Future Satellite Based Products at NOAA – Multispectral, Multiplatform and Some In-Situ Thrown in as Well!

3rd CICS-MD Science Meeting 13-14 Nov 2014

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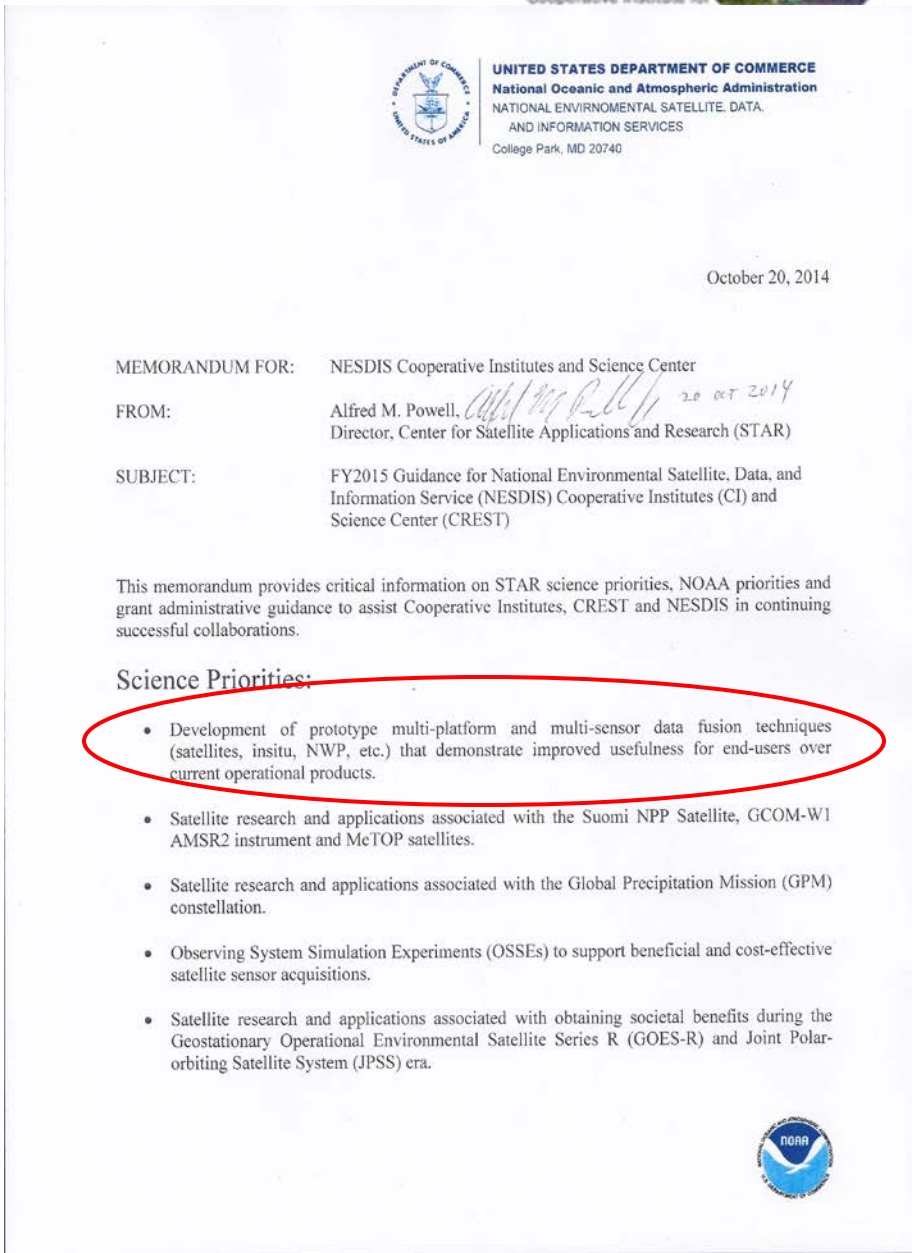
Why fusion?

- Why not!
- Take advantage of best attributes of similar data sources
  - Sum of parts > sum of components
- NOAA research priority
  - Has been done in past but only within "random" programs
  - It's now part of JPSS product requirements
- NESDIS restructuring (next slide)
  - Huge paradigm shift…
  - Long term goals
    - Better products for users
    - "Commonality"
    - Long term cost savings



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL ENVIRNOMENTAL SATELLITE, DATA, AND INFORMATION SERVICES
College Park, MD 20740

October 20, 2014

MEMORANDUM FOR: NESDIS Cooperative Institutes and Science Center

FROM: Alfred M. Powell, 20 OCT 2014
Director, Center for Satellite Applications and Research (STAR)

SUBJECT: FY2015 Guidance for National Environmental Satellite, Data, and Information Service (NESDIS) Cooperative Institutes (CI) and Science Center (CREST)

This memorandum provides critical information on STAR science priorities, NOAA priorities and grant administrative guidance to assist Cooperative Institutes, CREST and NESDIS in continuing successful collaborations.

Science Priorities:

- Development of prototype multi-platform and multi-sensor data fusion techniques (satellites, insitu, NWP, etc.) that demonstrate improved usefulness for end-users over current operational products.
- Satellite research and applications associated with the Suomi NPP Satellite, GCOM-W1 AMSR2 instrument and MeTOP satellites.
- Satellite research and applications associated with the Global Precipitation Mission (GPM) constellation.
- Observing System Simulation Experiments (OSSEs) to support beneficial and cost-effective satellite sensor acquisitions.
- Satellite research and applications associated with obtaining societal benefits during the Geostationary Operational Environmental Satellite Series R (GOES-R) and Joint Polar-orbiting Satellite System (JPSS) era.

NESDIS Restructuring and role of CICS

- New office of "Ground Systems" formed to lead satellite systems – space and ground
- Merge the science and product systems for GOES and JPSS
  - Common algorithm physics/similar sensor capability
  - Common algorithm "threads"
    - Cloud masks, land/sea tag, NWP model fields
- GEARS – Ground Enterprise Architecture System
- CICS is poised to be at the forefront of this activity!

How best to do this?

- Depends on user needs
  - Is data latency important?
  - Temporal and spatial resolution
  - Product domain – regional, global?
  - Accuracy
  - Precision - small values vs. large values
  - Dynamic range
- Trade offs
  - Computation time vs. accuracy
  - Computation time vs. resolution (time and space)
  - Data sources and availability
  - Automation (Objective) vs. Manual (Subjective)

Some methods used by the precipitation community

- LEO and GEO satellite fusion
  - Collocation databases for "tuning"
    - Statistics done regionally and change over time to reflect seasonal changes
      - NRL Blended Rainfall
      - NESDIS SCaMPR
  - Morphing
  - IR "adjustments" (GPCP)
- Rain gauge bias correction
  - Climate quality satellite products – GPCP V2
  - Radar based products – MRMS (NMQ)
- Satellite used as gap filler of CONUS….
  - NOAA MPE

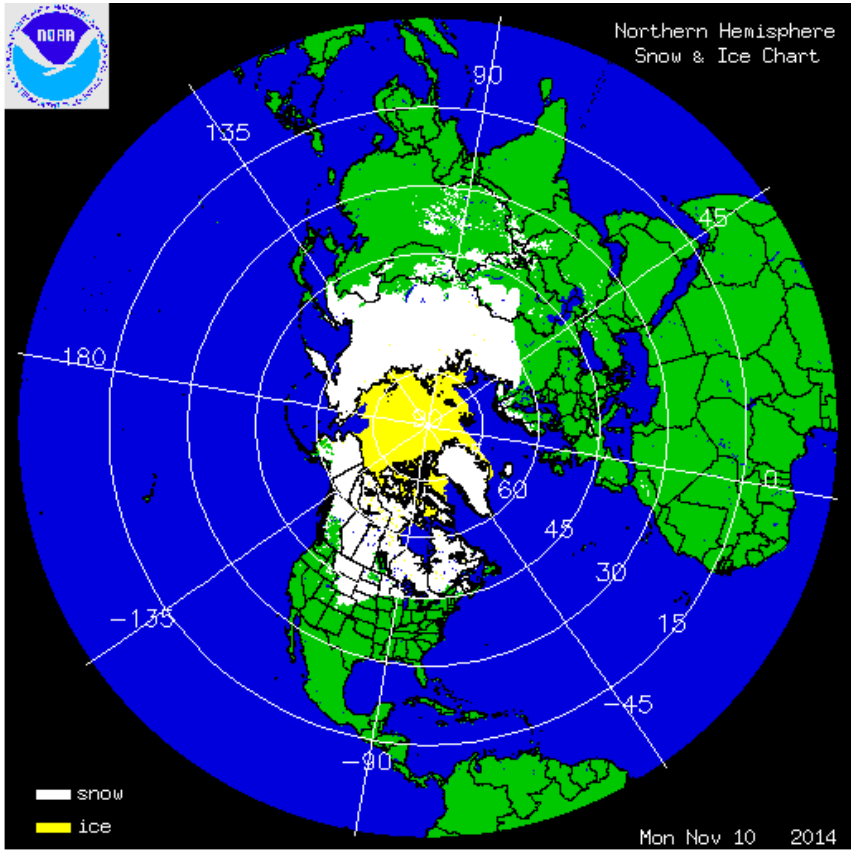
What are some new, relevant concepts that we could pursue

- Direct broadcast
  - Reduces MW and LEO data latency for use with GEO
- Ensemble approach
  - You take the best attributes of every data source
- Newer sensors
  - More A-train
  - GLM
- More physical retrievals
  - Vis/IR cloud properties to drive MW retrievals…
- Other products besides precipitation
  - SST – MW (cloudy) + IR (high spatial resolution) + GEO IR (high temporal resolution
  - Soil moisture – MW (active and passive)
  - Wind Vectors – LEO and GEO; passive/active MW over oceans

Some product examples at NOAA that already utilize "fused" products – Early and Mature Prototypes

IMS – Interactive Multisensor Snow and Ice Mapping System

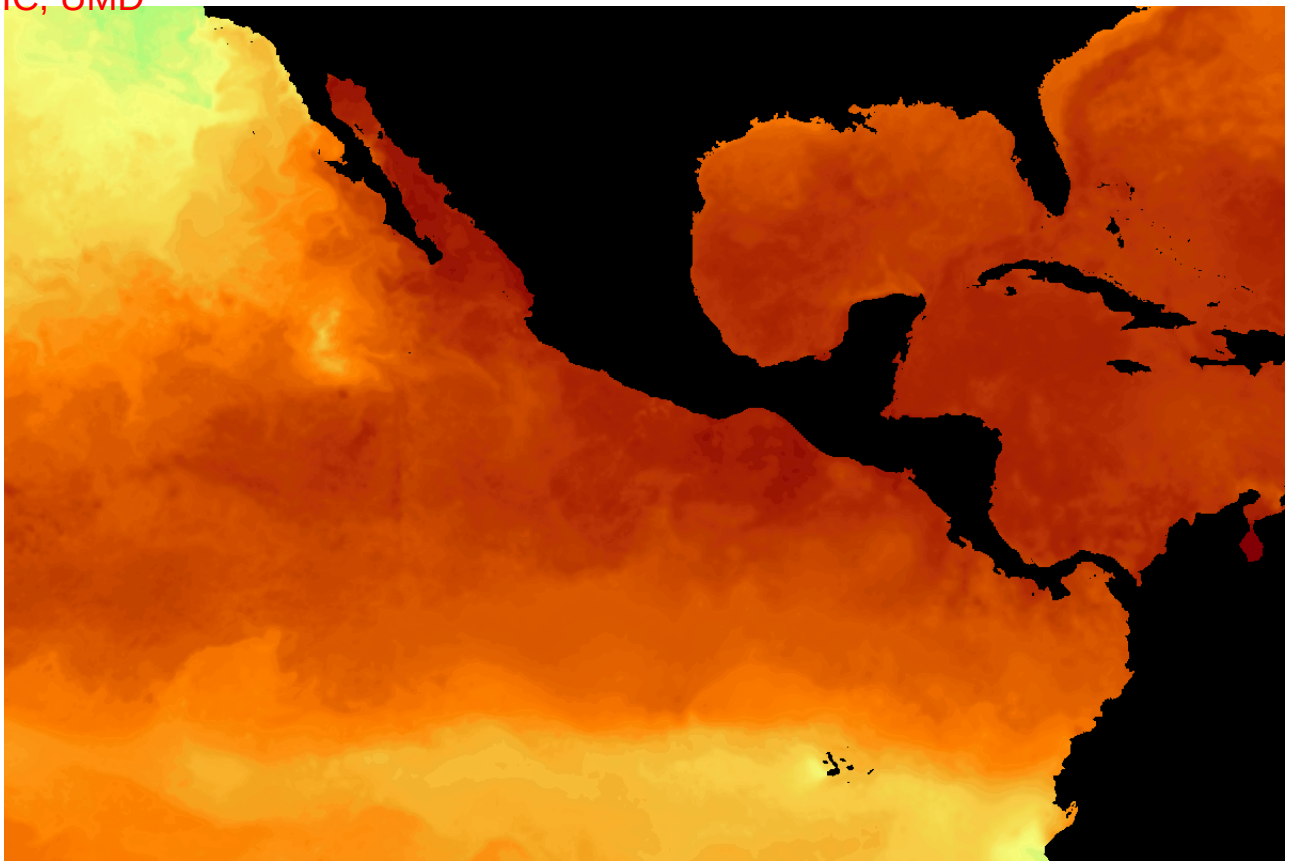
- Perhaps the first NOAA based fused satellite product
  - LEO and GEO vis/IR
  - LEO MW – DMSP, POES
  - Ground reports
- Human in the loop
  - Vis/IR in clear regions, MW in cloudy regions
  - Analyst makes final decision



Geo-Polar 5-km SST analysis

Andy Harris, NOAA-CICS, ESSIC, UMD

Day+night 5-km, Oct 1 – Dec 31, 2012



Combines Geo-SST & Polar IR SST:

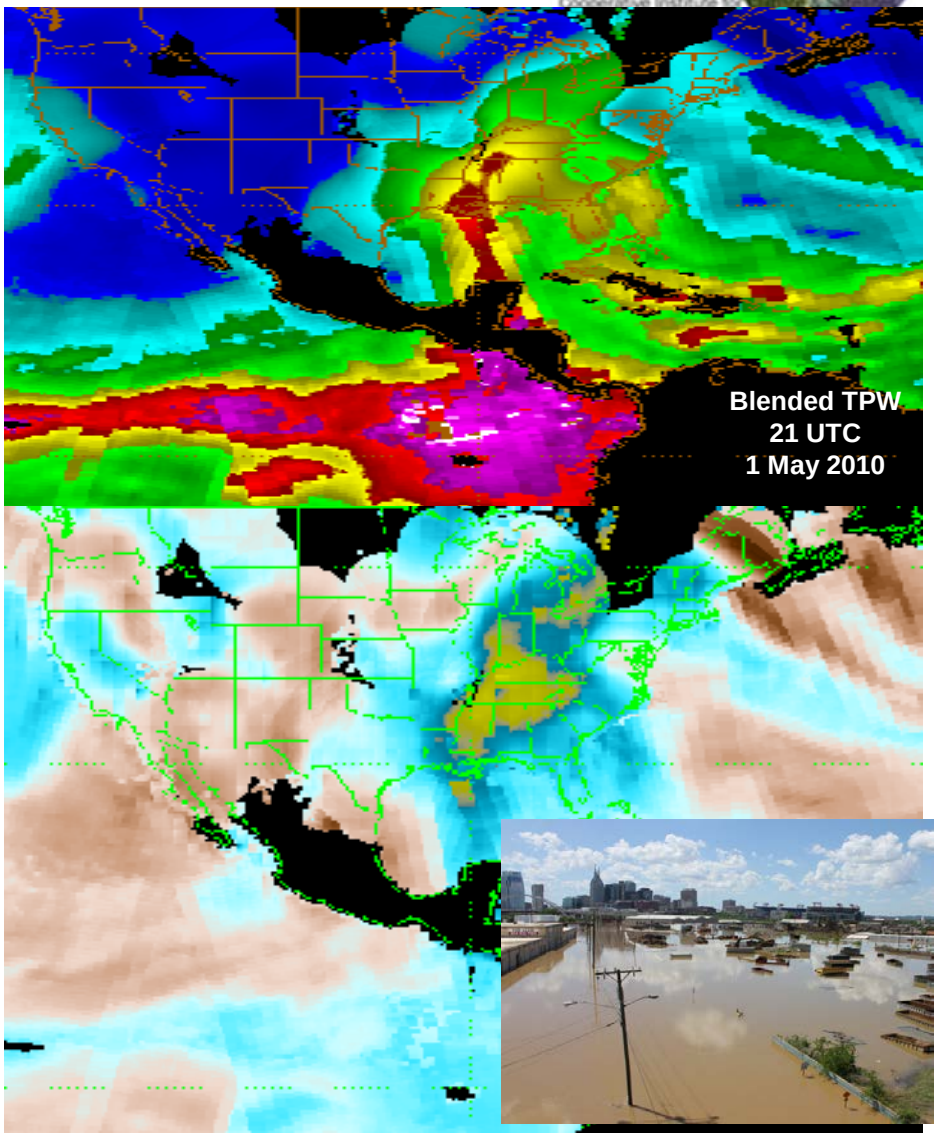
- *GOES-E&W*
- *Meteosat-10*
- *MTSAT-2*
- *MetOp-B AVHRR*
- *NPP-VIIRS*
- [*AMSR-2*]
- [*INSAT-3D*]
- [*HIMAWARI-8*??]
- [*Sentinel-3 SLSTR*]

- Multi-scale OI emulates Kalman filter
- Data adaptive correlation length preserves detail without introducing excessive noise
- Diurnal warming adjustment being incorporated
- Reprocessing most recent decade to establish baseline for NOAA Coral Reef Watch

Blended TPW (bTPW) Product

http://www.osdpd.noaa.gov/bTPW/index.html

- bTPW algorithm – Kidder and Jones, 2007
  - Histogram matching to common reference
- The bTPW product combines all available data sources into a "seamless" product for use by the NWS forecaster
  - Ocean – Satellite MW
  - Land – Satellite MW and GOES Sounder; GPS Met
- Most flooding events can be linked to "atmospheric rivers" – high TPW that focus on a given location for extended period
  - Connection from (sub)tropics to mid and high latitudes
- Product is useful to weather forecasters
  - Timing & magnitude of moisture "surges" (NWP models might miss)
- Companion TPW Anomaly (from climatology) Product

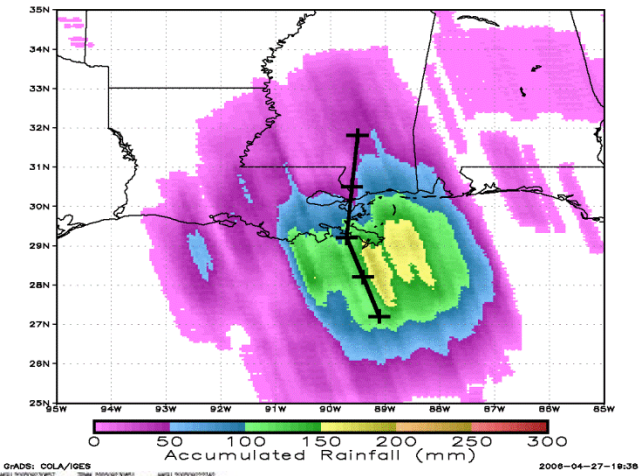


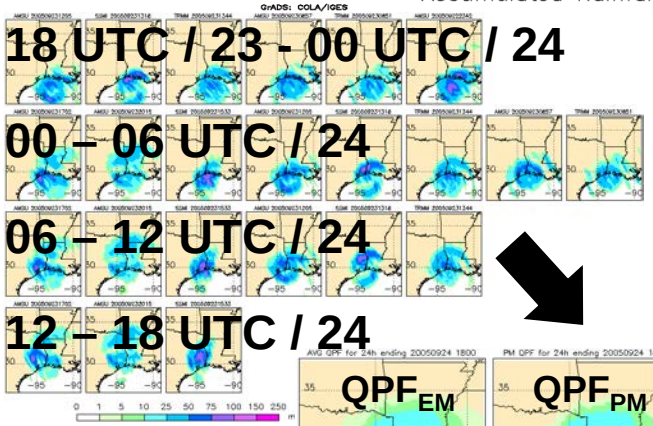
Provided by S. Kussleson, NESDIS/SAB

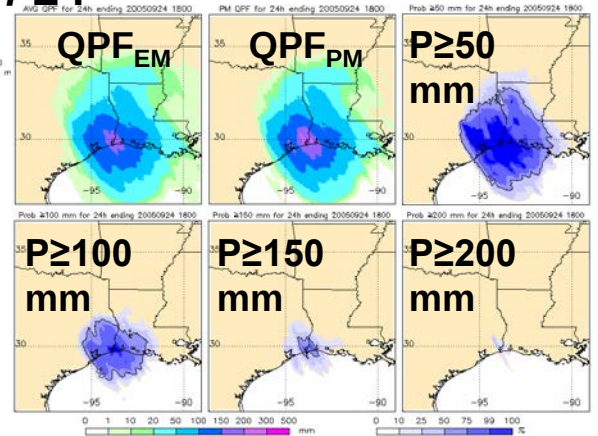
Ensemble Tropical Rainfall Potential (eTRaP)

http://www.ssd.noaa.gov/PS/TROP/etrap.html

- eTRaP algorithm – E. Ebert (BOM/Australia)
  - Based on TRaP from Kusselson, Kidder, et al.
- Forecast of 24-hour rainfall potential for tropical systems about to make landfall.
- Based on extrapolation of microwave-derived rainfall rates along predicted storm track.
- Ensembles improve deterministic forecasts and provide uncertainty information
  - Weight errors of individual MW retrievals
  - Weight the timeliness of the retrievals
- Produced worldwide and used by operational agencies
- Additional ensemble members (GOES, LEO) plus orographic, shear, storm rotation adjustments planned







Some ongoing projects in the "GEARS Spirit"

Enterprise Algorithm Development within STAR

Provided by W. Wolf NESDIS/STAR

- US National Weather Service (NWS) has requested continuity of NOAA products between current and future NOAA operational satellites
- Therefore, STAR is in the process of implementing and transitioning to operations a common software base for multiple algorithms.
- This common algorithm software base will create the same product for multiple satellite instruments. Two examples are:
  - Derived Motion Winds
    - Same software for GOES, GOES-R, and VIIRS
    - Currently implementing AVHRR and MODIS processing within the software to be transitioned to operations
  - Cloud Mask
    - Same software for GOES, GOES-R, VIIRS, AVHRR, SEVIRI, and MTSAT
    - Current projects will be transitioning this common software to operations
- This migration to Enterprise Algorithms will reduce both system and algorithm development and maintenance costs

Ground Enterprise Architecture System (GEARS) Precipitation Common Ground System

Provided by N-Y. Wang, IMSG Corp.

- Build a level 3 service that currently does not exist in NESDIS ground system
- Combine level 2 LEO and GEO satellite precipitation information
  - Improve the quality of GEO precipitation information from using polar satellite information by leveraging the "morphing" methodology from CPC's CMORPH
  - Improve temporal refresh of polar satellite information by using geostationary satellite information
  - The LEO MW will be advanced through a systematic weighted ensemble mean

Summary and Future Opportunities

- Traditional NOAA satellite products developed in a single sensor, platform series mindset
  - Some exceptions like IMS, bTPW, eTRaP
- Through NESDIS restructuring and more "modern" vision from GOES-R/JPSS Project Scientists…
  - Mandate for more efficient, common algorithms and processing systems
  - Best products derived from best combination of satellite and in-situ data
- CICS-MD has opportunity to be a part of this activity over the next 5 years
  - Some researchers already involved.