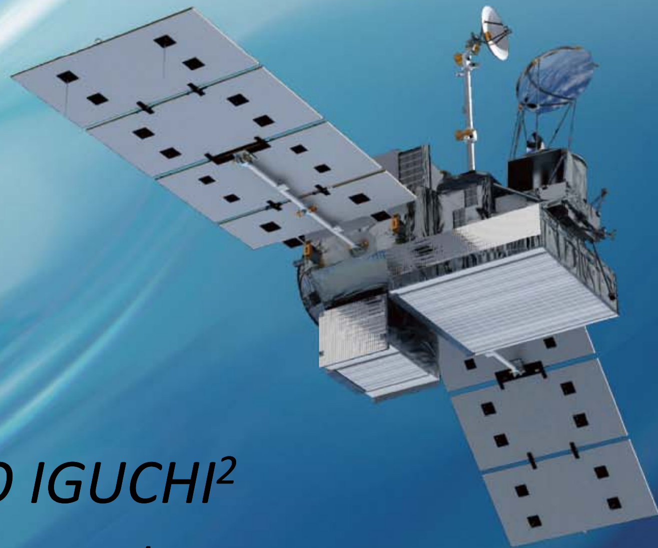
Global Precipitation Measurement in Japan



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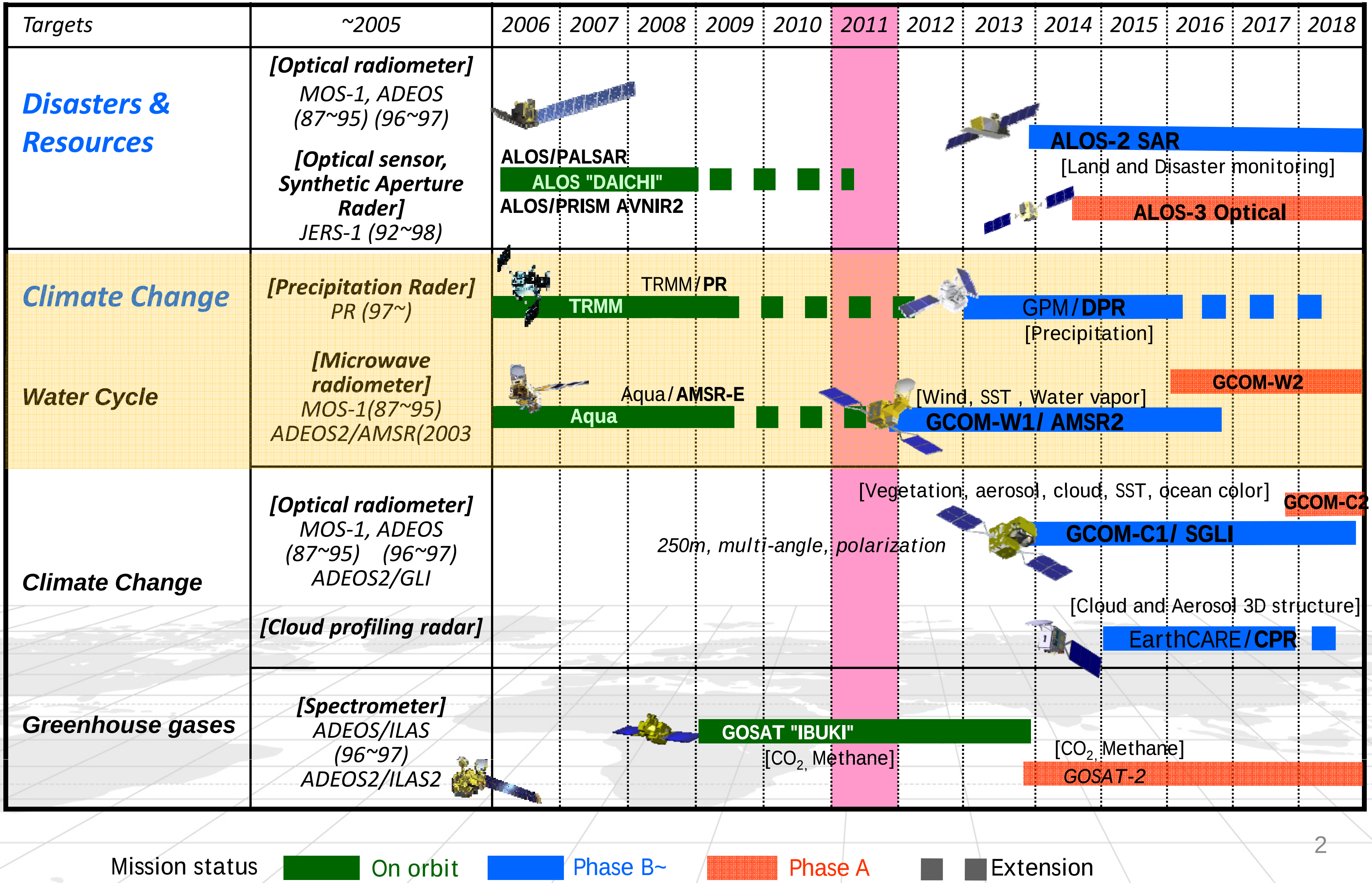
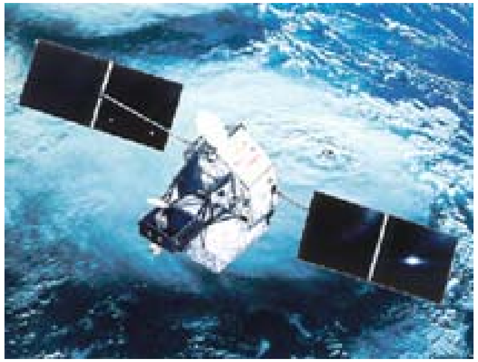
Long-Term Plan of Earth Observation



Tropical Rainfall Measuring Mission (TRMM)

- *Major characteristics*
  - *Focused on rainfall observation. First instantaneous rainfall observation by three different sensors (PR, TMI, VIRS). PR, active sensor, can observe 3D structure of rainfall.*
  - *Targeting tropical and subtropical region, and chose non-sun-synchronous orbit (inc. angle 35 degree) to observe diurnal variation.*
- *Major achievement in Japan*
  - *More than 14 years rain observation data archive*
  - *Demonstration of high quality and high reliability of a satellite onboard precipitation radar*
  - *Improvement of MWR precipitation retrieval by PR 3D observation*
  - *Pioneering precipitation system climatology by PR observation*
  - *Operational use in NWP etc.*
  - *New products including all-weather SST, global soil moisture*



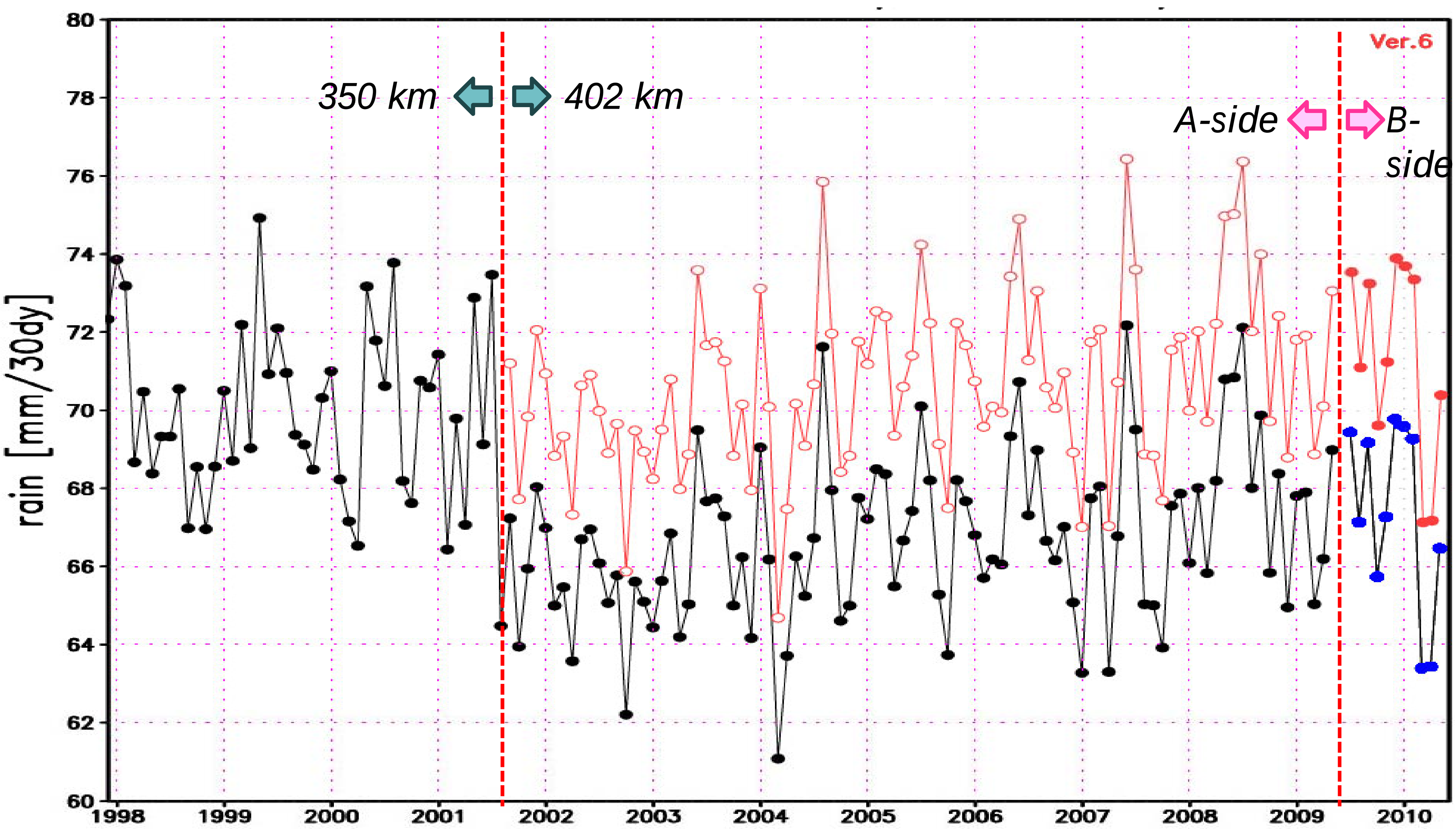
US-Japan joint mission

Japan: PR, launch

US: satellite, TMI, VIRS, CERES, LIS, operation

Launch	28 Nov. 1997 (JST)
Altitude	About 350km (since 2001, boosted to 402km to extend mission operation)
Inc. angle	About 35 degree, non-sun-synchronous orbit
Design life	3-year and 2month (still operating)
Instruments	Precipitation Radar (PR) TRMM Microwave Imager (TMI) Visible Infrared Scanner (VIRS) Lightning Imaging Sensor (LIS) CERES (not in operation)

Global Monthly Accumulated Rain by TRMM/PR
(Estimated Surface Rain 1997/12 – 2010/05)

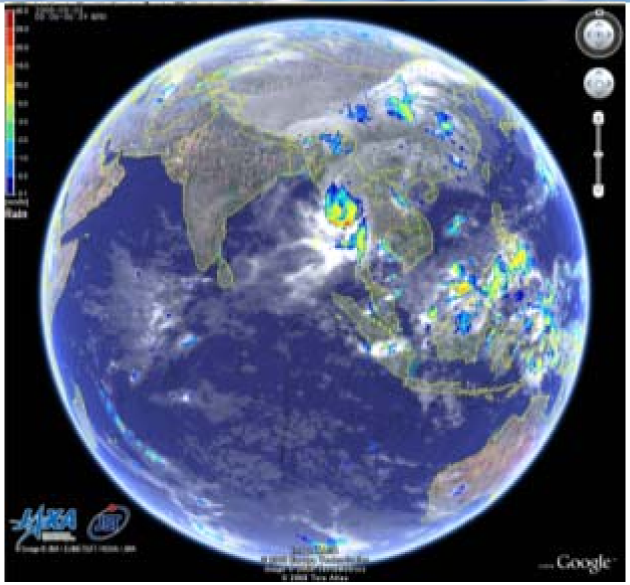


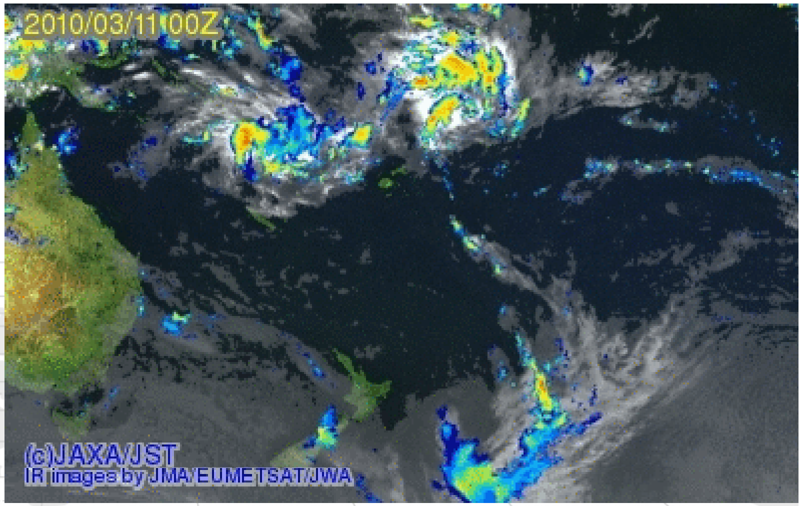
- *The total decrease in PR e_surface rain by altitude change is estimated to be 5.90% on average in a global scale.*
- *Data continuity was kept by calibration for B-side H/W.*

GSMaP_NRT: A proto-type for GPM

- *Global rainfall map by merging TRMM, AMSR-E, and other satellite information.*
- *0.1-degree lat/lon grid, hourly products.*
- *GSMaP near-real-time version (GSMaP_NRT) is distributed via internet*
  - *Available 4-hr after observation*
  - *Binary and text data has been freely available since Oct. 2008 via password protected ftp site.*
  - *Hourly browse images are also available.*
  - *SSMIS (F16, F17) has been introduced into the NRT system since June 2010.*
  - *Introduction of AMSU/MHS (NOAA N15/16/18/19, MetOp-A) into the NRT system is in preparation.*
- *Reanalysis of GSMaP (GSMaP_MVK) in latest version is underway.*
  - *Processing of 2007 data is completed, and it has been distributed to NRT registered users..*
  - *Use all available microwave imagers, including SSMIS, AMSU, and MHS.*

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

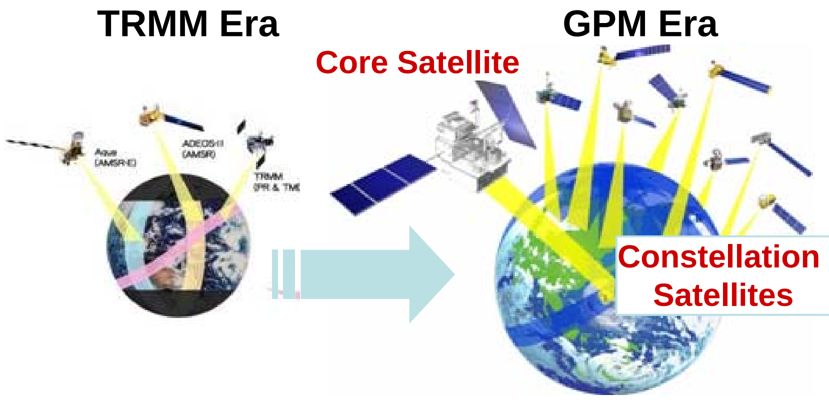




3-hourly animation of two Tropical Cyclones over the South Pacific in March 2010 by GSMaP_NRT.

Global Precipitation Measurement (GPM)

- *The Global Precipitation Measurement (GPM) is an expanded mission of the Tropical Rainfall Measuring Mission (TRMM)*



Core Satellite (JAXA, NASA)

Dual-frequency precipitation radar (DPR)

GPM Microwave Imager (GMI)

- ***Precipitation with high precision***
- ***Discrimination between rain and snow***
- ***Adjustment of data from constellation satellites***

(launch in 2014)

Constellation Satellites (International Partners)

Microwave radiometers

Microwave sounders

- ***Global precipitation every 3 hours***

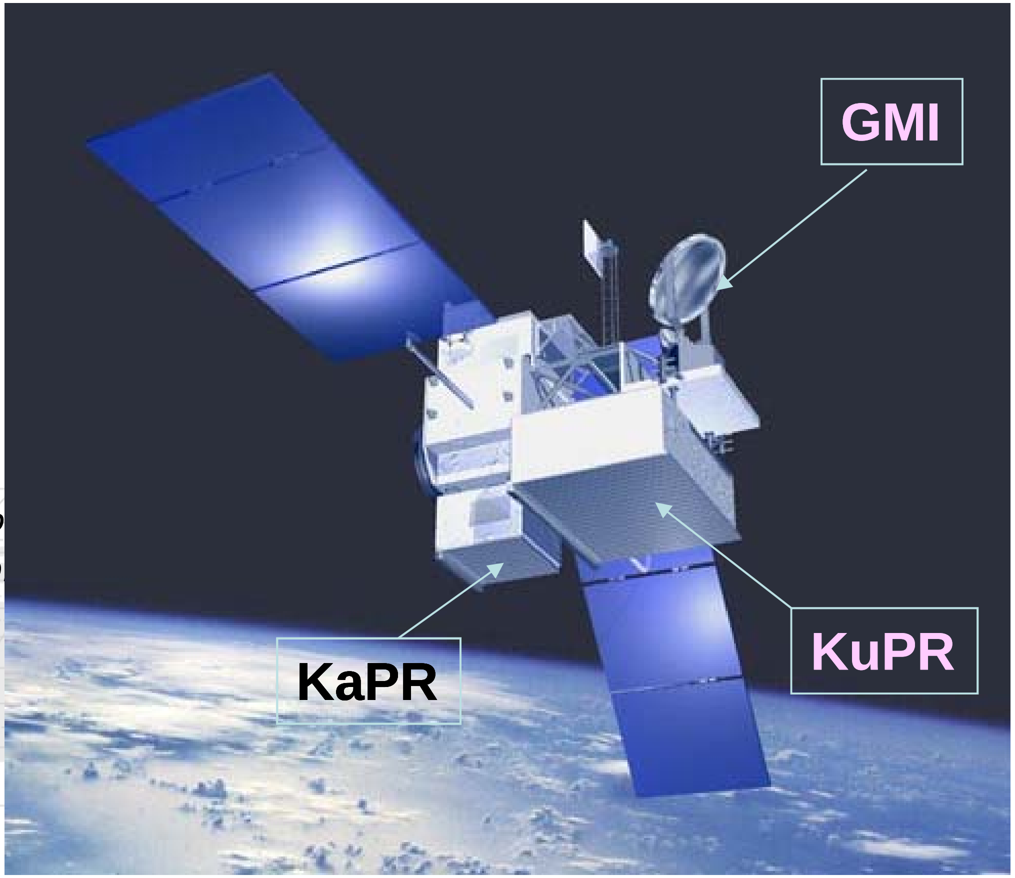
(launch around 2014)

- ***Improve the accuracy of both long-term and short-term weather forecasts***
- ***Improve water resource management in river control and irrigation systems for agriculture***

Dual-frequency Precipitation Radar (DPR)

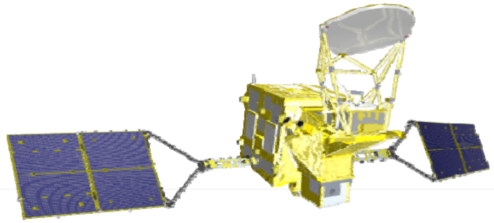
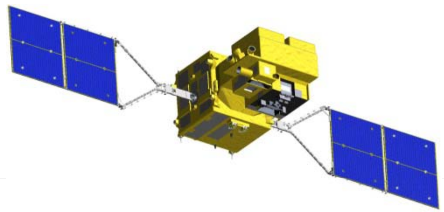
- *JAXA's primary contribution in GPM*
  - *Development of the DPR (Dual-frequency Precipitation Radar) onboard the GPM core observatory with NICT*
  - *Launch of the GPM core observatory by H-IIA in 2013*
  - *Joint development of the GPM standard algorithm with NASA*
  - *Contribution by GCOM-W1/AMSR2, which will be launched in the end of 2011, as one of constellation satellites*

- *Characteristics and the role of the DPR*
  - *Unique space borne precipitation radar (maximize heritage of PR on TRMM)*
  - *High sensitivity*
    - *0.7 mm/Hr (PR on TRMM)*
      → 0.2mm/Hr (DPR on GPM)
  - *Dual frequency (Ku-band and Ka band) matched beam observation*
    - *Estimation of the raindrop size distributio*
  - *Highly sensitive and accurate precipitatio measurement from the heavy rainfall to the weak rain*
  - *Calibrator for the rain retrieval from the constellation satellites*



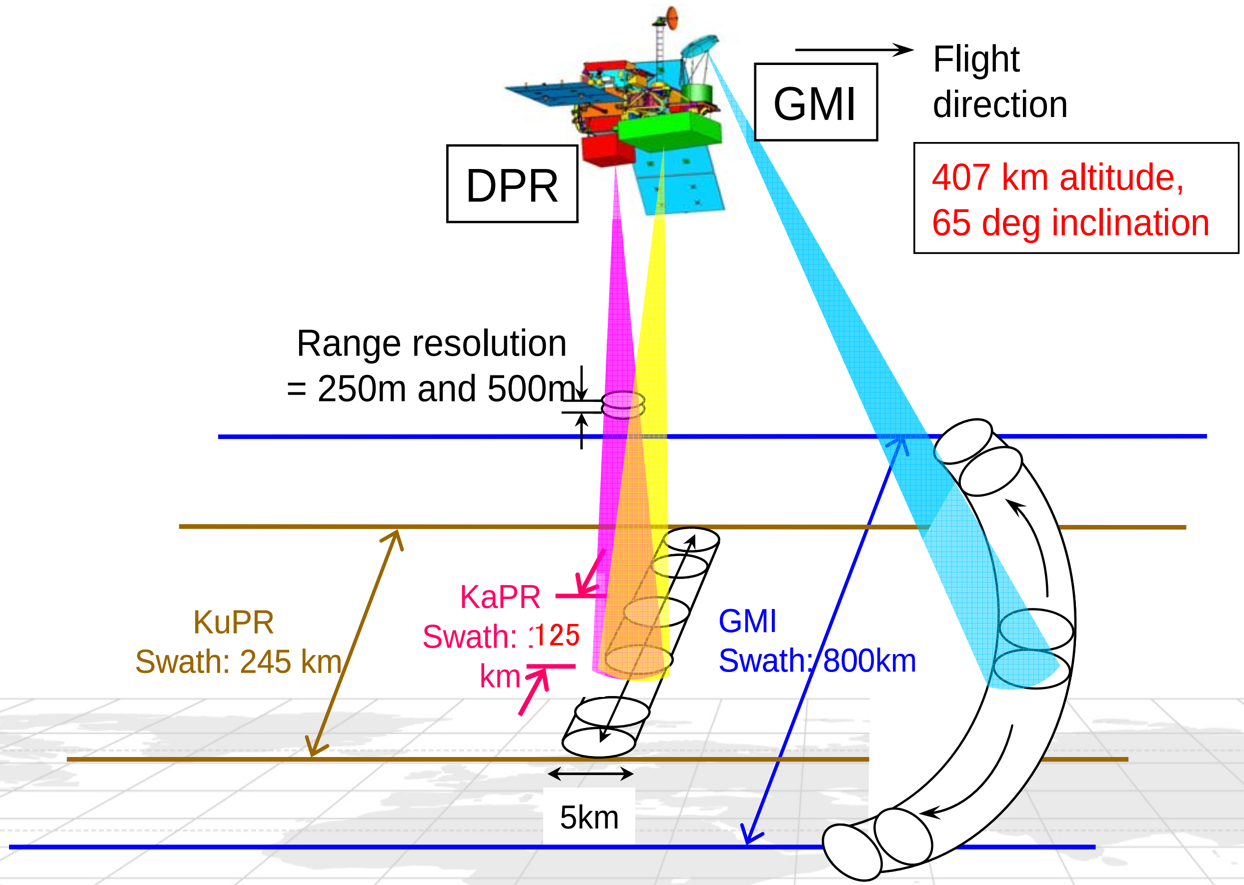
Global Change Observation Mission (GCOM)

- *GCOM consists of GCOM-W and GCOM-C series*
  - *GCOM-W with and its follow-on will contribute to the observations related to global water and energy circulation.*
  - *GCOM-C with SGLI and its follow-on will contribute to the surface and atmospheric measurements related to the carbon cycle and radiation budget.*
- *GCOM is long-term mission to observe more than 10 years.*
  - *Three consecutive generations of satellites with one year overlap in orbit enables over 13 years*

	GCOM-W	**GCOM-C**
Orbit	Type : Sun-synchronous orbit Altitude : 699.6 km Inclination : 98.2 degrees Local sun time : 13:30±15min	Type : Sun-synchronous orbit Altitude : 798 km Inclination : 98.6 degrees Local sun time : 10:30±15min
Satellite overview		
Mission life	5 years	
Launch vehicle	H2A launch vehicle	
Instrument	AMSR 2 (Advanced Microwave Scanning Radiometer-2)	SGLI (Second Generation Global Imager)
Launch	JFY 2011	JFY 2014

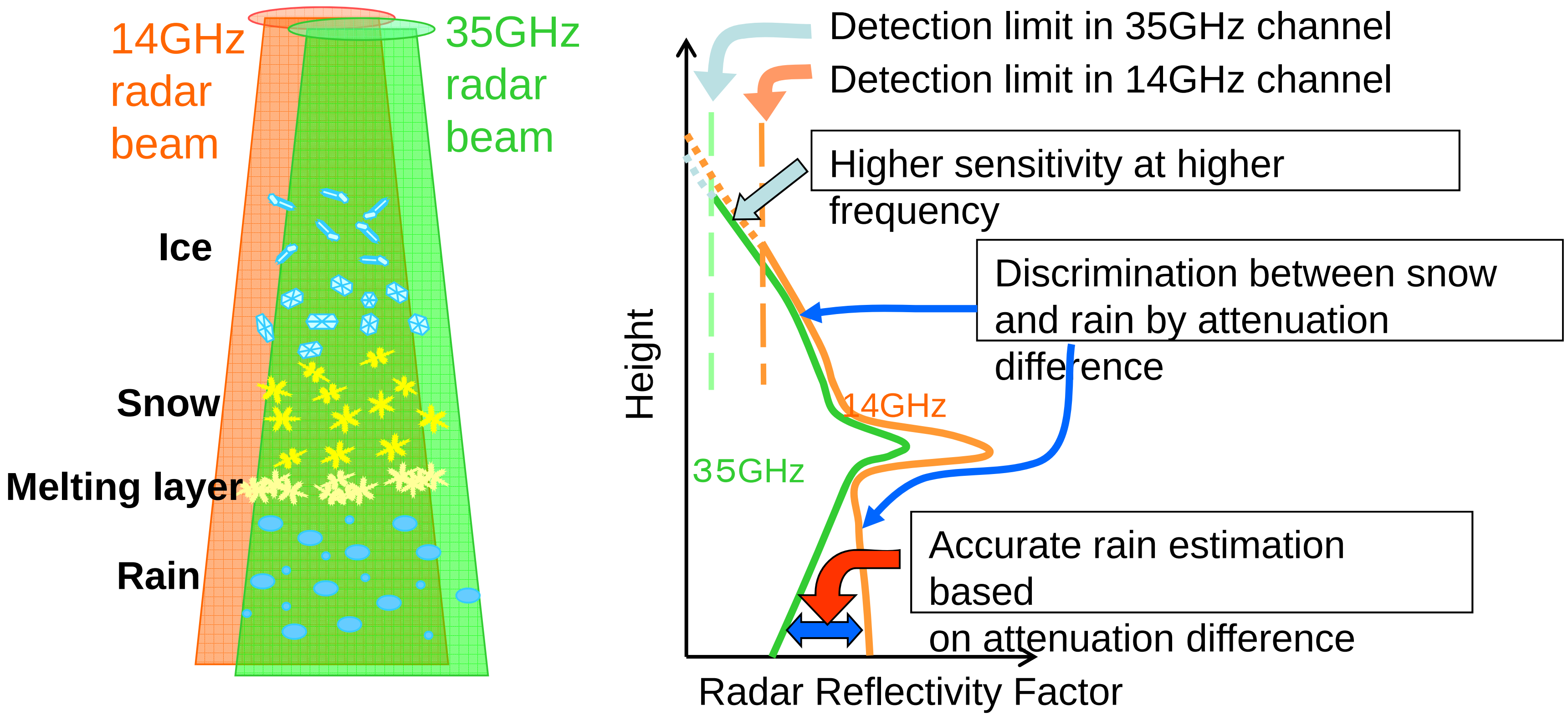
Outline of the DPR

Dual-frequency precipitation radar (DPR) consists of
Ku-band (13.6GHz) radar : KuPR and
Ka-band (35.5GHz) radar : KaPR



DPR beam scanning

Dual Frequency Precipitation Radar



Roles of DPR

- *Accurate 3D measurements of precipitation as TRMM, but with better sensitivity*
- ***Improvement of estimation accuracy***
  - *Identification of hydrometer type, phase state*
- *Improvement of MWR algorithms*
  - *Simultaneous measurements with GMI*

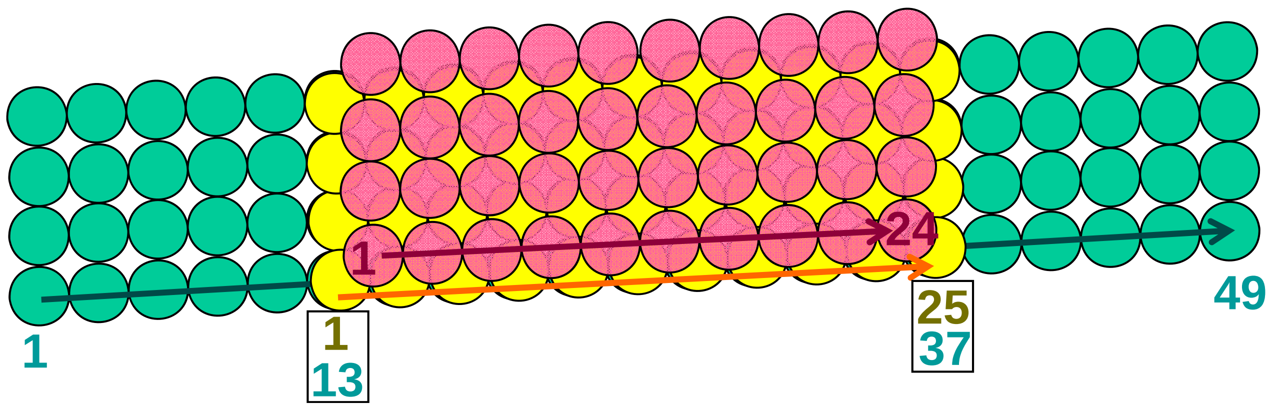
Main Characteristics of DPR

Item	KuPR	KaPR	TRMM PR
Antenna Type	Active Phased Array (128)	Active Phased Array (128)	Active Phased Array (128)
Frequency	13.597 & 13.603 GHz	35.547 & 35.553 GHz	13.796 & 13.802 GHz
Swath Width	245 km	120 km	215 km
Horizontal Reso	5 km (at nadir)	5 km (at nadir)	4.3 km (at nadir)
Tx Pulse Width	1.6 μs (x2)	1.6/3.2 μs (x2)	1.6 μs (x2)
Range Reso	250 m (1.67 μs)	250 m/500 m (1.67/3.34 μs)	250m
Observation Range	18 km to -5 km (mirror image around nadir)	18 km to -3 km (mirror image around nadir)	15km to -5km (mirror image at nadir)
PRF	VPRF (4206 Hz±170 Hz)	VPRF (4275 Hz±100 Hz)	Fixed PRF (2776Hz)
Sampling Num	104～112	108～112	64
Tx Peak Power	> 1013 W	> 146 W	> 500 W
Min Detect Ze (Rainfall Rate)	< 18 dBZ (< 0.5 mm/hr)	< 12 dBZ (500m res) (< 0.2 mm/hr)	< 18 dBZ (< 0.7 mm/hr)
Measure Accuracy	within ±1 dB	within ±1 dB	within ±1 dB
Data Rate	< 112 Kbps	< 78 Kbps	< 93.5 Kbps
Mass	< 365 kg	< 300 kg	< 465 kg
Power Consumption	< 383 W	< 297 W	< 250 W
Size	2.4×2.4×0.6 m	1.44 ×1.07×0.7 m	2.2×2.2×0.6 m

* Minimum detectable rainfall rate is defined by $Ze=200\ R^{1.6}$ (TRMM/PR: $Ze=372.4\ R^{1.54}$)

Concept of the DPR antenna scan

- KuPR footprint : Δz = 250 m
- KaPR footprint (Matched-beam with KuPR) : Δz = 250 m
- KaPR footprint (High-sensitivity beam) : Δz = 500 m



KaPR: 120 km (24 beams)

KuPR: 245 km (49 beams)

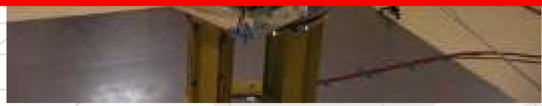
In the interlacing scan area (●), the KaPR can measure snow and light rain in a high-sensitivity mode with a double pulse width.

The synchronized matched beam (●) is necessary for the dual-frequency algorithm.

Test Configurations

KuPR

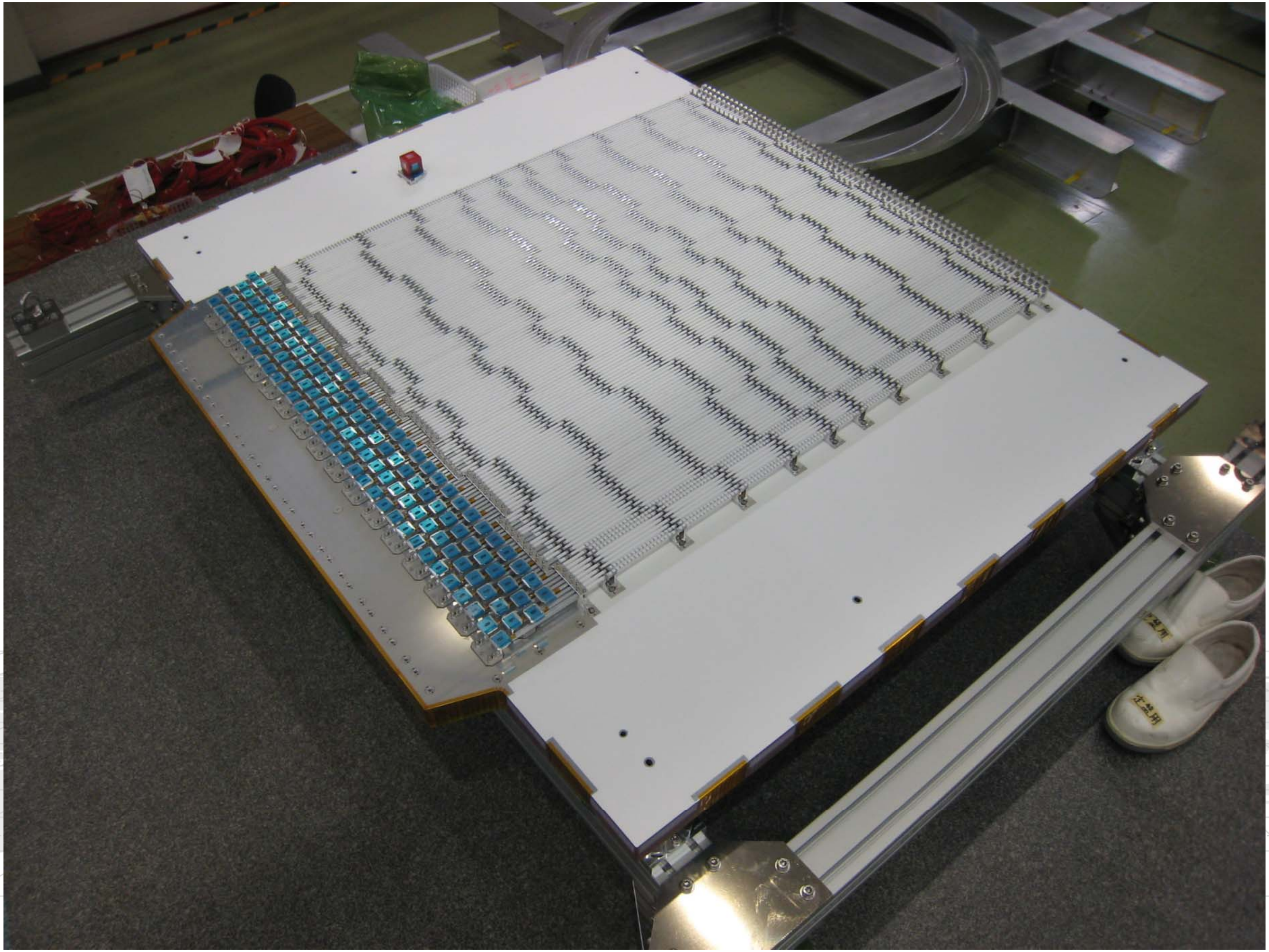
Electrical Performance Test



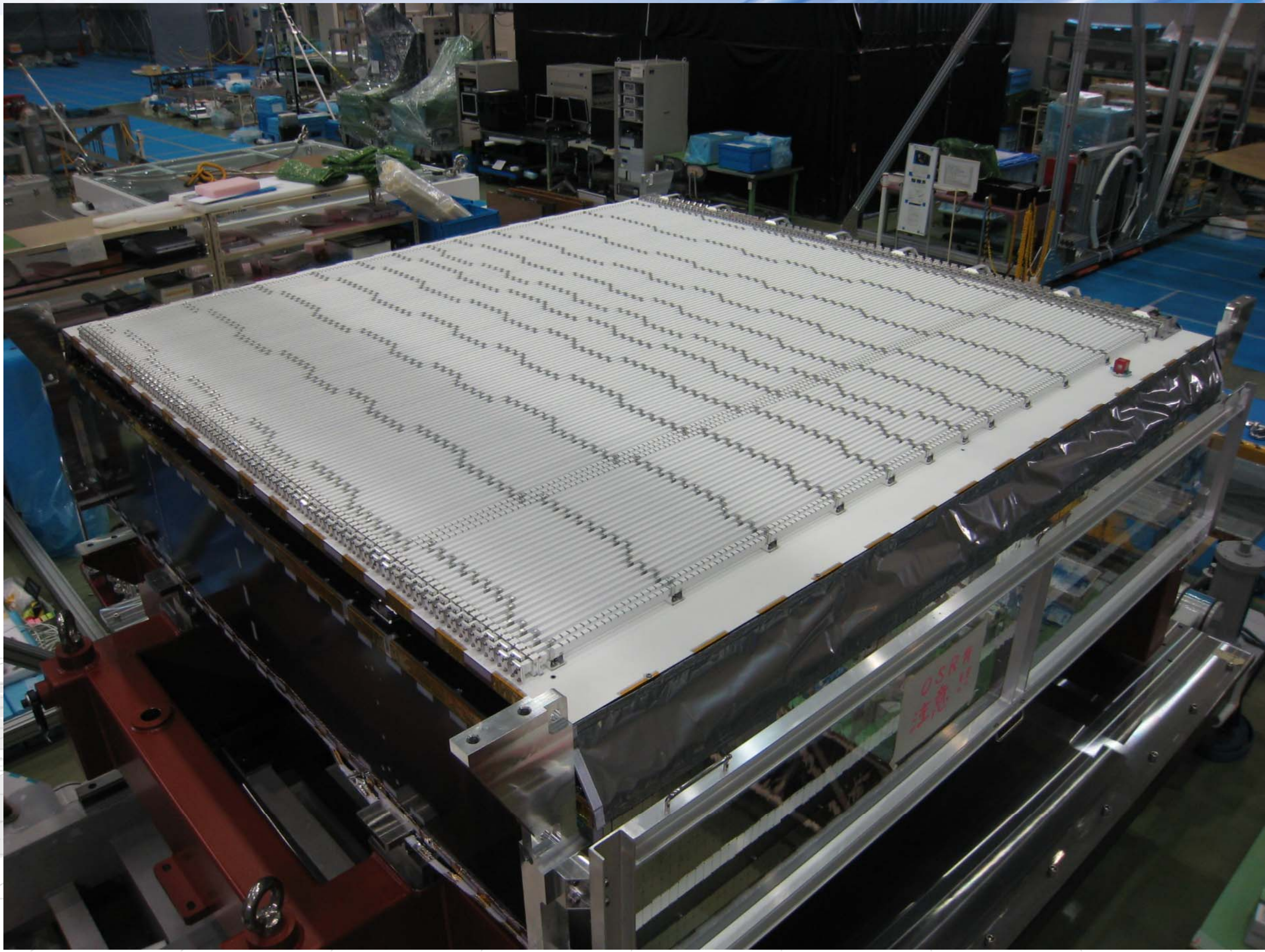
Acoustic Test
(Covers are attached in this picture.
They are removed during test)

Vibration test

KaPR antenna model for thermal test

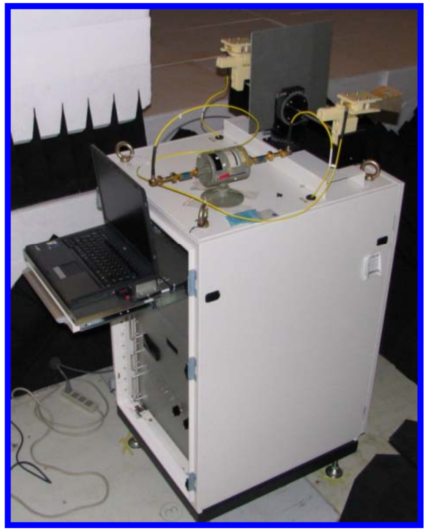


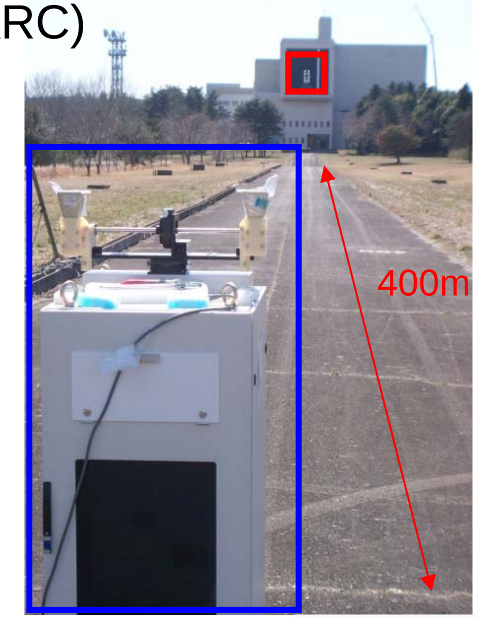
KuPR model for thermal test



KaPR RF link system test

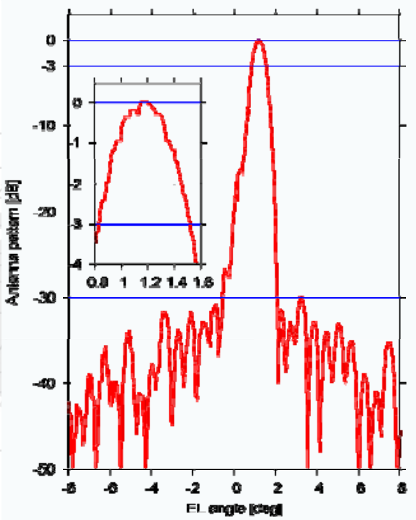
Active Radar Calibrator (ARC)



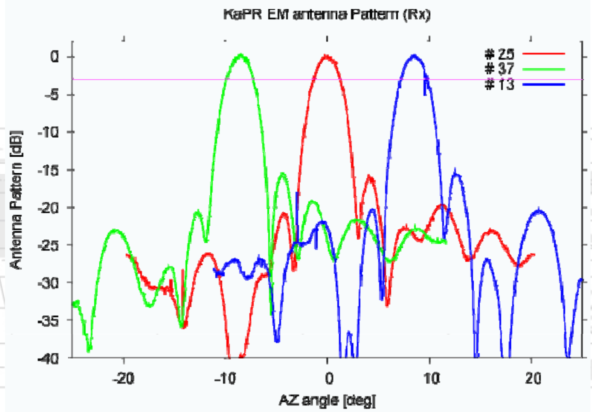


(A). Transmit beacon (CW) ⇒ Receiver
Receiving antenna pattern measurement
(B). Receiver <= Transmitter
Transmit antenna pattern measurement
(C). Transponder ⇔ radar function test

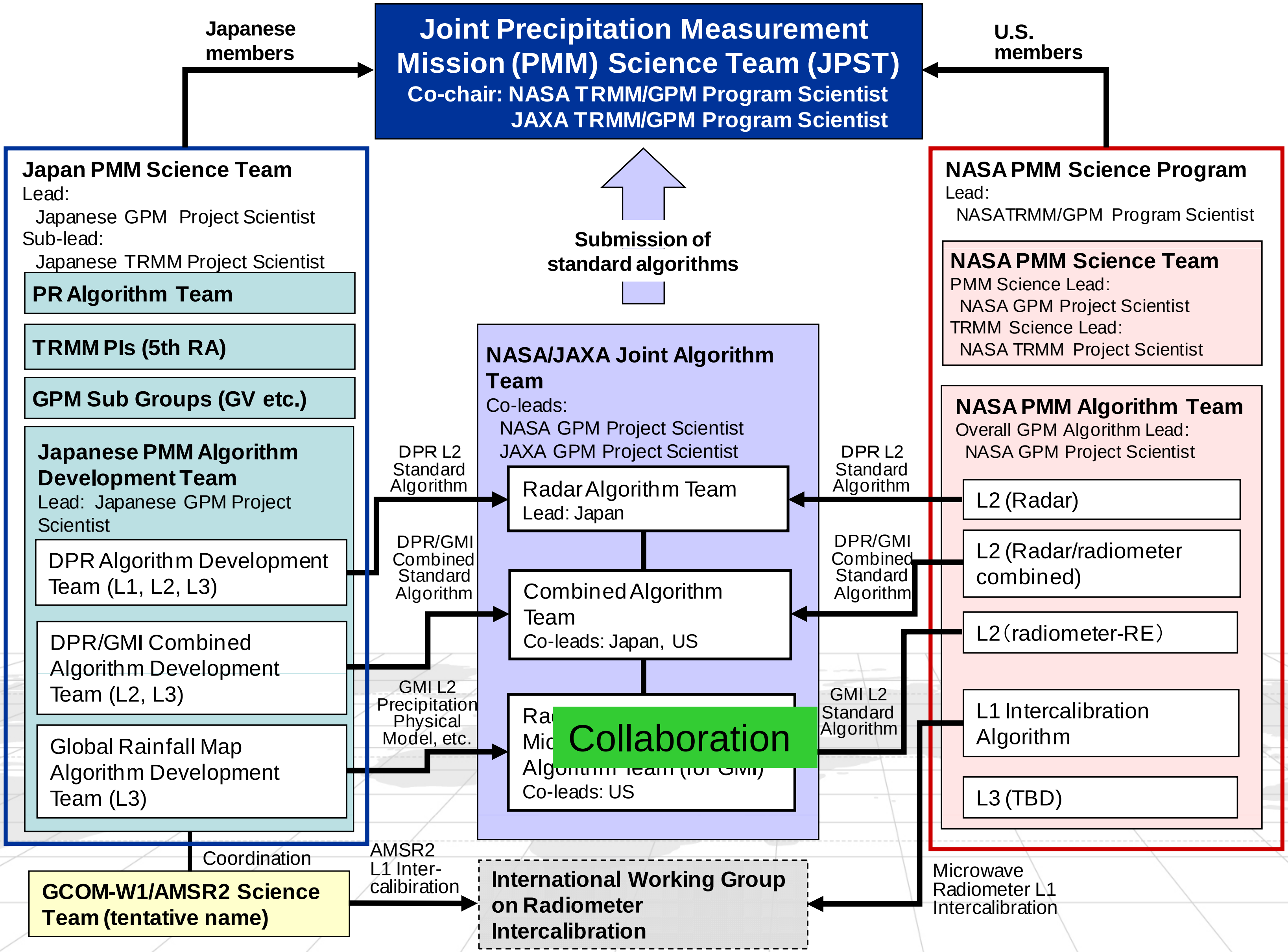
Receiving antenna pattern
(Elevation Plane)

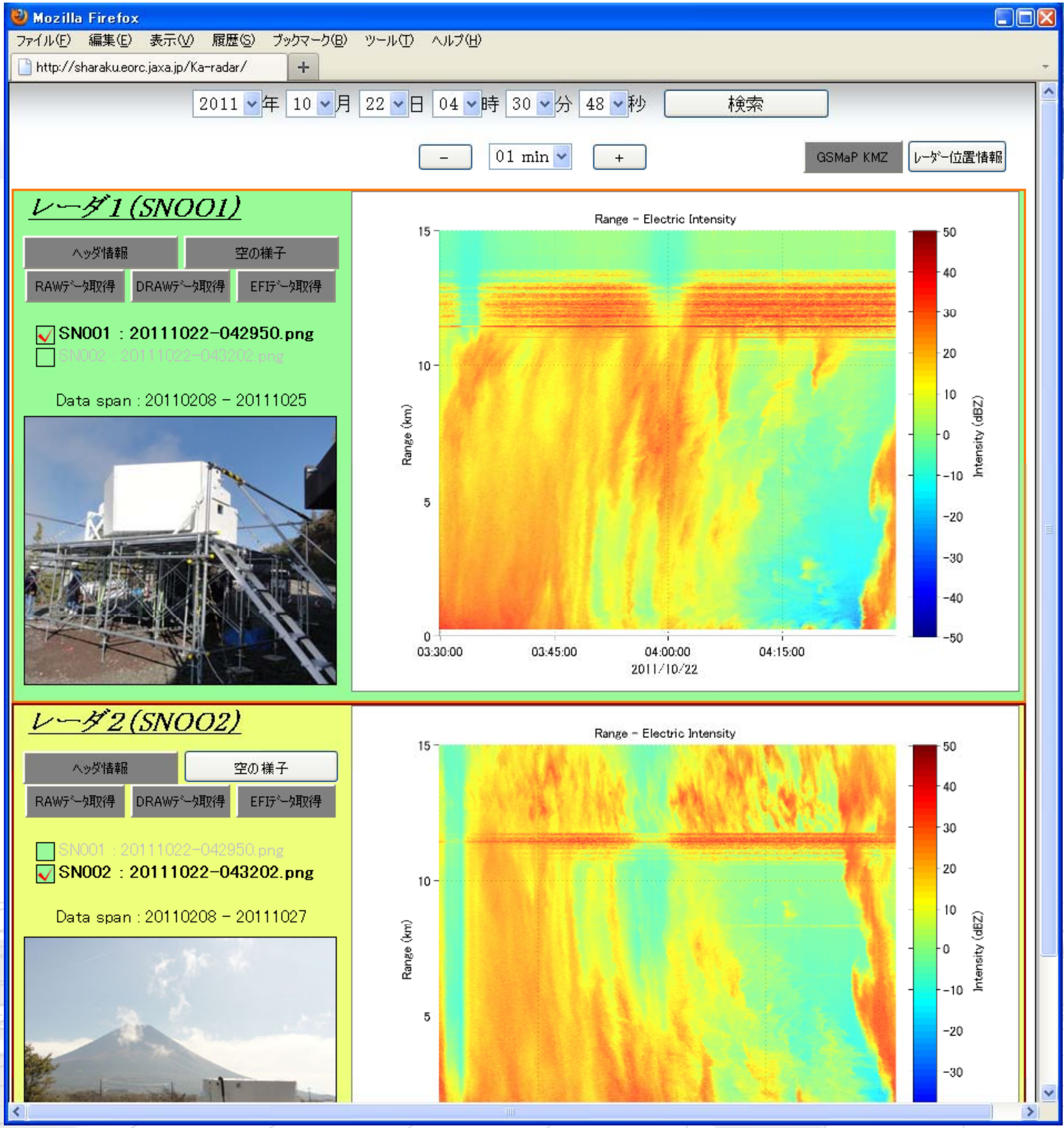


Receiving antenna pattern
(Azimuth Plane)



Japan and U.S. PMM Science Framework





Kaレーダのクイックルック画像と、同期した「空の様子」の動画を、準リアルタイムで見ることが出来ます。

Recent activities of Asian Collaboration for GPM GV

- Objectives
  - Seeking GV collaboration in Asia for achivement of the GPM mission requirement
- 2nd GPM Asia Workshop on Precipitation Data Application Technique@Tokyo (27-29 Sep. 2010)
  - Asian countries are strongly interested in the high resolution rain map products for their weather prediction models, flood monitoring, etc.

  ➔ Application of rainfall map data for operational use, cross validation of satallite data and ground-based data

  ➔ Science interactions and discussions of methodology
- KMA-JAXA collaboration meeting on Feb., Sep. 2010, Dec. 2011
  - To use Korean high temporal resolution data of rain gauges for validation of PR/DPR data
- Satellite Precipitation Session on AOGS, Jul. 2010, Aug. 2011, (Aug. 2012)
- GPM Asia WS: 7-9 Dec. 2011