Real-time Production of 2nd Generation CMORPH

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Introduction

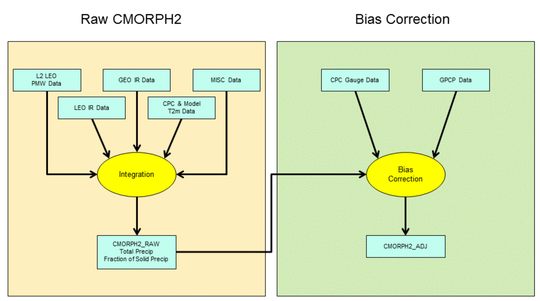
A test system has been developed at NOAA Climate Prediction Center (CPC) to produce a CMORPH, IR-based, and model integrated high-resolution precipitation estimation on a 0.05°lat/lon grid covering the entire globe from pole to pole (PTP). This PTP "beta" version of CMORPH is currently running quasi-operationally (since 1 May 2017, and in frozen algorithm version since January 2019) at NOAA/NCEP/CPC, in parallel to the operational CMORPH, however ATM not yet available for public use. The PTP global CMORPH system is built upon the Kalman Filter based CMORPH algorithm of Joyce and Xie (2011). First, retrievals of instantaneous precipitation rates from passive microwave (PMW) observations aboard low earth orbit (LEO) satellites 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, the GPM GMI-based PMW retrievals over tropics and mid-latitudes. PMW retrievals over high latitudes and winter seasons consisting of cold surfaces however present a host of problems. Land and sea-ice retrieval methods rely on a weak signal of rainfall scattering on high-frequency channels that make use of empirical thresholding and regression-based techniques. Because of the increased surface signal interference, retrievals over complex surfaces including sea ice and snow covered land often result in either erroneously zero precipitation values or often extremely high precipitation anomalies. Thus for these regions and seasons, the Advanced Very High Resolution Radiometer (AVHRR) Global Area Coverage (GAC) 4km InFrared (IR) rightness temperatures (Tb) and associated cloud flag parameters present observations that can be used to indirectly estimate precipitation (LICOMB) from cloud top information calibrated with CloudSat CPR precipitation retrievals. In addition to the total precipitation, fraction of solid precipitation is computed from the surface air temperature and other surface meteorological variables using the algorithm of Sims and Liu (2015).

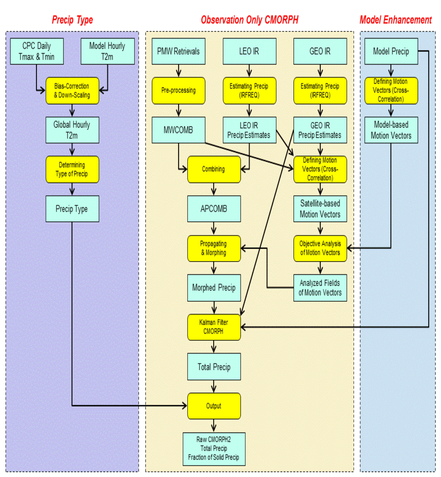
Objectives

- **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*

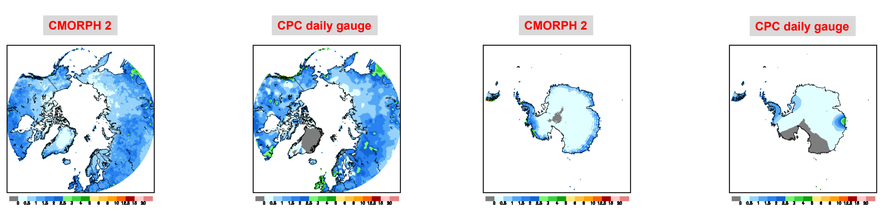


Figure 1. PTP & Operational 2nd generation CMORPH and CPC Daily Gauge analyses 1Feb – 30Sept 2019.

Evaluation of 2nd generation CMORPH

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

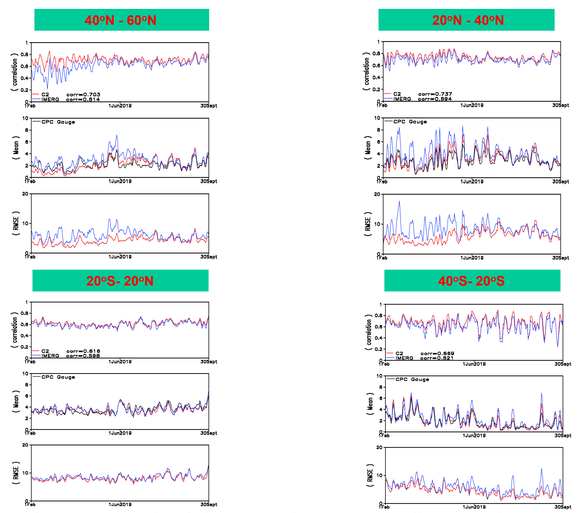


Figure 2. PTP, operational 2nd generation CMORPH [red], IMERG (late run V06B.RT) [blue], with CPC Daily Gauge analyses 1Feb – 30Sept 2019, 40N-60N [upper left], 20N-40N [upper right], 20S-20N [lower left], 40S-20S lower right. Correlation/mean/RMSE top/middle/bottom panels.

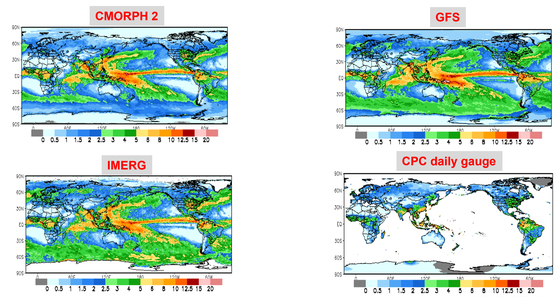


Figure 3. 2nd generation CMORPH [upper left], IMERG (late run V06B.RT) [lower left], GFS model precipitation [upper left], and CPC Daily Gauge analyses [lower right] 1Feb – 30Sept 2019 [mm/day].

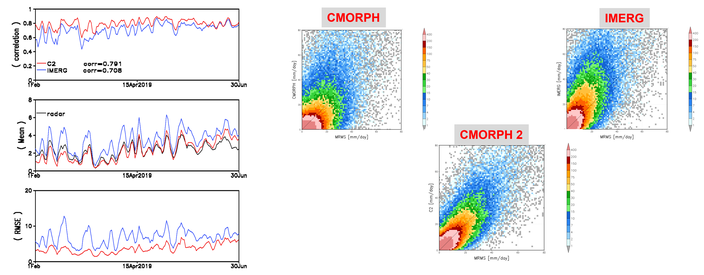


Figure 4. PTP, operational 2nd generation CMORPH [red], IMERG (late run V06B.RT) [blue], compared with gauge corrected MRMS 1Feb – 30June 2019, Correlation [upper left], Mean [middle left], RMSE [lower left].

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

- **CMORPH correlation relative to MRMS increases significantly from 1 hour to 3 hour near real time latencies**
- **Bias reduces with increasing latency**

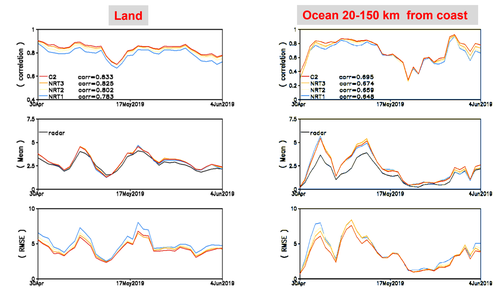


Figure 5. 2nd generation CMORPH at latencies of 1 hour[blue],2 hours[yellow], 3 hours[orange], and C2 15 hours [red] -vs- MRMS precipitation Correlation (top); mean (middle)[mm/dy]; RMSE (bottom) for 23 Sept – 11 Oct 2017.

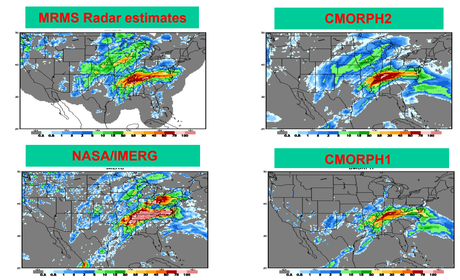


Figure 6. 2nd generation CMORPH [upper right], IMERG (late run V06B.RT) [lower left], gauge corrected MRMS [upper left], and original CMORPH [lower right] 23 Feb 2019 [mm/day].

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 a under/over estimation in the Northern Hemisphere winter relative to both gauge and radar, and a under/over estimation over high-latitude ocean relative to GFS**
- **CMORPH correlation increases significantly from the 1 to 3 hour near real time latencies**

•Joyce, R.J., Janowiak, J.E., Arkin, P.A., and P. Xie, 2004: CMORPH: A Method that Produces Global Precipitation Estimates from Passive Microwave and Infrared Data at High Spatial and Temporal Resolution. Journal of ydrometeorology Vol. 5, 487-503.

•Joyce, R.J., P Xie 2011, Kalman filter-based CMORPH Journal of Hydrometeorology 12 (6), 1547-1563.