Updates on the JPSS Infused 2nd Generation CMORPH

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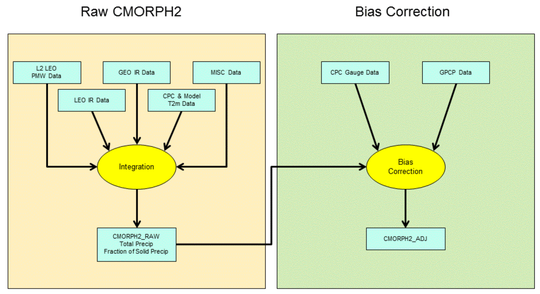
Introduction

A system has been developed at NOAA Climate Prediction Center (CPC) to produce 2nd generation CMORPH (CMORPH2) integrated high-resolution satellite precipitation estimates on a 0.05°lat/lon grid covering the entire globe from pole to pole. The CMORPH2 is built upon the Kalman Filter based integration algorithm of Joyce and Xie (2011). First, retrievals of instantaneous precipitation rates from passive microwave (PMW) observations aboard low earth orbit (LEO) satellites derived from SNPP and ~10 other passive microwave (PMW) sensors are decoded and mapped onto a 0.05°lat/lon grid over the globe. The mapped PMW retrievals are then calibrated utilizing a PDF matching technique against a reference field. In particular, snowfall rate retrievals of Meng et al. (2011) are utilized to capture the cold season precipitation. Precipitation estimation is derived from infrared (IR) window channels aboard the low earth orbit (LEO) satellites to fill in the gaps of PMW observations. The above mentioned retrievals of instantaneous precipitation rates are combined into a single gridded field called APCOMB. These instantaneous precipitation rates are then propagated from their respective observation times to the target analysis time along the motion vectors of the precipitating clouds. The motion vectors are computed through comparing the precipitation fields of two consecutive time steps as depicted by the 30-min precipitation estimates derived from the geostationary IR images and the NCEP/GFS hourly precipitation forecasts. The propagation is performed in both the forward and backward directions and the weighted mean of the forward and backward propagated APCOMB is defined as the CMORPH total precipitation estimates, with the weights set as a function of sensor type, length of propagation time, season, and location. Fraction of solid precipitation is then computed from the surface air temperature with the algorithm of Sims and Liu (2015).

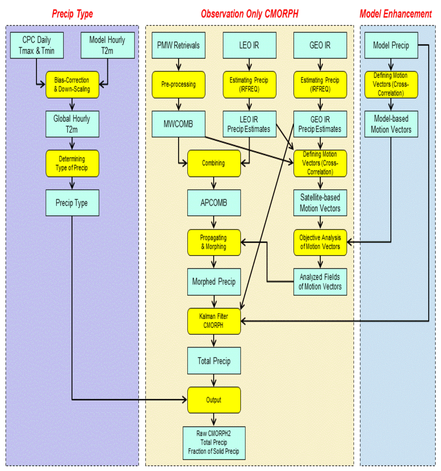
- **Introduce the current status of second generation CMORPH**
- **Illustrate examination results for the real-time production of the 2nd generation CMORPH**

Overview of PTP 2nd generation CMORPH

- Pole to Pole Complete Global Coverage
  - *90°S-90°N*
  - *0.05° lat/lon*
- Improved Representation of Cold Season Precipitation
  - *New Versions of PMW retrievals (MiRS et al)*
  - *PMW Snowfall Rate (SFR) retrievals (STAR/Huan Meng)*
  - *LEO IR based precipitation estimates (in-house)*
- Strategy
  - *Combining information from > 15 geostationary and low earth orbit satellites*
  - *Kalman filter based objective technique*



- Greatly refined integration algorithm at NOAA/CPC
  - *Inter-satellite calibration algorithm*
  - *Precipitation motion vectors*
  - *Kalman Filter analysis framework*
- Improved input satellite retrievals of rainfall and snowfall from NASA and NESDIS/STAR
- Satellite IR based precipitation estimates developed / refined at NOAA/CPC
- Newly added technique to determine fraction of solid precipitation from surface meteorology (T_{2m} et al) through collaboration with FSU
  - *Global hourly T_{2m} analysis*



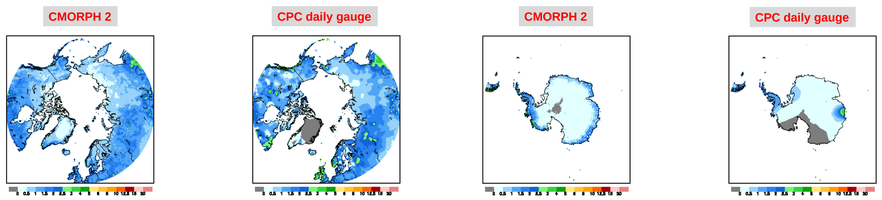


Figure 1. PTP & Operational 2nd generation CMORPH and CPC Daily Gauge analyses 1Feb – 30Sept 2019.

Evaluation of 2nd generation CMORPH

- **Higher relative skill for 2nd generation CMORPH**
- **CMORPH2/IMERG has negative/positive bias over winter hemisphere**

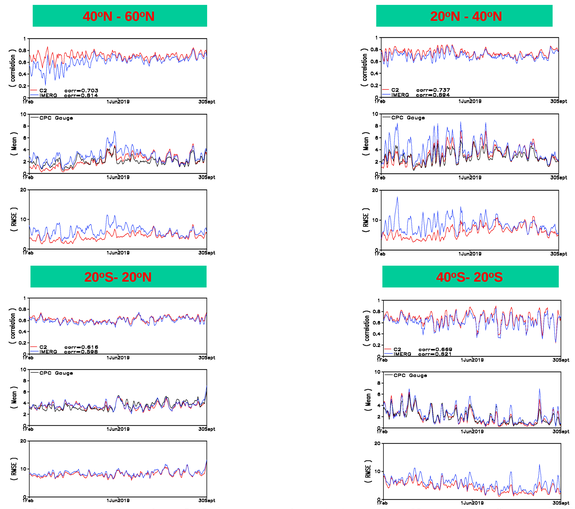


Figure 2. PTP, operational 2nd generation CMORPH [red], IMERG (late run V06B.RT) [blue], with CPC Daily Gauge analyses 1Feb – 30Sept 2019, 40N-60N [upper left], 20N-40N [upper right], 20S-20N [lower left], 40S-20S lower right. Correlation/mean/RMSE top/middle/bottom panels.

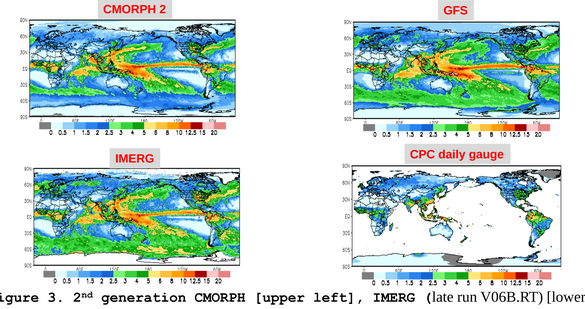


Figure 3. 2nd generation CMORPH [upper left], IMERG (late run V06B.RT) [lower left], GFS model precipitation [upper left], and CPC Daily Gauge analyses [lower right] 1Feb – 30Sept 2019 [mm/day].

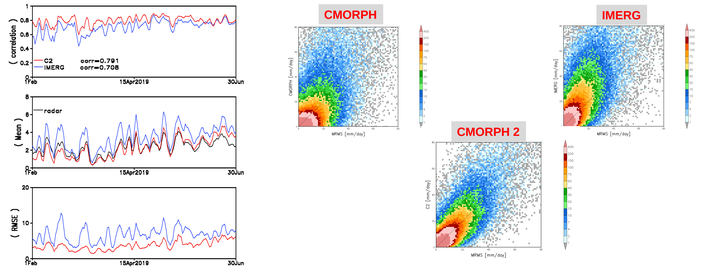


Figure 4. PTP, operational 2nd generation CMORPH [red], IMERG (late run V06B.RT) [blue], compared with gauge corrected MRMS 1Feb – 30June 2019, Correlation [upper left], Mean [middle left], RMSE [lower left].

Evaluating CMORPH at multiple near real time delay production latencies over CONUS

CMORPH2 Real-Time Production Improves with Production Latency but Maintains Good Quantitative Consistency among Productions of Different Latencies

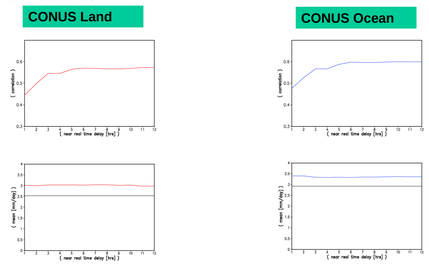


Figure 5: *Comparison of the real-time 2nd generation CMORPH generated at various latency levels against the MRMS radar precipitation July, 2019, over CONUS land (left) and adjacent oceans (right) Comparisons are conducted for hourly precipitation on a 0.25°lat/lon grid box. Top and bottom panels show correlation and mean precipitation, respectively. Black line in the bottom panels are radar precipitation.*

Daily precipitation (mm)

for 23 February, 2019

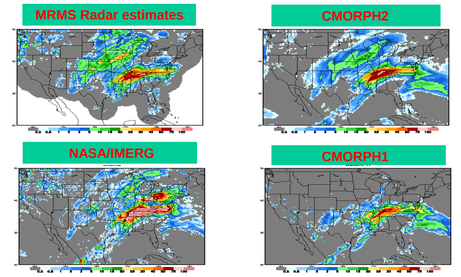


Figure 6. 2nd generation CMORPH [upper right], IMERG (late run V06B.RT) [lower left], gauge corrected MRMS [upper left], and original CMORPH [lower right] 23 Feb 2019 [mm/day].

CONCLUSIONS AND REFERENCES

- **PTP CMORPH in beta mode since 1 May 2017, frozen algorithm version since Jan 2019**
- **2nd generation CMORPH precipitation estimation and gauge reports generally agree over high latitude, Arctic, and Antarctica regions**
- **C2 more skill than IMERG relative to both CPC daily gauge and MRMS especially during winter mid and high latitudes, however very similar in skill and mean over the Tropics**
- **C2/IMERG had an under/over estimation in the Northern Hemisphere winter relative to both gauge and radar, and an under/over estimation over high-latitude ocean relative to GFS**
- **CMORPH correlation increases significantly from the 1 to 3 hour near real time latencies**
- **Infusion of Level 2 precipitation retrievals from JPSS plays important role in improving the CMORPH especially for the representation of snowfall rate (SFR).**