TRMM Tropical Rainfall Measuring Mission

JAXA

Overview of Global Satellite Mapping for Precipitation (GSMaP)

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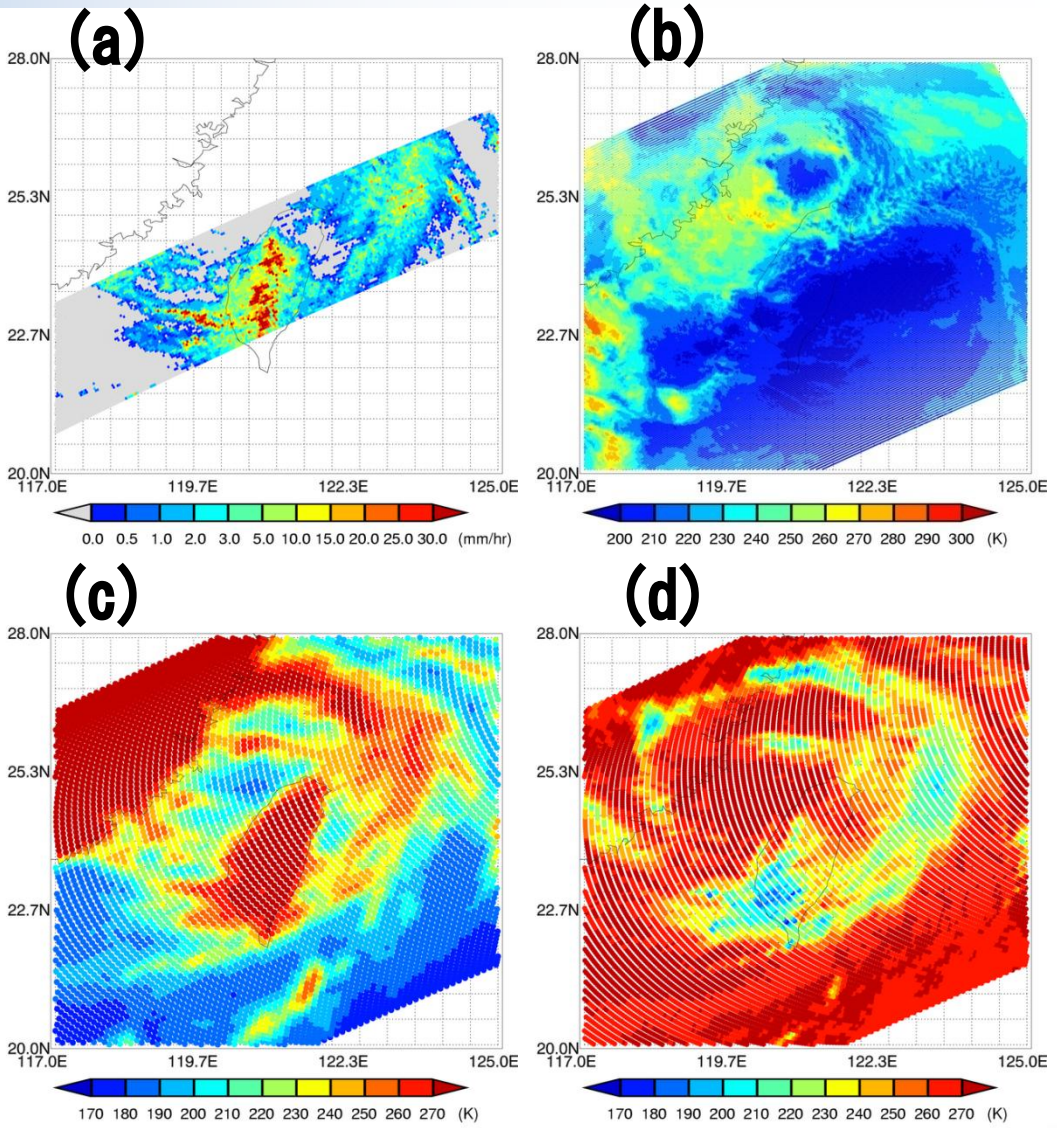
Precipitation characteristics observed by the space borne sensors

Typhoon MORACOT (8 Aug. 2009) by TRMM

(a)Precipitation radar
Back scattering from rain drops
High accuracy
Narrow swath width

(b)Infrared radiometer:
Cloud top information
Not related to surface precipitation rates

(c)Microwave imager (19V):
(d)Microwave imager (85V):
Directly measures emission from rainfall & scattering from snow/ice over the ocean
Directly measures scattering from snow/ice over the land



It is important to combine the data from different frequencies to retrieve precipitation

Production of "GSMaP" from Multi-satellite Data

TRMM
TMI

Aqua
AMSR-E

DMSP
SSM/I, SSMIS

NOAA&MetOp
AMSU-A/MHS

Geostationary Satellite

Rain models developed from PR observations

Rainfall data retrieved from each microwave imager and/or sounder

Hourly merged microwave rainfall map

Calculate cloud moving vectors

GSMaP rainfall in 0.1-deg grid and hourly

How to merge MWR and IR Info.

- Combination of the moving vector and GPCP type method
  - We have decided to combine each method (sampling from both world).

  That is…..

  1. Propagates the rainy pixels on the moving vector derived from the successive IR images
  2. And then, optimally estimates the rain rate from the brightness temperature at IR wavelength

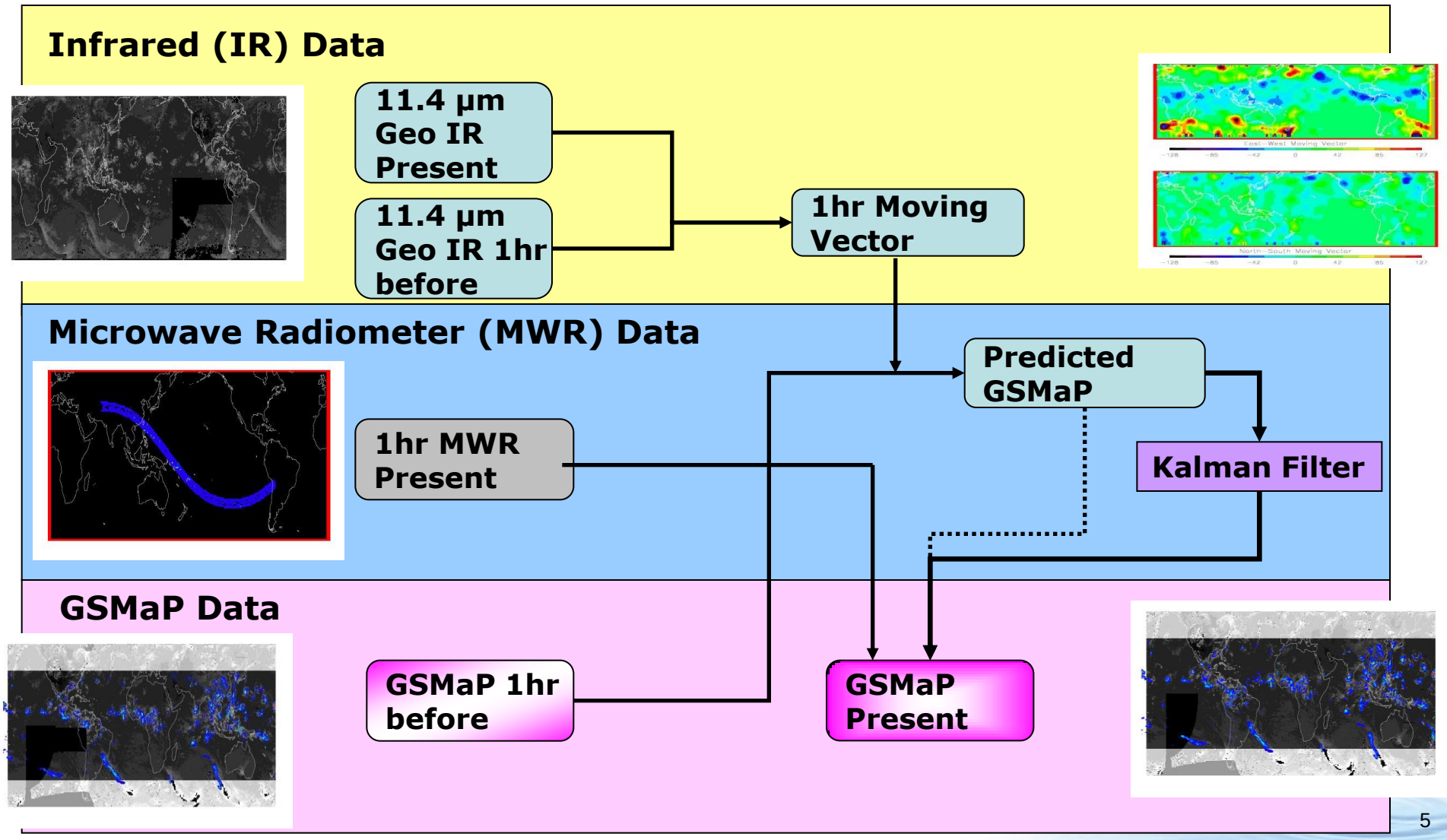
- What is the best way to realize this?
  - Global precipitation mapping is a sequential process.
  - So, the Kalman filter is the best way to do this.

GSMaP

- Kalman filter approach
  - Refine precipitation rate on Kalman gain after propagating the rain pixel
  - The Kalman gain is determined from the database on the relationship between the IR Tb and surface rain rate.

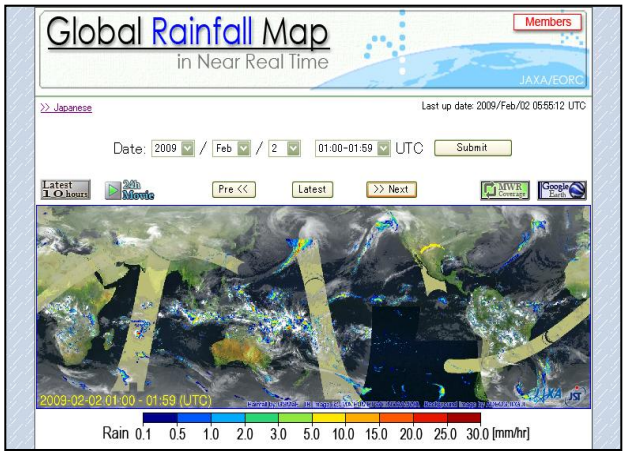
Production of high temporal (1 hr)/high spatial (0.1-deg) resolution precipitation map

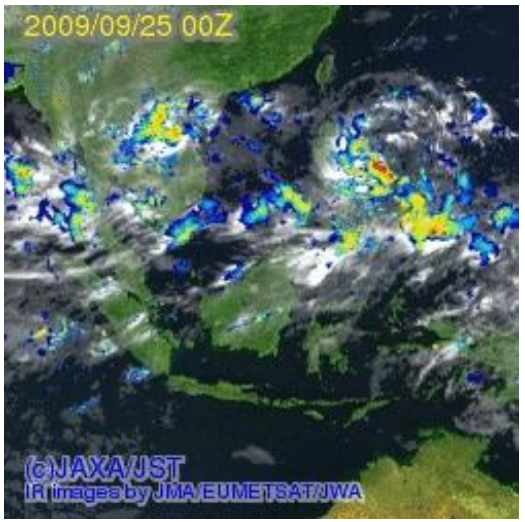
Algorithm flow to predict the movement of raining areas by applying the cloud motion vector of the past 1 hour estimated from the IR cloud image



Global Rainfall Map in Near-Real-Time: a proto-type for GPM

- GSMaP (Global Satellite Mapping for Precipitation)
  - Rainfall retrievals from available MWRs are merged, and moving vector information from five GEO IR data with Kalman filtering techniques is combined to fill temporal gaps.
- GSMaP_NRT is distributed via internet
  - Binary and text data has been freely available since Oct. 2008 via password protected ftp site.
  - Recently introduced
    - SSMIS (F16, F17) since Jun. 2010.
    - AMSU-A/MHS (N19, MetOp-A) since Aug. 2011.
- Reprocessing of whole period (2000-present) by latest algorithms introducing SSMIS and AMSU is underway.



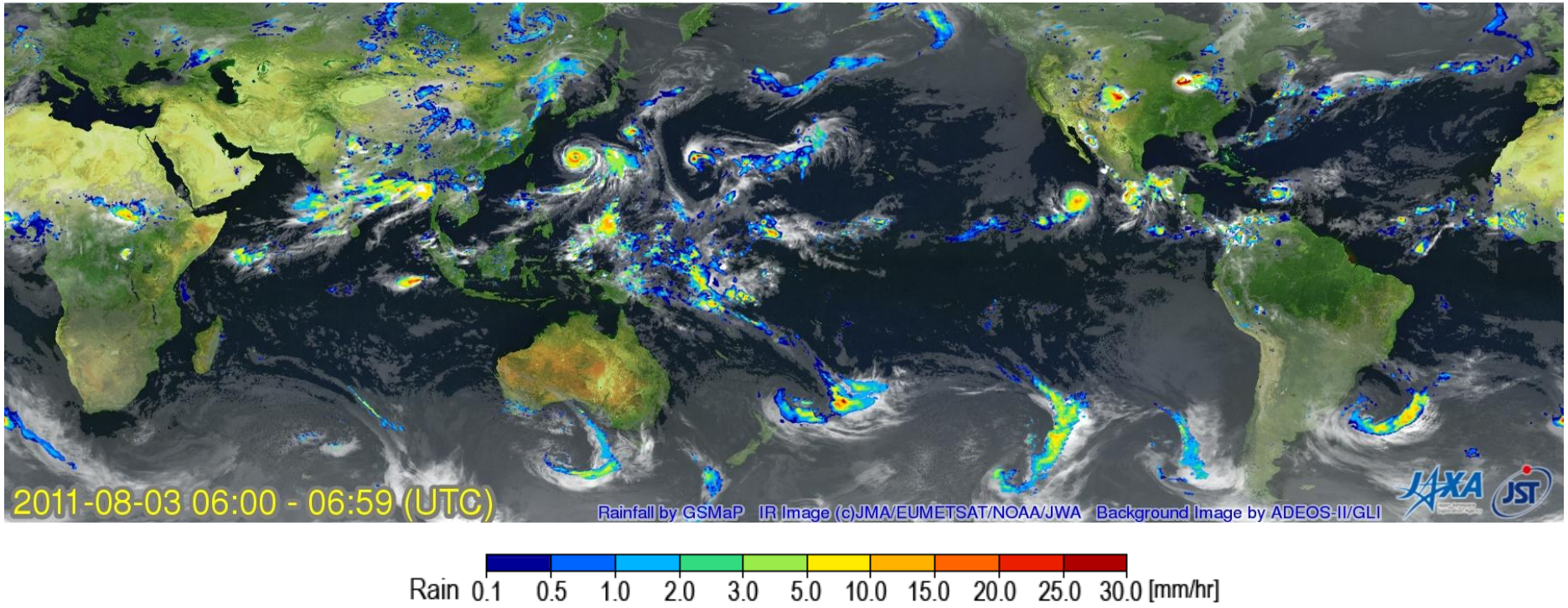


3-hourly animation of three typhoons (No.17-19) in 2009 by GSMaP_NRT.

http://sharaku.eorc.jaxa.jp/GSMaP/

JAXA/EORC Global Rainfall Watch

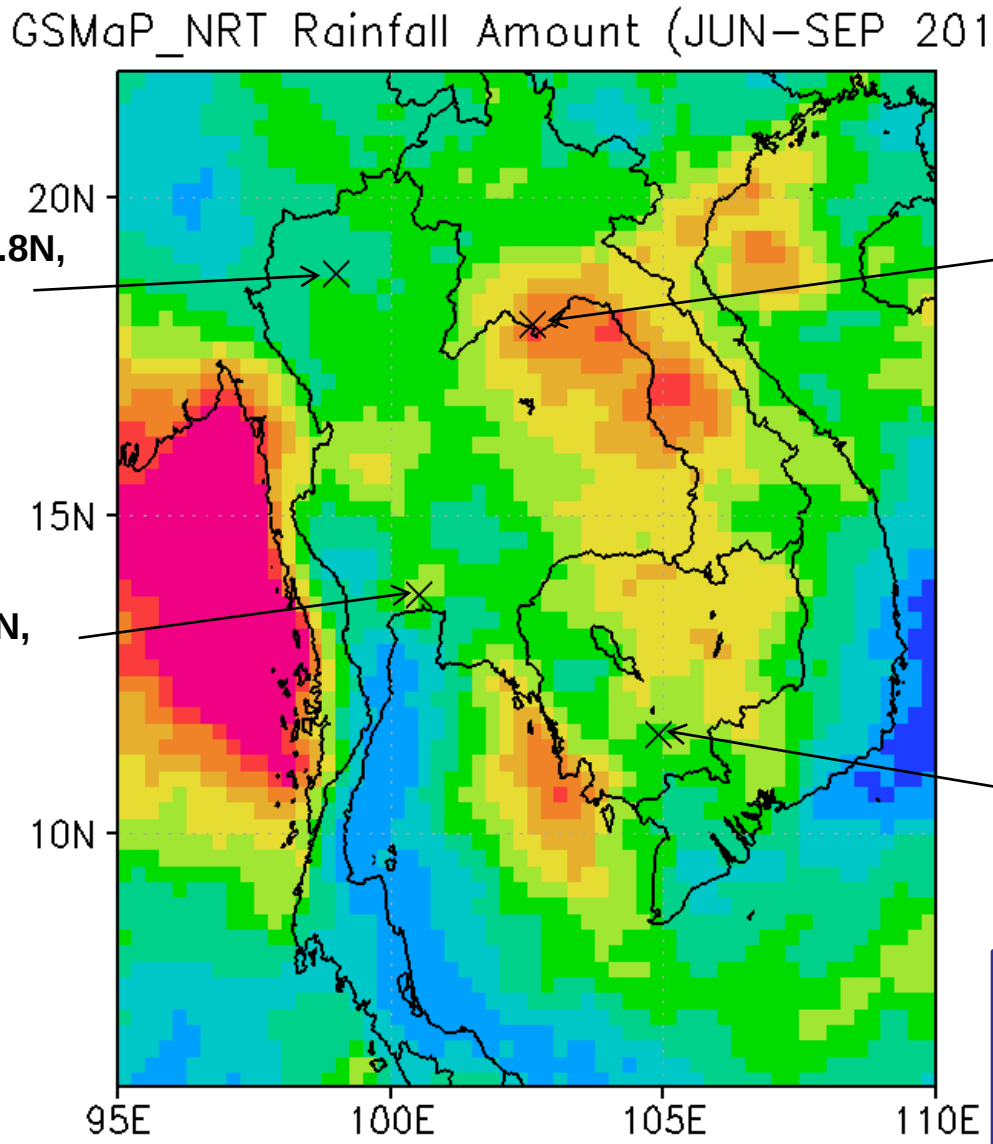
06Z 3 August 2011. Typhoon No.9 in 2011 "MUIFA" can be seen near Okinawa, Japan.



0.1-deg and hourly global rainfall product available 4-hour after observation via internet.

http://sharaku.eorc.jaxa.jp/GSMaP/

GSMaP_NRT accumulated rainfall amount over Thailand during Jun-Sep 2011



Chiang Mai (18.8N, 99E) [Rain Gauge: 921mm]

Bangkok (13.75N, 100.5E) [Rain Gauge: 1251mm]

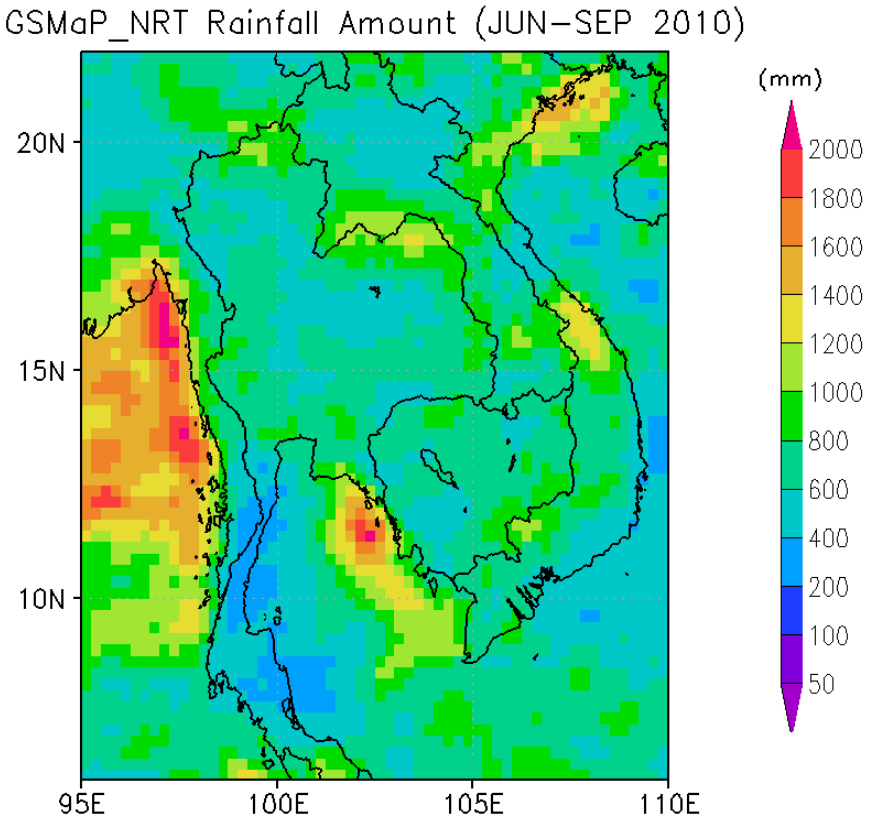
Vientian (18N, 102.6E) [Rain gauge: 1641mm]

Phnom Penh (11.55N,104.9E)

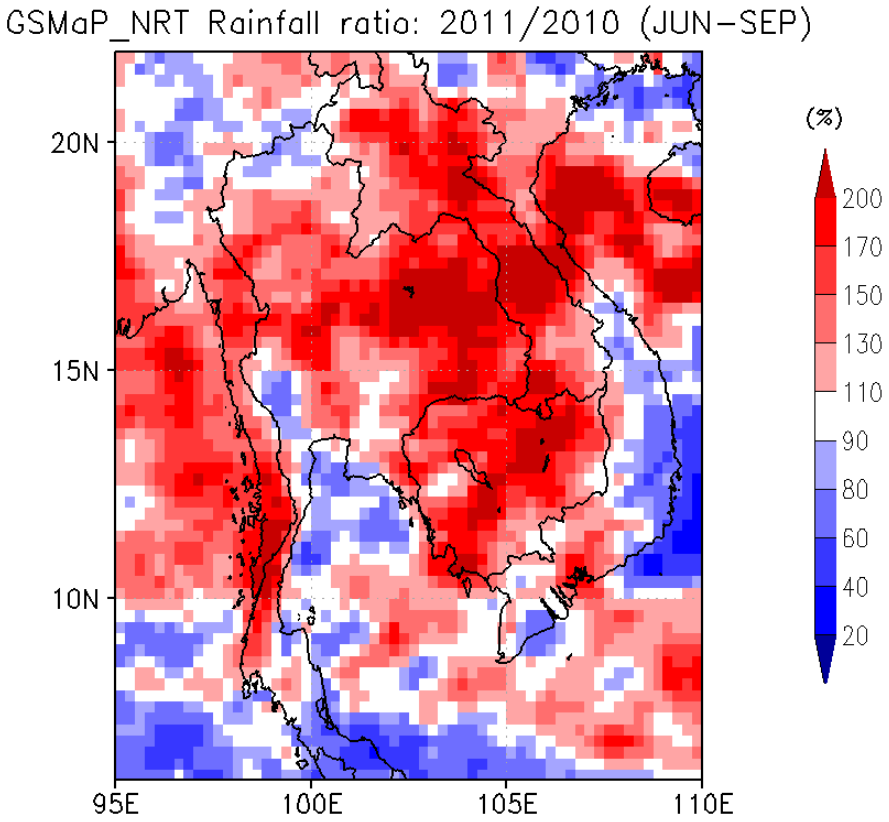
Accumulated rainfall amount by GSMaP_NRT was similar to those by rain gauges at Bangkok, Chiang Mai, and Vientian, provided by JMA .

Comparison to rain amount in 2010

Acculated rainfall amount during Jun-Sep 2010



Ratio of R_{2011}/R_{2010} during Jun.-Sep.



International Precipitation Working Group (IPWG) Validation Program

- Web site
  - http://cawcr.gov.au/bmrc/SatRainVal/validation-intercomparison.html
- Continental-scale validation (single number for entire domain) of satellite-based rainfall map
  - Some sites include NWP output rainfall as "data"
- Performed on daily totals
  - 12 – 12 UTC – N. America, S. America, Western Europe
  - 00 – 24 UTC – Australia, Japan
- Performed on 0.25-degree grid box
- Statistics and maps disseminated via web pages
- Rain gauge & radar (some) used as "truth"
- Currently 5 active validation "sites"
  - N. America, S. America, W. Europe, Australia, Japan

Japanese Site by Kyoto Univ.

http://www-ipwg.kugi.kyoto-u.ac.jp/IPWG/sat_val_Japan.html

Hourly comparisons are also available.

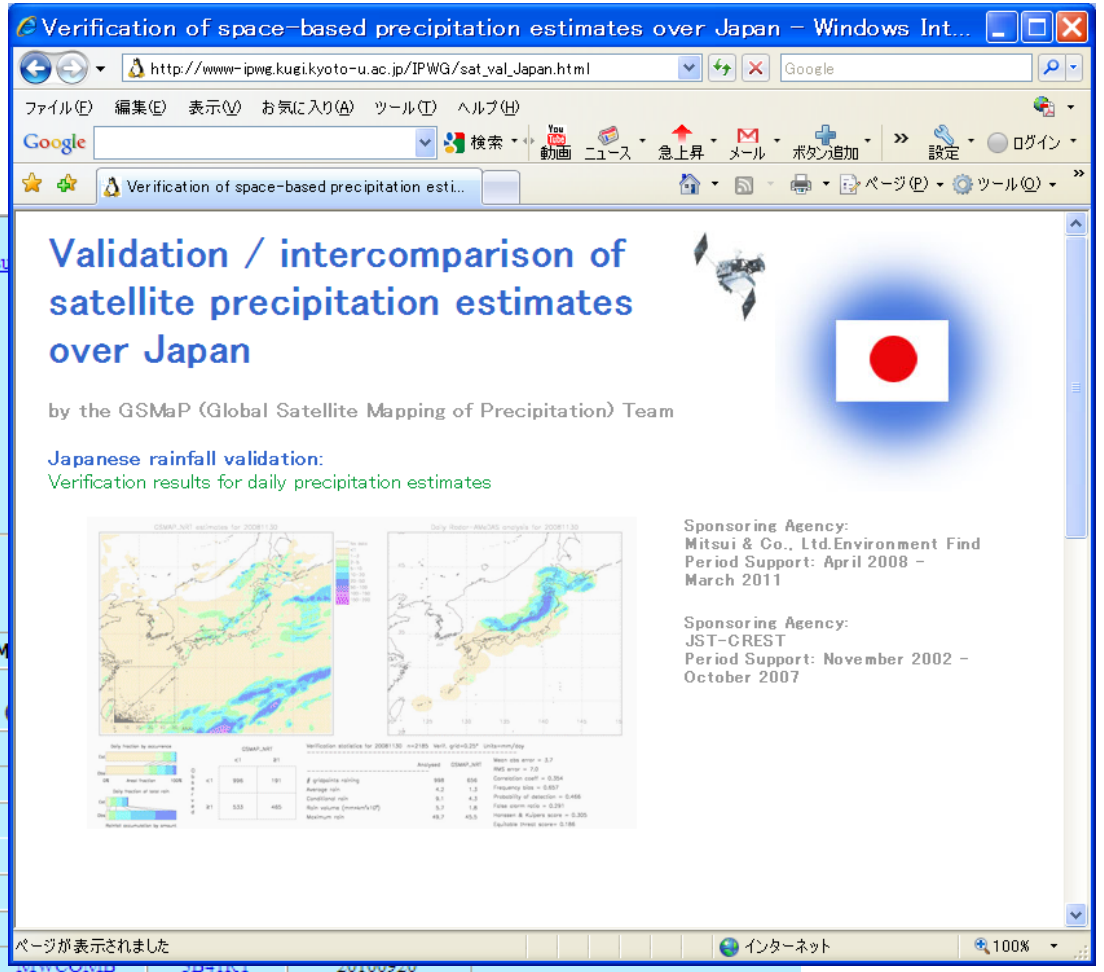
Home | Validation results during 2009 | Validation results during 2008 | Validation results during 2007 | Validation results during 2005

Daily validation results for daily precipitation estimates

Click here to go to the BMRC validation page for the Australia.
Click here to go to the U. Maryland validation page for the US.
Click here to go to the U. Birmingham validation page for Europe.
Click here to go to the U. Maryland validation page for South America.

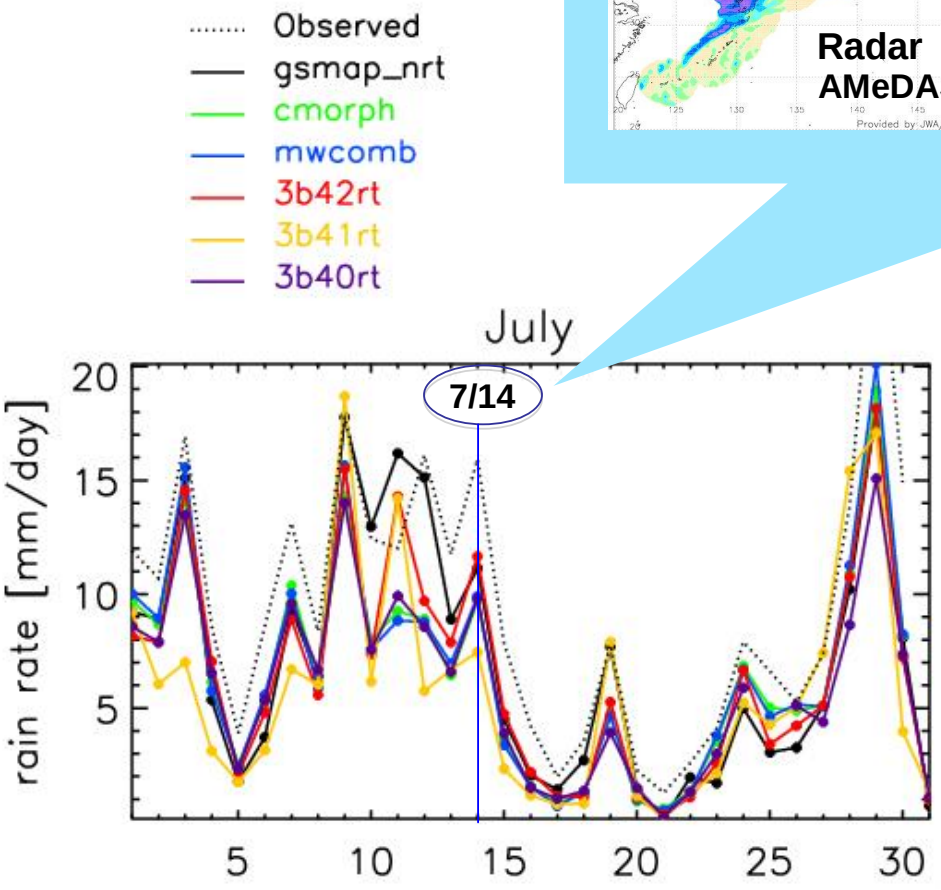
September

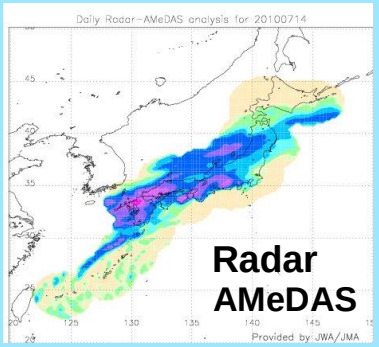
---	Blended PMW and IR			Merged PM			
Valid Date (12-12 UTC)	GSMaP_NRT	NASA (3B42RT)	CPC (CMORPH)	NASA (3B40RT)			
20100926	---	---	---	---			
20100925	GSMaP_NRT	3B42RT	---	3B40RT			
20100924	GSMaP_NRT	3B42RT	CMORPH	3B40RT			
20100923	GSMaP_NRT	3B42RT	CMORPH	---			
20100922	GSMaP_NRT	3B42RT	CMORPH	3B40RT			
20100921	GSMaP_NRT	3B42RT	---	3B40RT			
20100920	GSMaP_NRT	3B42RT	CMORPH	3B40RT			
20100919	GSMaP_NRT	3B42RT	CMORPH	3B40RT	MWCOMB	3B41RT	20100919
20100918	GSMaP_NRT	3B42RT	CMORPH	3B40RT	MWCOMB	3B41RT	20100918
20100917	GSMaP_NRT	3B42RT	CMORPH	3B40RT	MWCOMB	3B41RT	20100917
20100916	GSMaP_NRT	3B42RT	CMORPH	3B40RT	MWCOMB	3B41RT	20100916
20100915	GSMaP_NRT	3B42RT	CMORPH	3B40RT	MWCOMB	3B41RT	20100915

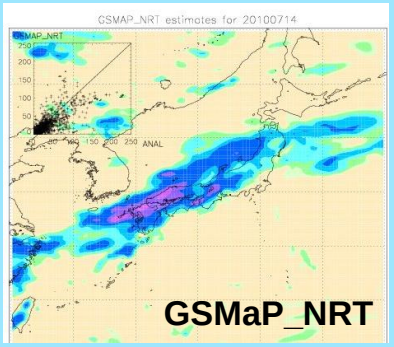


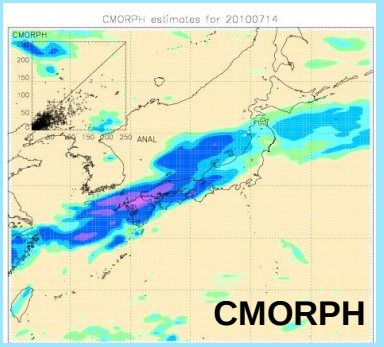
Example : Heavy rain in 14 Jul 2010

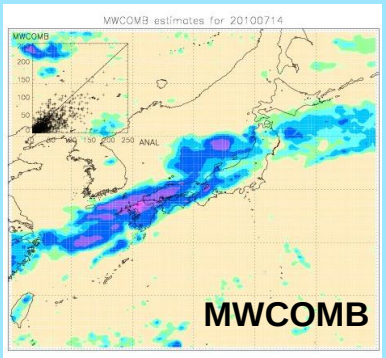
http://www-ipwg.kugi.kyoto-u.ac.jp/IPWG/sat_val_Japan.html

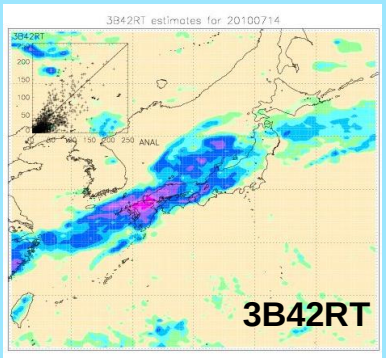


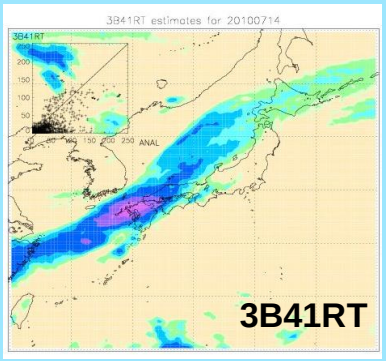


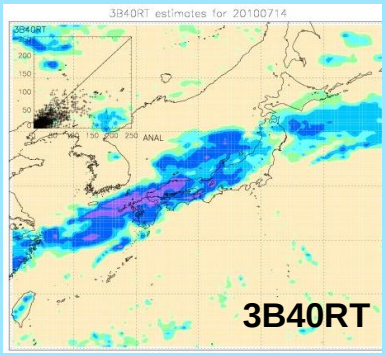












Promotion of GPM data utilization in Asian countries (1/2)

- GPM Asia Workshop
  - Held every year in Japan since , inviting 5-10 meteorological, hydrological or remote sensing agencies in Asian countries.
  - Promote satellite precipitation data utilization in Asia.
  - Utilization of GSMaP and/or TRMM data and their comparison with ground-based data have started in Vietnam, Bangladesh, Philippines, Lao PDR, ICIMOD, Thailand, and Indonesia.

The 3rd GPM Asia Workshop on Precipitation Data Application Techniques, 7and 9 Dec. 2011, Tokyo, Japan

Promotion of GPM data utilization in Asian countries (2/2)

- Following projects related to GSMaP are ongoing unser JAXA and Asian countries. These projects focus on flood including river basin management and landslide (short-term events, debris flows, slope failures, etc).
  - ADB Technical Assistance - 'Applying Remote Sensing Technology in River Basin Management'
    - ADB Technical Assistance with BWDB and MoFDM in **Bangladesh**, MONRE and MARD in **Vietnam**, PAGASA in the **Philippines**
  - THEOS Series and ALOS Series Cooperation
    - Joint study with GISTDA in **Thailand**
    - **Flood WG**, Rice WG, Coastal WG
  - Sentinel Asia Success Story in the Philippines
    - Joint study with PHIVOLCS, PAGASA, MGB, NAMRIA, OCD-NDCC and PCIEERD in the **Philippines**
    - Volcanic Eruption & Fault Monitoring, **Landslide Warning**, Land Subsidence Monitoring

Summary

- Production of GSMaP and GSMaP_NRT
  - JAXA and collaborative organizations has developed precipitation product, GSMaP, and distributed its near-real-time version 4-hrs after observation in hourly and 0.1-degree grid box.
  - Rainfall retrievals from available MWRs are merged, and moving vector information from five GEO IR data with Kalman filtering techniques is combined to fill temporal gaps
- Validation of multi-satellite products
  - International Precipitation Working Group compares various multi-satellite products in a same manner at five active sites, including North America, South America, Eastern Europe, Australia and Japan.
  - Japanese site operated by Kyoto Univ. in collaboration with JAXA to compare with JMA's Radar-AMeDAS (gauge calibrated radar rainfall).
- Promotion in GSMaP and TRMM/GPM data in Asia
  - JAXA holds yearly workshop focused on satellite precipitation utilization, and invites Asian meteorological/hydrological agencies.
  - JAXA also promotes several projects to utilize GSMaP and other satellite data in Asian countries.