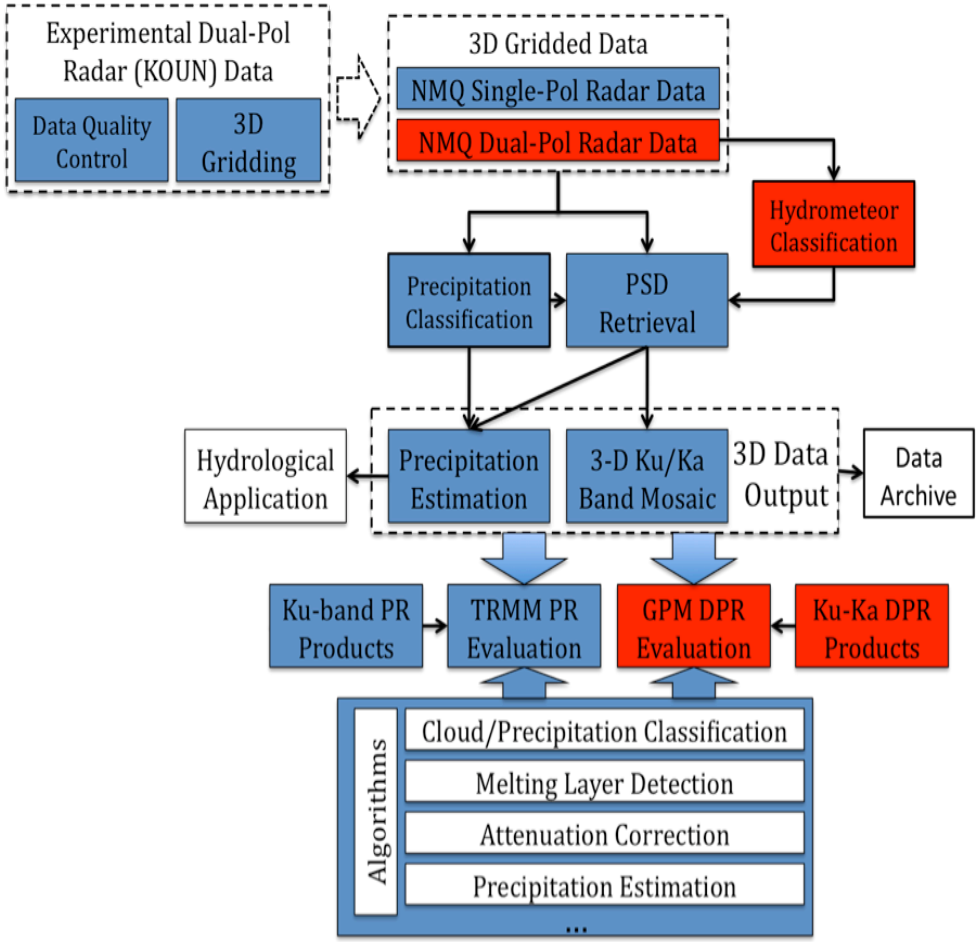


WiMerge: Research and Development of Unified CONUS 3-D Mosaics and QPE products

J. Gourley, Y. Zhang, P. Xie, D. Kitzmiller, B. Kuligowski

Contributes to ROSES Focus Areas of Methodology Development for Improved Applications of Satellite Products

- The principal objective of the proposed study is to develop merged 3-D mosaics of reflectivity, hydrometeor type, and PSD retrievals over the CONUS by fusing dual-pol radar data from ground and dual-frequency data from space
- Will yield level-II precipitation rate and type products (1km/5min) using the merged mosaics and further enhanced with passive microwave precipitation estimates



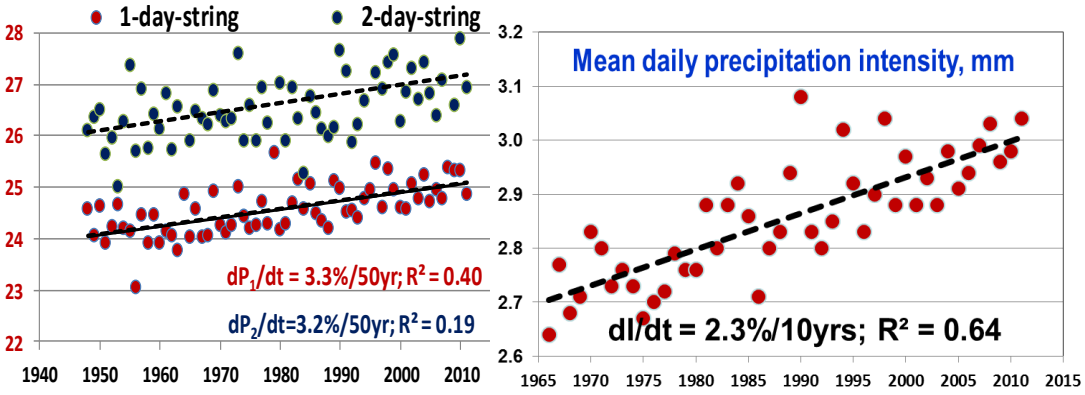
Merging of space and ground radar data relies on the physical consistency through the particle size distribution (PSD) of hydrometeors

Characterization of Precipitation Field in High Latitudes of the Northern Hemisphere for the Future Use with the GPM Mission Products for Hydrological & Climate Change Assessments

P. Groisman, D. Easterling, B. Nelson, D. Yang, V. Alexeev, et al.

Contributes to ROSES Focus Areas of Algorithm/Product Validation, Enhancement & Utilization of Satellite/GV Products for Process Studies

- *In the United States*, we will secure the time series homogeneity of most national in situ networks used for the national climate change assessments;
- *For the high latitudes of the Northern Hemisphere*, we will update and maintain the science-quality archive of homogeneous daily precipitation time series;
- *To facilitate the future fusion of GPM products with other hydrometeorological information in the high latitudes,* we will generate the '*ground truth*' regional (grid cell) precipitation and estimate the accuracy of this '*truth*' values;



Left. Mean intense (i.e., >12.7 mm d^{-1}) precipitation, mm×$(event)^{-1}$ that comes with 1-day- and 2-day-long events over the contiguous United States.

Right. Nationwide annual precipitation intensity, I, changes over Russia.

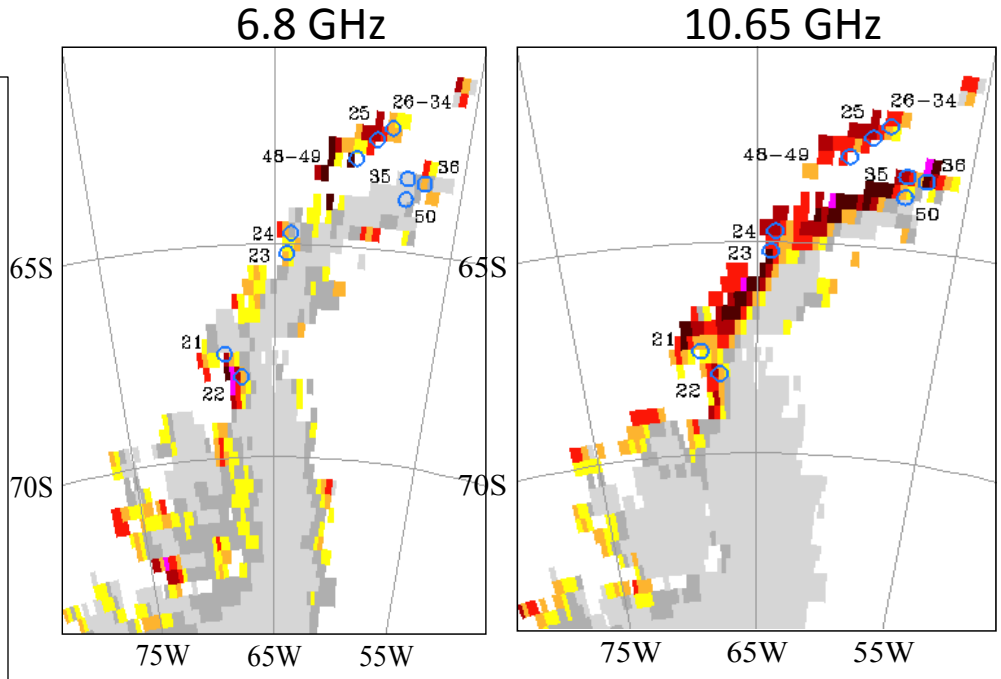
- We will estimate *light precipitation in high latitudes* using gauges in combination with synoptic and surface data. Because the perspectives to secure measurements of light precipitation from space are elusive, these in situ data will complement future GPM products in high latitudes and jointly serve for hydrological applications and climate and environmental change analyses.

Calibration of GMI Sounding Channels and Global Detection of Radio Frequency Interference

Fuzhong Weng (NESDIS/STAR), Xiaolei Zou (FSU) and Tiger Yang (ESSIC/UMD)

Contributes to ROSES Focus Areas of Algorithm/Product Validation and Enhancement and Utilization of Satellite/GV Products for Process Studies and Model Development

- Assessment of GMI non-linearity parameter through the WMO Global Space-Based Inter-calibration System (GSICS) algorithm
- Calibration of GMI high-frequency sounding channels using ATMS
- Global Detection of GMI Radio Frequency Interference (RFI) through a Double Principle Component Analysis



RFI distributions of WindSat 6.8 and 10.65 GHz at horizontal polarization using double PCA technique over Antarctic during Feb 1-10, 2011. Indicated by circles are Antarctic research stations where RFI signals were transmitted.

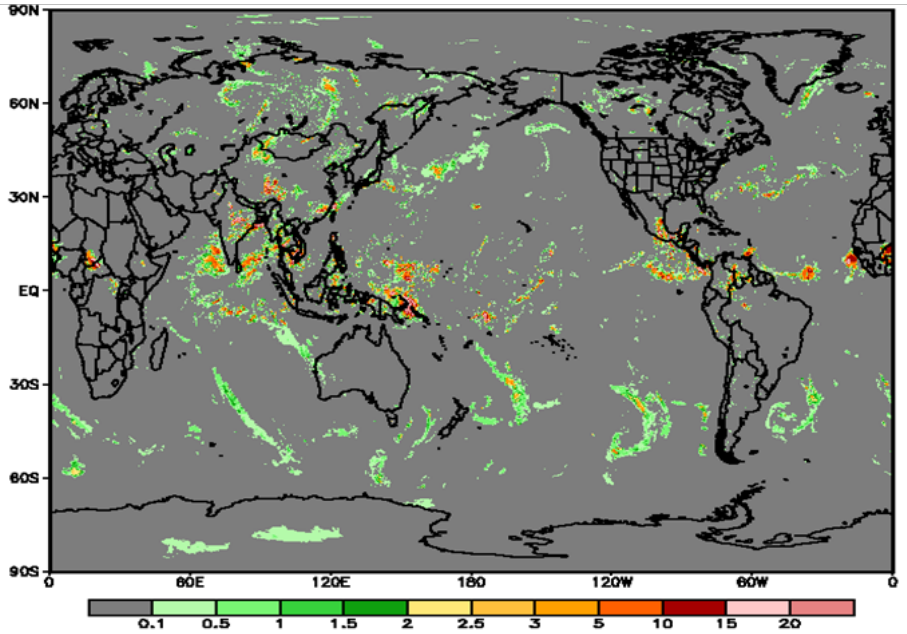
Pole-to-Pole CMORPH and Integrated Regional Precipitation Analyses

P.Xie and R.Joyce

Contributes to ROSES Focus Area of Algorithm/Product Validation and Enhancement

- **Pole-to-pole CMORPH**
  - *0.05°lat/lon over the globe in 30-min interval*
  - *Integration of PMW, GEO/LEO IR, and model info through Kalman filter*
  - *Framework designed, prototype under development*
- **Regional CMORPH**
  - *With R. Kuligowski*
  - *2km grid 15-min analysis over North America and nearby ocean*
  - *Including GOES-R hi-res IR*
  - *Products comprised of different latencies (15-min to 18 hours)*
- **Gauge-Radar-Satellite-Model merged analyses**
  - *With Y.Zhang and OHD*
  - *Hourly analysis over CONUS*
  - *OI technique*
  - *Prototype being tested*

Sample Pole-to-pole CMORPH For 10:00GMT, July 1, 2009

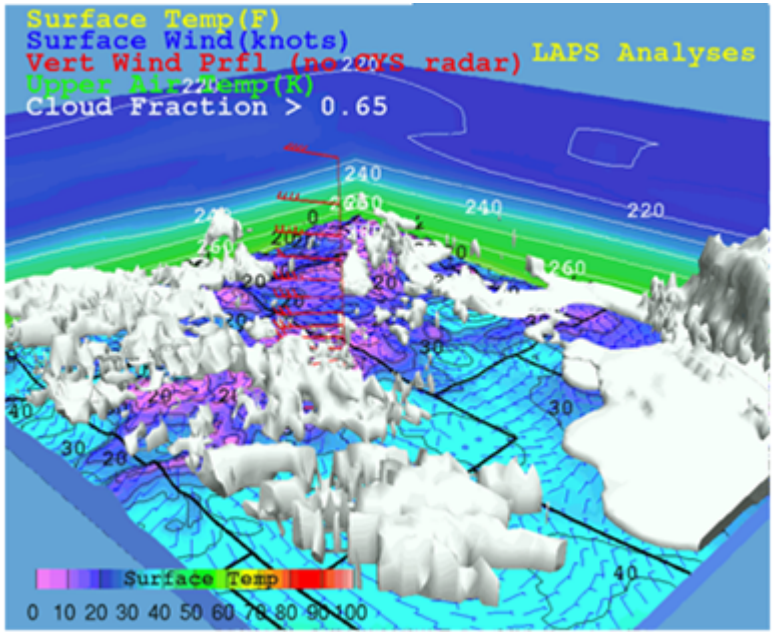


Analysis and Validation of GPM in LAPS Data Assimilation System

Y. F. Xie, S. Albers, S. Gutman, D. Birkenheuer, H. L. Jiang, and Z. Toth
Global Systems Division, Earth System Research Lab, NOAA/OAR

Contributes to ROSES Focus Areas of Methodology Development for Improved Applications of Satellite Products

- Variational LAPS is a hotstart and multiscale data assimilation system used by 150+ users worldwide;
- With new or modified forward operators, GPM data will be tested in V-LAPS analysis and evaluated for its impact;
- For data validation, assimilated GPM data or products will be compared with Doppler radar reflectivity over selected domains and the differences will be described;
- After validation, GPM forward operators and assimilation methodologies can be used in parallel runs of global forecast systems (e.g. the Finite-volume Icosahedral Model-FIM) to evaluate the impact of GPM data in these models, particularly over the ocean.



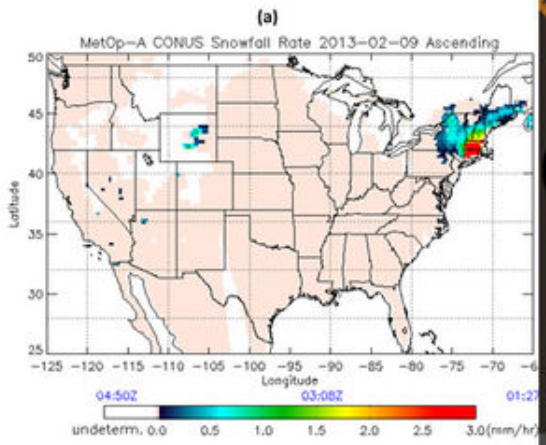
GPM data could potentially improve LAPS cloud, rain, snow, and graupel analysis over areas without radar coverage

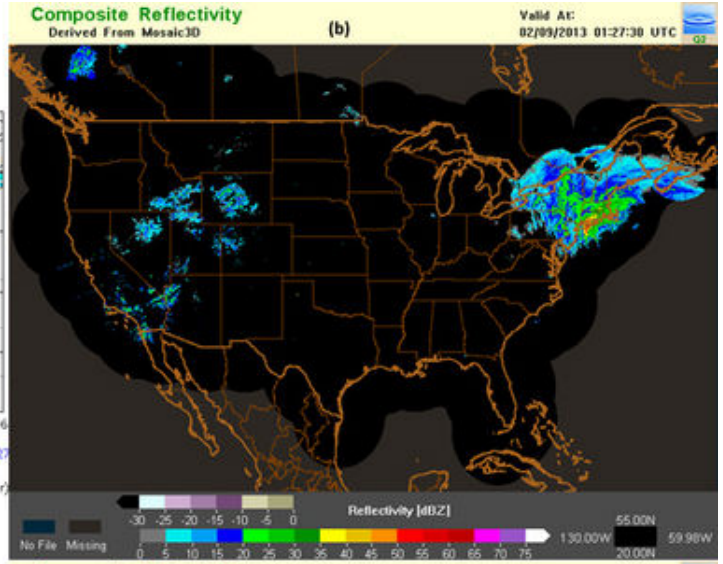
Contributions to GPM at NOAA NWS/OHD & NESDIS/STAR – Data Fusion and Applications

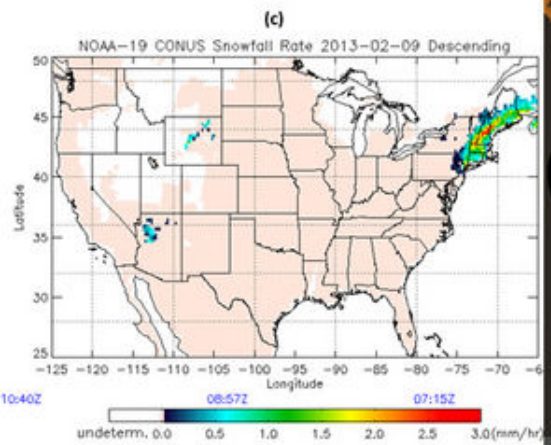
Y. Zhang, J. Gourley, R. Kuligowski, D. Kitzmiller, P. Xie

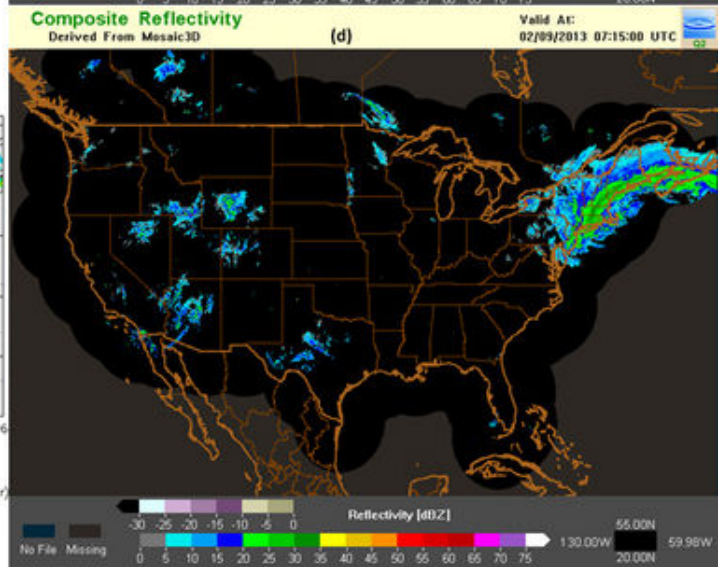
Operational AMSU/MHS Snowfall Rates

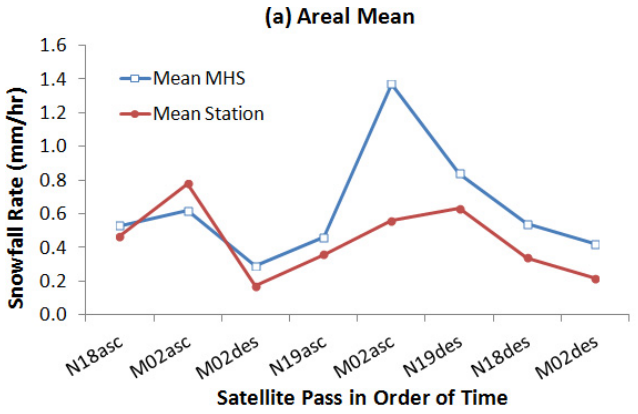
H. Meng

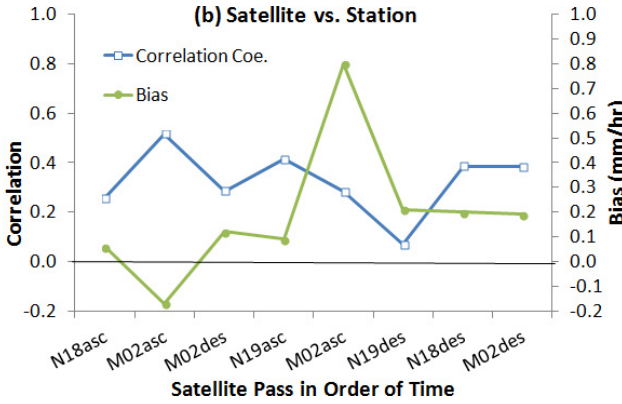






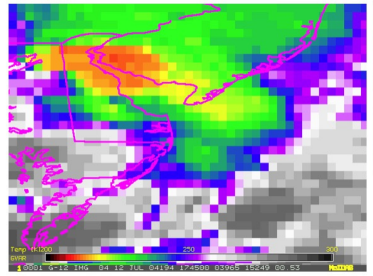


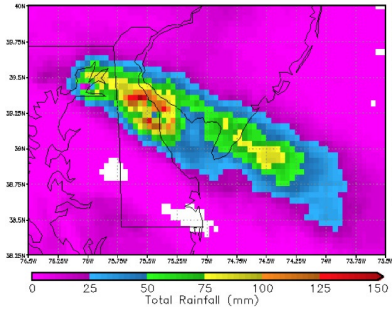




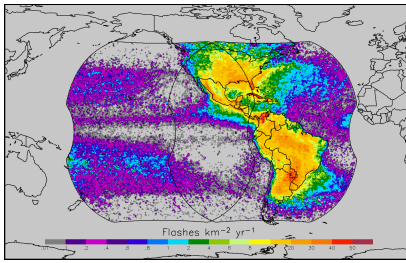
GPM Synergy with GOES-R and JPSS

- **GOES-R**
  - Sensors useful for rapid refresh precipitation estimation and storm monitoring -
    - ABI (Advanced Baseline Imager) & GLM (Geostationary Lightning Mapper)
  - GOES-R^3 (Risk Reduction Program)
    - Several precipitation related projects that utilize GPM-era sensors
  - Contributions to GPM Ground Validation Program
    - Ground lighting sensors in support of CHUVA (Brazil)
  - GOES-R Proving Ground
    - Accelerating the use of GOES-R proxy products across NOAA





- **JPSS**
  - Key sensors to precipitation
    - ATMS & AMSR-2 (via JAXA/GCOM)
  - JPSS Risk Reduction and Proving Ground Program
    - Initiated in FY12, supporting projects related to snowfall estimation and merged precipitation products



- **Risk Reduction and Proving Ground Projects – perfect opportunity for GPM-era R&D and product usage at NOAA**
- **3rd NOAA User Workshop on GPM (April 2-4, College Park, MD) – GPM Proving Ground Focus!**

2nd NOAA User Workshop on the GPM
(November 29 - December 1, 2011)

- **Over 60 participants from NOAA, NASA, DoD, Academia and Private Sector**
- **Meeting format - Plenary sessions, Panelists /Working Groups focused on four main themes**

WG1 : Enhancing R&D and Innovation of GPM-era data at NOAA

- NOAA Unique Products

WG2 : Accelerating GPM Data use at NOAA

- Existing testbeds? Or new infrastructure (e.g. proving ground)

WG3 : Data Fusion

- How to integrate GPM data into merged products (e.g Q2, MPE, CMORPH etc.)

WG4 : Data Delivery and Formats

- How to improve product processing and delivery to users at minimal data latency

Some Key 2nd Workshop Recommendations

- **NOAA needs to prepare immediately to exploit GPM era data and products:**
  - **Data delivery and distribution**
  - **Research and Development**
    - **Continuity of operations from current sensors into GPM-era sensors**
    - **Climate applications and model verification**
    - **NWP assimilation and model verification**
    - **Data fusion and uncertainty estimation**
    - **NOAA unique products from GPM sensors**
  - **Accelerating the use of GPM data at NOAA through emerging Proving grounds and existing test-beds**
    - **Look to exploit activities under both GOES-R and JPSS Programs**
    - **Climate, Hydrometeorology, Hurricane, etc. test-beds**

Follow-up on the 2nd Workshop Recommendations

- **A tiger team was formed to develop GPM Level-1 Requirements Document (L1RD) [C. Kondragunta/NESDIS]**
  - **Captures specific NOAA-wide needs for GPM-era data**
  - **Needed at NOAA to move forward with advance planning and budgeting**
  - **Sign-off is imminent**

- **A draft plan to transition PPS from NASA Research to NOAA operations was prepared. [C. Kondragunta/NESDIS]. The specific objectives of this plan are**
  - **Transition NASA GPM PPS to NOAA to support 24 x 7 operations**
  - **Design, implement, and establish the operational dataflow architecture of required data from NASA and other agencies to NOAA /NESDIS PPS**
  - **Expand the utility of NOAA PPS to generate NOAA Unique Products (e.g. Total Precipitable Water, Ocean Wind surface Wind speed, etc.)**

3rd NOAA User Workshop on GPM
April 2-4, 2013
College Park, MD

[Remote participation will be available via WebEx]

Meeting Objectives: This three-day meeting, co-sponsored by NESDIS, NWS and OAR, will follow up on the highly successful previous two workshops (August, 2010 and November, 2011 – see http://www.star.nesdis.noaa.gov/star/meeting_GPM2011.php) **with a focus on the development, functionality, and priorities of a new NOAA GPM Proving Ground.**

The meeting objectives and anticipated outcomes for each topic are as follows:

Objective 1: Identify the purpose of the NOAA GPM Proving Ground and how it will improve NOAA precipitation products and services

Expected outcomes:

- A clear statement of the purpose and need for a NOAA GPM Proving Ground
- A plan describing how the Proving Ground will facilitate interaction among NESDIS, NWS, and OAR, as well as NASA, on GPM precipitation issues

Objective 2: Identify use of GPM data in research and operational algorithm development

Expected outcomes:

- Identify Proving Ground participants and timelines for the use of GPM-era precipitation products in NOAA
- Catalogue or list current operational products derived from the TRMM and passive microwave constellation
- Gather information on ongoing multi-sensor precipitation product development efforts for both continental and global scales
- Benchmark GPM-era algorithms at multiple space-time scales over the CONUS
- Establish a framework for multi-sensor fusion of precipitation products from satellites, radars, gauges and numerical weather prediction model outputs that can be used across NOAA line offices
- Identify paths of research to operations, e.g., establish and evaluate methods to assimilate GPM products in numerical weather prediction models, and assess the operational values of GPM-based, multi-sensor fused precipitation products for climate, flood and water resources predictions
- Novel strategies for calibration of space-based microwave measurements using Multi-Radar Multi-Sensor System

Objective 3: Identify training needs for use of GPM data in NOAA operations (WFOs, RFCs, NHC, NCEP)

Expected outcomes:

- Determine target audience – general users and operational entities
- Determine knowledge gaps relative to what most people know about current operational suite
- Evaluate available human resources for training – whom to approach and how

Intended Participants: Current and future users of satellite-based precipitation, water cycle products, and radiance data from government, private sector, and academia

For more information, contact the workshop organizers:
NESDIS: Ralph.R.Ferraro@noaa.gov, Chandra.Kondragunta@noaa.gov
NWS: Pingping.xie@noaa.gov,Yu.Zhang@noaa.gov
OAR: JJ.Gourley@noaa.gov, Rob.Cifelli@noaa.gov

Summary and Future Plans

- **NOAA continues to be an active player in GPM and related activities**
  - Lead role in JPSS and GOES-R science
  - Supporting it's PI's on the PMM science team
  - GV activities – HMT-SEPS
  - Calibration - GSICS & X-CAL
  - CDR program – now supporting 3 projects related to water cycle sensors/ CDR's
  - International partnerships
  - Advocacy – Upcoming 3rd NOAA User Workshop on GPM (April 2-4)

- **NOAA will continue to prepare for GPM**
  - Budget and planning process
    - Competition is tough and money is tighter than ever, yet, GPM makes so much sense….
    - Looking for more NOAA partners for GPM data use and synergy
      - Educate and Inform (Some think no need for GPM…we will use TRMM!)
  - Pursue recommendations from NOAA GPM User Workshops

WMO

7th International Precipitation Working Group Workshop

21-25 October 2014

Tsukuba, Japan

JAXA Japan Aerospace Exploration Agency

CGMS IPWG