CMORPH:
An Operational High-Resolution Global Precipitation from NCEP

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Overview

- CMORPH:
  - *CPC Morphing technique*
  - *Integrating multi-satellite information into a high-resolution (8km/30-min) global precipitation analysis*
  - *Operational from December 2002*

- CMORPH reprocessing
  - *Fixed algorithm*
  - *Inputs of identical versions throughout the data period*
  - *Back extended to 1998*

- Bias correction

- Blending with gauge analysis

CMORPH Reprocessing

1) Algorithm and Inputs

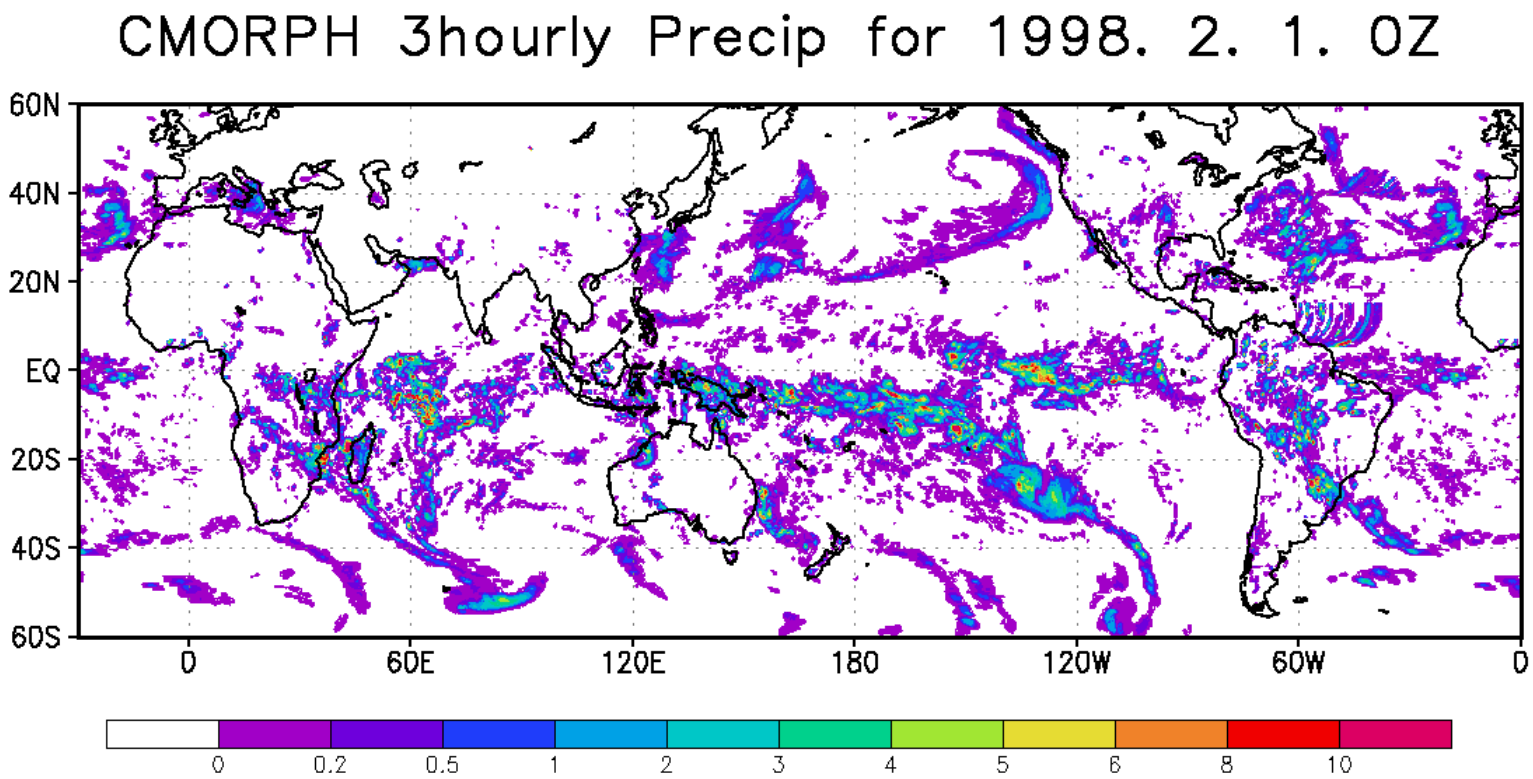
- Algorithm
  - *CMORPH algorithm as of 2009*
  - *Joyce et al (2004)*
  - *No KF enhancements*

- Inputs
  - *PMW L2 retrievals (GPROF 2004) from all available satellites including FY3B*
  - *CPC Geo sat IR at 4km (Janowiak et al. 1999)*
  - *NESDIS daily snow maps*

CMORPH Reprocessing

2) Products

- 8kmx8km / 60°S-60°N
- 30-min interval / January 1998 to the present



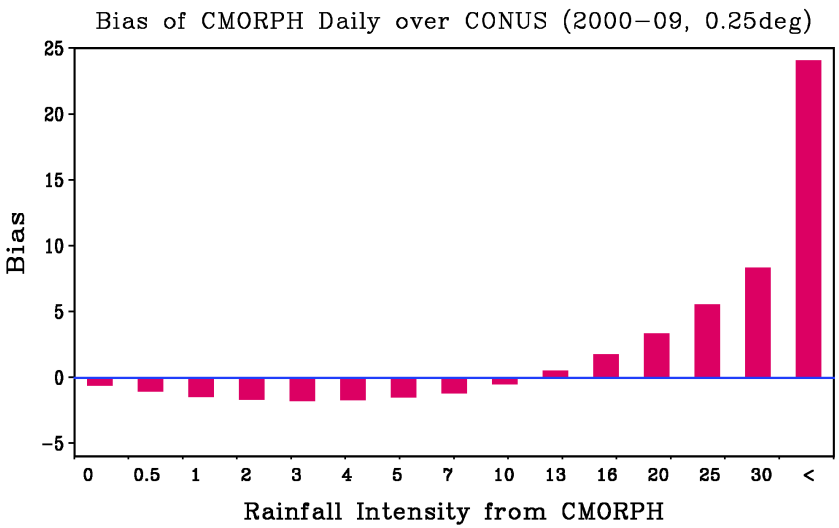
CMORPH Bias Correction

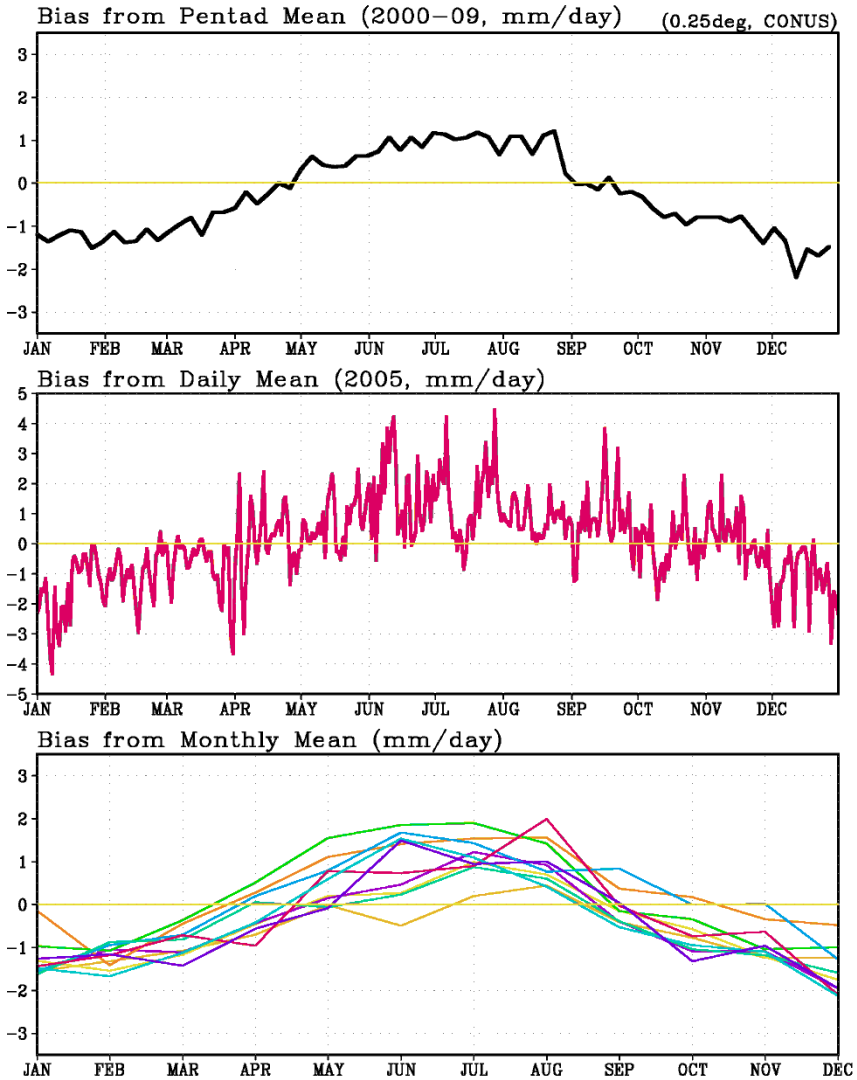
1) Bias in the raw CMORPH

Regionally different

Temporally changing

Non-linear





CMORPH Bias Correction

2) Strategy

- Over Land
  - PDF matching against daily gauge analysis
    - PDF tables established as a function of region and season using historical and real-time data

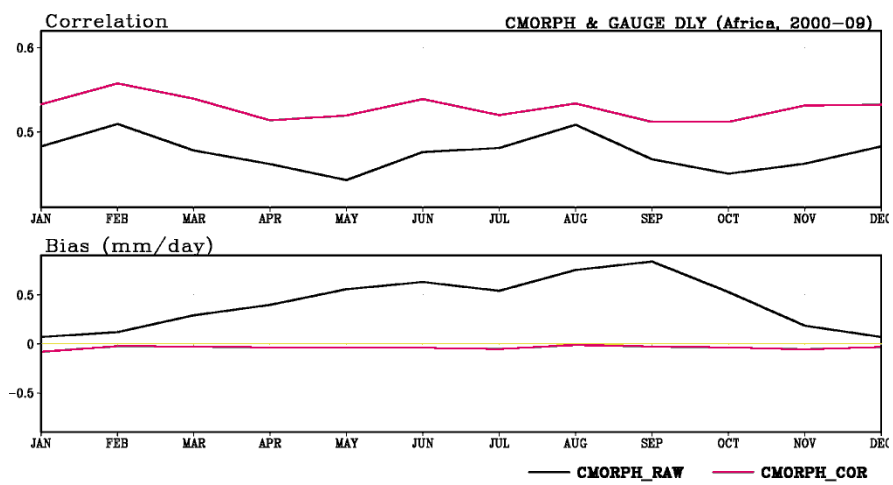
- Over Ocean
  - Calibration against a long-term record (pentad GPCP) with stable quality but coarser resolution (2.5^{o}lat/lon, 5-day)

CMORPH Bias Correction

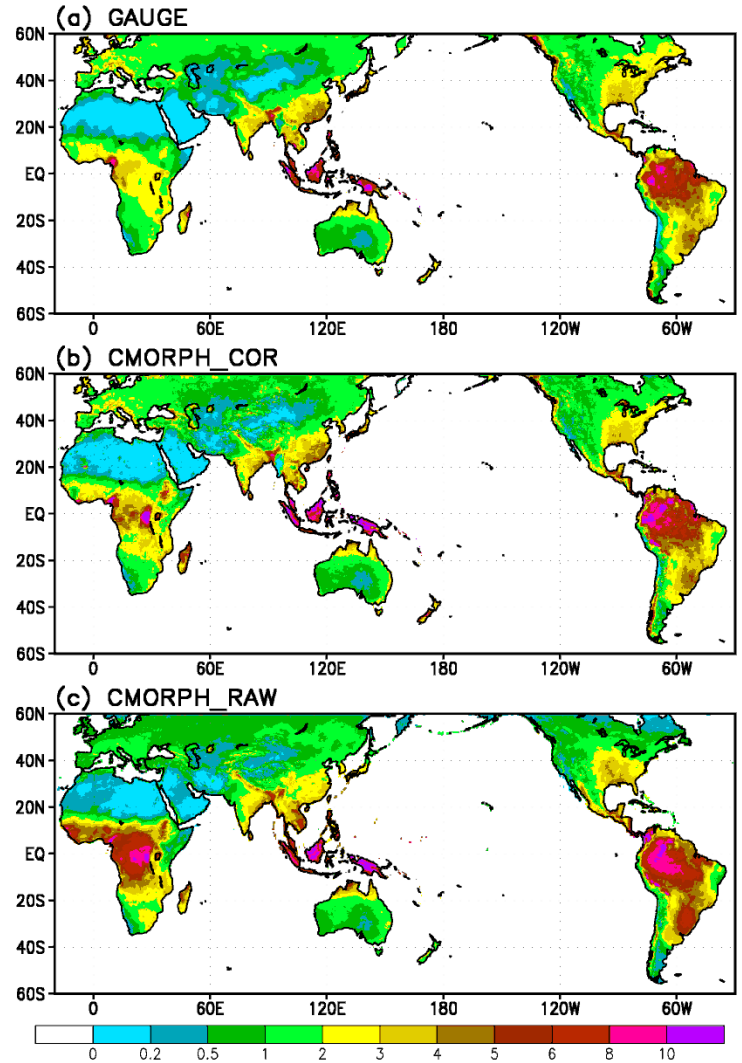
1) Results over land

- Large-scale bias removed
- Correlation improved

Comparison over Africa



2000-2009 Annual Mean



CMORPH Bias Correction

1) Comparison with daily gauge for 2012

Correlation

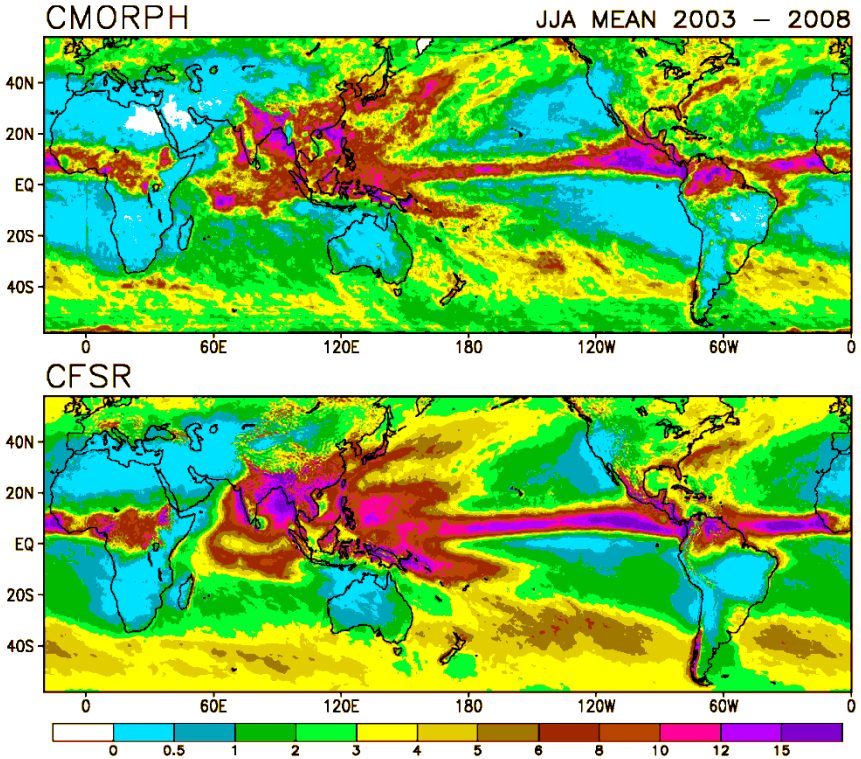
Region	RAW	HS	RT
50N-50S	**0.610**	**0.679**	**0.710**
50N-40N	0.533	0.643	0.668
40N-20N	0.664	0.732	0.767
20N-20S	0.571	0.618	0.636
20S-40S	0.637	0.701	0.739
40S-50S	0.570	0.621	0.648

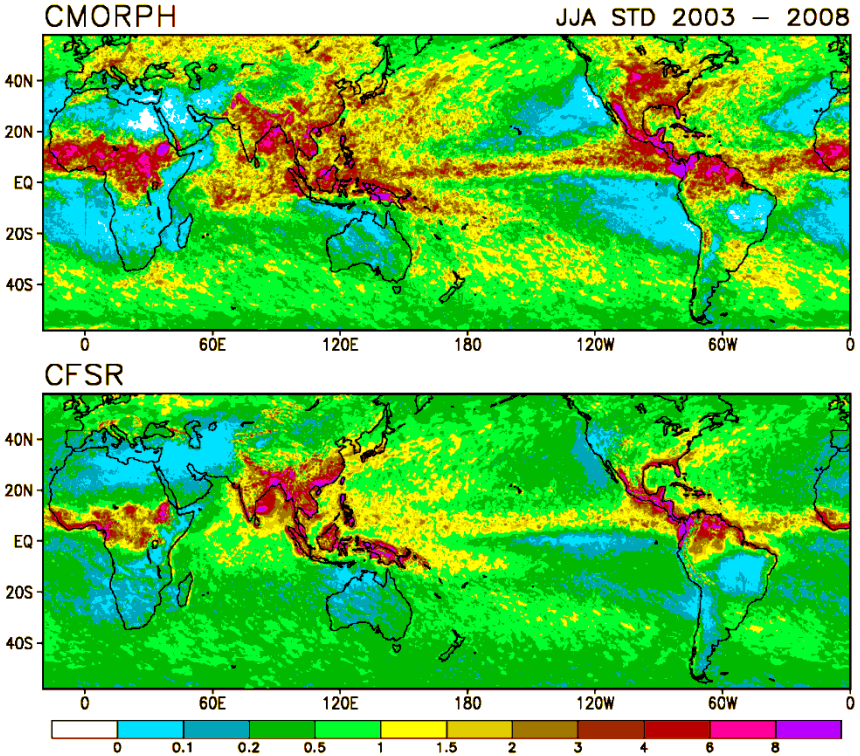
Bias

50N-50S	**-0.257**	**0.070**	**-0.058**
50N-40N	-0.457	0.049	-0.128
40N-20N	0.076	0.260	-0.018
20N-20S	-0.427	-0.191	-0.036
20S-40S	-0.498	-0.144	-0.007
40S-50S	-1.843	-0.538	-0.061

CMORPH Bias Correction

1) Applications in verification of CFSR precipitation





Combining Bias-Crtd CMORPH with Gauge

1) Strategy

– This is only possible for several regions due to different daily ending time in the gauge reports

- **Africa (06Z)**
- **CONUS/MEX (12Z)**
- **S. America (12Z)**
- **Australia (00Z)**
- **China (00Z)**

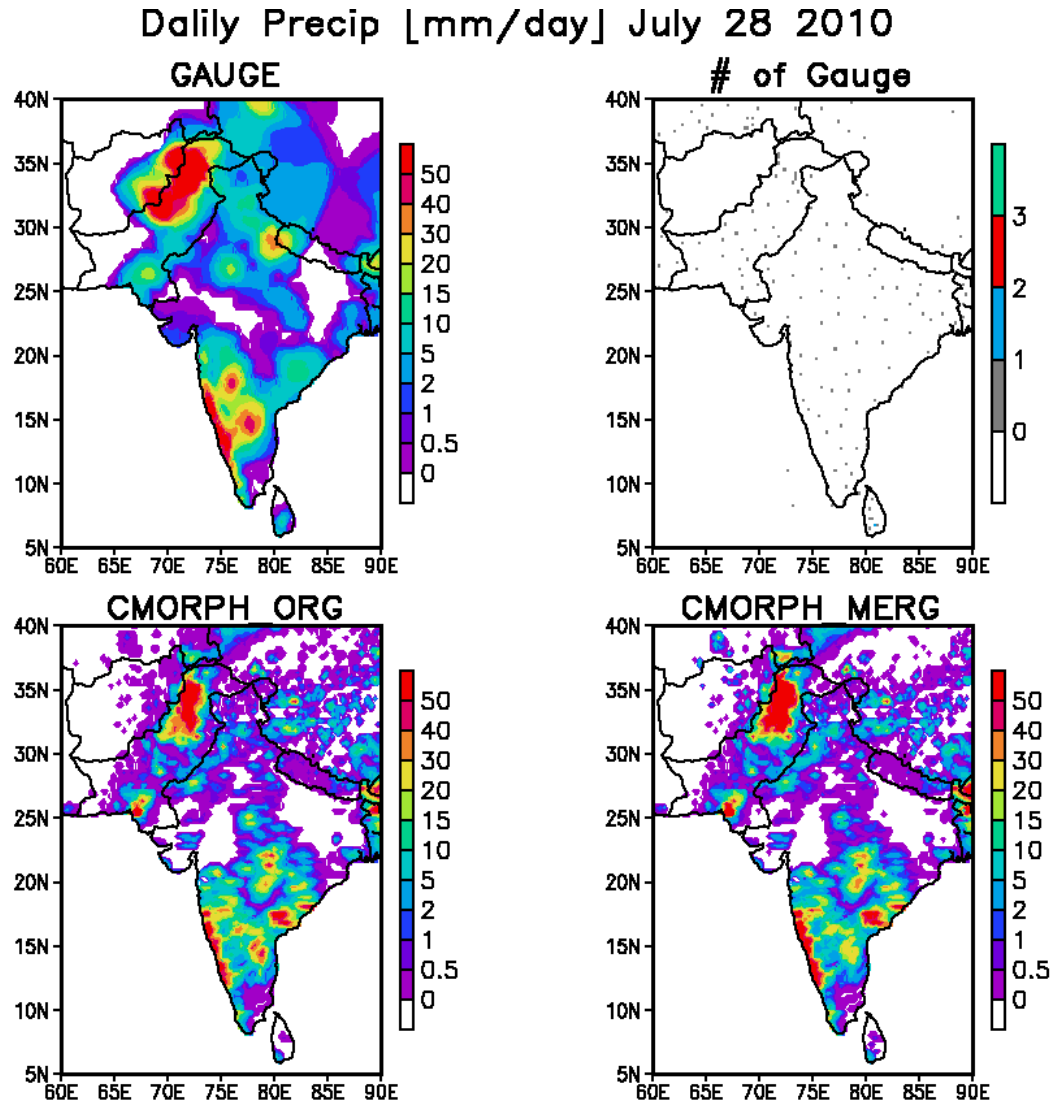
– Based on Xie and Xiong (2011)
Combining the bias-corrected CMORPH with gauge observations through the Optimal Interpolation (OI) over selected regions where gauge observations have the same daily ending time

- *CMORPH and gauge data are used as the first guess and observations, respectively*

Combining Bias-Crtd CMORPH with Gauge

2. Example

- Gauge analysis depict heavy rain but tend to extend the raining area
- Satellite data tend to under-estimate
- Merged analysis present improved depiction of the heavy rain



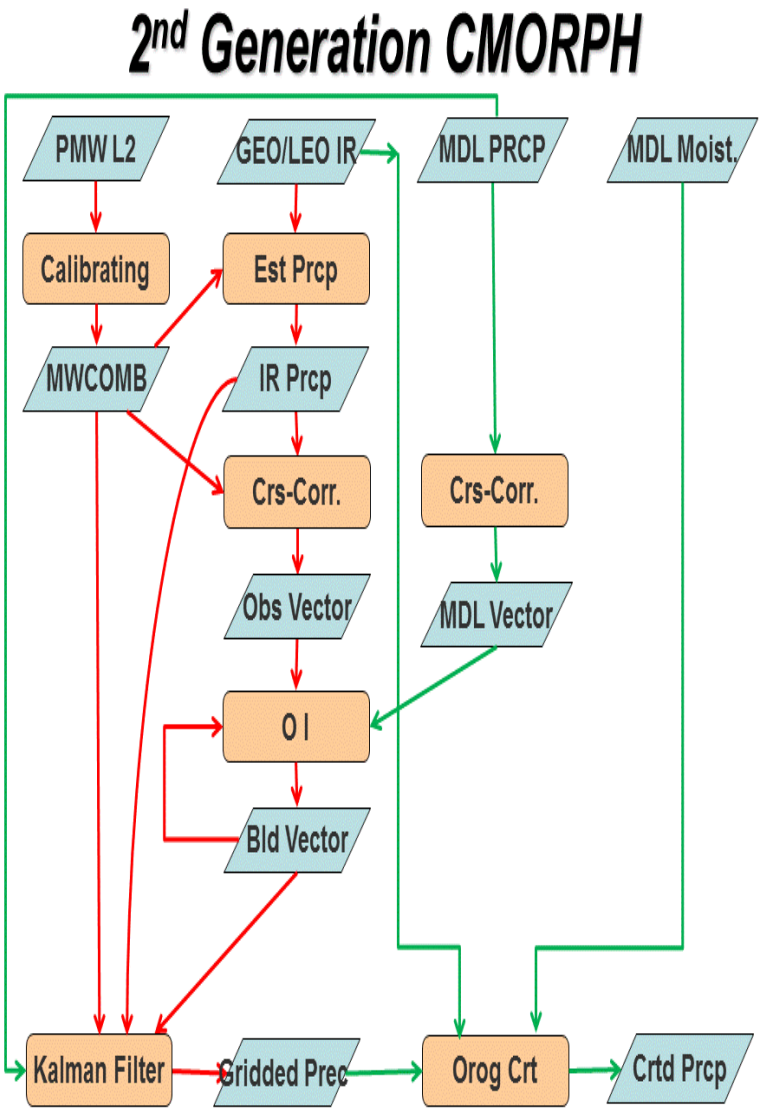
Summary

- Three sets of gauge-satellite precipitation analyses
  - **Reprocessed CMORPH Satellite Estimates**
    - Global
    - 8kmx8km; 30-min
    - 1998 to the present
  - **Bias-corrected Satellite Estimates**
    - Global
    - 8kmx8km; 30-min
    - 1998 to the present
  - **Gauge-satellite combined analyses**
    - Regional
    - 0.25^{o}lat/lon; daily
    - 1998 to the present

Ongoing Developments

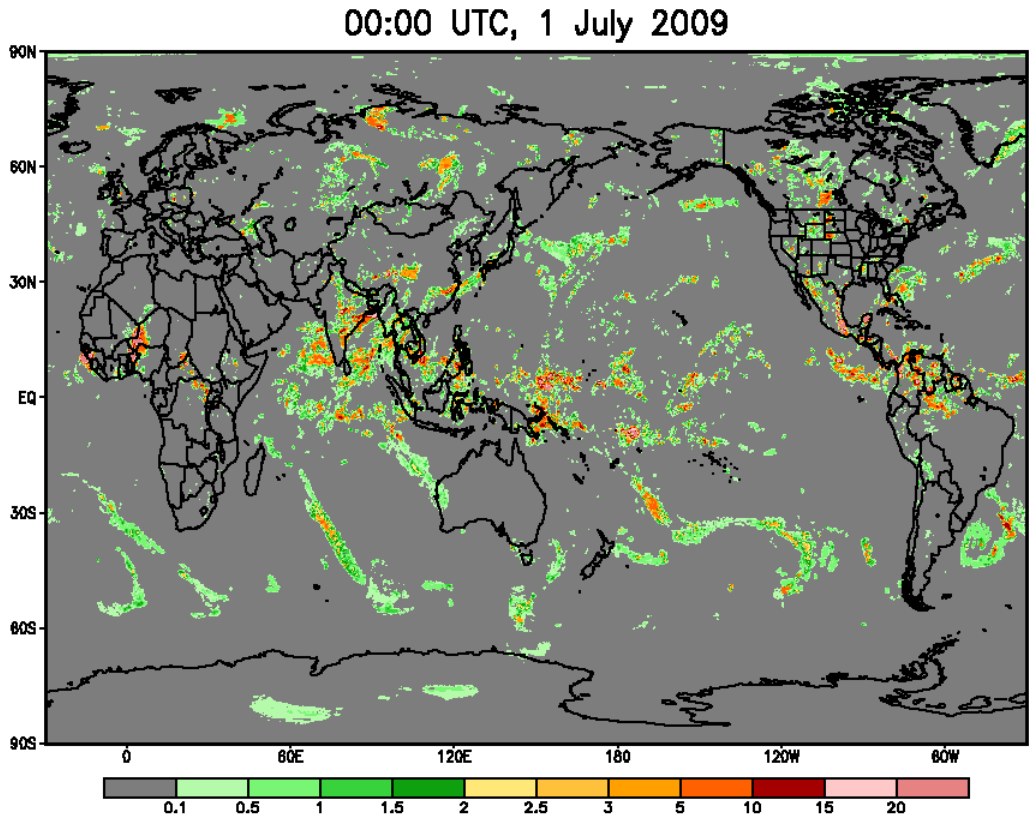
2nd generation Pole-to-Pole CMORPH - 1

- **Goal:**
  - *Covering the entire globe from pole to pole on a 0.05°lat/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..*



Ongoing Developments

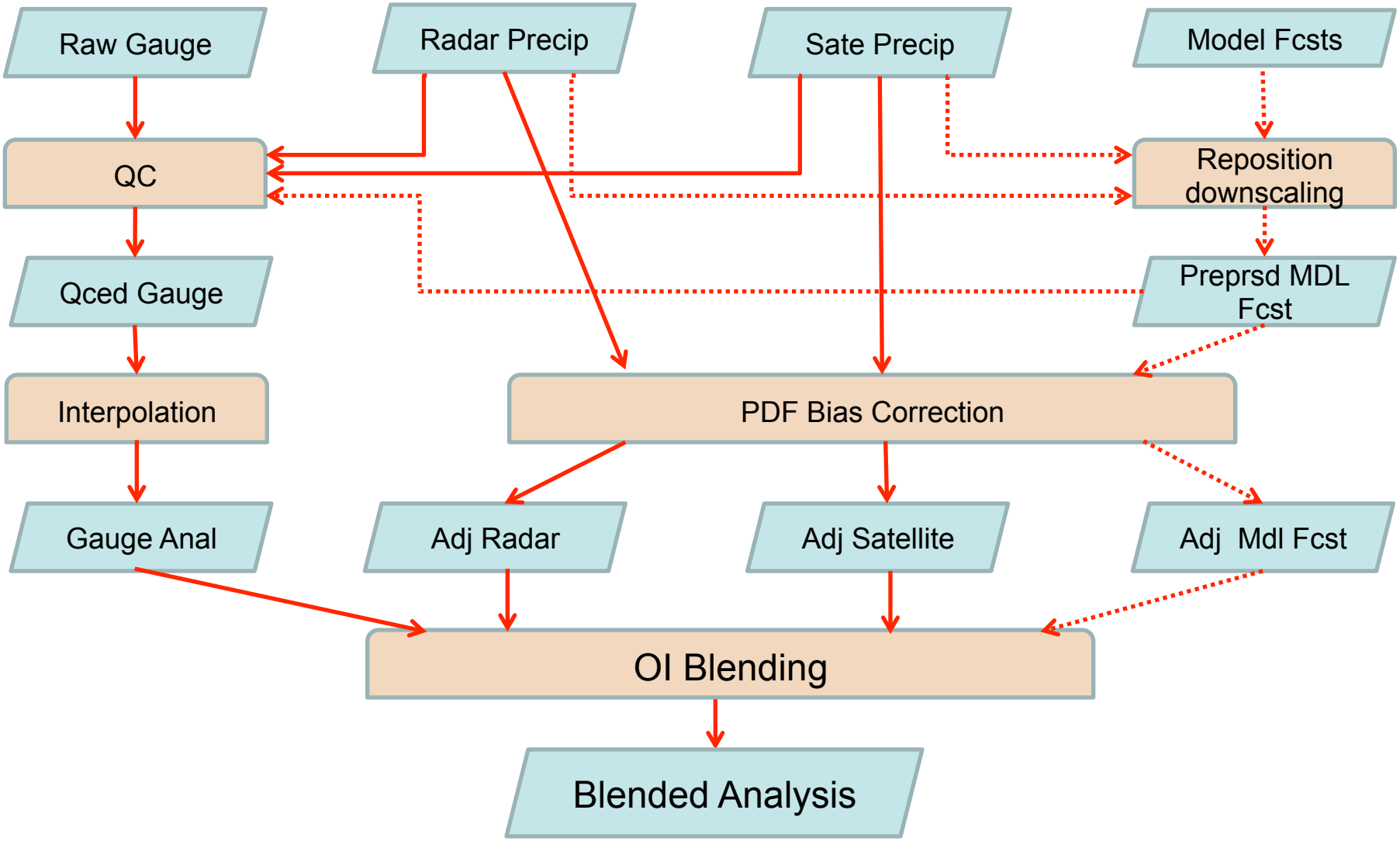
2nd generation Pole-to-Pole CMORPH - 2



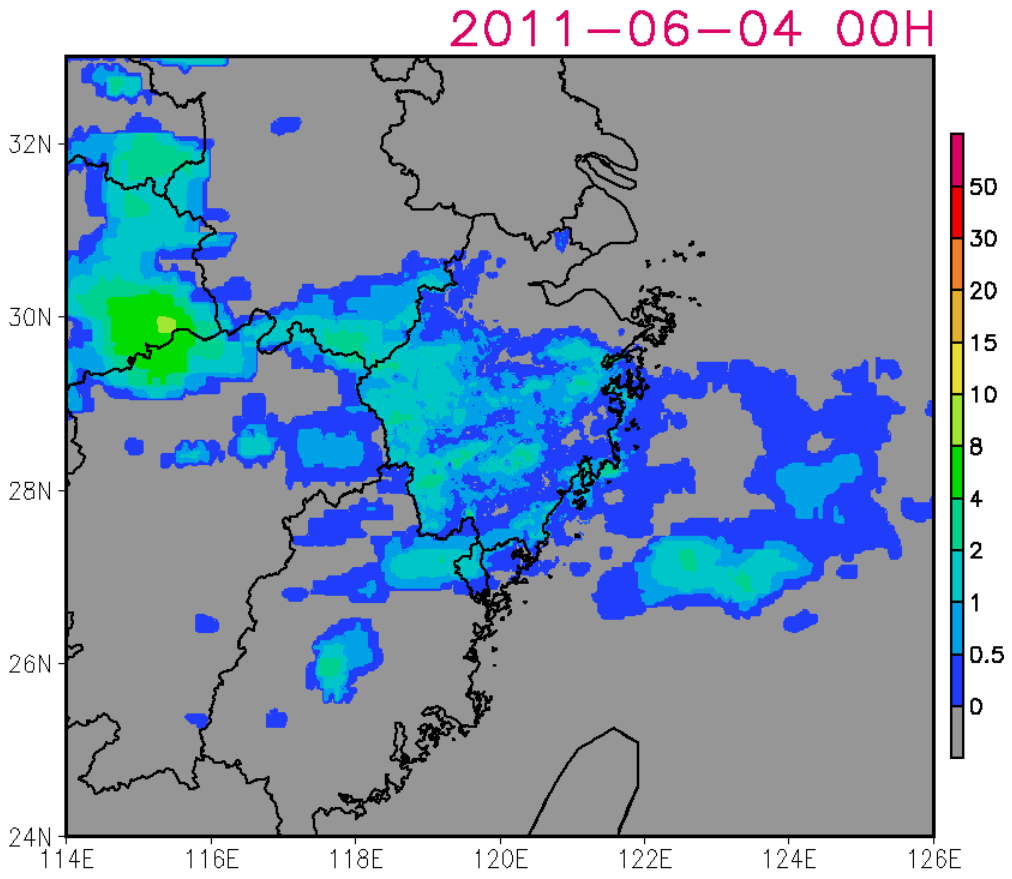
- *Development of AVHRR IR based technique*
- *Refining vectors from hourly model fields*
- *Deriving vectors from combined LEO platforms*
- *Combining vectors from different sources (will OI processing take too much CPU time?)*
- *Reducing CPU time with limited loss in accuracy*

Ongoing Developments

Gauge-Radar-Satellite-Model Blended Analysis - 1



Ongoing Developments

Gauge-Radar-Satellite-Model Blended Analysis - 2

Sample Results over SE China