

Status reports: JMA and JAXA



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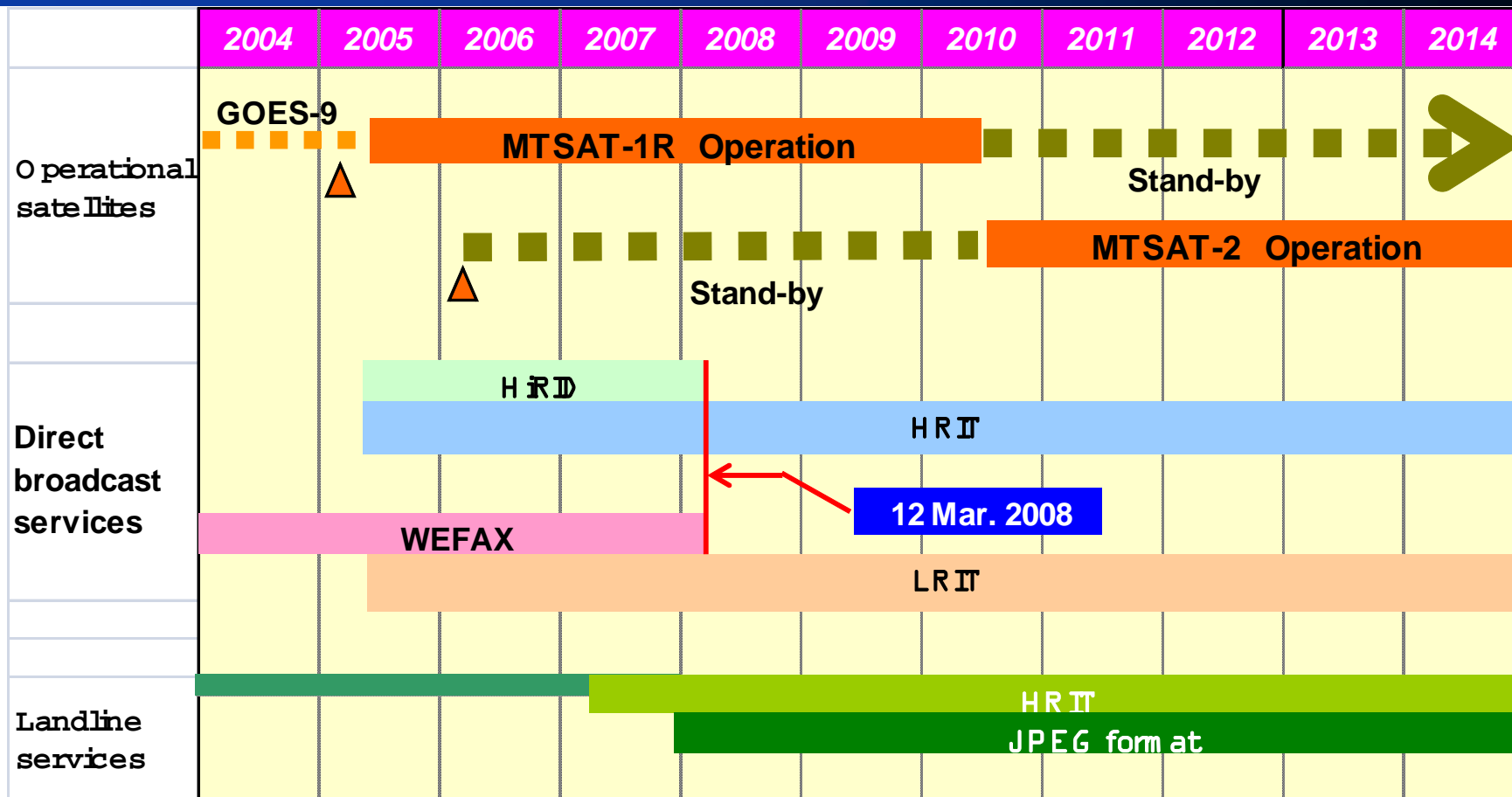


1 : Japan Meteorological Agency (JMA)
2 : Japan Aerospace Exploration Agency (JAXA)



ITSC16, Angra dos Reis, Brazil, 7-13 May 2008

JMA



- Discontinued services of **HiRID** (High Resolution Imager Data) & **WEFAX** (Weather Facsimile)
- Focus on the services of **HRIT** (High Rate Information Transmission) & **LRIT** (Low Rate Information Transmission)
- Rapid scan operation for target observation is planned in this summer for TPARC
 - THORPEX Pacific Inter-regional Predictability Campaign

MTSAT-1R	Japanese Advanced Meteorological Imager (JAMI)
Status	Operational (Utilisation period: 2005 to 2010)
Instrument type	5-channel VIS/IR radiometer
Resolution	4.0 km for IR channels; 1.0 km for the VIS channel

Central	Spectral interval
0.725 μ m	0.55 - 0.90 μ m
3.75 μ m	3.50 - 4.00 μ m
6.75 μ m	6.50 - 7.00 μ m
10.8 μ m	10.3 - 11.3 μ m
12.0 μ m	11.5 - 12.5 μ m

MTSAT-2	Imager
Status	Standby (Operational utilisation period: 2010 to 2015)
Instrument type	5-channel VIS/IR radiometer
Resolution	4.0 km for IR channels; 1.0 km for the VIS channel

Central	Spectral interval
0.675 μ m	0.55 - 0.80 μ m
3.75 μ m	3.50 - 4.00 μ m
6.75 μ m	6.50 - 7.00 μ m
10.8 μ m	10.3 - 11.3 μ m
12.0 μ m	11.5 - 12.5 μ m

■ For NWP

- Atmospheric Motion Vectors (AMV)
- Clear Sky Radiance (CSR)

■ For Cloud Monitoring

- Cloud Grid Information (amount, type, height)

■ For Ocean/Land Monitoring

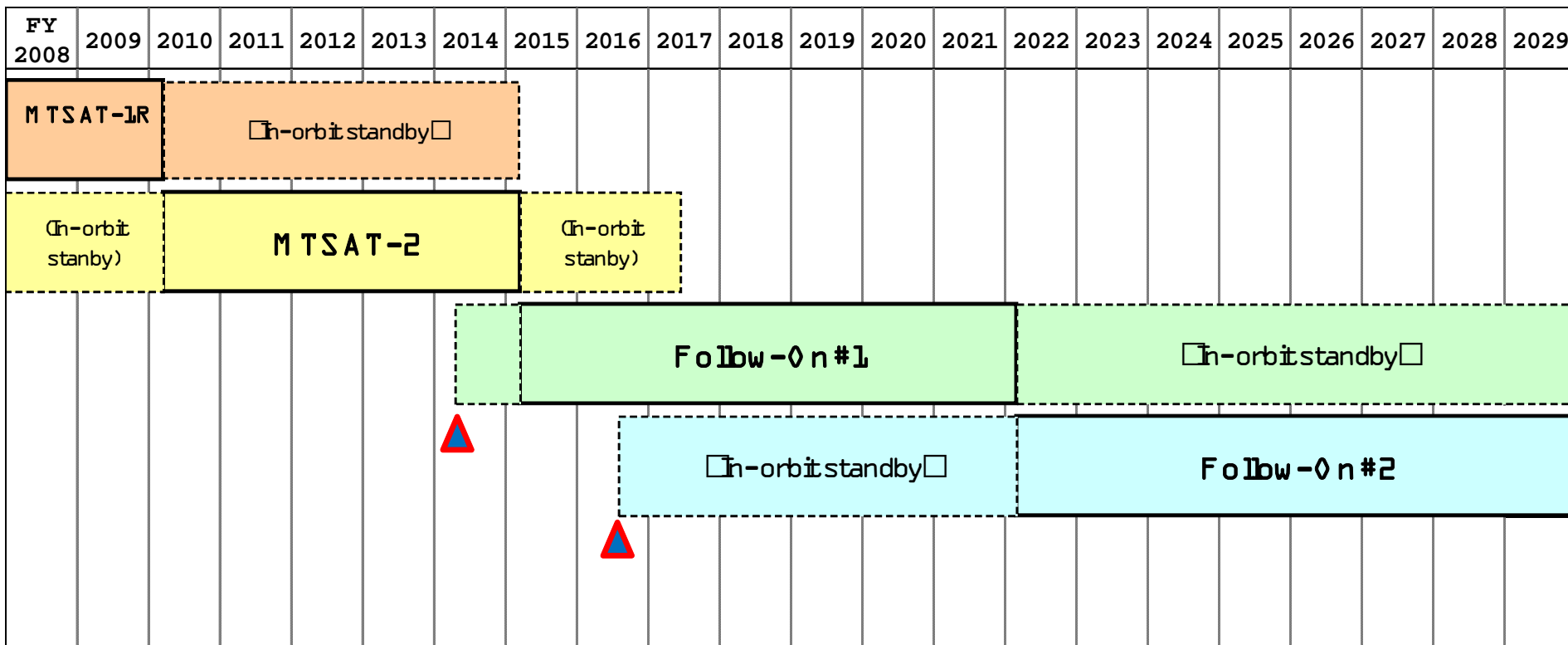
- Sea Surface Temperature
- Snow/Ice Index

■ For Environmental Monitoring

- Aerosol Optical Thickness
- Dust Detection

Tentative Plans

- launch in 2014 and 2016
- operate for $7 \times 2 = 14$ years





Tentative Plans of instruments on MTSAT follow-on



Outline of the specification of the Follow-on satellite to MTSAT-2

1. Imaging Channels

	Spatial resolution	Number of observational bands
-Visible (- 1 micron)	0.5 km	4
-Near Infrared (1-3 micron)	2 km	4
-Infrared (3 micron -)	2 km	10

2. Observation

-Repeat Cycle	< 10 min (Full Disk)	
-Scan Capability	Full Disk : Normal Operation Limited Area : Adaptive schedule, size and location	



JAXA

■ TRMM (Tropical Rainfall Measuring Mission)

- 1997 ~
- World first satellite-borne precipitation radar (PR)
- => GPM



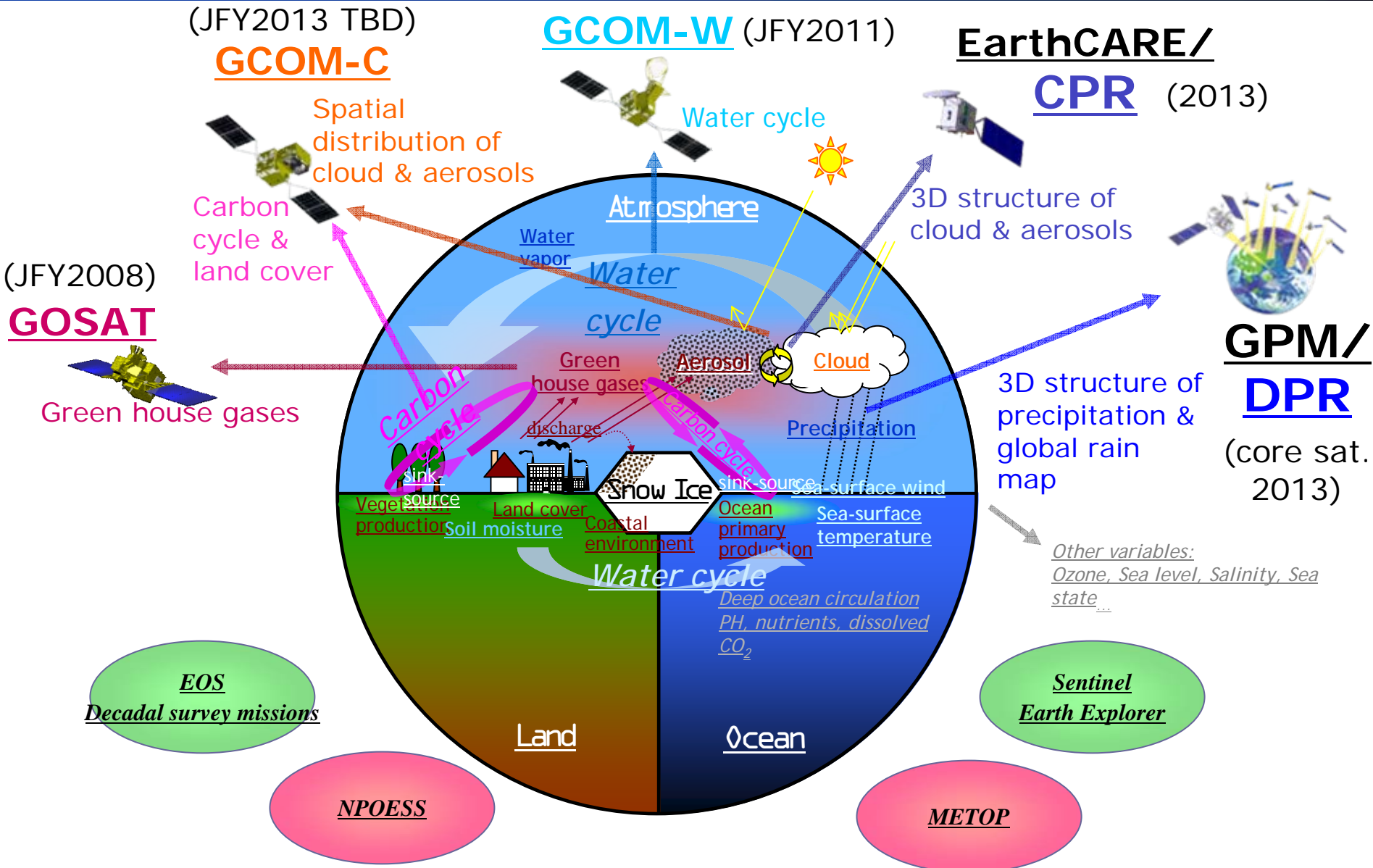
■ AMSR-E (Advanced Microwave Scanning Radiometer for EOS)

- 2002 ~
- Higher spatial resolution by using 1.6m diameter antenna
- Addition of 6.9-GHz ch for estimating SST and soil moisture
 - ▣ 6x2ch
- => AMSR2 on GCOM-W



■ ALOS "DAICHI" (Advanced Land Observing Satellite)

- 2006 ~
- Objectives: Disaster monitoring, Cartography, ...
- 3 instruments : AVNIR-2, PRISM, PALSAR
 - ▣ Advanced Visible and Near Infrared Radiometer type 2
 - ▣ Panchromatic Remote sensing Instrument for Stereo Mapping
 - ▣ Phased Array type L-band Synthetic Aperture Radar

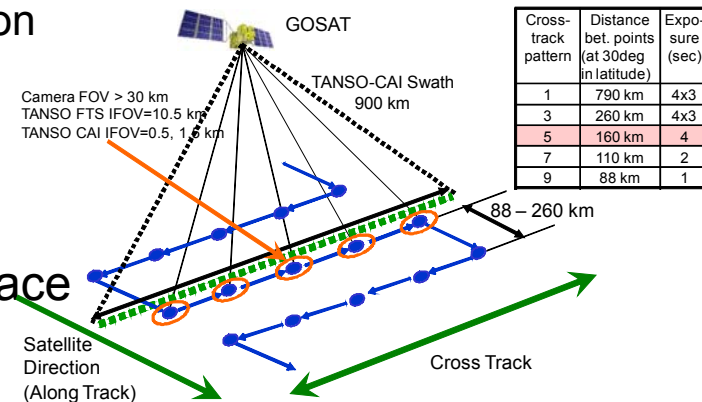


TANSO-FTS

- The Thermal And Near infrared Sensor for carbon Observation (TANSO) - Fourier-Transform Spectrometer (FTS)
- Detect CO2
 - Around the earth surface, by measuring the absorption of reflected SWIR (band-2 & 3 or 1.6 & 2.0 μm)
 - At upper levels, by measuring thermal IR radiation (band4 or 14 μm)

TANSO-CAI

- Cloud and Aerosol Imager (CAI)
- Detect and correct the cloud and aerosol interface



TANSO-FTS specifications

Configuration	2-axes scanner (fully redundant)			
Scanning	Cross Track (± 35 deg), Along Track (± 20 deg)			
Field of view	IFOV < 10.5 km (scan width), 790 km (latitude of 30 deg)			
Spectral band	1P, 1S	2P, 2S	3P, 3S	4
Coverage	0.75 - 0.78 μm	1.56 - 1.72 μm	1.92 - 2.08 μm	5.5 - 14.3 μm
resolution (cm^{-1})	0.5	0.2	0.2	0.2
SNR	>300 (measured)	>300 (measured)	>300 (measured)	>300 (target, under testing)

TANSO-CAI specifications

	Band center wavelength (μm)	Band width (nm)	Spatial resolution (IFOV) (km)	No. of pixels (cross track)	SNR (measured)
1	0.380	20	0.5	2000	>200
2	0.674	20	0.5	2000	>200
3	0.870	20	0.5	2000	>200
4	1.60	90	1.5	500	>200



- Deployable main reflector system with **2.0m** diameter.
- Frequency channel set is identical to that of AMSR-E except **7.3GHz** channel for **RFI mitigation**.
- 2-point external calibration with the **improved HTS (hot-load)**.

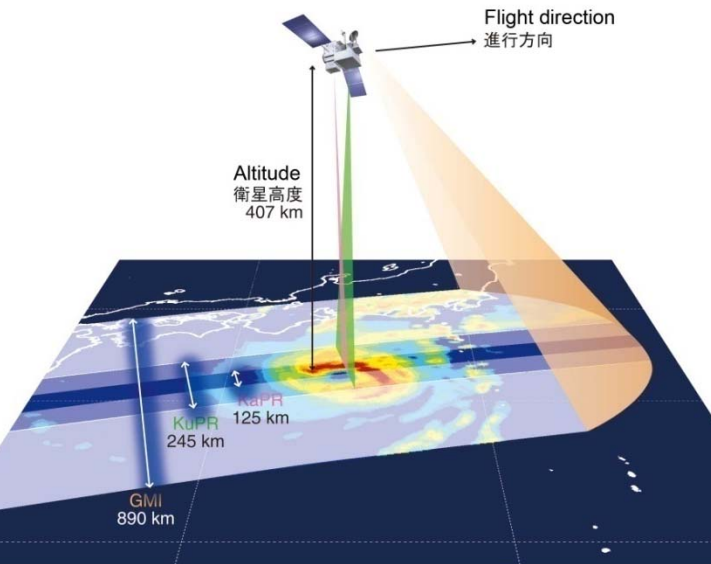
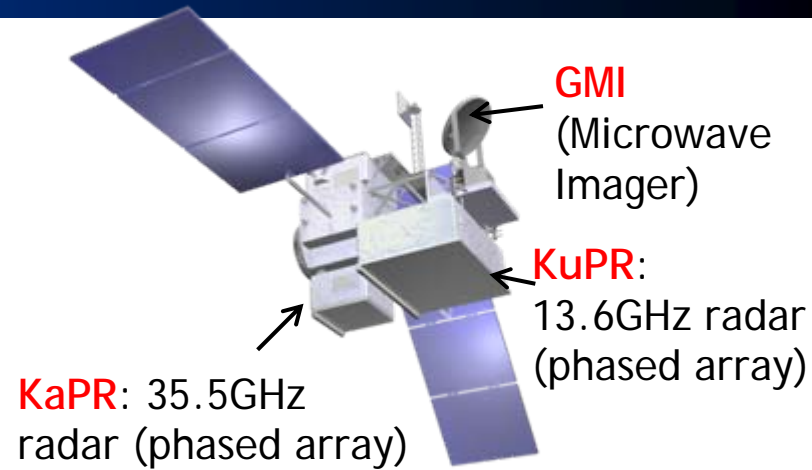
AMSR2 Channel Set				
Center Freq. [GHz]	Band width [MHz]	Polarization	Beam width [deg] (Ground res. [km])	Sampling interval [km]
6.925/ 7.3	350	V and H	1.8 (35 x 62)	10
			1.7 (34 x 58)	
10.65	100		1.2 (24 x 42)	
18.7	200		0.65 (14 x 22)	
23.8	400		0.75 (15 x 26)	
36.5	1000		0.35 (7 x 12)	
89.0	3000		0.15 (3 x 5)	5

■ Second Generation Global Imager

GCOM-C SGLI characteristics	
Scanning Type	SGLI-VNR Push-broom electric scan (VN & P) SGLI-IRS Wisk-broom mechanical scan (SW & T)
Observation Channel (see right table for details)	SGLI-VNR (Visible & Near infrared) Non-Polarized Observation 11 channel Polarized Observation 2 channel SGLI-IRS Shortwave infrared 4 channel Thermal infrared 2 channel
Swath	1150km cross track (VN & P) 1400km cross track (SW & T)
Digitalization	12bit
Polarization	3 polarization angles for P
observing direction	P : Along Track at 0, +45 and -45 deg VN, SW and T : Nadir
LTDN	Descending local time - 10: 30

SGLI channels						
CH (19)	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR at L_{std}	IFOV
	VN, P, SW: nm T: μm		VN, P: $\text{W}/\text{m}^2/\text{sr}/\mu\text{m}$ T: Kelvin		VN, P, SW: - T: NE Δ T	m
VN1	380	10	60	210	250	250
VN2	412	10	75	250	400	250
VN3	443	10	64	400	300	250
VN4	490	10	53	120	400	250
VN5	530	20	41	350	250	250
VN6	565	20	33	90	400	250
VN7	670	10	23	62	400	250
VN8	670	20	25	210	250	250
VN9	763	8	40	350	400	1000
VN10	865	20	8	30	400	250
VN11	865	20	30	300	200	250
P1	670	20	25	250	250	1000
P2	865	20	30	300	250	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	1640	200	3	50	57	250
SW4	2210	50	1.9	20	211(TBD)	1000
T1	10.8	0.7	300	340	0.2	500
T2	12.0	0.7	300	340	0.2	500

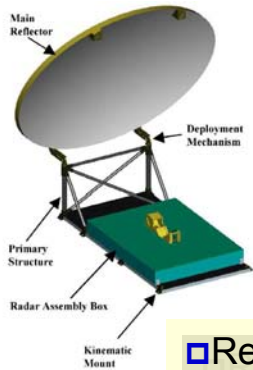
- The major sensors on the GPM core satellite are
 - the Dual-frequency Precipitation Radar (DPR) by JAXA and NICT
 - the GPM Microwave Imager (GMI) by NASA.
- DPR radar will measure
 - intense rain in tropics by 14GHz
 - weak rain & snow in mid/ high-latitudes by 35GHz



GPM Primary Satellite characteristics

Orbit	sun-asynchronous
Inclination	Apporox. 65 degrees
Altitude	Apporox. 407 km
Mission Instrument	Dual-frequency Precipitation Radar (DPR) Passive Microwave Radiometer (GMI)
Swath width	245 km (KuPR), 100 km (KaPR), 850km (GMI) 10.65, 18.7, 23.8, 36.5, 89 GHz V&H
Resolution	DPR: 5km, Range Resolution 250 m GMI: 19.4x32.2km (10.65GHz), 11.2x18.3km (18.7GHz), 9.2x15.0km (23.8GHz), 8.6x14.4km (36.5GHz), 4.4x7.3km (89.0GHz)
Mission Life	Apporox. 3 years (5 years target)

Cloud Profiling RADAR (CPR) – JAXA/NICT

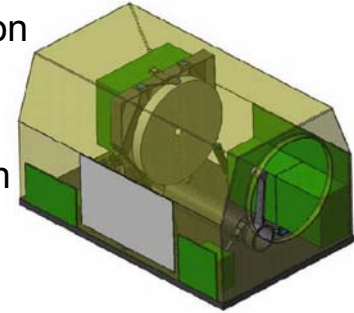


- ▣ Frequency: 94.05GHz
- ▣ VPRF: 6000~7200Hz
- ▣ Reflector Dia.: 2.5m
- ▣ Resolution(H/V): 500/100m
- ▣ Height: 0.5~20km
- ▣ Field of View: 650m
- ▣ Dynamic range: -35~+21dBZ
- ▣ Doppler : -10~+10m/s

- ▣ Reflectivity profiles
- ▣ Doppler profiles
- ▣ Doppler spectral width profiles

Atmospheric LIDAR (ATLID) - ESA

- ▣ λ_c : 355nm high spectral resolution
- ▣ PRF: 70Hz
- ▣ 3 channels
 - ▣ Mie[Co/Cross-Polar], Rayleigh
 - ▣ Height \square -0.5~30km
- ▣ Resolution(V): 100m(Mie)
- ▣ FOV: 80 μ rad



- ▣ Rayleigh profiles
- ▣ Mie profiles
- ▣ Depolarisation profiles

Multi-spectral Imager (MSI) -ESA

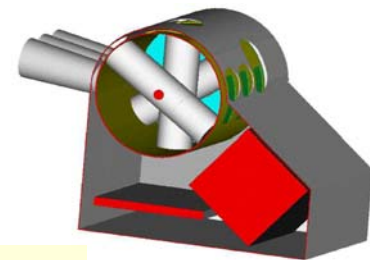


- ▣ 7 channels:
 - ▣ 0.659, 0.865, 1.61, 2.2, 8.8, 10.8, 12.0 μ m
- ▣ SNR >500(VNIR), >250(SWIR)@ $\rho=1.0$
- ▣ NE Δ t < 0.25K@293K
- ▣ FOV: 0.5kmx0.5km
- ▣ Swath: 150km

- ▣ Radiances in all 7 channels

Broadband Radiometer (BBR) - ESA

- ▣ 3 Direction: Nadir, ± 55 deg
- ▣ 2 channels:
 - ▣ 0.4~4.0 μ m
 - ▣ 4.0~50 μ m
- ▣ FOV: 10kmx10km

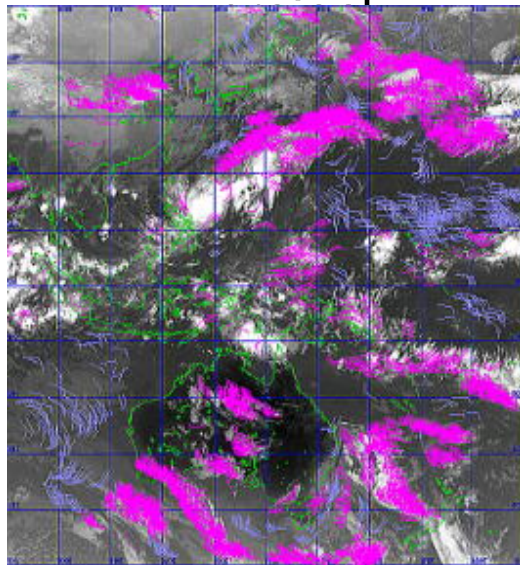


- ▣ Radiances in all 6 channels

* Specifications are all preliminary

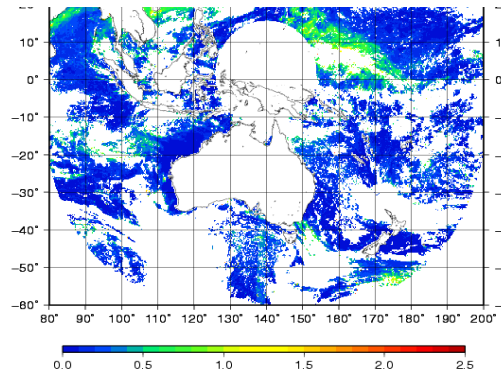
End

AMVs Reprocessing for Japanese ReAnalysis (JRA)

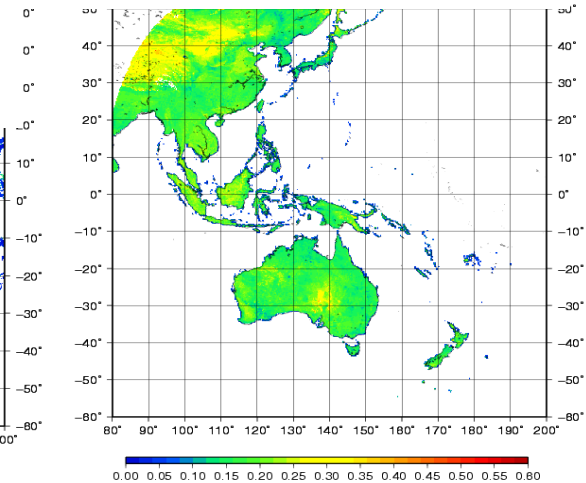


VIS Data Reprocessing (in collaboration with Tokyo Univ.)

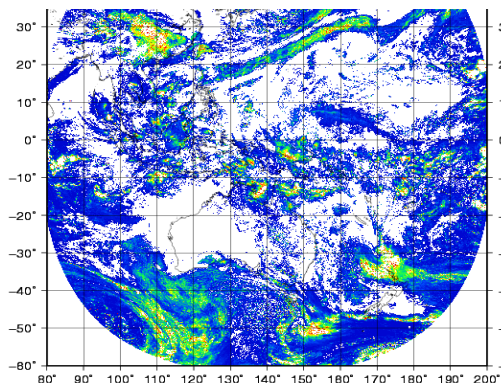
Aerosol Optical Thickness over the sea



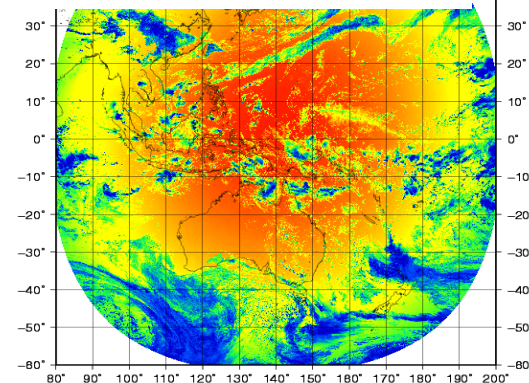
Land Surface Albedo



Cloud Optical Thickness







Downward Solar Flux at Surface



These products are used for climate monitoring and diagnosis.

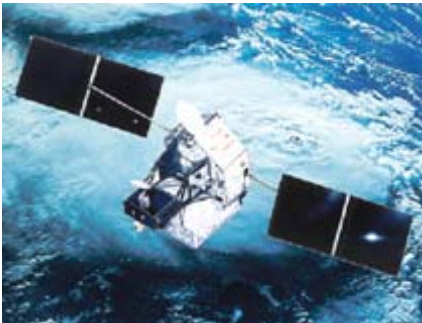
The Long Term Plan of JAXA Earth Observation



Japanese Contribution Field	Observation Parameter	JFY 2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Reduction and Prevention of Disasters	Land-cover change, volcanic ash fall, flooded area, etc.	Terra/ASTER 																	
	Crustal deformation, biomass, flooded area, etc.																		
Climate Change including Water Cycle Variation	3D structure of precipitation, soil moisture, etc.	TRMM/PR 																	
	Precipitation, water vapor, sea surface temperature, etc.	Aqua/AMSR-E 																	
	Sea surface wind vector, etc.	ADEOS-II/SeaWiFS																	
	Cloud optical thickness, aerosol optical thickness, land biomass, etc.	ADEOS-II/GLI																	
	3D distribution of cloud and aerosol, etc.																		
	Carbon dioxide(CO ₂), methane(CH ₄), etc.	ADEOS-II/LAS-II 																	
Global Warming and Carbon Cycle Change	Carbon dioxide(CO ₂), methane(CH ₄), etc.																		

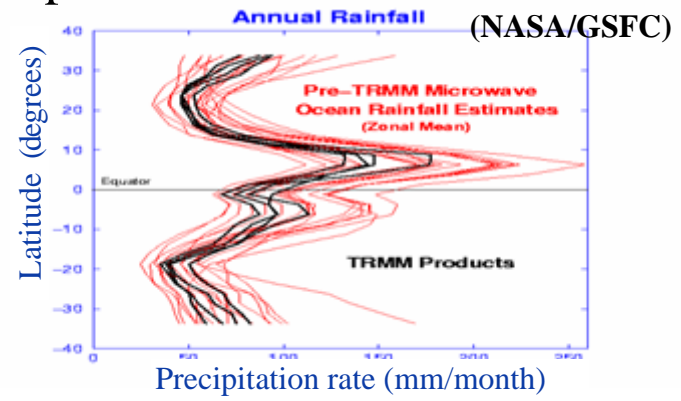
Approved Project
 Planned Project
 GEOSS 10-Year Implementation Period

Legends: Satellite name/Sensor name Japanese Satellite/Japanese Sensor, Foreign satellite/Foreign Sensor

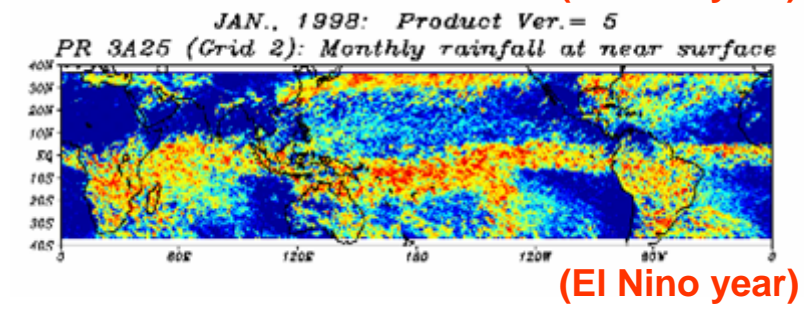
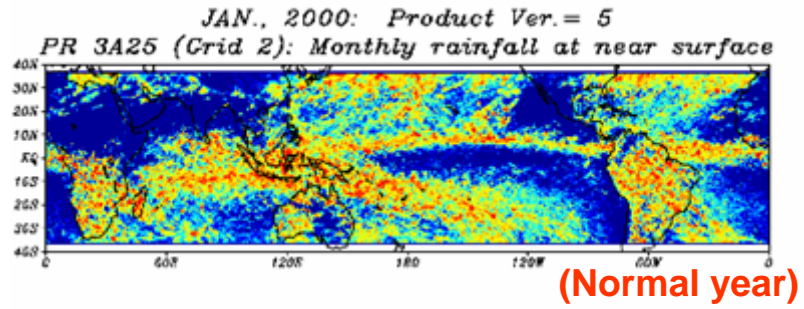


- Japan-U.S. joint mission, launched in Nov. 1997 by H-II rocket.
- More than 10-year observation of tropical/subtropical rainfall.
- World first satellite-borne precipitation radar (PR).
- Simultaneous rainfall observation by radar (PR), microwave radiometer (TMI) and VIS-IR imager (VIRS).

Improvement of rain estimation

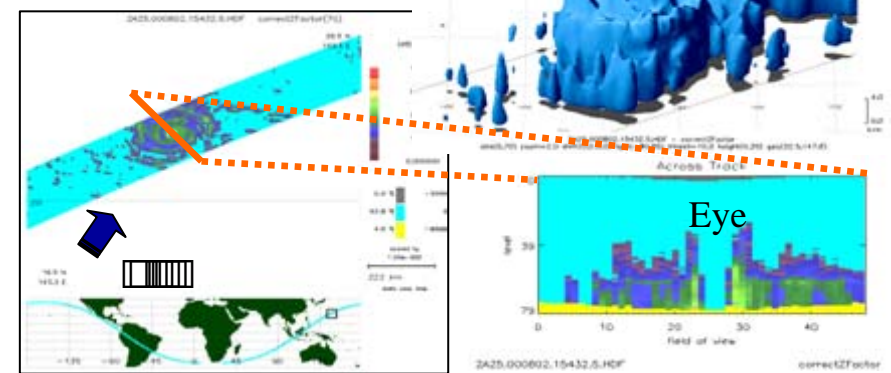


Global rainfall monitoring



3D-observation

Typhoon observed Aug. 2, 2000 over pacific ocean.



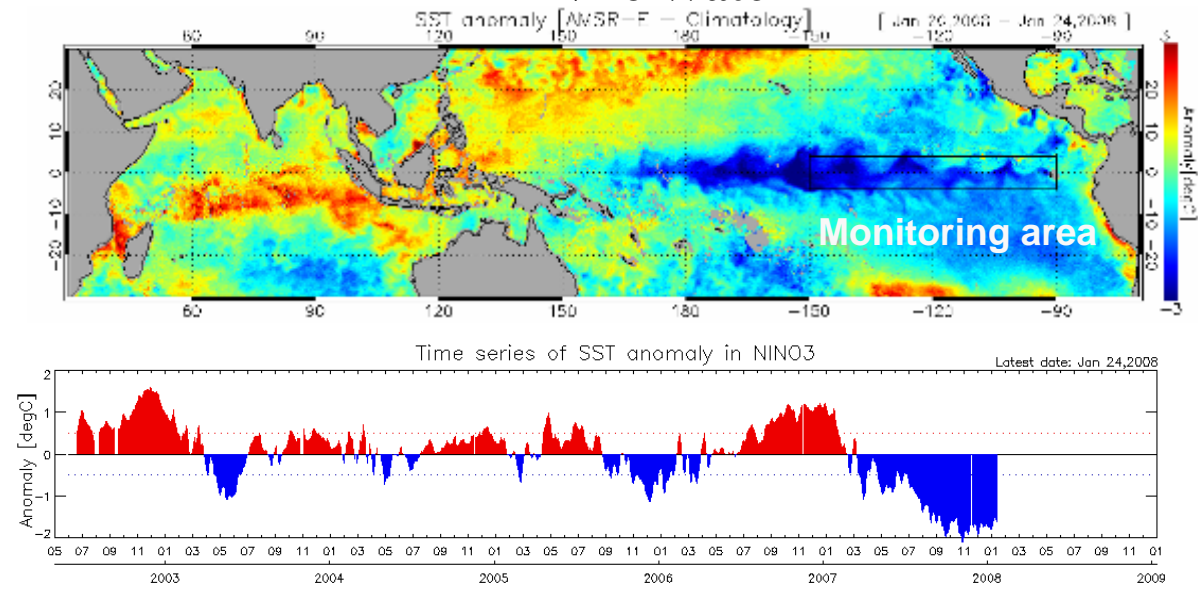
AMSR-E



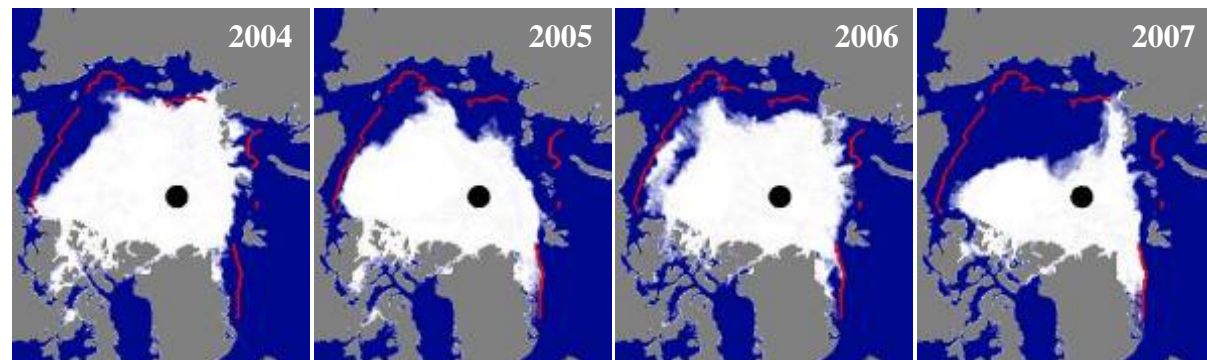
NASA/Aqua

- Launched in May 2002.
- Over 5-year observation.
- Multi-frequency, dual-polarized passive microwave radiometers for observing global climate and hydrology.
- Higher spatial resolution compared to existing instruments (e.g., SSM/I) by using **1.6m diameter antenna**.
- **Addition of 6.9-GHz channels** for estimating SST and soil moisture.
 - 6x2 channels

El-Nino Watch

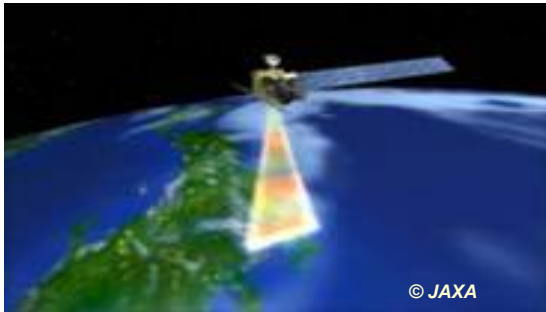


September sea ice distribution in the Arctic



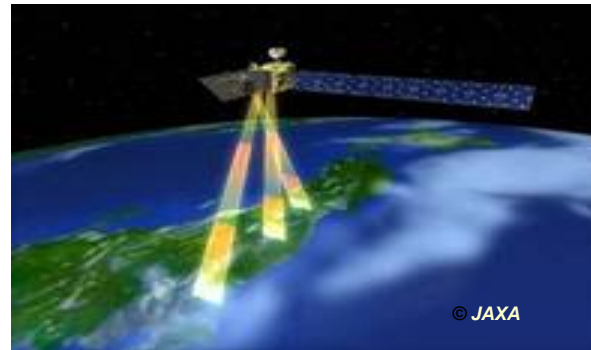
Observation date: September 20

- launched on January 24th, 2006
- Objectives
 - Disaster monitoring
 - Cartography
 - Regional observation
 - Resources surveying



AVNIR-2

Advanced Visible and Near Infrared Radiometer type 2



PRISM

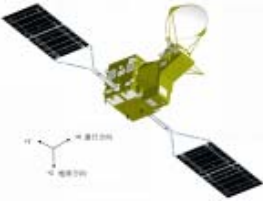
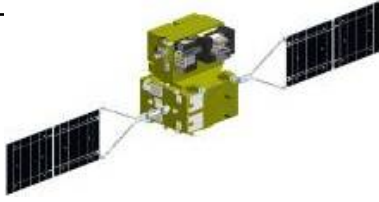
Panchromatic Remote sensing Instrument for Stereo Mapping



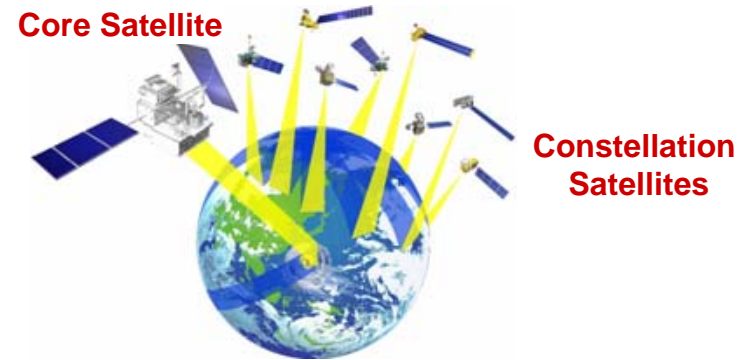
PALSAR

Phased Array type L-band Synthetic Aperture Radar

- Contribute to improving climate change prediction in concert with climate model research institutions
 - GCOM-C targets water energy cycle
 - GCOM-W targets surface and atmospheric variables related to carbon cycle and radiation budget
 - 3x5=15years

	GCOM-W	GCOM-C
Orbit	Type : Sun-synchronous, sub-recurrent Altitude : 699.6 km Inclination : 98.19 degrees Local time of ascending node : 13:30	Type : Sun-synchronous, sub-recurrent Altitude : 798 km Inclination : 98.6 degrees Local time of ascending node : 10:30
Satellite overview		
Launch vehicle	H2A launch vehicle	
Mass	1880kg (AMSR2 400 kg)	1950 kg (SGLI 400 kg included)
Instrument	AMSR2	SGLI
Launch	JFY 2011	JFY 2013 (TBD)

- The Global Precipitation Measurement (**GPM**) is a follow-on and 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 2013)

Constellation Satellites (International Partners)
Microwave radiometers
Microwave sounders

- Global precipitation around every 3 hours

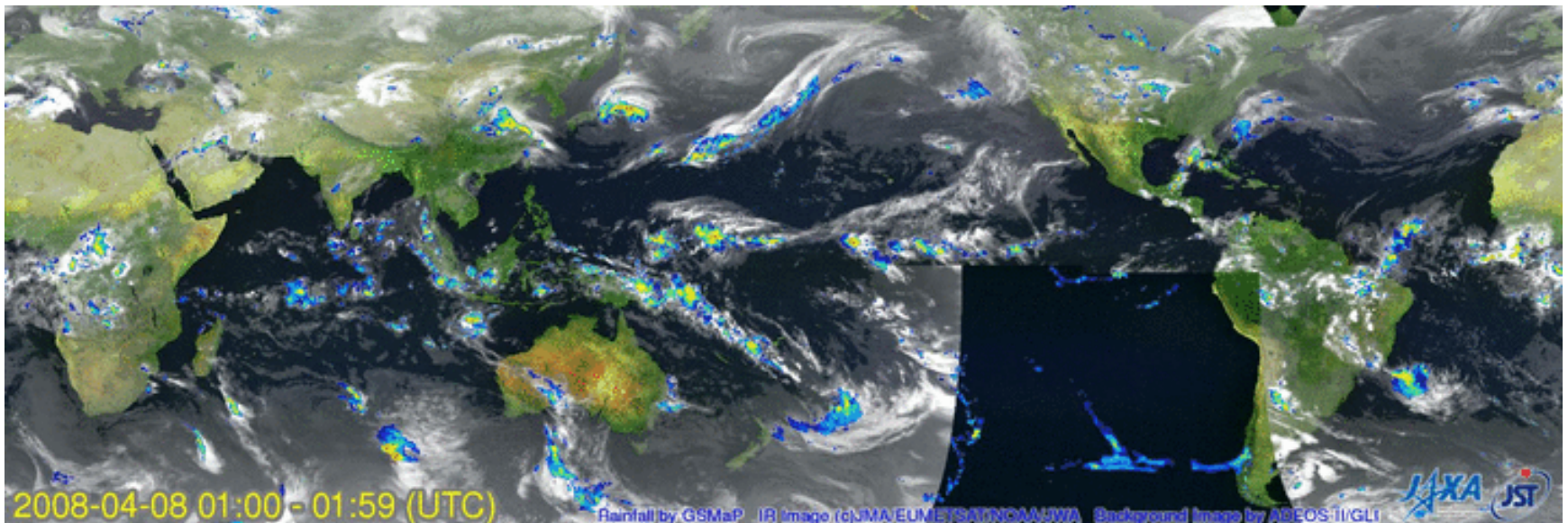
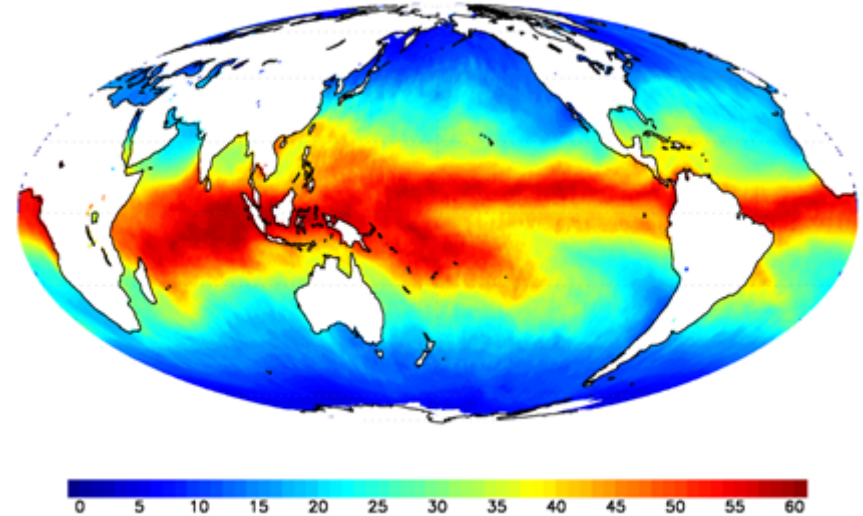
(launch around 2013)



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

- As a precursor of GPM, JAXA is providing the 0.1 degree grid, hourly global precipitation map in near real-time (4 hours after observation) by using microwave radiometers, such as AMSR-E, TMI and SSM/I, and Geo-IR information.
- Utilizing the results of the GSMaP (Global Satellite Mapping of Precipitation) project sponsored by the Japan Science and Technology Agency.

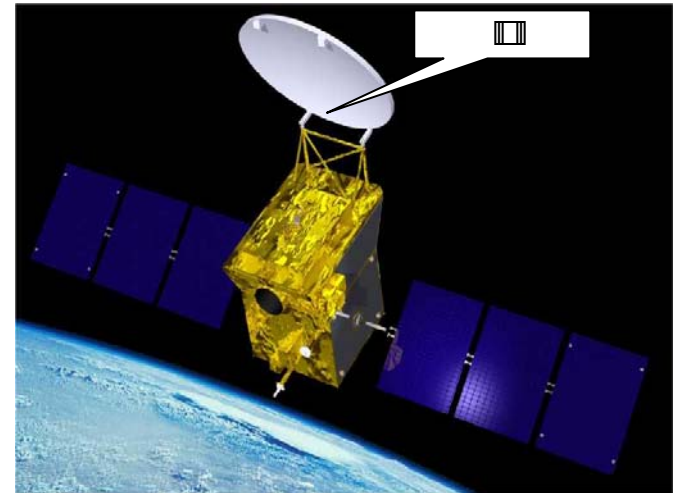
AMSR 200304 Monthly TPW (kg/m²) Takeuchi Algorithm



2008-04-08 01:00 - 01:59 (UTC)

Rainfall by GSMaP IR Image (c)JMA/EUMETSAT/NOAA/JAXA Background Image by ABEOS-II/GLI

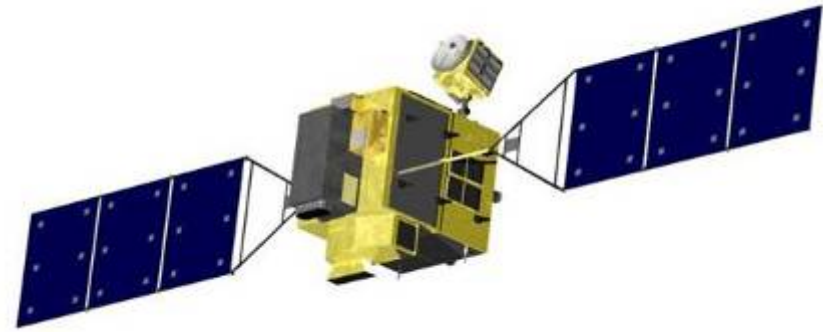
- Climate monitoring of earth radiation, cloud and aerosol
 - Vertical profile of clouds, aerosol
 - Interaction between clouds and aerosol
 - Cloud stability and precipitation
- Cooperation between ESA and JAXA
- Specifications of the satellite
 - Mass □ approx. 1300kg
 - Orbi □ Sun-synchronous Polar (13:30)
 - 4 Instruments
 - Launcher: Denepr/PSLV/Vega (TBD)
 - Operation (ESA)
 - 2013 Launch for 2~3 year mission



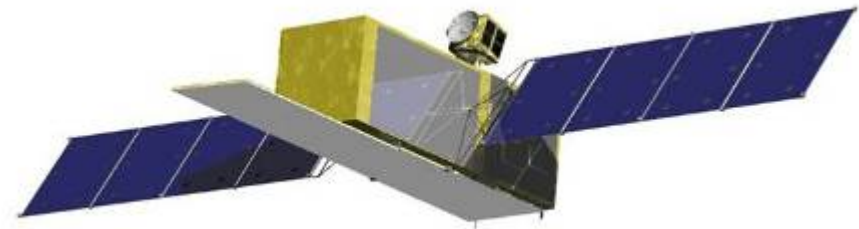
- **ALOS F/O Mission is for disaster monitoring**
 - Disaster monitoring (main mission)
 - Regional observation
 - Cartography
 - Resources surveying

Current System Concept

- Monitoring disaster area affected by earthquake, volcano, flood, etc.
- Observing the disaster affected area within 3 hr (6 hr in night)
- A satellite constellation of 2 optical sensor satellites and 2 SAR satellites
- Higher spatial resolution: 1-2m (pan), 3-5m (multi), 5m (SAR)



Optical Sensor Satellite



SAR Satellite

■ Launch in 2008

■ Objectives

1. Observe CO₂ and CH₄ column density
 - at 100-1000km spatial scale (with scanning mechanical)
 - with relative accuracy of 0.3-1% for CO₂ (1-4ppmv, 3 month average).
2. Reduce sub-continental scale CO₂ annual flux estimation errors by half
 - 0.54GtC/yr-0.27GtC/yr

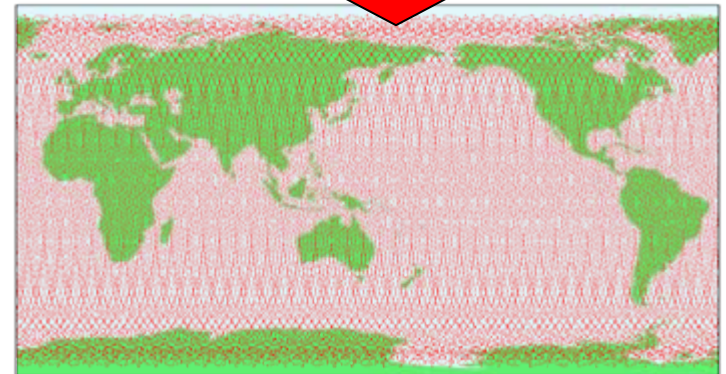
✓ Designed Life Span: 5years

✓ Orbit Plan: Altitude 666km, Sun-Synchronous Sub-Recurrent Orbit

✓ Orbit Inclination: 98deg.

✓ 2 instruments onboard

Current Ground-based Observation Points (320pts)
 Provided by WMO WDCGG



Increase of Observation Points using GOSAT
 (56,000pts for 3 days)

