Enhancing the Monitoring of Global Precipitation with the Second Generation CMORPH Integrated Satellite Estimates

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Objectives

- To report the development of ***the second generation CMORPH*** integrated satellite pole-to-pole global precipitation estimates; and

- To get feedbacks from our colleagues and potential users on users requirements et al;

The First Generation CMORPH

1) Basic Notion & Flowchart

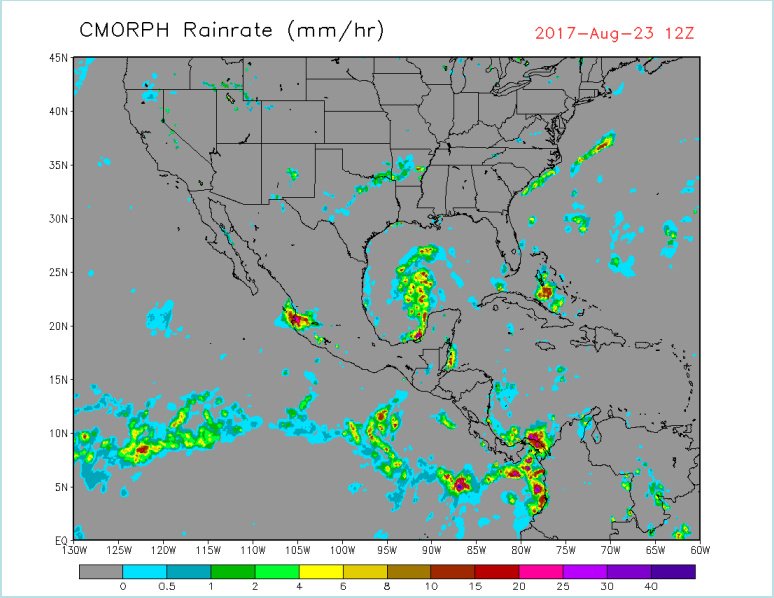
- CPC Morphing Technique

  Joyce et al. (2004),Joyce and Xie (2011), Xie and Joyce (2015), Xie et al. (2017)

- Basic Notion

  to construct a high-quality, high resolution precipitation analysis over the globe through integrating information from satellite observations and in situ measurements

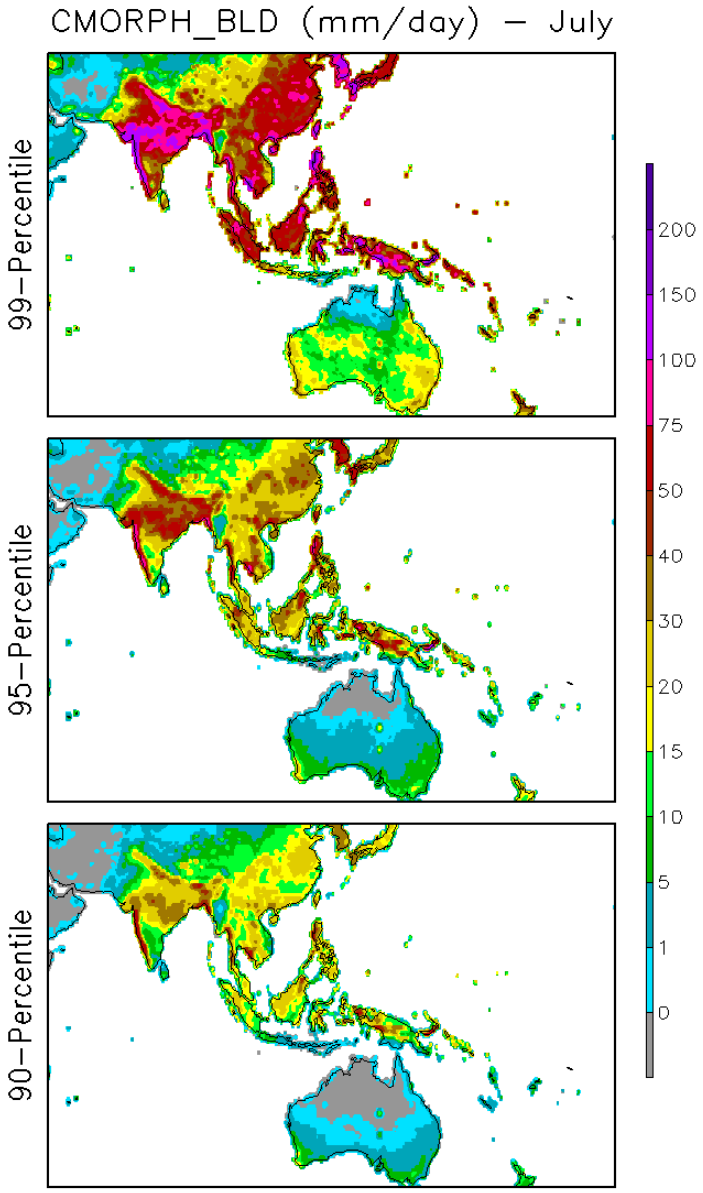
- Key Elements
  - *Satellite retrievals of instantaneous precip. rates from multi sensors*
  - *Cloud motion vectors to propagate the fields of instantaneous rates*
  - *In situ / long-term data to perform bias correction*



The First Generation CMORPH

2) Products

- Purely Satellite Based Products
  - *8kmx8km resolution from 60°S-60°N*
  - *30-min interval from 1998 to the present updated at a latency of 2 hours*
- Gauge-CMORPH Blended Precipitation
  - *0.25°lat/lon grid over the global land*
  - *Daily precipitation from 1998, updated at a latency of one day*
- Associated Climatology
  - *Daily Precipitation climatology defined on 0.25°lat/lon with the 20-year data (1998-2017)*
    - *Mean precipitation, 99-, 95, 90-percentiles, frequency of raining days*
    - *(right) Gauge-CMORPH blended daily precipitation extreme climatology for July*



The First Generation CMORPH

3) Shortcomings

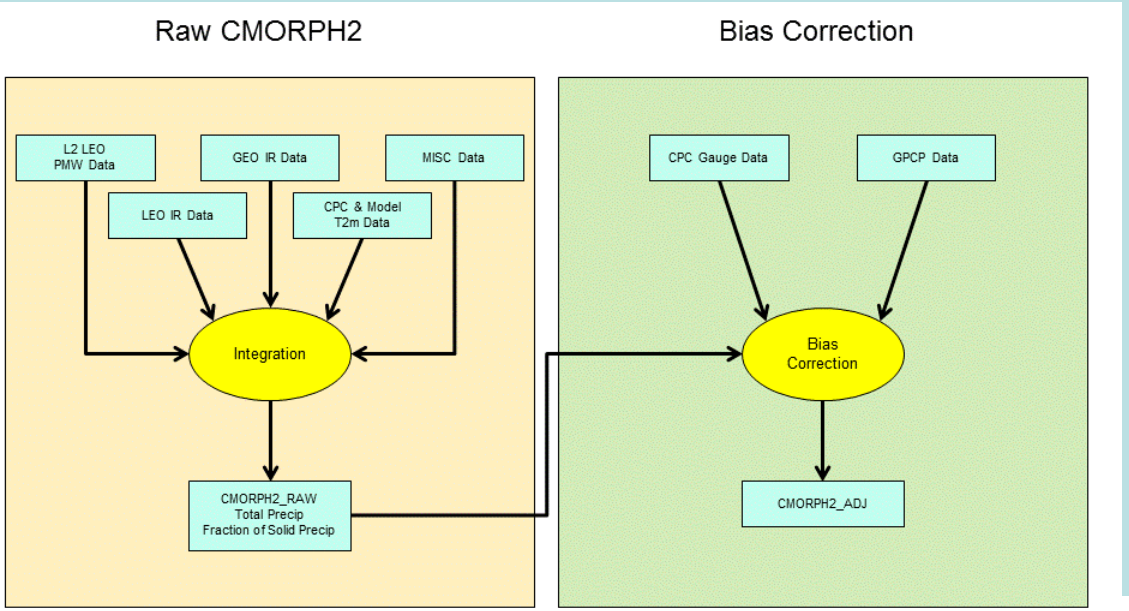
- Incomplete Global Coverage
  - *60°S-60°N*
  - *Restricted by the use of GEO IR to derive motion vectors*
- Compromised Representation of Cold Season Precipitation and Orographic Rainfall
  - *Restricted by poor performance of PMW retrievals*

Second Generation CMORPH

1) Features

- Goal
  - *0.05° lat/lon over the entire globe (90°S-90°N)*
  - *30-min interval updated at a latency ~ one hour*
  - *(eventually) back extended to 1991*
- Basic Notion

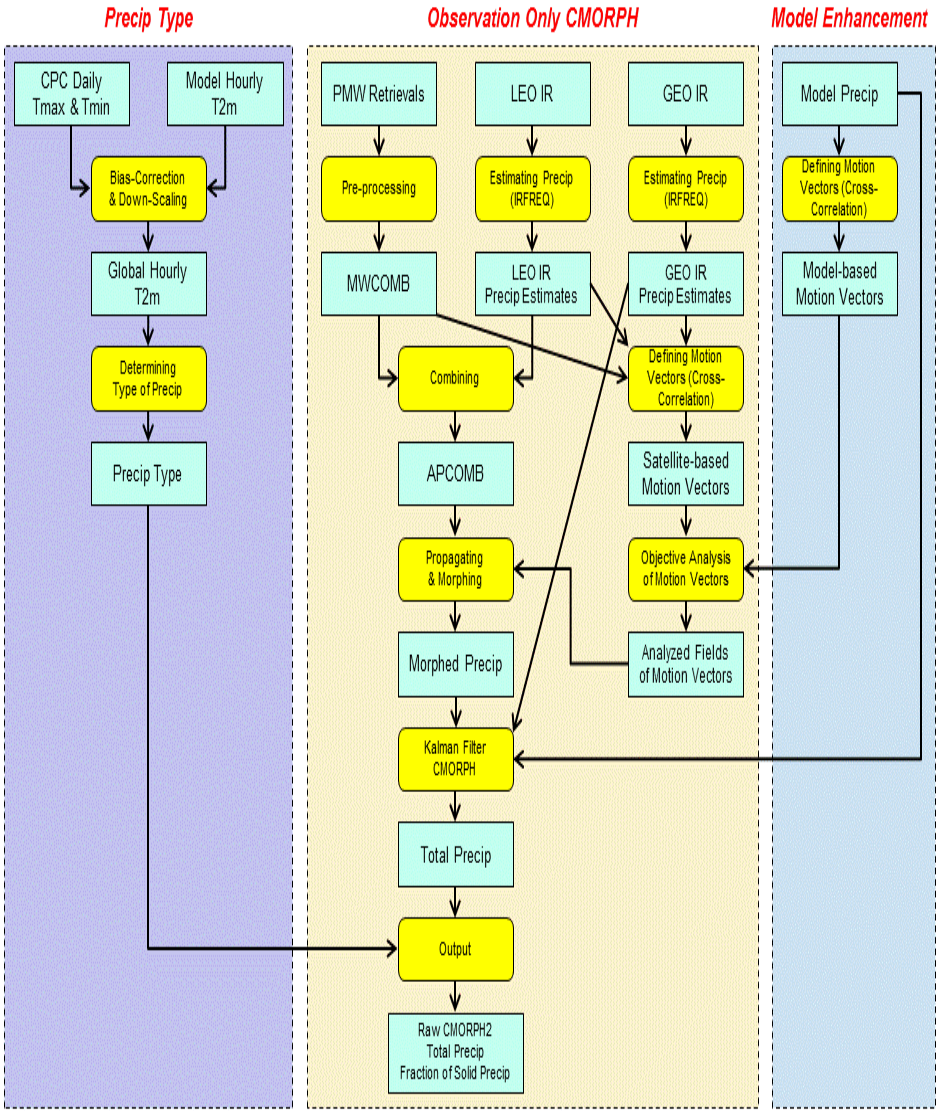
  to construct a high-quality, high-resolution precipitation analysis over the globe through integrating information from satellite observations as well as in situ measurements and model simulations
- Approach
  - *Integrating information from LEO/GEO to define raw CMORPH*
  - *Removing bias through calibration against ground observations and long-term low-res merged analysis*



Second Generation CMORPH

2) Inputs / Algorithms Upgrades

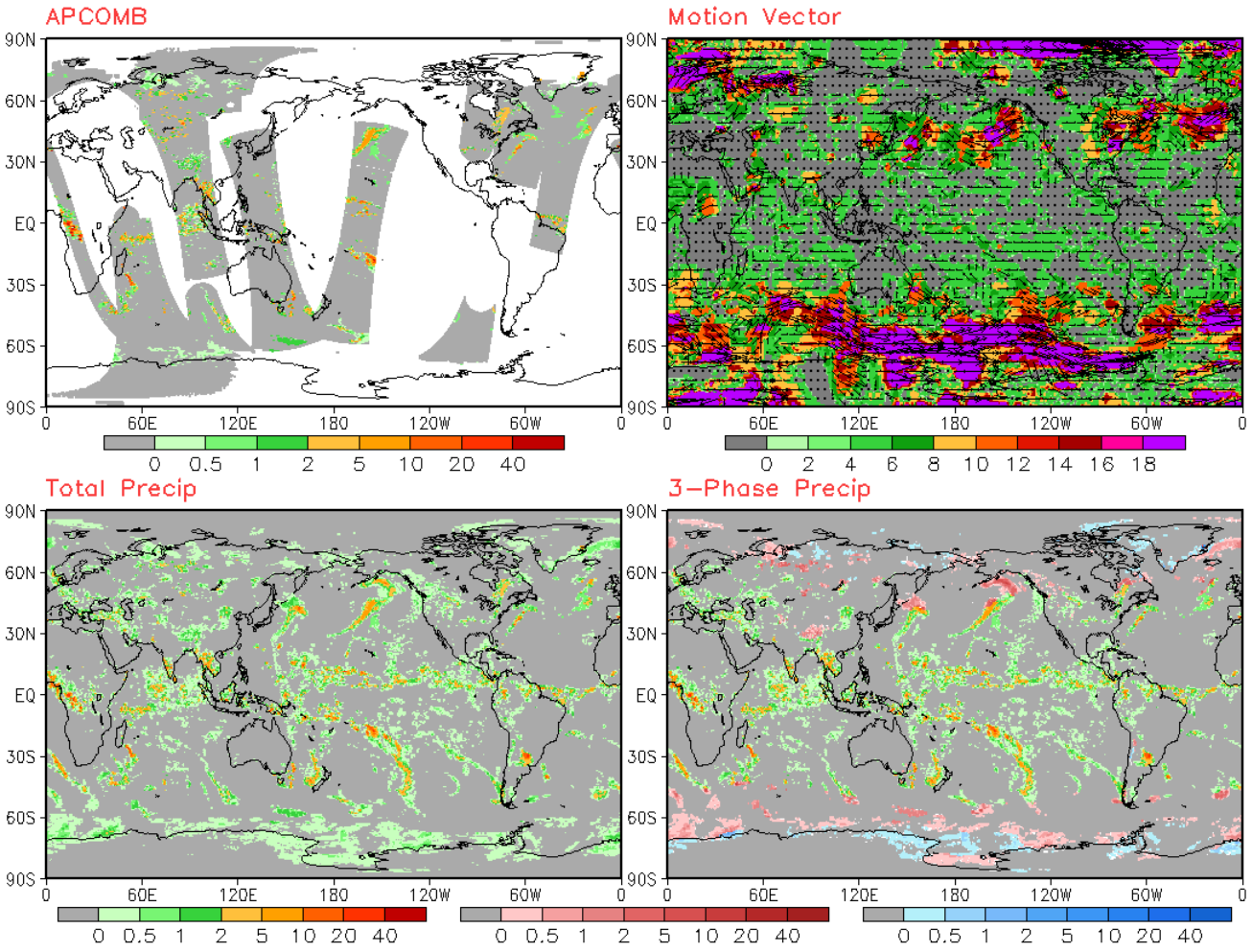
- Improved input satellite retrievals of rainfall and snowfall from NASA and NESDIS/STAR
- Satellite IR based precipitation estimates developed / refined at NOAA/CPC
- Greatly refined integration algorithm at NOAA/CPC
  - *Inter-satellite calibration algorithm*
  - *Precipitation motion vectors*
  - *Kalman Filter analysis framework*
- 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*



Second Generation CMORPH

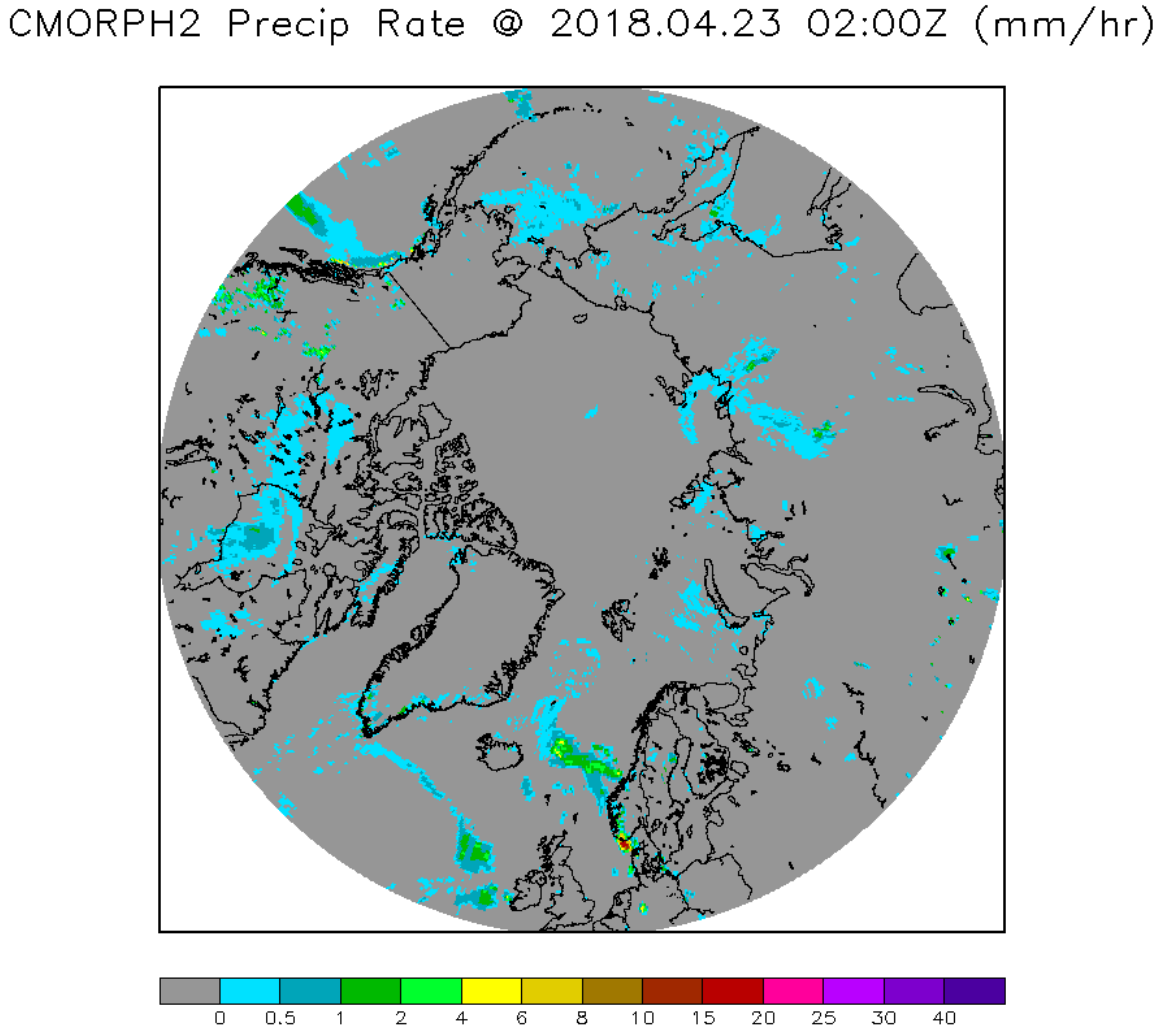
3) Sample APCOMB, Motion Vectors, & CMORPH2

12:00Z, 10 May 2018



Second Generation CMORPH

4) North Pole Animation



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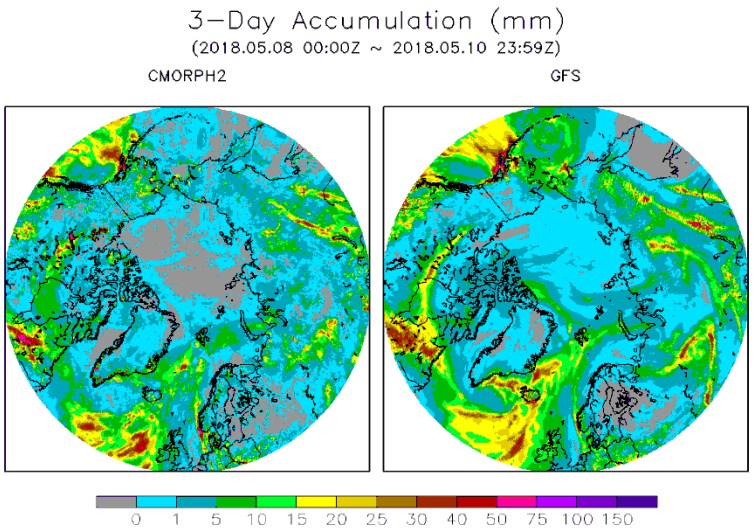
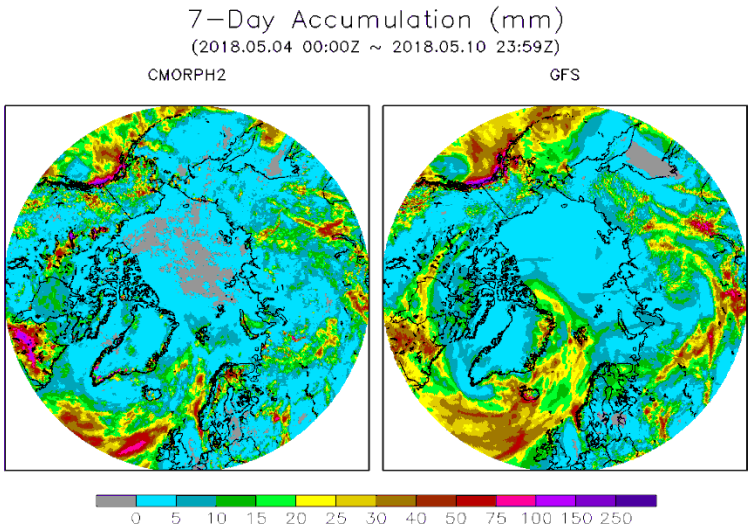
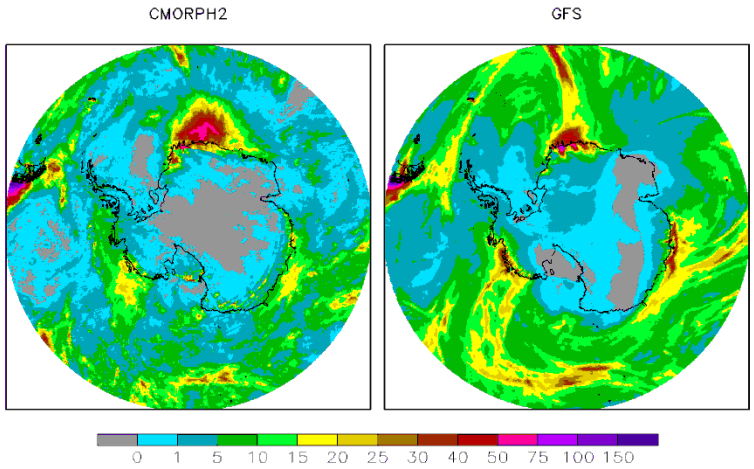
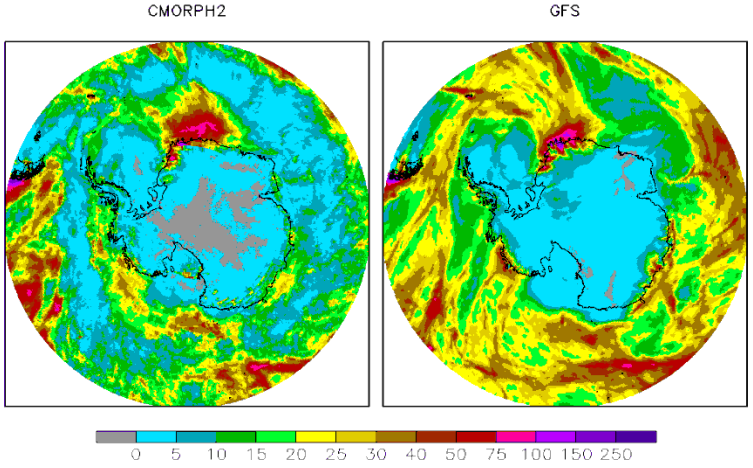
5) Comparison with GFS 6-12 Hour Forecasts









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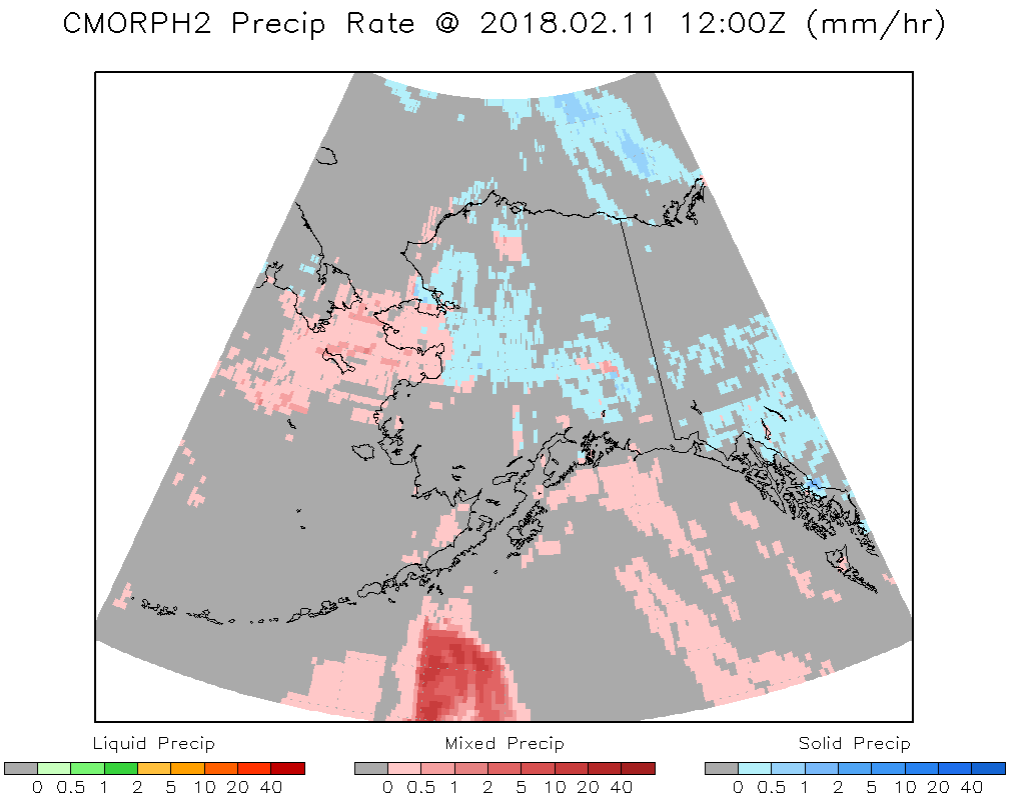
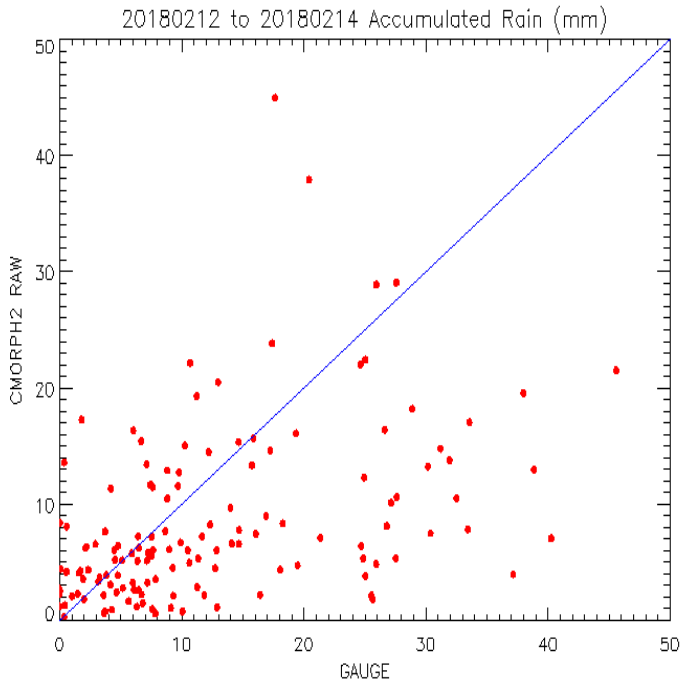
6) Alaska Snow Storm of Feb., 2018



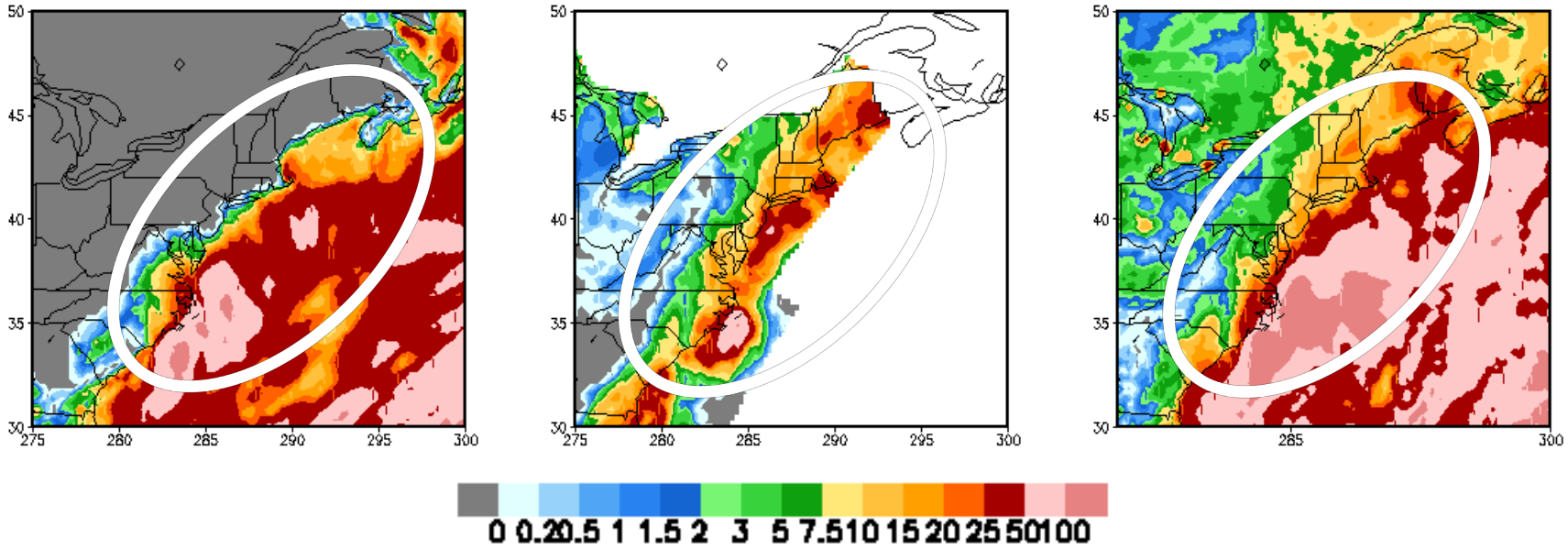


Scatter plots between 3-day accumulated precipitation from the RAW CMORPH2 and the CPC gauge based analysis on 0.25°lat/lon grid boxes over Alaska

Second Generation CMORPH

7) Winter Storm Grayson 3-5 January 2018

CMORPH | Stage IV Radar | CMORPH2



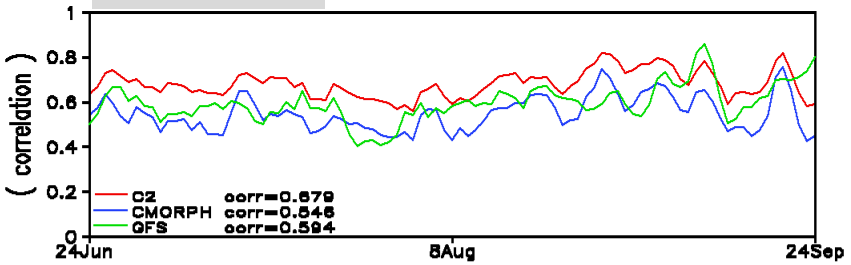
- *Accumulated precipitation (rainfall, snowfall, mixed) from the Stage IV radar observations (middle), the currently operational CMORPH (left) and the second generation CMORPH (CMORPH2, right);*
- *The operational version CMORPH missed / under-estimated snowfall over most of the regions covered with surface snow;*
- *CMORPH2 is capable of capturing snowfall along the path of Grayson over the east coast.*

Second Generation CMORPH

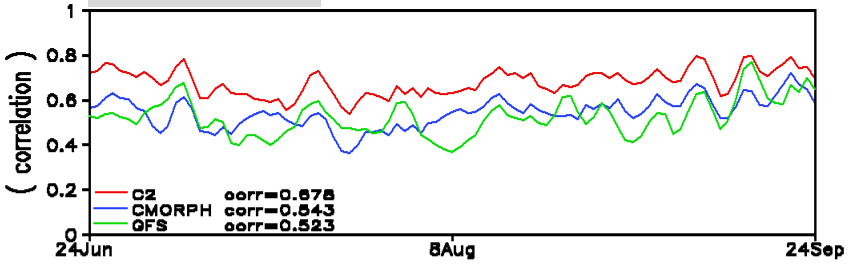
8) Comparison against CPC Gauge Analysis

- Comparison to CPC gauge analysis of daily precipitation on 0.25°lat/lon for JAS of 2018
- 2nd generation CMORPH compares well to CPC daily gauge analyses relative to both operational CMORPH and GFS precipitation for all latitudes

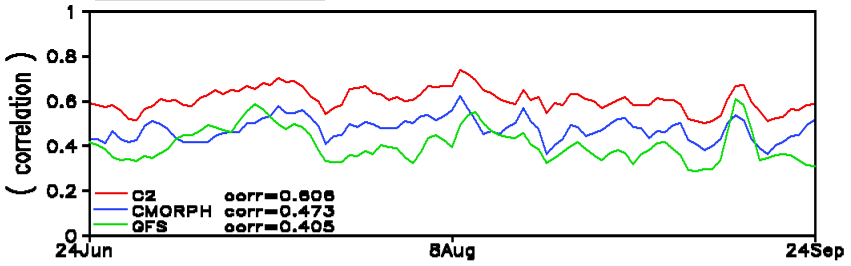
40N-60N



20N-40N



20S-20N



Second Generation CMORPH

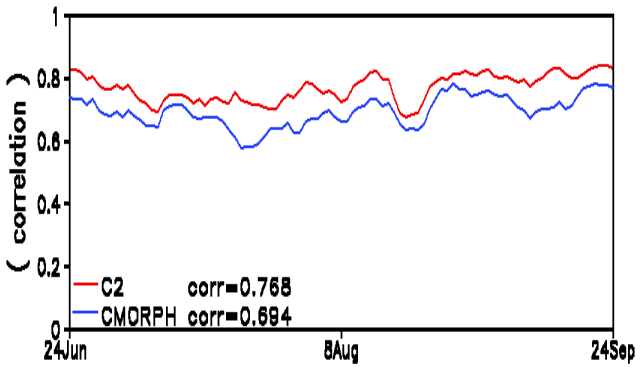
9) Comparison against RMRS Radar Precipitation

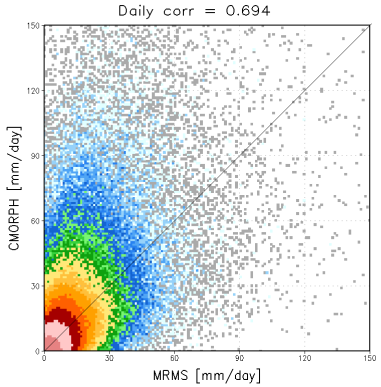
Time Series of Correlation

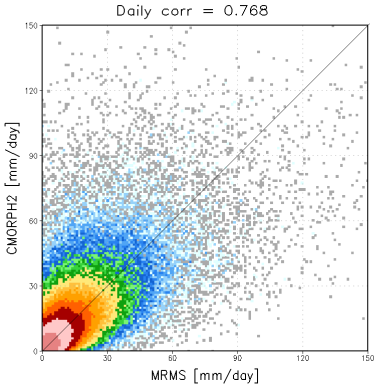
CMORPH

CMORPH2

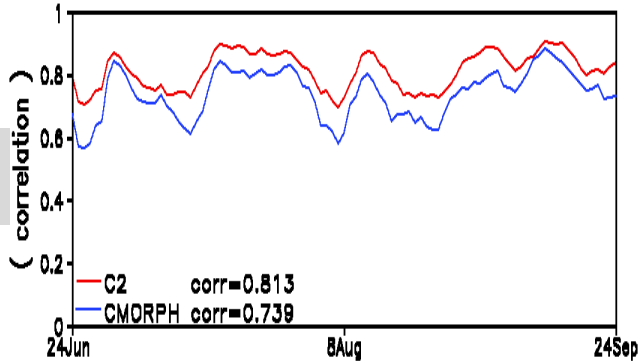
LAND

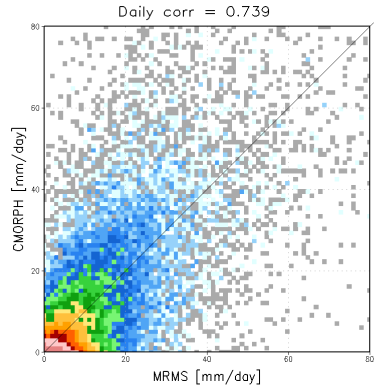


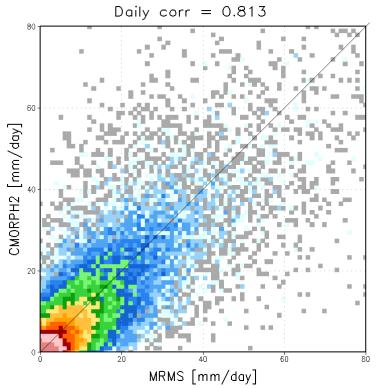




OCEAN







- *Comparison between CMORPH and MRMS radar daily precipitation on 0.25°lat/lon grid boxes over land east of 110°W (top) and over ocean 20-150Km off the coasts (bottom) for JAS of 2018.*
- *Significantly improved performance for the second generation CMORPH upon its predecessor (CMORPH).*

Summary and Future Plan

- What we have done
  - *Put the CMORPH2 processing system into the (parallel run) real-time production at a CPC work station*
  - *The second generation CMORPH:*
    - *Covering the entire globe from pole to pole on a fine resolution of 0.05°lat/lon*
    - *in a 30-min interval and updated on a real-time basis*
    - *With much improved representation of snowfall and cold season precipitation*
- What are on the way (FY19)
  - *Comprehensive examinations for May 2017 to the present*
  - *Reducing the latency to one hour*
  - *Pushing the CMORPH2 into NWS/AWIPS II*
  - *Fine-tuning and finalizing the system*
  - *Interactions with users*
- In the upcoming 2-3 years
  - *Reprocessing CMORPH2 for 1991 to present*
  - *Generating associated product (gauge-CMORPH blended) for the same period*
  - *Constructing precipitation climatology for 1991 – 2020*
  - *Regional enhancements to CMORPH*

- Sample Real-Time CMORPH2 (Globe)
- Sample Real-Time CMORPH2 (Antarctica)
- Sample Real-Time CMORPH2 (Arctic)