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

Pingping Xie, Robert Joyce, Shaorong Wu and Fengying Sun
NOAA Climate Prediction Center

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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 2\textsuperscript{nd} 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].
Specific Goals

• A pole-to-pole complete global coverage at a refined spatial resolution (0.05° 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 2\textsuperscript{nd} 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..

The New CMORPH Infused by JPSS [3]

Sample Results for Northern Winter

02:30 UTC, 3 March 2014
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

Comparison of CMORPH with Stage IV Radar
(13 LST [top] 14 LST [bottom] hourly statistics)
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
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.
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)
Sample Results over SE China

2011-06-04 00H
Summary

• Prototype systems developed for the JPSS infused 2\textsuperscript{nd} 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