Refinement of the technical aspects of the second generation CMORPH

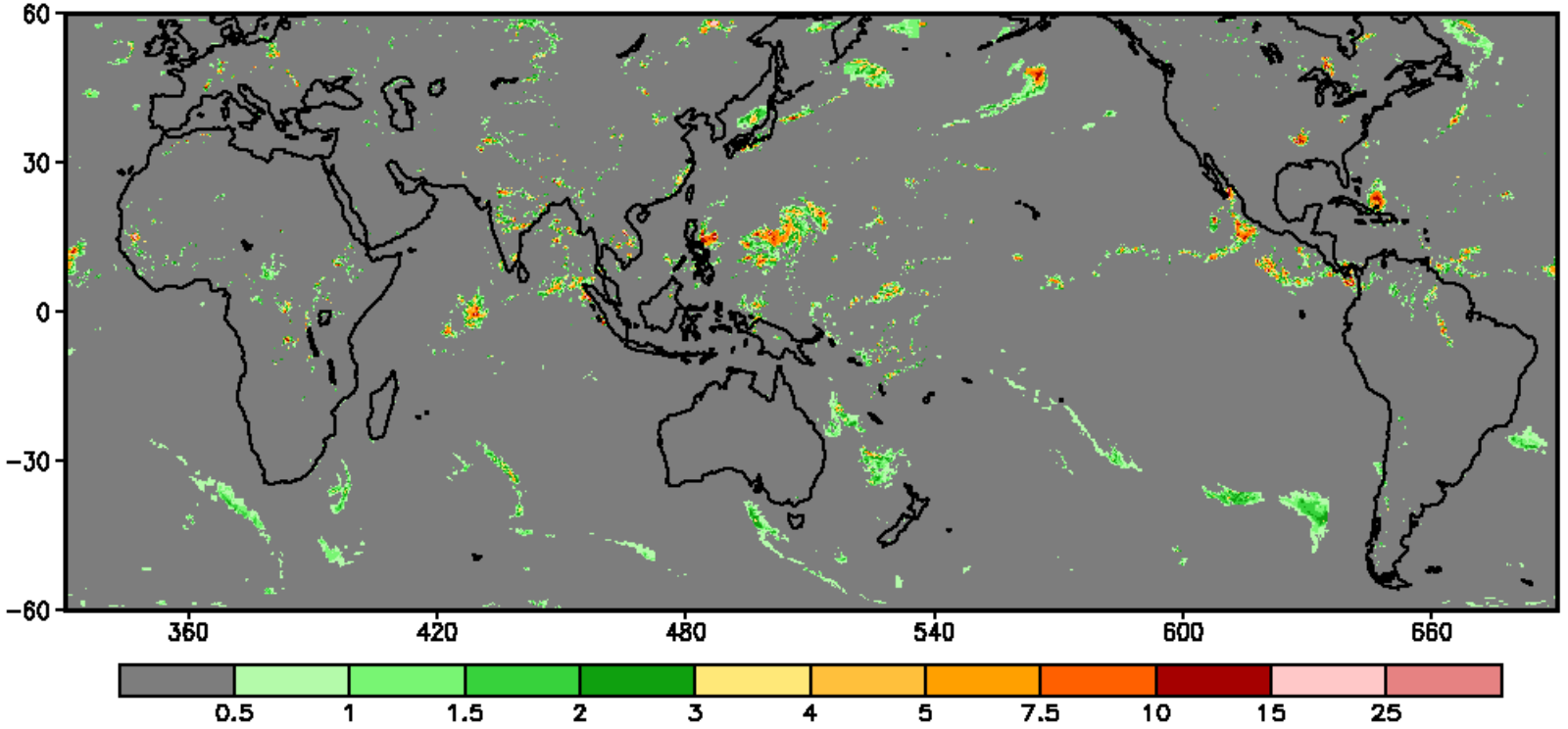
Robert Joyce[1] and Pingping Xie[2]

1. **NOAA/NCEP/CPC [INNOVIM]**
2. **NOAA/NCEP/CPC**

EUMETRAIN Precipitation Event Week, 23 November 2015

Current CMORPH

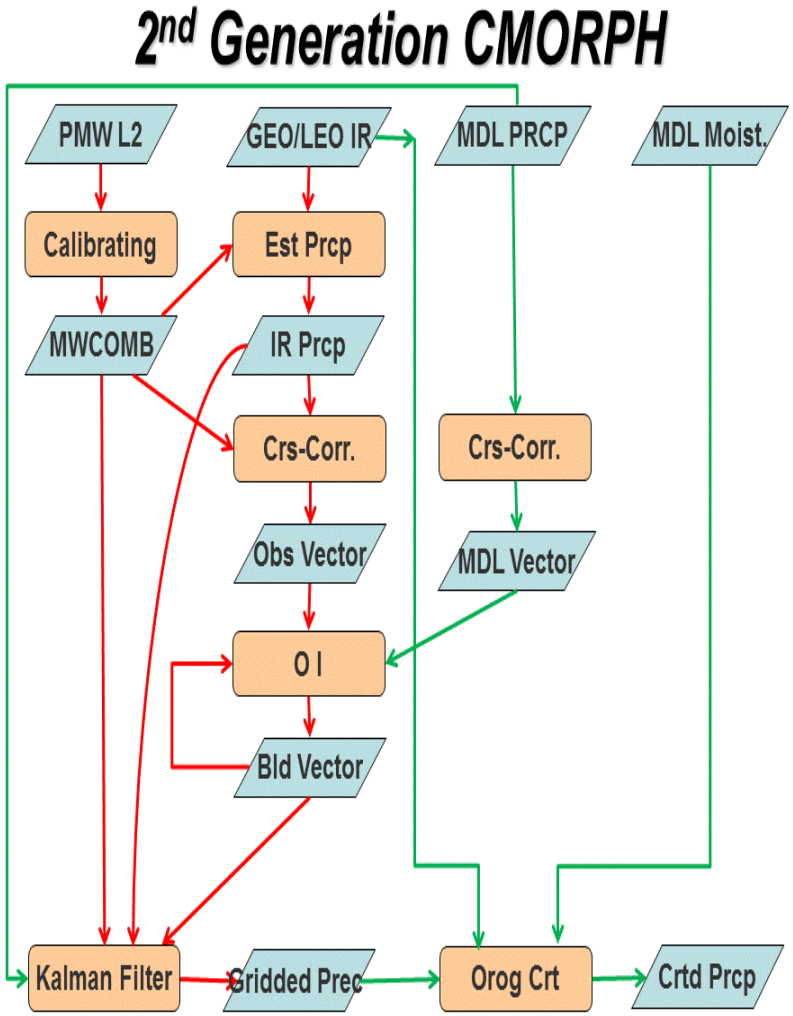
14:00-14:30 UTC 24, August 2011



- **PMW based satellite estimated precipitation**
  - PMW precipitation derived from all available sensors
  - IR derived cloud motion vectors
  - Forward and backward PMW propagation and morphing
- **Products and availability**
  - 30 min 8km [1998-current]
  - 3 hrly 0.25 deg [1998-current]

The 2nd Generation CMORPH Strategy

- **INPUT Precip**
  - PMW L2
  - GEO/LEO IR-based estimates
  - CFSR
- **Precipitation motion vectors**
  - Cross-correlation from GEO/LEO IR based precip
  - Cross-correlation from CFSR
  - Blended analysis through OI
- **Integration Framework**
  - Kalman Filter based algorithm
- **Other components**
  - Orographic effects..

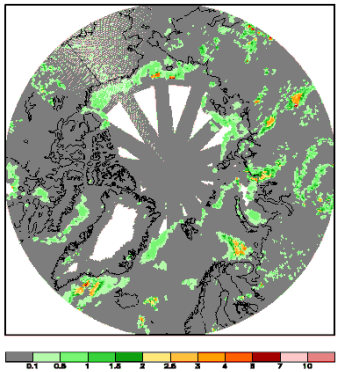


Challenges Beyond 60^{o} Parallels

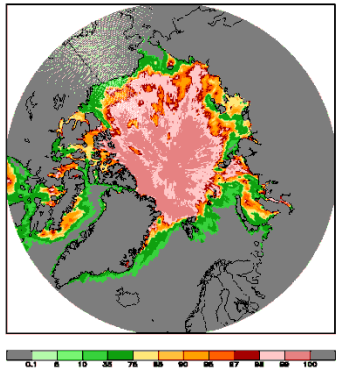
- Source information for **PRECIPITATION** (rainfall + snowfall)
  - **PMW:**
  - **IR/AVHRR:**
  - **Model / Reanalysis:**
- Motion vectors over high latitudes
  - **Vectors over regions with no GEO IR data?**
  - **Vectors from PMW/IR/Model precipitation fields?**
  - **Transition from tropics, subtropics and mid-, and hi-latitudes**

PMW Retrieval Problems over Polar Caps

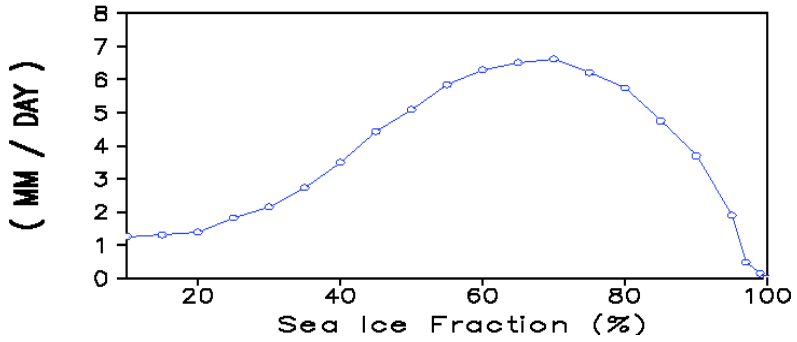
NOAA-15 AMSU precip
1 July 2009 mm/hr



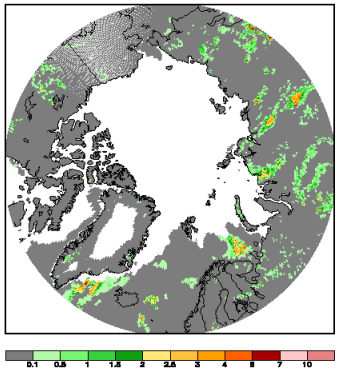
AVHRR V2 Sea Ice Fraction
1 July 2009 [%]



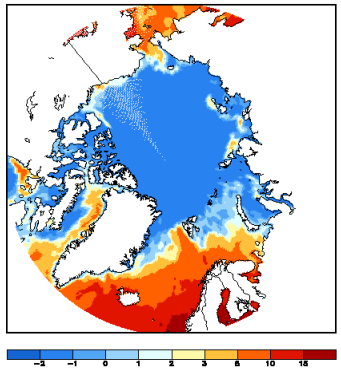
PMW precipitation relative to AVHRR V2 Sea Ice Fraction 60N-90N: July 2009 mm/hr



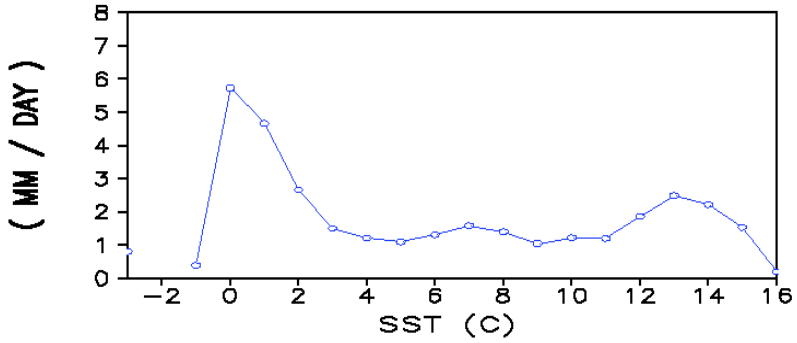
Sea ice + SST screened precip
1 July 2009 mm/hr



AVHRR V2 SST
1 July 2009 [C]



PMW precipitation relative to AVHRR V2 SST 60N-90N: July 2009 mm/hr



March 2014 PTP Precipitation [mm/dy] (no screening)

TRMM

DMSP-16

FY3B

METOP-B

GCOM-W1

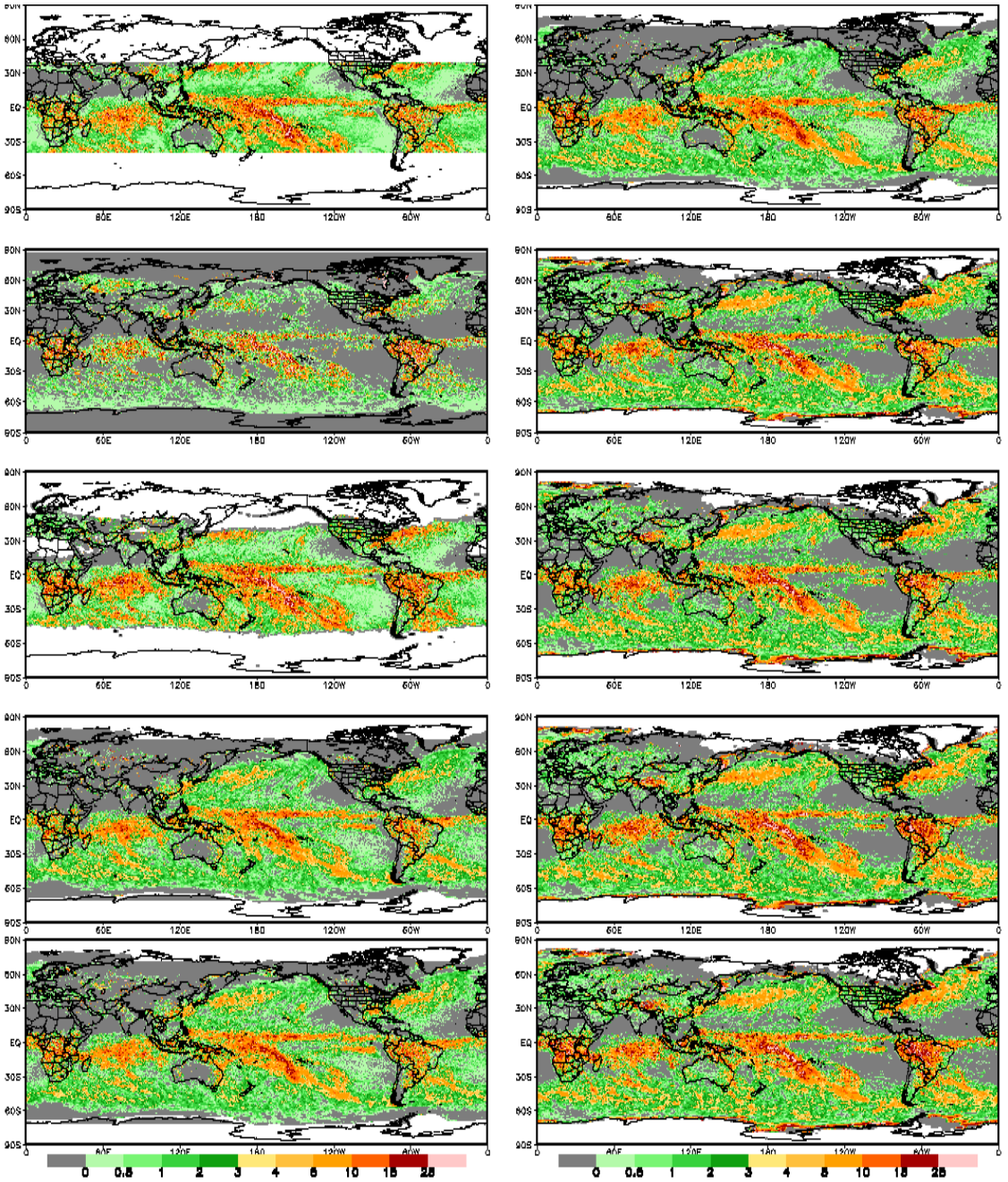
METOP-A

DMSP-18

NOAA-19

DMSP-17

NOAA-18



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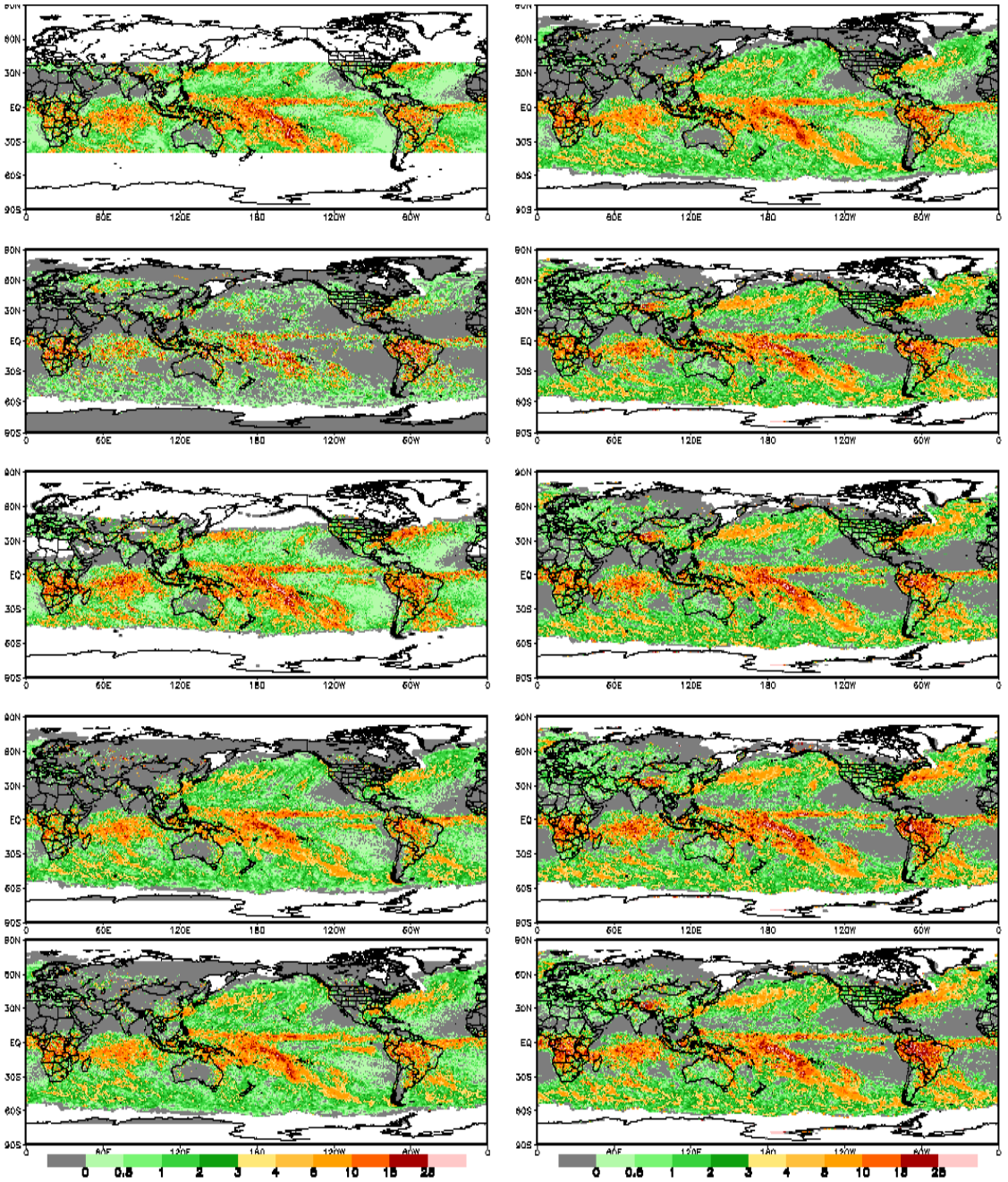
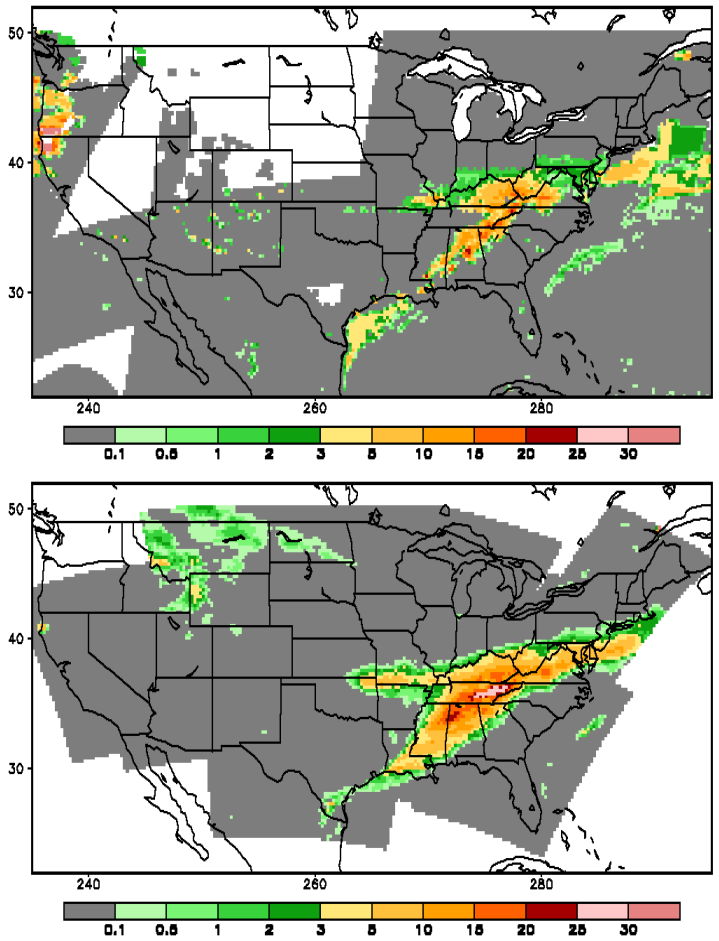


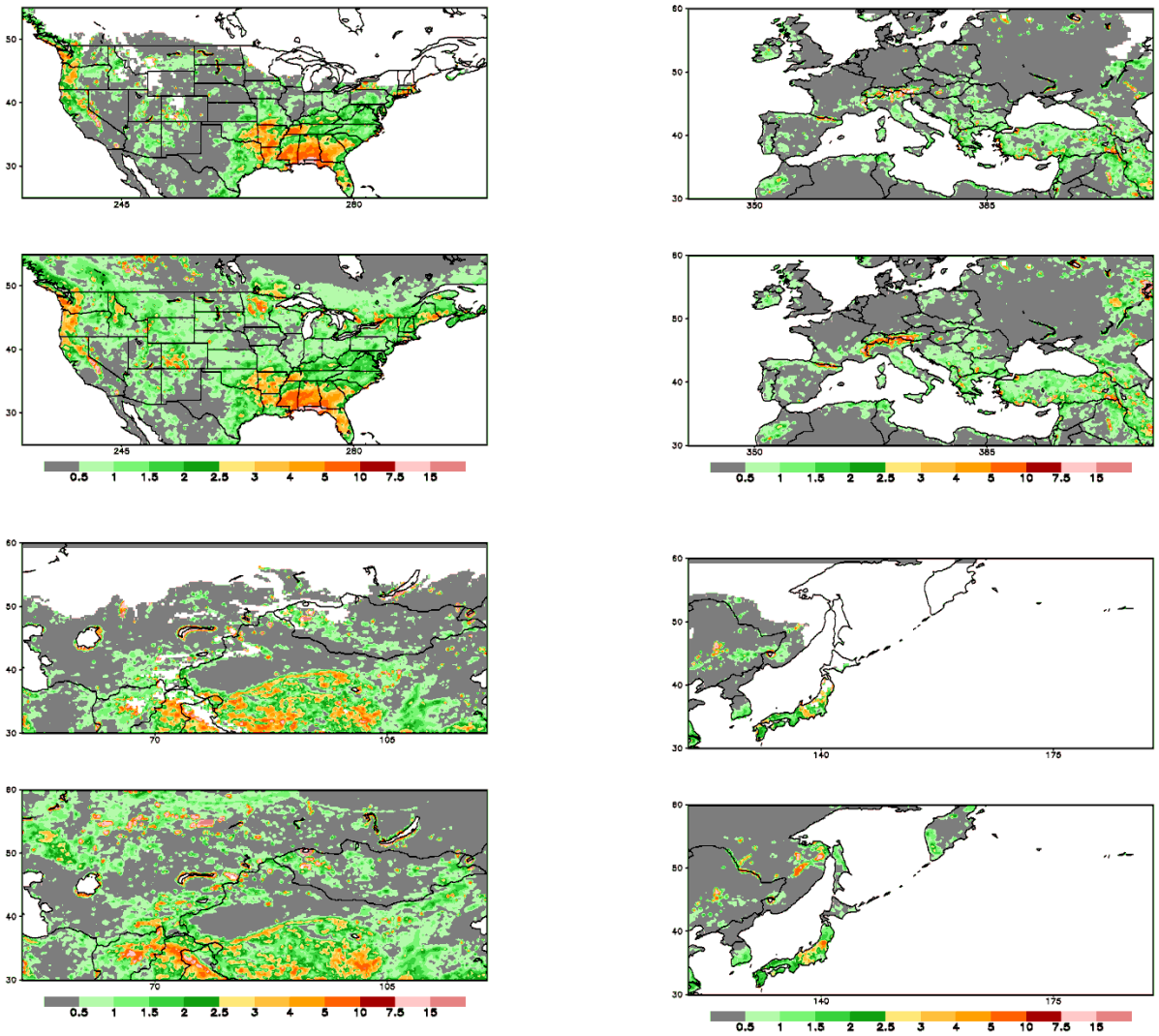
Combined PMW Snowfall + Rainfall Retrievals (top)

03:00 – 09:00 UTC 3 March, mm/6 hr
Correlation = 0.622

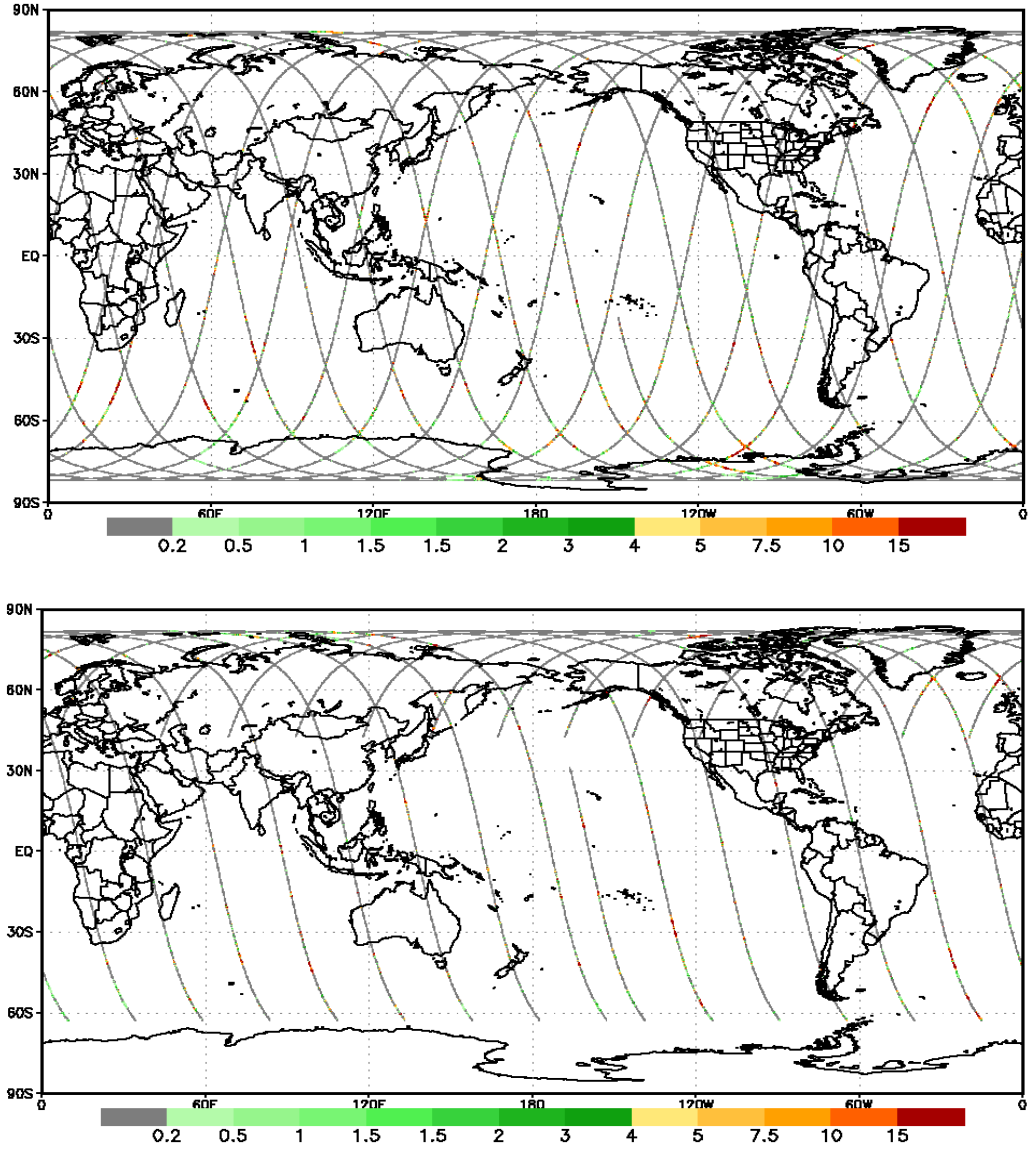
Stage IV radar precipitation (bottom)



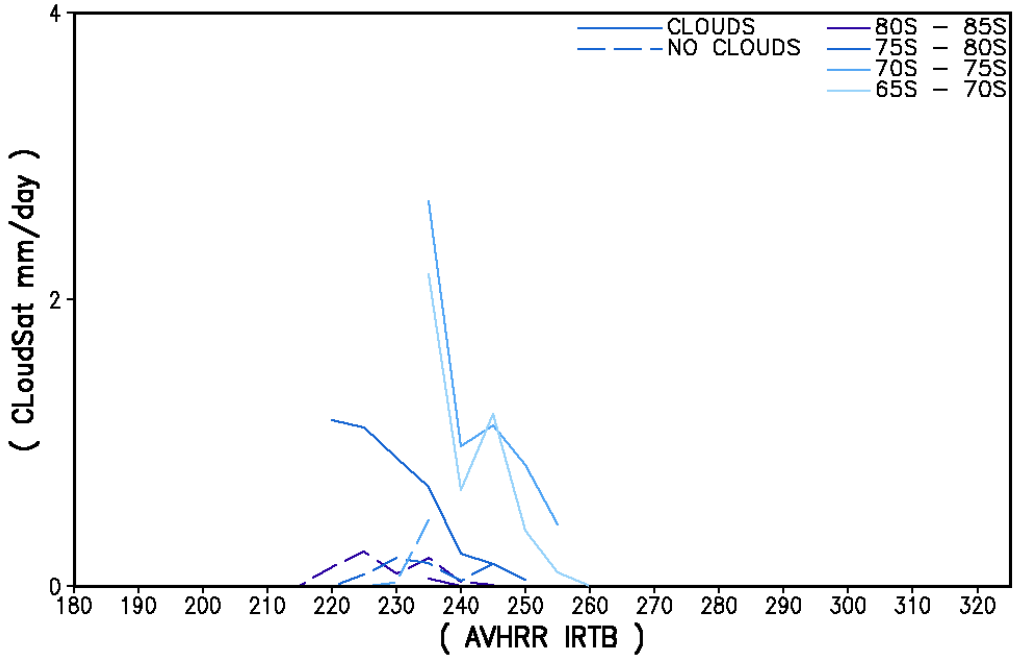
Operational MWCOMB (top panels) March 2014 [mm/day]
PMW snowfall Enhanced MWCOMB (bottom panels)



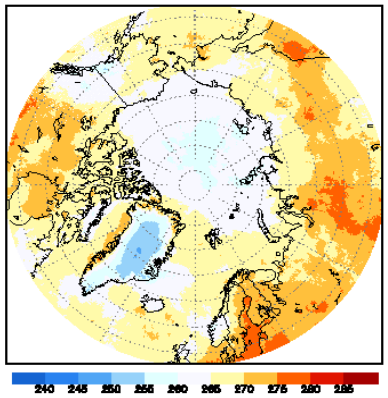
CloudSat precipitation 1 August 2009 (top) 1 August 2014 (bottom) [mm/day]

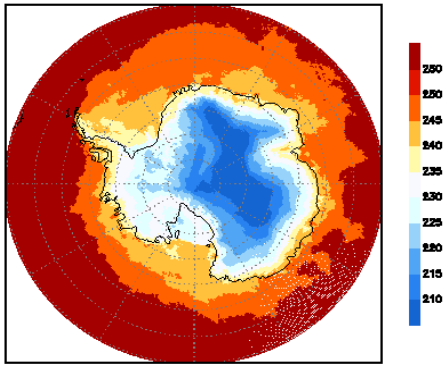


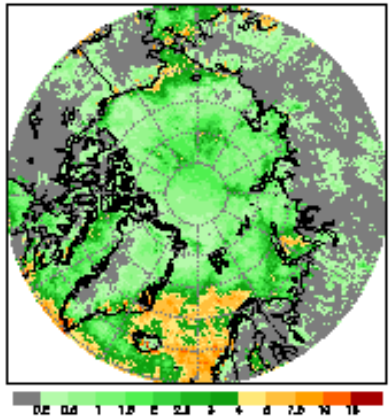
CloudSat radar snow-sea ice cover precipitation for AVHRR IRTB: September – October 2009 [mm/day]

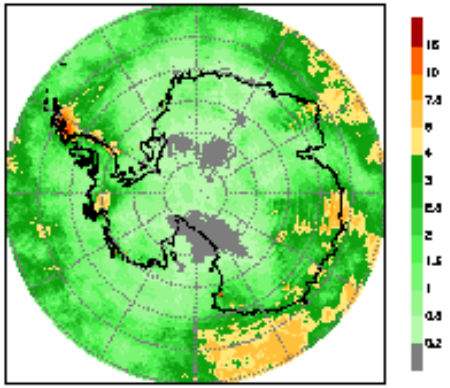


AVHRR IRTB (top) 1-10 August 2009
AVHRR IRFREQ + using cloud classification 1-10 August 2009 (bottom)

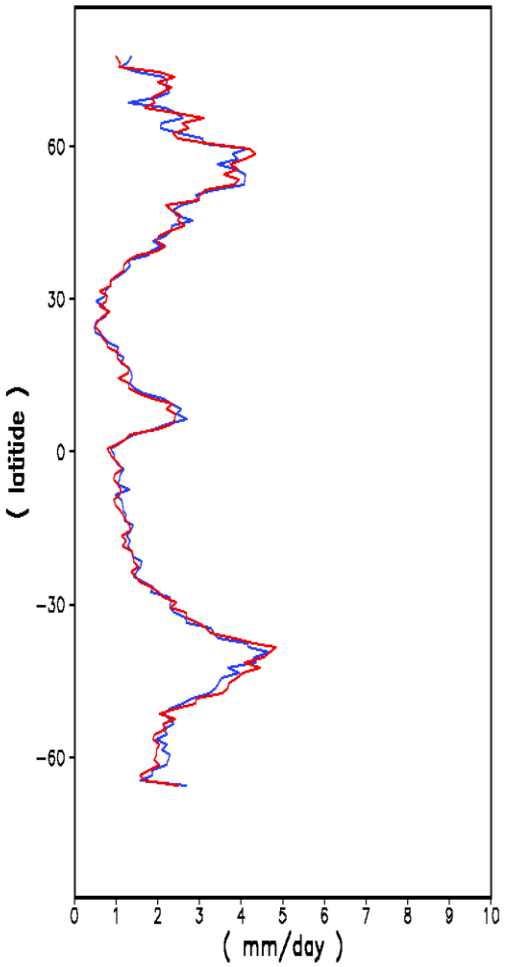


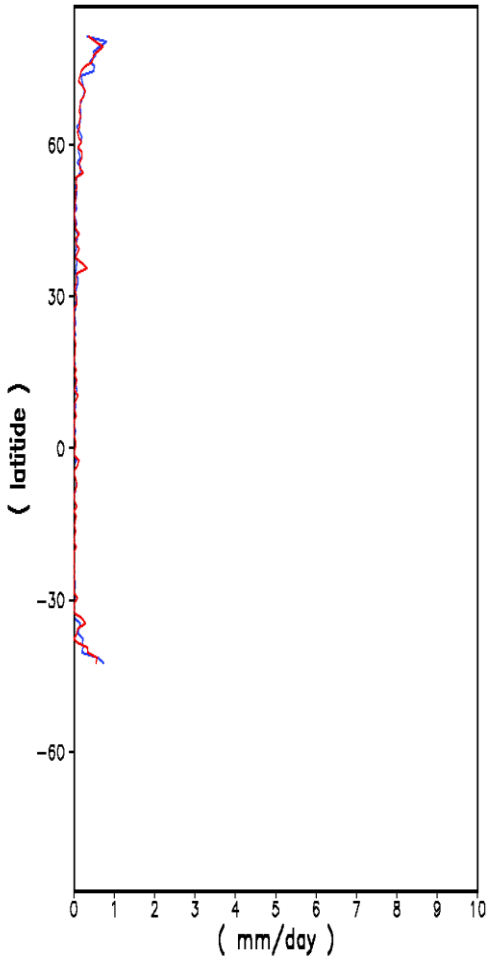


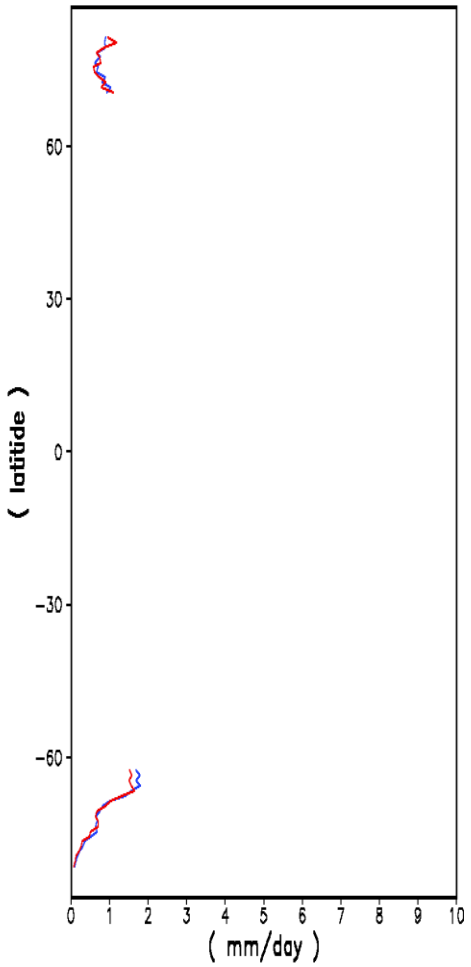




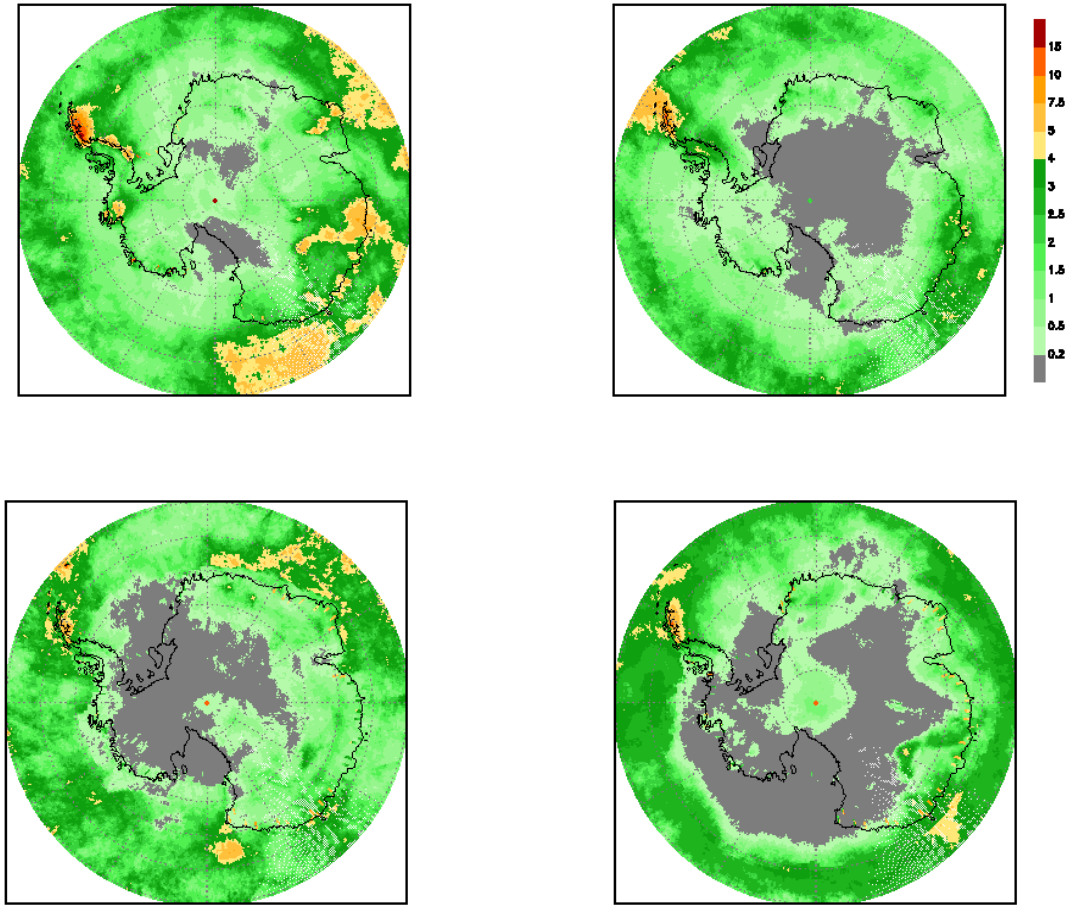
CloudSat/AVHRR August precipitation (red/blue) [ocean, land, snow sea ice]
July – September 2009





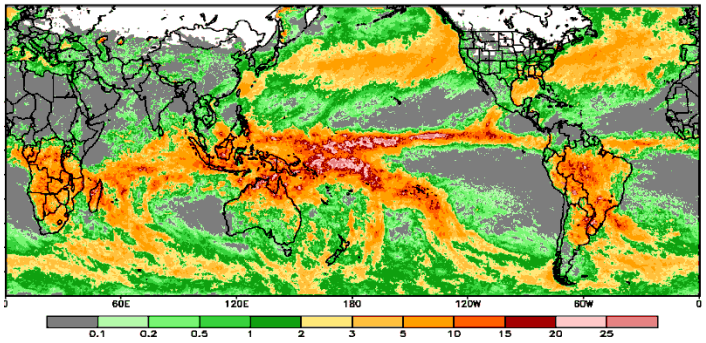


CloudSat calibrated AVHRR IRFREQ August precipitation Aug 2009 (upper left), Nov 2009 (upper right), Feb 2010 (lower left), May 2010 (lower right)

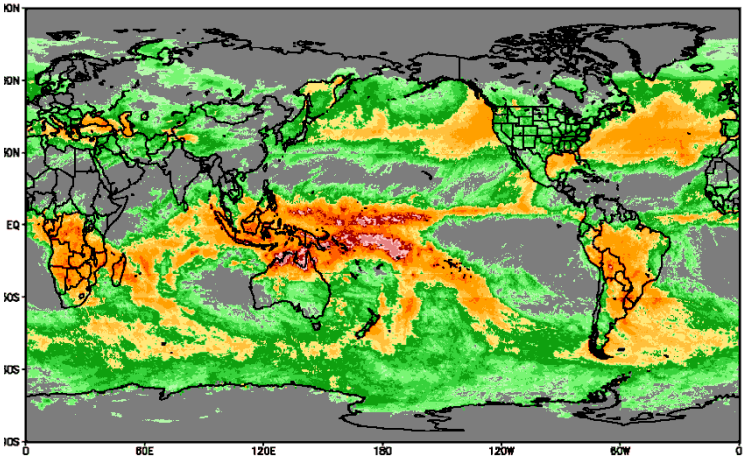


Satellite derived precipitation: Jan 2010 (mm/day)

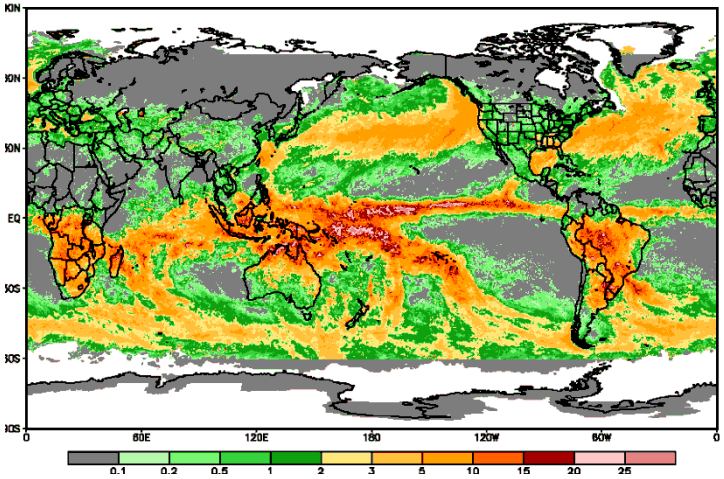
CMORPH 60N-60S



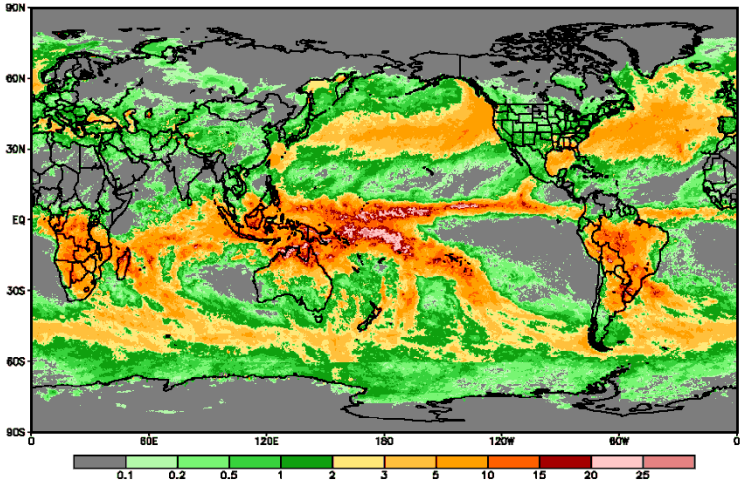
AVHRR PTP



CMORPH PTP Extended



CMORPH + AVHRR PTP



Summary of Source Precipitation Info

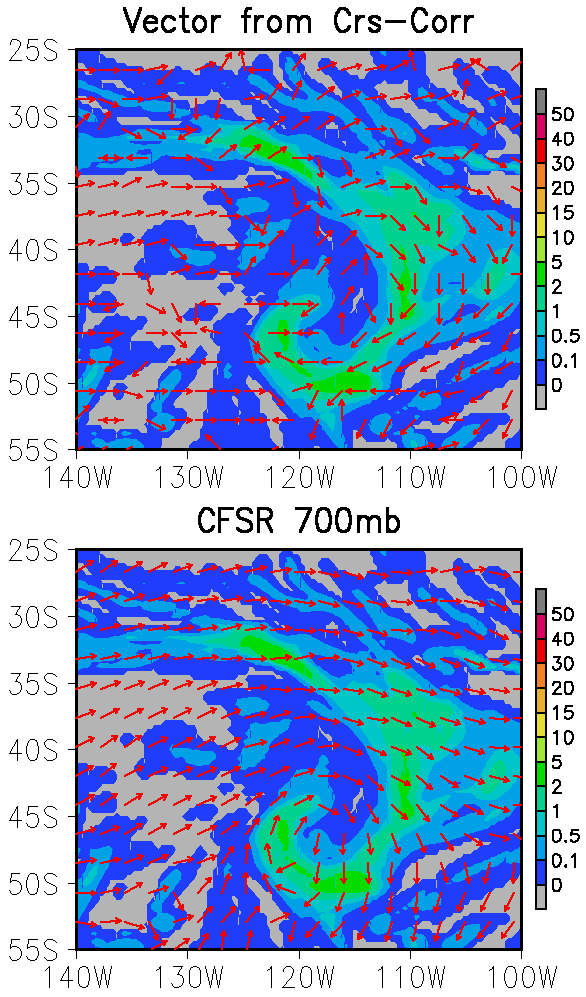
- Current PMW retrievals do not provide accurate spatial coverage over the entire globe
- PMW based snowfall retrievals promising but need to go through comprehensive tests before they may be utilized as inputs
- Estimates derived from AVHRR IR cover the polar caps with reasonable (usable) accuracy using CloudSat for calibration
- Model based precipitation fields are important source of information for cold season / high latitude precipitation

Precipitation Motion Vector of 2nd Generation CMORPH

Motion vectors can be computed from consecutive fields of PRECIPITATION using the cross-correlation method

- **GEO IR based precipitation from 60ºS to 60ºN**
- **Model (CFSR) precipitation fields from 90ºS to 90ºN**
- **LEO PMW & IR based precipitation estimates from 90ºS to 90ºN**
  [Did not test in this preliminary examination]
  - Much more technically challenging
    - *Narrow strips*
    - *changing observation times*
    - *Computing vectors using PMW / AVHRR separately or jointly?*

Vectors Derived from CFSR Hourly Precip Fields Appear Reasonable



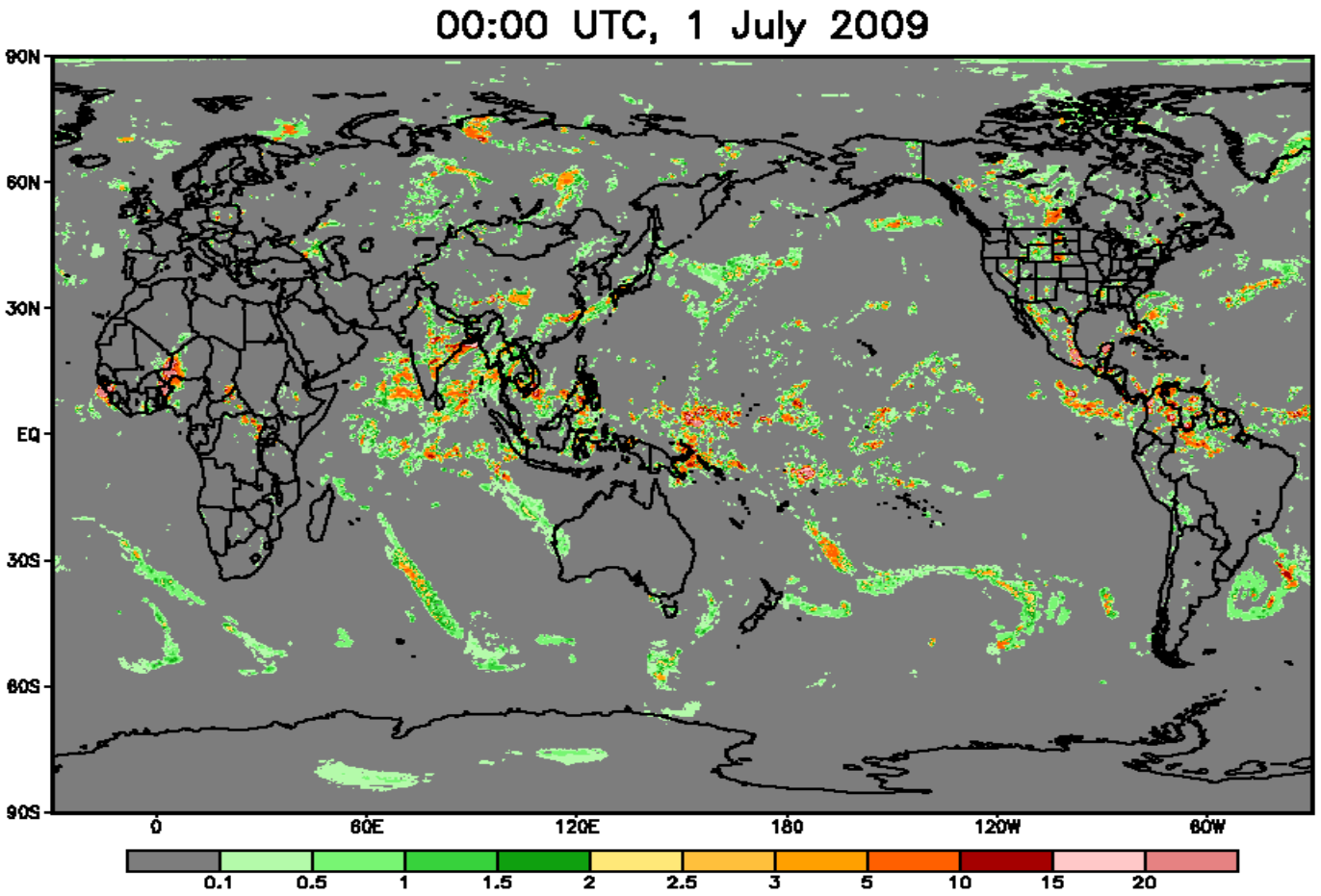
- **Defining motion vectors through computing cross-correlation between precipitation fields at two close time steps**

- **Cloud motion vectors derived from CFSR hourly precipitation fields present reasonable quality**

PTP Feasibility Tests:

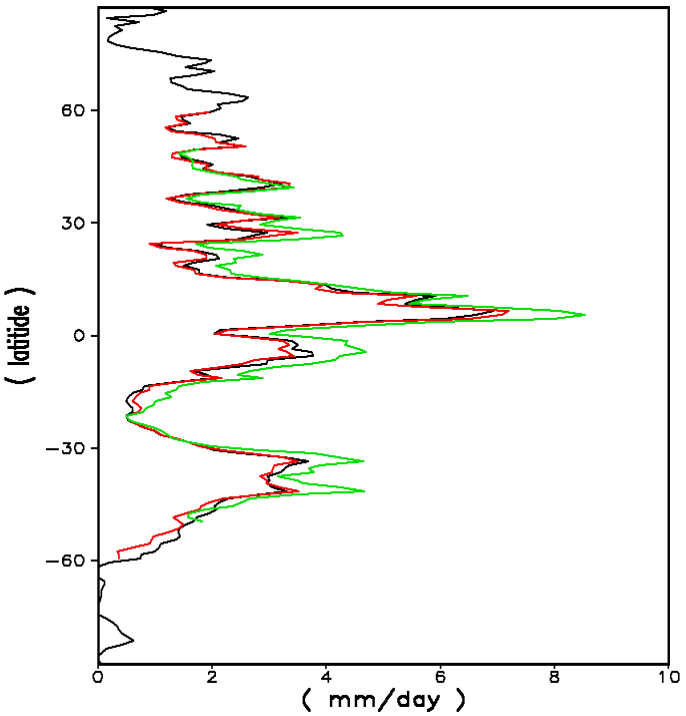
- **0.05^{o}lat/lon over the globe**
- **Input Precip:**
  - ***PMW precipitation***
  - ***AVHRR precip over high latitudes***
- **Motion vectors**
  - ***Weighted mean of CFSR based and GEO IR based vectors***
- **Integration algorithm**
  - ***Original CMORPH***

PTP CMORPH


00:00 UTC, 1 July 2009
90N
60N
30N
EQ
30S
60S
90S
0
60E
120E
180
120W
60W
0.1
0.5
1
1.5
2
2.5
3
5
10
15
20

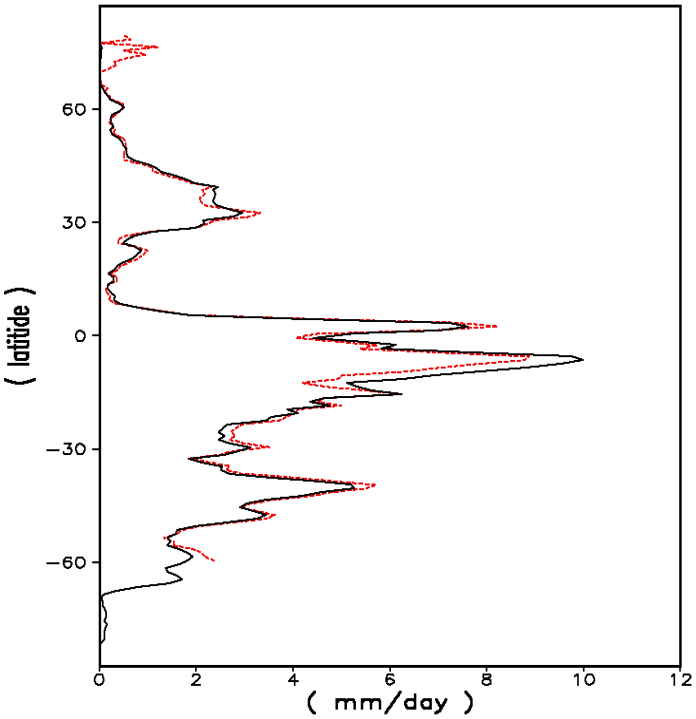
Latitudinal profiles of zonal mean precipitation (mm/hr)

1 July 2009



TMPA ----------
PMW + AVHRR ----------
PMW only (CMORPH) ----------

1-31 Jan 2010



PMW + AVHRR ----------
PMW only (CMORPH) ----------

Remaining Technical Challenges

- Deriving regionally/seasonally CloudSat calibrations for AVHRR IRTB
- Refining vectors from hourly model fields
- Deriving vectors from combined LEO platforms
- Combining vectors from different sources