NOAA Satellite Data Fusion: Current Status and Future Plan

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Objective

- To provide a brief description of the current status and future plans for operational integrated satellite precipitation products developed and maintained at NOAA centers

- Two operational products

  - CMORPH
    - CPC Morphing Technique
    - NWS / NCEP / CPC

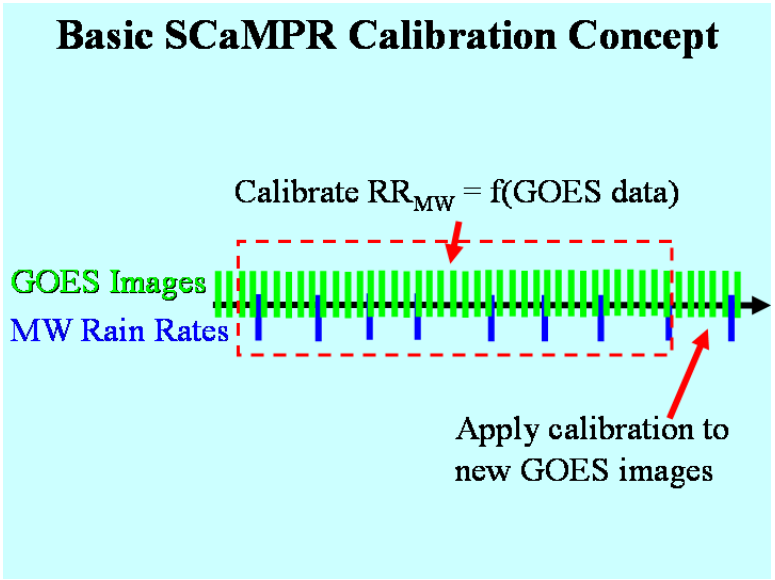
  - SCaMPR
    - Self-Calibrating Multivariate Precipitation Retrievals
    - NESDIS / STAR

SCaMPR Background

- Self-Calibrating Multivariate Precipitation Retrieval
- An IR-based, multi-spectral algorithm trained against MW rainfall rates (currently CPC-MWCOMB) in real time
- Selected as the GOES-R Rainfall Rate algorithm—will use the GPM Merged MW as its calibration source
- Low-latency algorithm that will extend use of GPM data for fast-response (<3h) applications such as flash flood forecasting
- Running a version in real time on current GOES that uses 2 of the 5 needed bands (6.7 and 11.0 μm—the full version will also use 6.2, 8.5, and 12.0 μm)

SCaMPR Algorithm Basics (1/2)

- Calibrated using matched MW-IR data (IR aggregated to the MW footprint); the matched data and calibration are updated whenever new IR data become available.
- Each matched dataset goes back far enough to have 25,000 pixels with MWCOMB rain rates ≥2.5 mm/h.
- Separate calibrations for four latitude bands (30° wide) and two cloud types (overshooting convection and "other", based on $T_{6.7}$-$T_{11.0}$).
- (The GOES-R version has water-top and ice-top classes based on $T_{8.5}$, $T_{11.0}$ and $T_{12.0}$ in place of "other".)



SCaMPR Algorithm Basics (2/2)

- Separate calibration for rain / no rain (discrminant analysis) and rain rate (stepwise forward liner regression).
- Four predictors (derived from $T_{6.7}$ and $T_{11.0}$) are available for rain / no rain discrimination; up to 2 are selected.
- Eight predictors are available for rain rate retrieval (original four plus log / log regression of all four vs. MWCOMB to capture nonlinear relationships); up to 2 are selected.
- (This is half the predictor set of the GOES-R version since $T_{6.2}$, $T_{8.5}$, and $T_{12.0}$ are not available.)

SCaMPR Product Specifications

- *Coverage:* currently entire GOES-East and –West coverage area between 60°S and 70°N plus the MSTAT full disk—expansion to full global coverage planned using available bands for each satellite
- *Spatial resolution:* 4 km (similar to resolution of IR bands on current GOES imager)—will be 2 km in the GOES-R era
- *Refresh rate:* full temporal resolution of the satellite
- *Latency:* ~20 minutes

Plans for this Project

- Reprocess SCaMPR for GOES-East and GOES-West coverage area for 2000-2013
- Provide data to OHD and work on how to best blend SCaMPR into a multisensor radar / gauge / satellite framework

The 1st Generation CMORPH

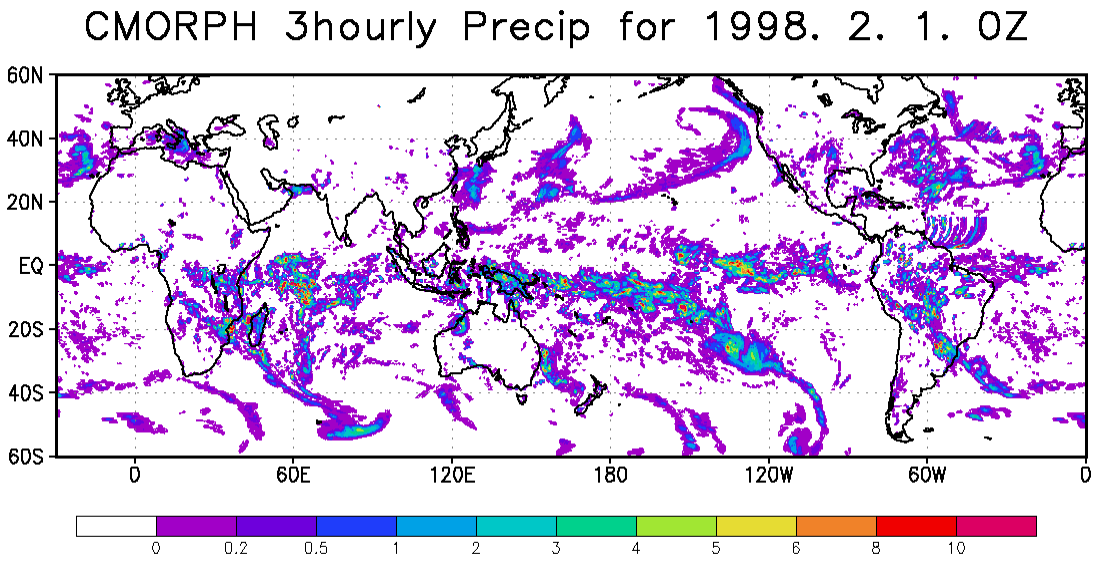
1) Inputs and Algorithm

- IR images from geostationary satellites to derive motion vectors of cold clouds
- L2 retrievals of instantaneous precipitation rates from PMW observations from all low earth orbit satellites
- Propagate the PMW retrievals from their respective observation times to the target analysis time
- Products
  - 8kmx8km over the globe (60°S-60°N)
  - From Jan.1, 1998 to the present
  - Updated on a real-time basis

The 1st Generation CMORPH

2) Reprocessed CMORPH for 1998 to the present

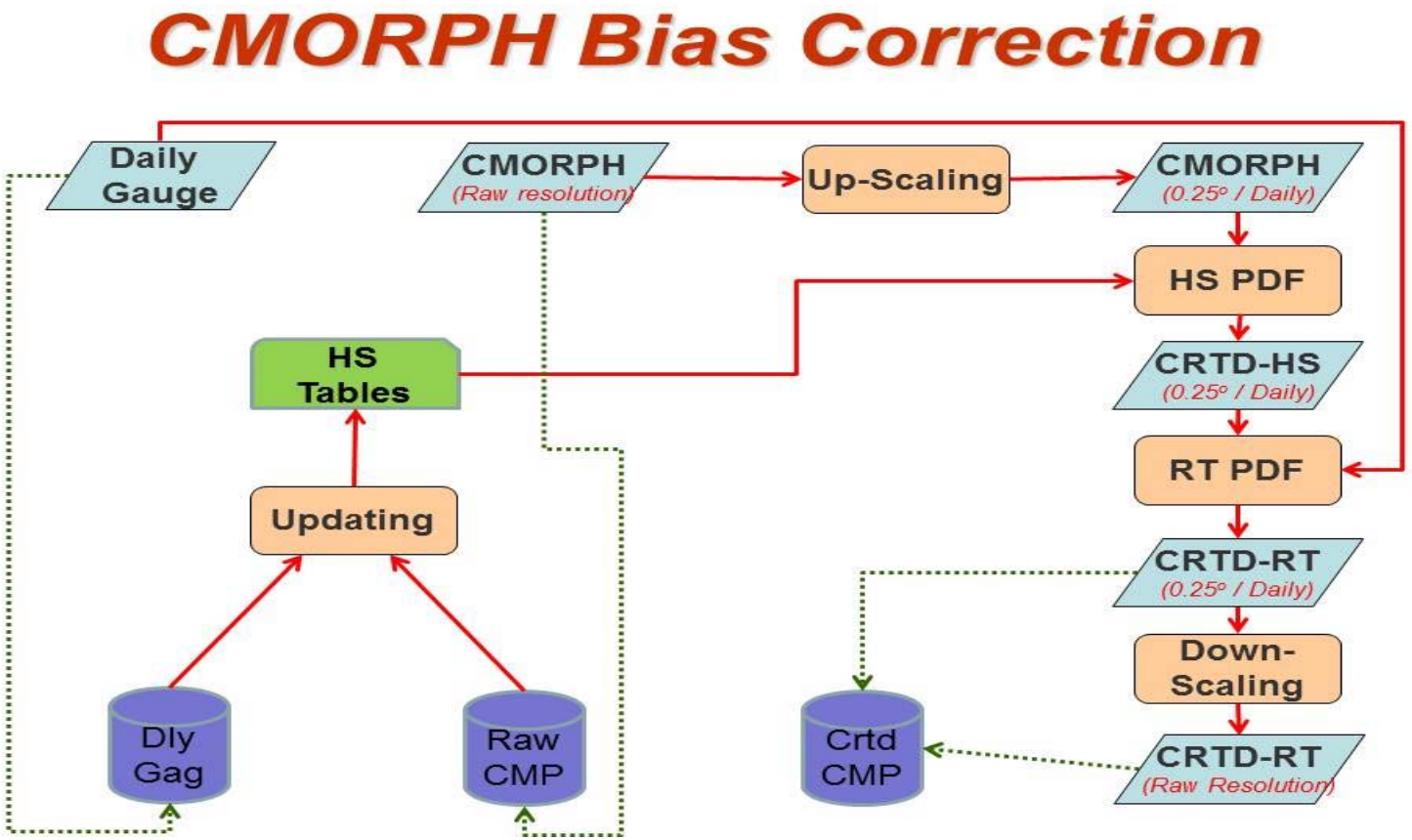
- **Objective:**
  - Reprocessing CMORPH for the entire TRMM era (1998-present) using a consistent version algorithm and fixed versions of inputs throughout the data period
- **Algorithm:**
  - CMORPH algorithm as of 2009 (Joyce et al 2004)
  - *No KF enhancement*
- **Inputs**
  - PMW L2 retrievals (GPROF 2004)
  - CPC Geo sat IR at 4km (Janowiak et al. 1999)
  - NESDIS daily snow maps



The 1st Generation CMORPH

3) Bias Correction

- Bias in raw CMORPH corrected through PDF matching against daily gauge analysis
- Bias corrected in two consecutive steps using PDF established using historical and real-time data, respectively



The 1st Generation CMORPH

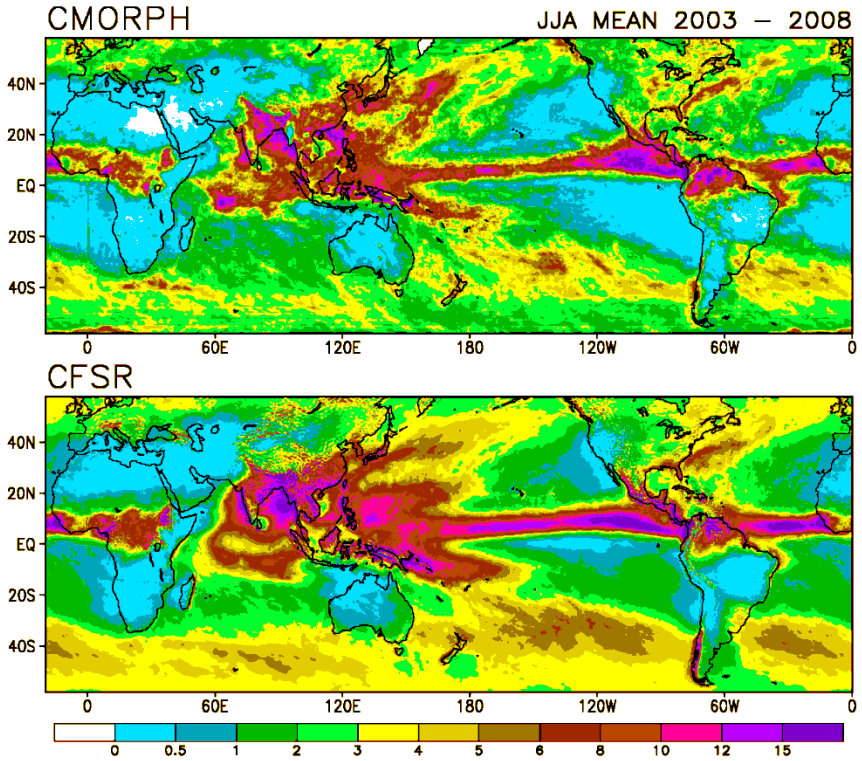
4) Comparison against gauge data (0.25°lat/lon, daily)

BIAS (mm/day)	RAW	HS	RT
50N-50S	-0.365	-0.126	-0.060
50N-40N	-0.617	-0.154	-0.144
40N-20N	-0.119	-0.058	-0.023
20N-20S	-0.257	-0.116	-0.018
20S-40S	-0.444	-0.195	-0.030
40S-50S	-1.832	-0.557	-0.052

Correlation	RAW	HS	RT
50N-50S	0.613	0.678	0.710
50N-40N	0.560	0.644	0.689
40N-20N	0.661	0.732	0.764
20N-20S	0.574	0.619	0.636
20S-40S	0.632	0.683	0.727
40S-50S	0.557	0.638	0.672

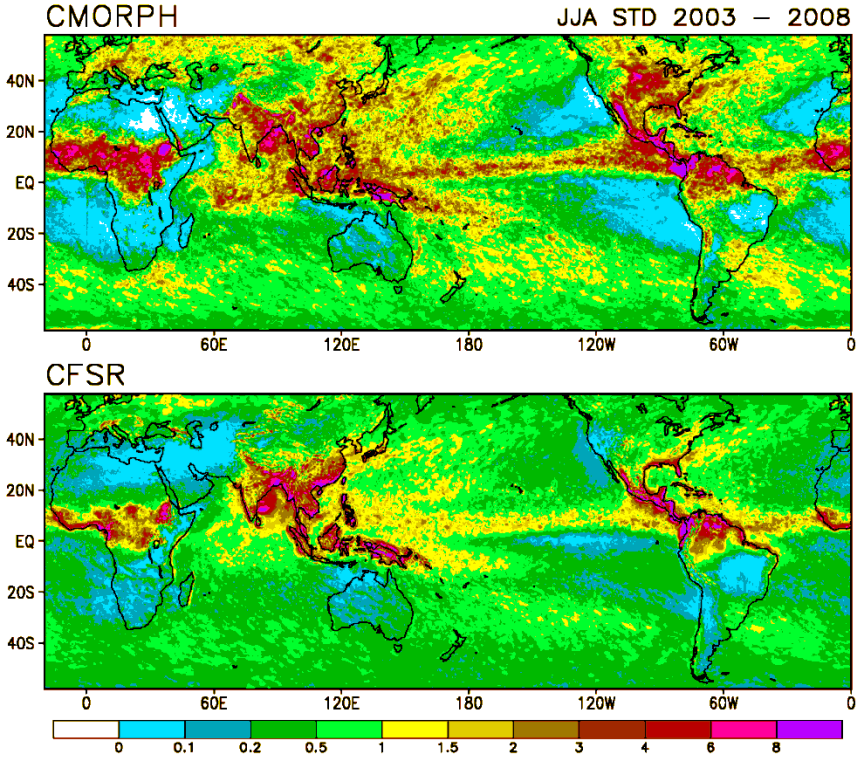
The 1st Generation CMORPH

5) Applications in Model verifications



JJA Precipitation Diurnal Amplitude

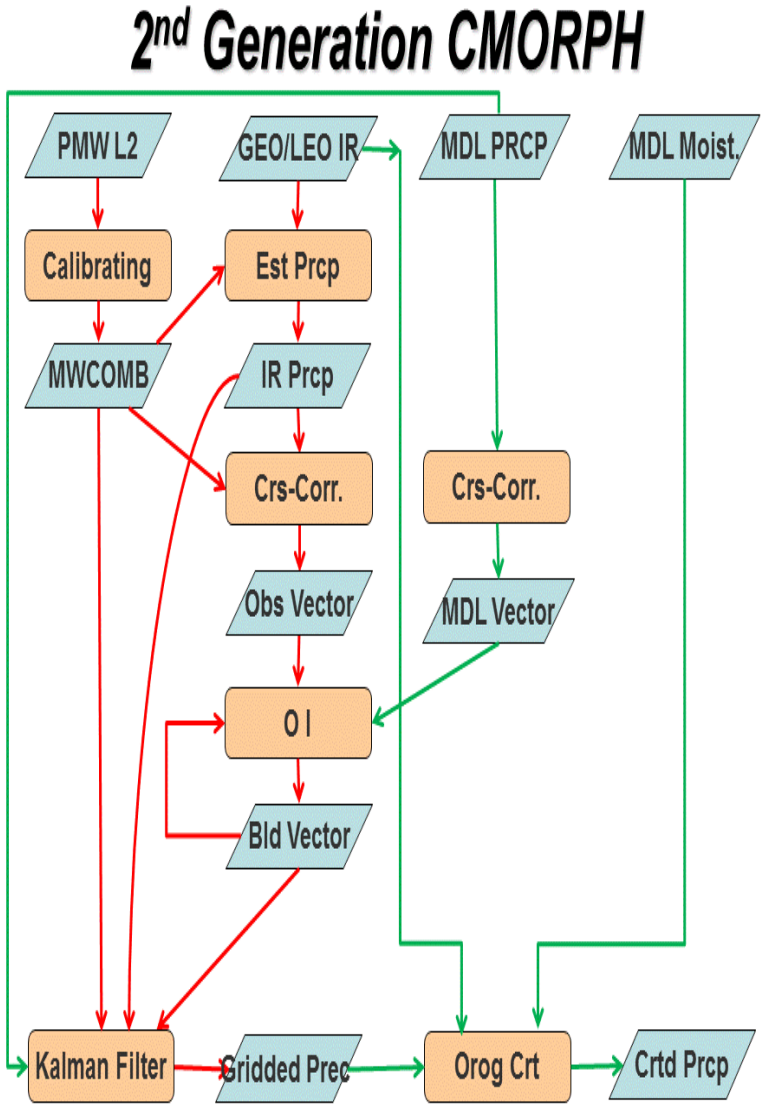
JJA Mean Precipitation



The 2nd Generation CMORPH

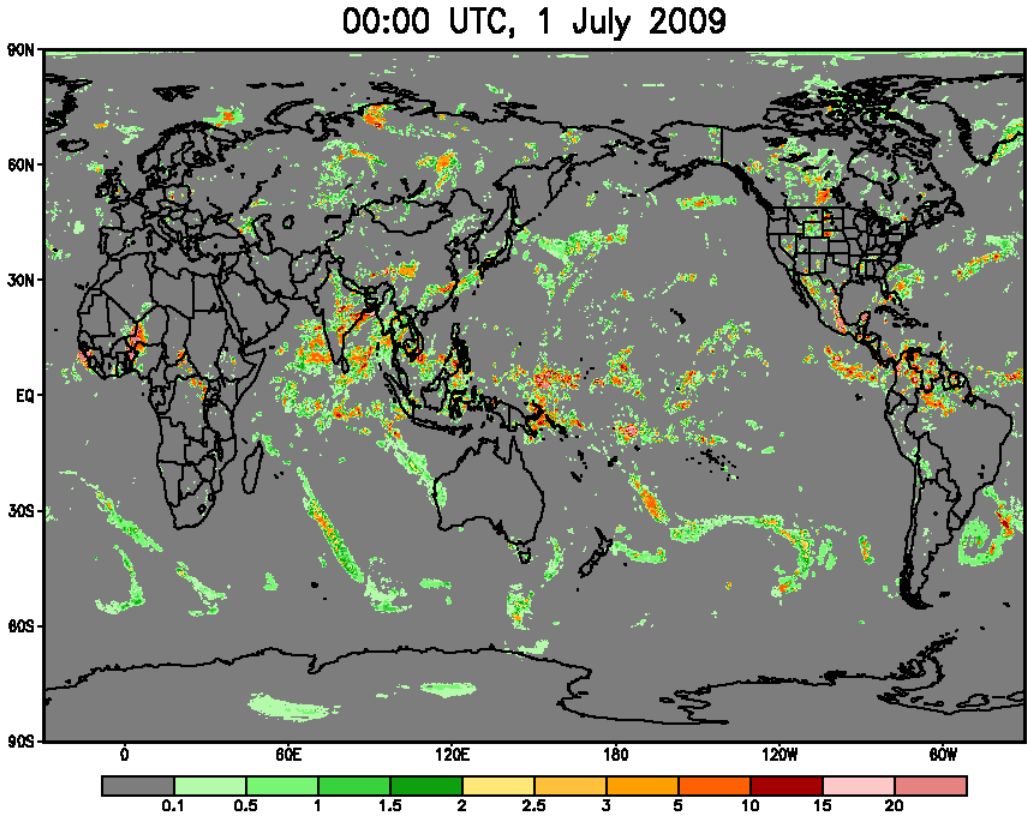
1) Overall Goal and Strategy

- **Goal:**
  - *Covering the entire globe from pole to pole on a 0.05ºlat/lon grid*
  - *Improved representation of snowfall and orographic precipitation*
  - *Refined temporal homogeneity for climate applications*
  - *Reduced latency for weather, climate, and hydrological monitoring*
- **INPUT Precip**
  - *PMW L2*
  - *GEO/LEO IR-based estimates*
  - *(optional) CFSR*
- **Cloud motion vectors**
  - *Cross-correlation from GEO/LEO IR based precip*
  - *Cross-correlation from CFSR (optional)*
  - *Blended analysis through OI*
- **Integration Framework**
  - *Kalman Fielter based algorithm*
- **Other components**
  - *Orographic effects..*



The 2nd Generation CMORPH

2) Early Results and Technical Challenges



- *Development of AVHRR IR based technique*
- *Refining vectors from hourly model fields*
- *Deriving vectors from combined LEO platforms*
- *Combining vectors from different sources (will OI processing take too much CPU time?)*
- *Reducing CPU time with limited loss in accuracy*

Regional CMORPH

1) A Brief Description

- Collaboration between NWS/CPC and NESDIS/STAR scientists
- To modify the 2nd generation global CMORPH to generate integrated satellite precipitation estimates over North America and its adjacent oceans on a refined time / space resolution with improved accuracy and reduced latency
- Taking advantage of the high-resolution, multi-channel, and frequent sampling of current GOES and future GOES-R observations
- GEO-based precipitation estimates from multi-channel GOES-R observations
- Regional CMORPH generated several times at different latency levels with available inputs
- Features
  - *Refined time / space resolution (2km / 15-min?)*
  - *Reduced latency at 10-min, 1-hour, 3-hour, and 18-hour*

CMORPH Summary

- Ist generation CMORPH reprocessed and bias corrected to form a 15+year record of global precipitation at 8km / 30-min resolution over the globe from 60^{o}S-60^{o}N

- Prototype algorithm developed for the 2nd generation CMORPH
  - *Pole-to-pole global coverage at 0.05^{o}lat/lon*
  - *Improved representation of snowfall and orographic precipitation*
  - *Refined temporal homogeneity*
  - *Reduced latency*

- Regional CMORPH aims to generate precipitation analysis over NA and nearby oceans with refined time / space resolution and further reduced latency