Infusing Information from SNPP and GOES-R Observations for Improved Monitoring of Weather, Water and Climate

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- The NESDIS/GOES-R Risk Reduction Programs.

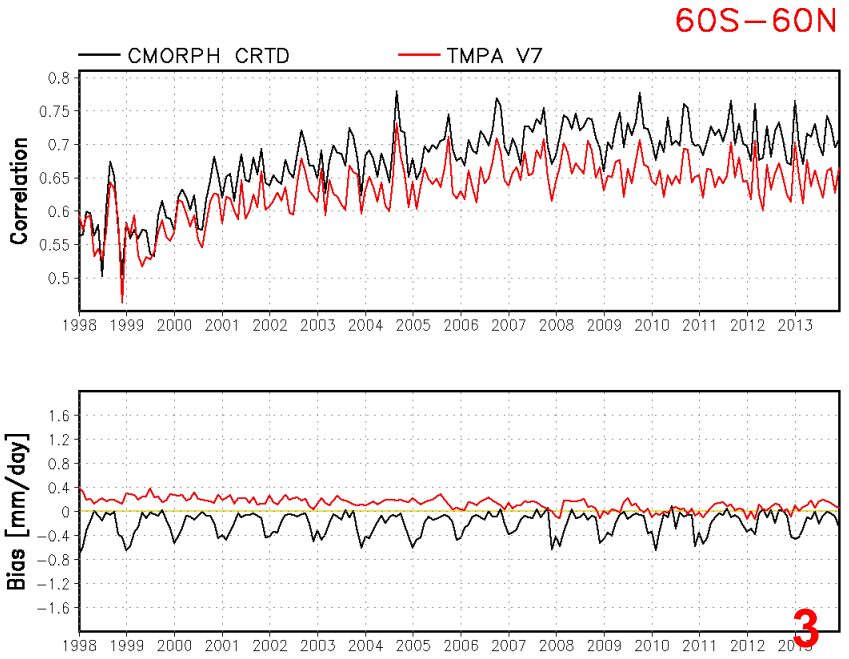
Background

The Current Operational CMORPH

- CPC Morphing Technique [Joyce et al. 2004]
- A technique to construct high-resolution global precipitation estimates through integrating information from multiple LEO and GEO platforms
- Motion vectors of precipitating clouds derived from consecutive GEO IR images and used to propagate PMW retrievals of instantaneous rain rates to target analysis time
- Bias correction performed against CPC daily gauge analysis
- 8km grid over the globe [60°S-60°N], 30-min interval from 1998 updated real-time (3 hr delay)
- Superior performance compared to similar products

Shortcomings:

- Incomplete global coverage
- No explicit representation of snowfall
- Less-than-desirable time/space resolution
- Relatively long latency



Overall Goal of Our JPSS/GOES-R Work

- Develop 2nd generation CMORPH integrated satellite precipitation estimates for improved weather, water, and climate applications
- Two components of this work
  - Extending the CMORPH to cover the entire globe with explicit snowfall representation *[JPSS project]*; and
  - Generating a regional CMORPH with a further refined resolution and reduced latency through enhancements from GOES-R observations *[GOES-R project]*.

The New CMORPH Infused by JPSS [1]

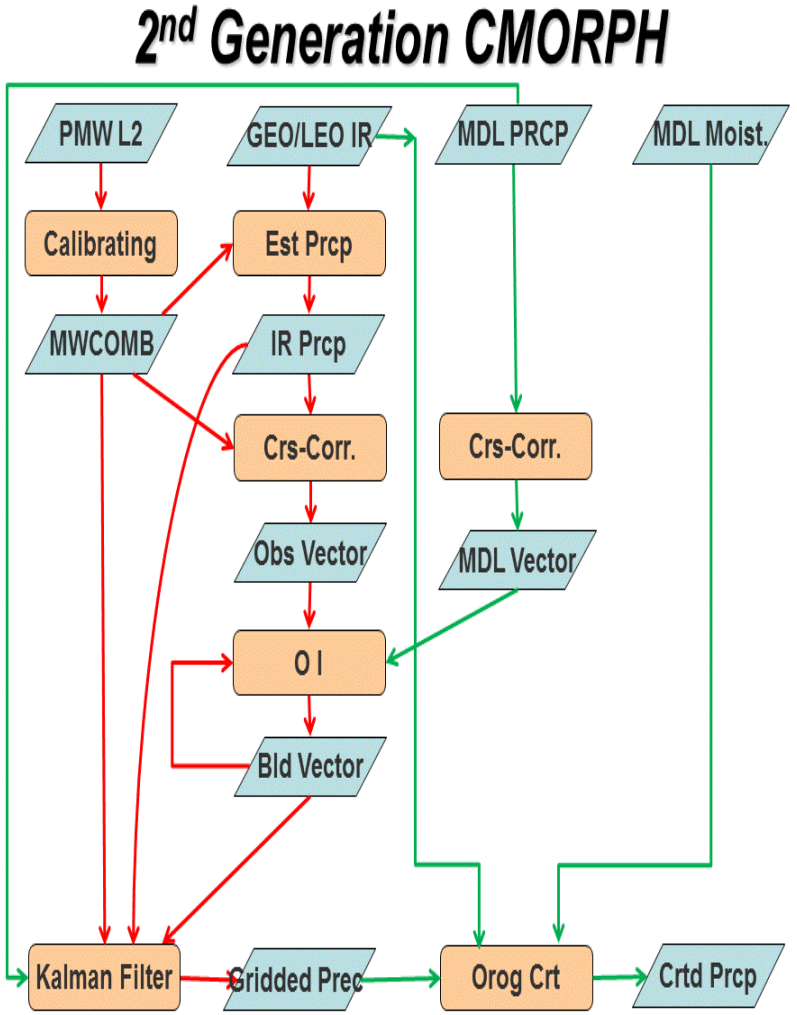
Specific Goals

- A pole-to-pole complete global coverage at a refined spatial resolution (0.05^{o}lat/lon)
- Explicit representation of snowfall and cold season rainfall
- Reasonable temporal homogeneity for climate applications
- Ability to detect heavy rainfall and orographic precipitation

The New CMORPH Infused by JPSS [2]

Development of the 2nd Generation CMORPH

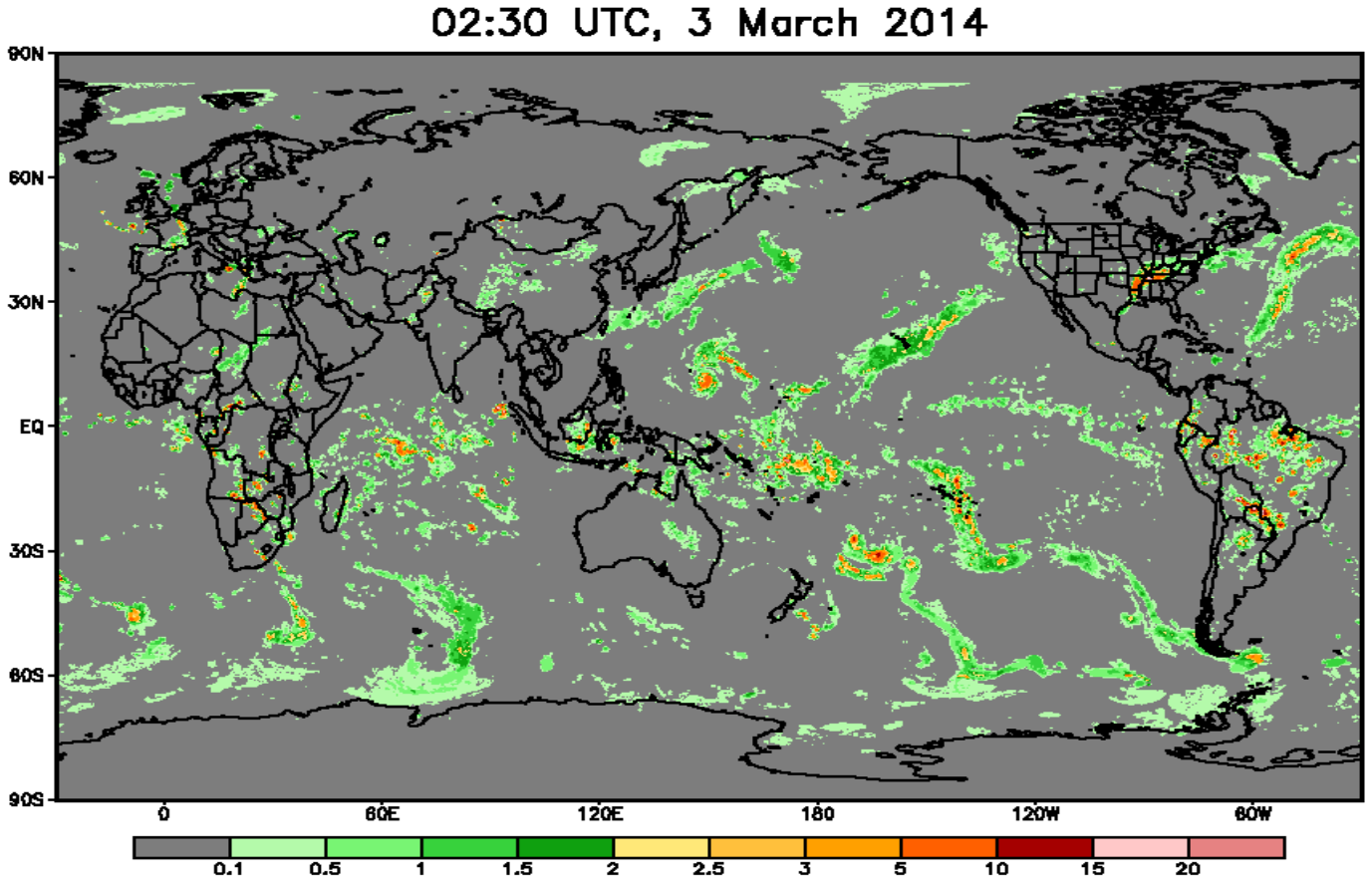
- **INPUT Precipitation**
  - PMW L2
  - GEO/LEO IR-based estimates
  - CFSR
- **Precipitation motion vectors**
  - Cross-correlation from GEO/ LEO IR based precip
  - Cross-correlation from CFSR
  - Blended analysis through 2D-VAR
- **Integration Framework**
  - Kalman Filter based algorithm
- **Other components**
  - Orographic effects..



Xie and Joyce, 2014: Integrating Information from Satellite Observations and Numerical Models for Improved Global Precipitation Analyses: Exploring for an Optimal Strategy. AGU *Monography for the AGU Chapman Conference on Remote Sensing of the Terrestrial Water Cycle.(in press)*

The New CMORPH Infused by JPSS [3]

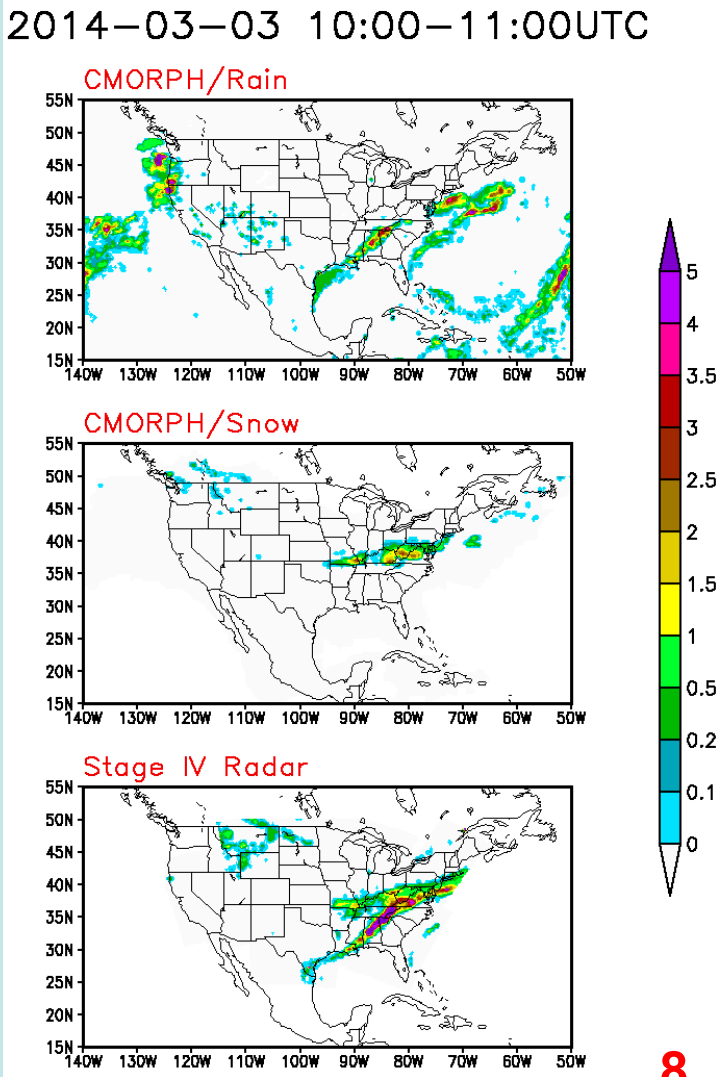
Sample Results for Northern Winter



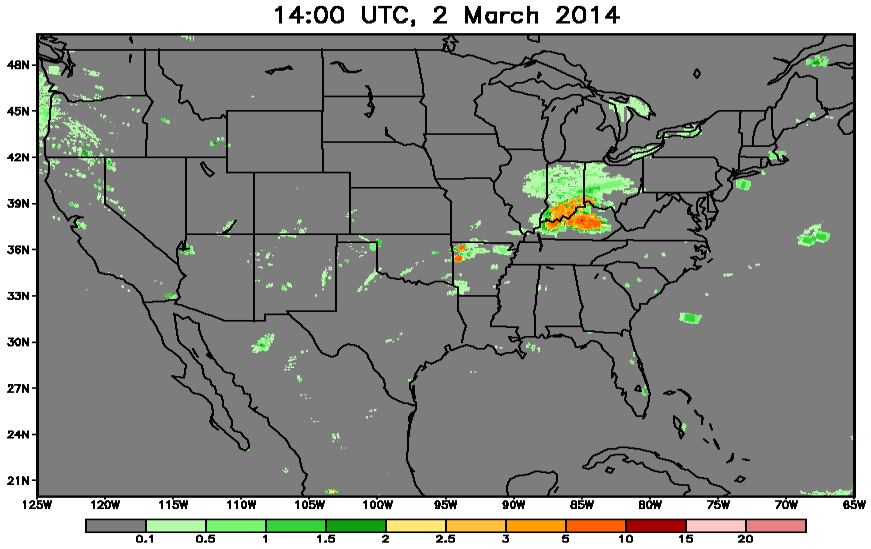
The New CMORPH Infused by JPSS [4]

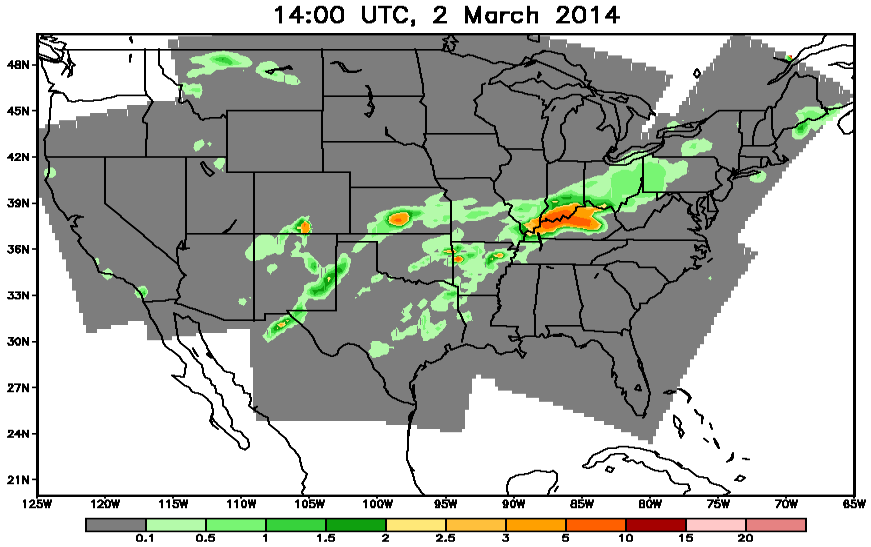
Explicit Representation of Snowfall in CMORPH

- Thanks to the operational production of snowfall rate retrievals from PMW sounders including those from SNPP/ ATMS, we were able to develop integrated snowfall rate analysis under the CMORPH framework
- A sample for a major snow storm over the east coast of US in March 2014
- (bottom) Radar image illustrates two bands of precipitation associated with the warm and cold part of the frontal system
- (top) CMORPH/Rain picked up the rainfall in the warm part of the system but missed the snowfall
- (middle) CMORPH/Snow captures the snow in the cold part of the system



2nd Generation CMORPH (top) STAGE IV Radar precipitation (bottom) mm/hr





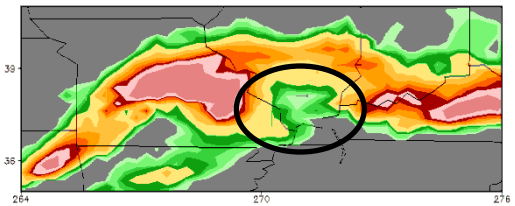
The New CMORPH Infused by JPSS [5]

Direct Contributions of SNPP/ATMS Retrievals

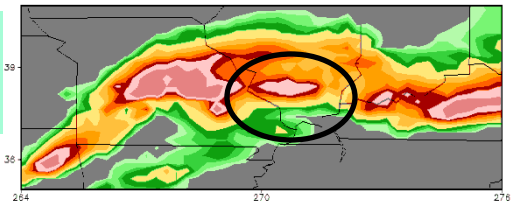
- High quality MiRS ATMS retrievals provide precipitation estimates of high quality and wide coverage along the satellite orbits
- MiRS ATMS retrievals improve the quality of combined PMW estimates (MWCOMB) used to calibrate the GEO- and LEO- IR based precipitation estimates that are also used as input to the new CMORPH

18-24 UTC, 3 April 2014

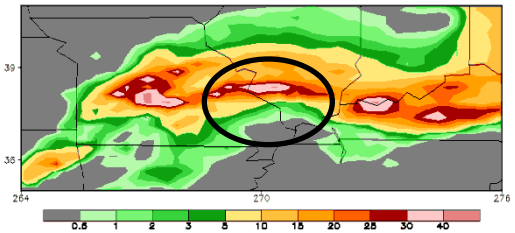
CMORPH w/o SNPP



CMORPH with SNPP

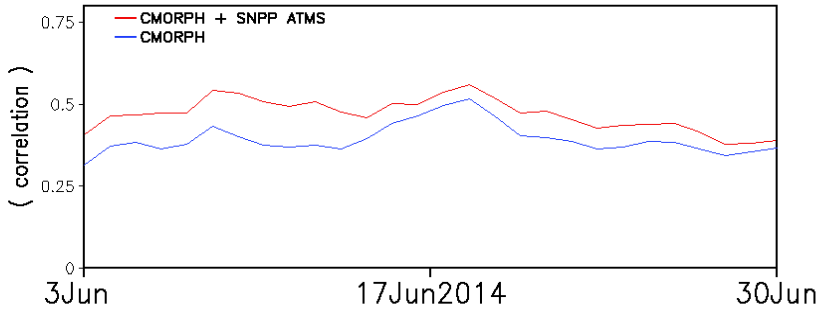


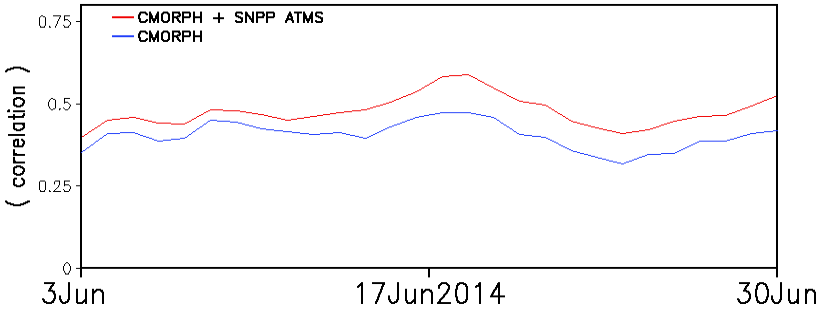
Stage IV Radar Est



Comparison of CMORPH with Stage IV Radar

(13 LST [top] 14 LST [bottom] hourly statistics)





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GOES-R Risk Reduction Program [1]

Specific Goals

- GOES-R Enhanced Regional CMORPH
  - *2kmx2km over the western hemisphere (future GOES-R coverage)*
  - *15 min interval updated at a combination of latencies (15-min, 1-hr, 3-hr,12-hr)*

- Gauge-Radar-Satellite-Model Fused Precipitation Analysis
  - *1kmx1km over CONUS and adjacent regions*
  - *15 min interval updated at a combination of latencies (15-min, 1-hr, 3-hr,12-hr,1-mon)*

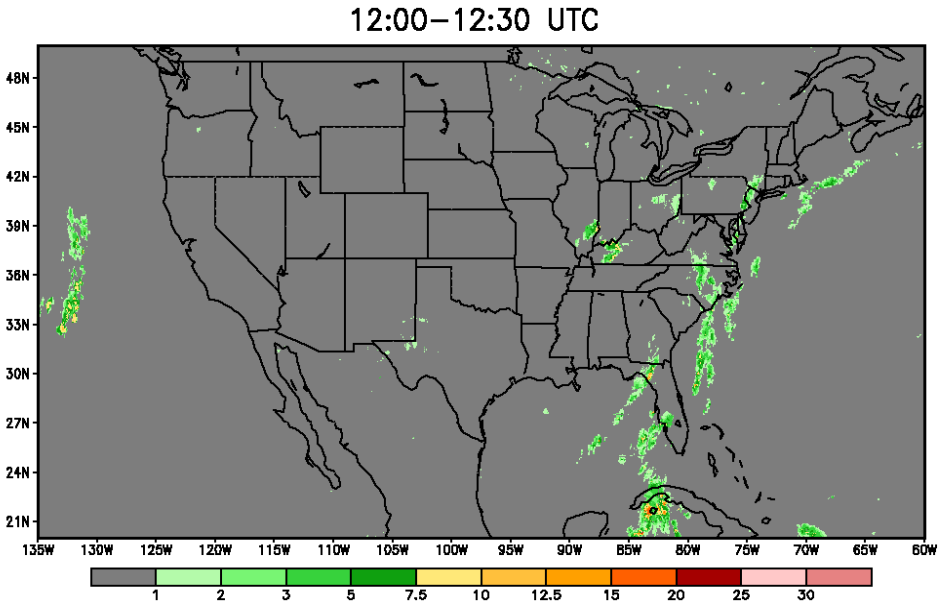
GOES-R Risk Reduction Program [2]

GOES-R Enhanced Regional CMORPH

- Same integration framework (Kalman Filter) as that for the global CMORPH
- Enhanced through the use of information from the upcoming GOES-R
  - *Improved precipitation inputs from GOES-R based precipitation estimates (GPE) based on IR, WV, and GEO lighting*
  - *Refined cloud motion vectors and cloud evolution model through the use of GPE*
  - *Reduced latency*
- Current Status
  - *Prototype developed*

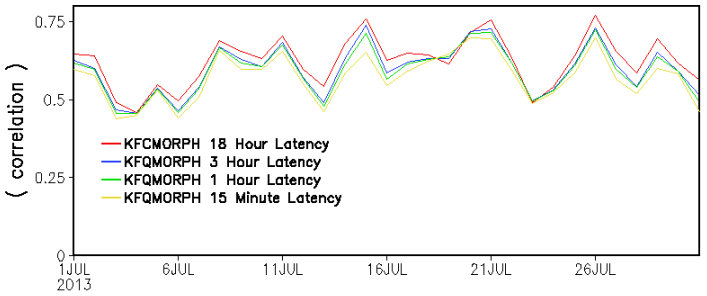
GOES-R Risk Reduction Program [3]

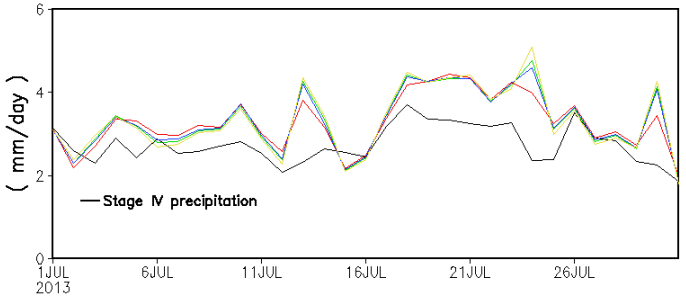
GOES-R Enhanced Regional CMORPH



Synthetic GOES-R enhanced regional CMORPH precipitation estimates for July 1, 2013, produced on a 4km resolution using satellite PMW and GOES IR data available at a latency of 15 minutes.

Performance of the synthetic GOES-R enhanced regional CMORPH precipitation estimates at different latency levels





GOES-R Risk Reduction Program [4]

Gauge-Radar-Satellite-Model Fusion

- Key features:
  - *Based on the CPC operational gauge-satellite fusion algorithm*
  - *Satellite centric: Satellite estimates (regional CMORPH) enhanced by regionally available additional information*
  - *Portable for other regions though developed with data from CONUS*

GOES-R Risk Reduction Program [4]
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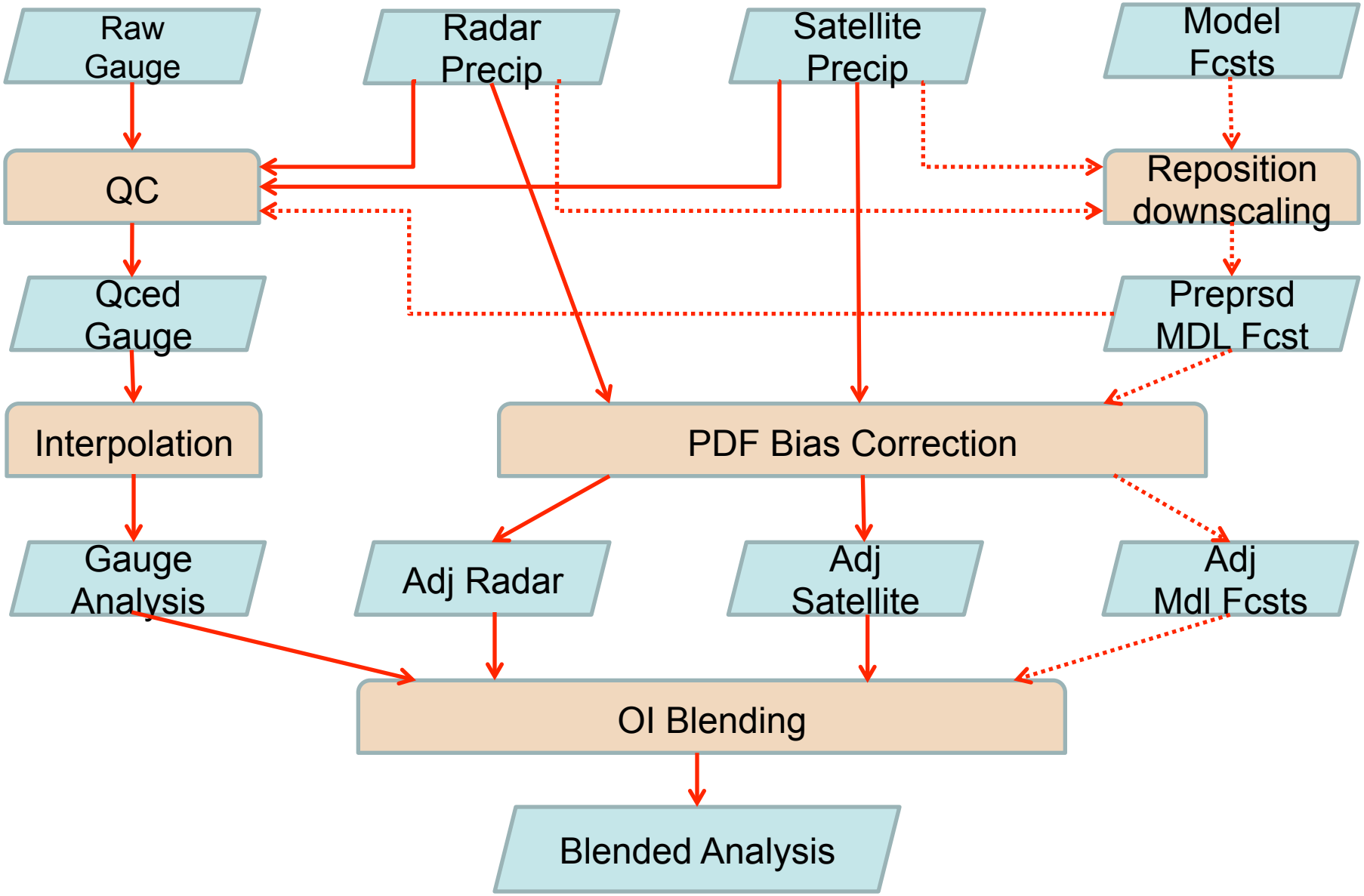
GOES-R Risk Reduction Program [5]

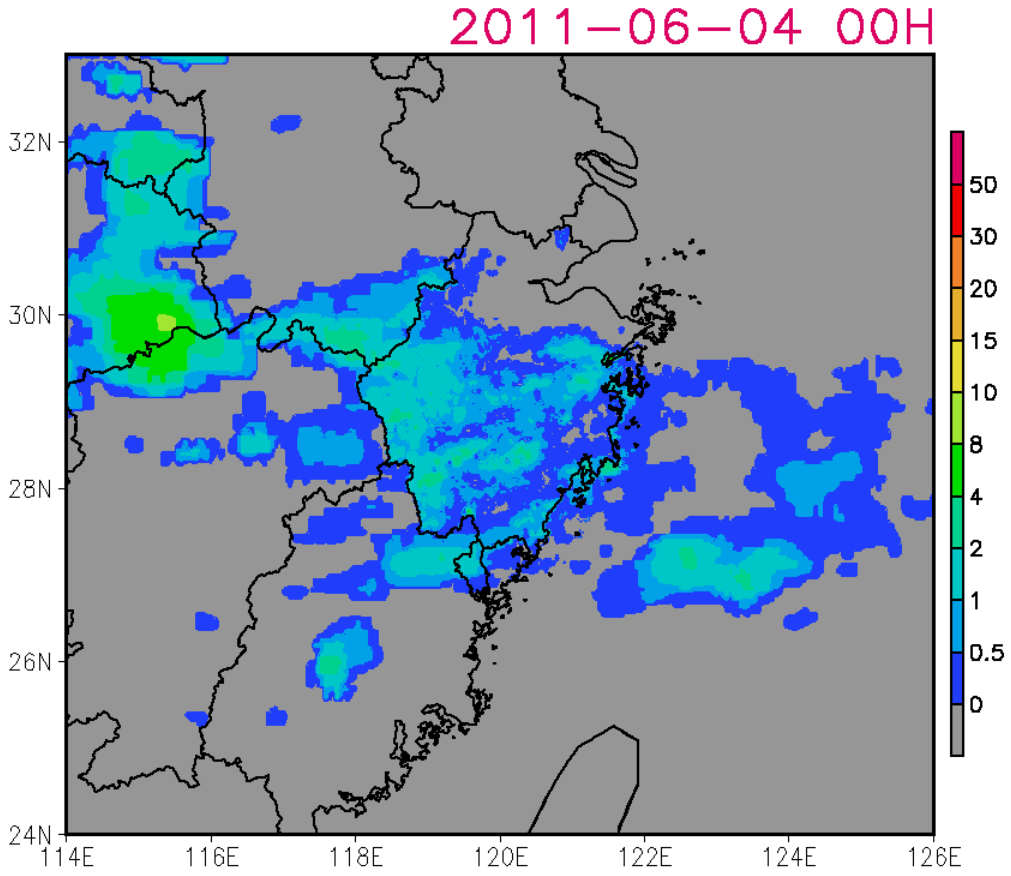
Gauge-Radar-Satellite-Model Fusion (flow chart)



GOES-R Risk Reduction Program [6]

Gauge-Radar-Satellite-Model Fusion (sample results)

Sample Results over SE China



Summary

- Prototype systems developed for the JPSS infused 2nd generation pole-to-pole CMORPH, GOES-R enhanced regional CMORPH and the gauge-radar-satellite-model infused regional precipitation analysis
- Work underway to refine the prototype models and to test operational version (for the global CMORPH)
- Information achieved from the JPSS and GOES-R satellite observations improves the quality of the global and regional precipitation estimates and reduces the latency of the products
- Combined use of the retrievals from the JPSS and GOES-R measurements maximizes the applications of satellite information in weather, water and climate