Status of GCOM-W1 and GCOM-W2

OVWST

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CONTENTS

- What is GCOM mission
- AMSR-E status
- GCOM-W1 satellite
- GCOM-W1 calibration
- AMSR-E reprocessing
- International cooperation
- GCOM-W2
- Conclusions

GCOM Mission

- **Continuation of ADEOS Ⅱ**
- **Contribution to GEOSS**
- **Climate, Weather, Water, Ecosystem, Agriculture, etc. in GEOSS 9 areas**
- **Focus on Climate change / Global warming and Water cycle committed in Summit**
- **Contribution to operational fields like weather forecast, fisheries, etc.**
- **Long term continuous measurements**

Scientific Targets

- **Accurate estimation of aerosol radiative forcing**
- **Validation of climate models**
- **Accurate estimation of primary production**
- **Better understanding of coastal phenomena**
- **Better understanding of sea ice trend**

Operational Applications

- **Input to NWP**
- **Extreme weather forecasting**
- **Fisheries**
- **Navigation**
- **Coastal management**
- **Crop yield estimation**
- **Monitoring forest decrease**
- **Monitoring volcano eruptions**
- **Monitoring forest fire**

AMSR-E Status

Status of Aqua/AMSR-E

- Mission status
  - Nearly 8-years observation after the launch on May 4, 2002 onboard NASA's EOS Aqua satellite.
  - Stable brightness temperature records, except the loss of 89GHz-A data from November 2004.
  - Motor torque increase and ADE fail-over to redundant system.
- Instrument characteristics
  - Multi-frequency and dual polarization radiometer developed by JAXA.
  - Main reflector with diameter of 1.6m.
  - 6.9GHz channels for SST and soil moisture retrievals.
  - Afternoon (1:30 pm) equatorial crossing time that is currently unique for microwave radiometers.

Pre-launch AMSR-E in Tsukuba Space Center

Radiometric Correction: Two Steps

Step 1 : PRT method

- Multiple regression model of T_{eff} using eight PRT readings.
- Coefficients of the regression model were determined by using SSM/I oceanic Tb (18GHz and higher channels) and computed Tb (6 and 10GHz channels) based on the Reynolds OI-SST analysis.

$$T_{B\_HTS} = T_0 + \sum_{i=1}^{8} F_i \cdot T_{Pt\_i}$$

HTS Effective Temp. PRT readings

SSM/I data were provided by the Global Hydrology Resource Center (GHRC) at the Global Hydrology and Climate Center, Huntsville, Alabama, USA. Reynolds OI-SST dataset were made available by NOAA.

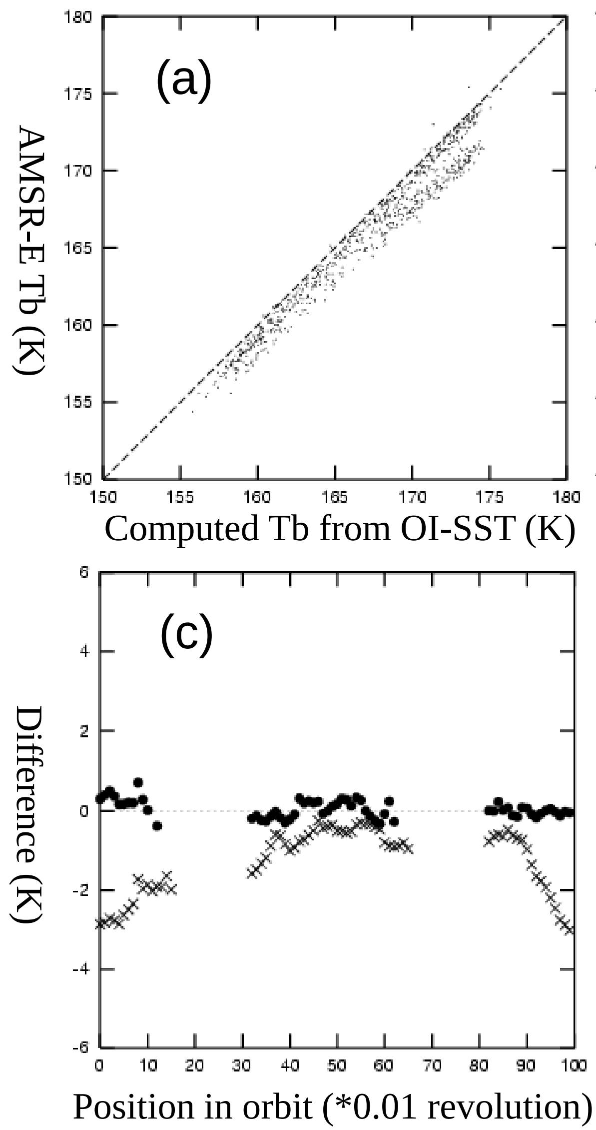
Step 2 : RxT method

- Utilize Relationship between receiver temperature and its gain variation.
- Applying this equation to HTS measurement and assuming T_{eff} derived by regression model as T_{OBS}, b_{RX} can be computed by regression analysis. Using this value, gain variations can be compensated by the equation.

$$T_{OBS} = \frac{C'_{OBS} - C'_{CSM}}{G_0 \cdot (1 + b_{RX} \cdot \Delta T_{RX})} + T_{CSM}$$

T_{OBS}	: Scene Tb (K)
T_{CSM}	: Deep space Tb (K)
C'_{OBS}	: Digital counts of scene
C'_{CSM}	: Digital counts of deep spece
G_0	: Nominal gain
b_{RX}	: Gain sensitivity to rec. temp. (℃$^{-1}$)
ΔT_{RX}	: Rec. temp. departure from mean value (℃).

Radiometric Correction : Results



Comparison between computed Tb based on OI-SST and AMSR-E Tb by (a) simple two-point calibration and (b) presented method for 6.925-GHz vertical polarization on July 4, 2002. (c) Daily average of difference between computed and AMSR-E Tb as a function of position in orbit for simple two-point calibration (cross) and presented method (closed circle).

GCOM satellites

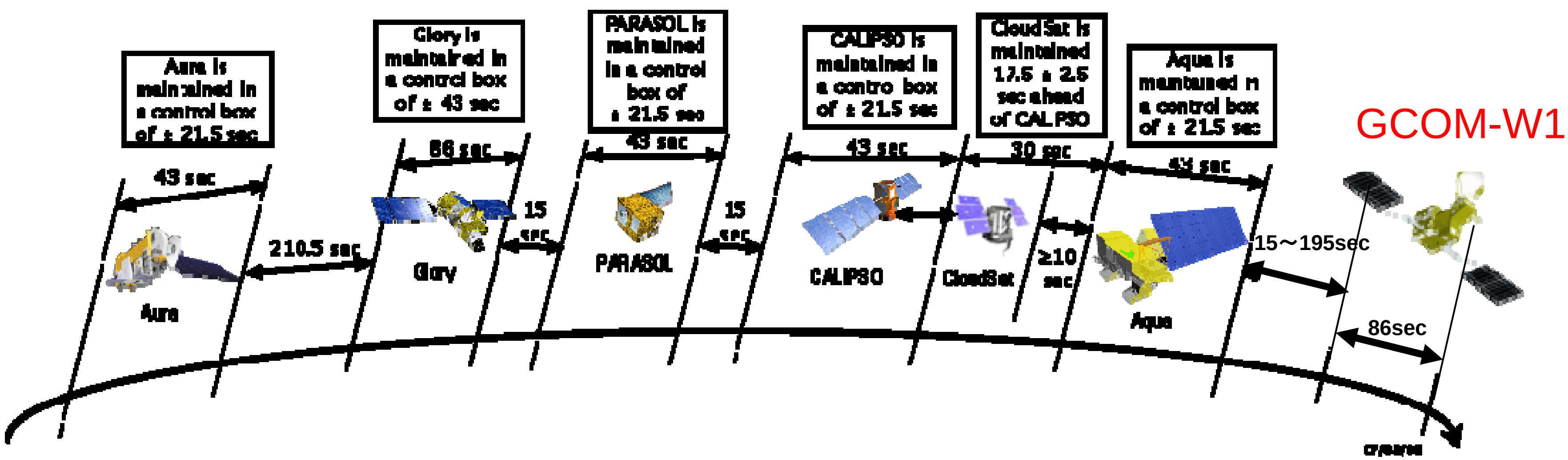
- **GCOM-W1**
  - **AMSR2 (Advanced Microwave Scanning Radiometer 2)**
  - **Planned to be launched on Nov., 2011**
- **GCOM-C1**
  - **SGLI (Second generation Global Imager)**
  - **Planned to be launched in fiscal 2013**
- **Plan for the 2nd and 3rd generations**
  - **GCOM-W2 (in 2015), GCOM-W3 (in 2019)**
  - **GCOM-C1 (in 2017), GCOM-C3 (in 2021)**

GCOM-W1

- Orbit : A-train
  - Sun synchronous orbit
  - Height: about 700km
  - Local time of ascending node: 13:30
- Weight: about 1.99t
- Power : about 3.9kW
- Lifetime: 5 years
- Data transmission
  - Global observation data are stored and transmitted every orbit period
  - Observed data are transmitted to ground stations in real time

A-Train and GCOM-W1

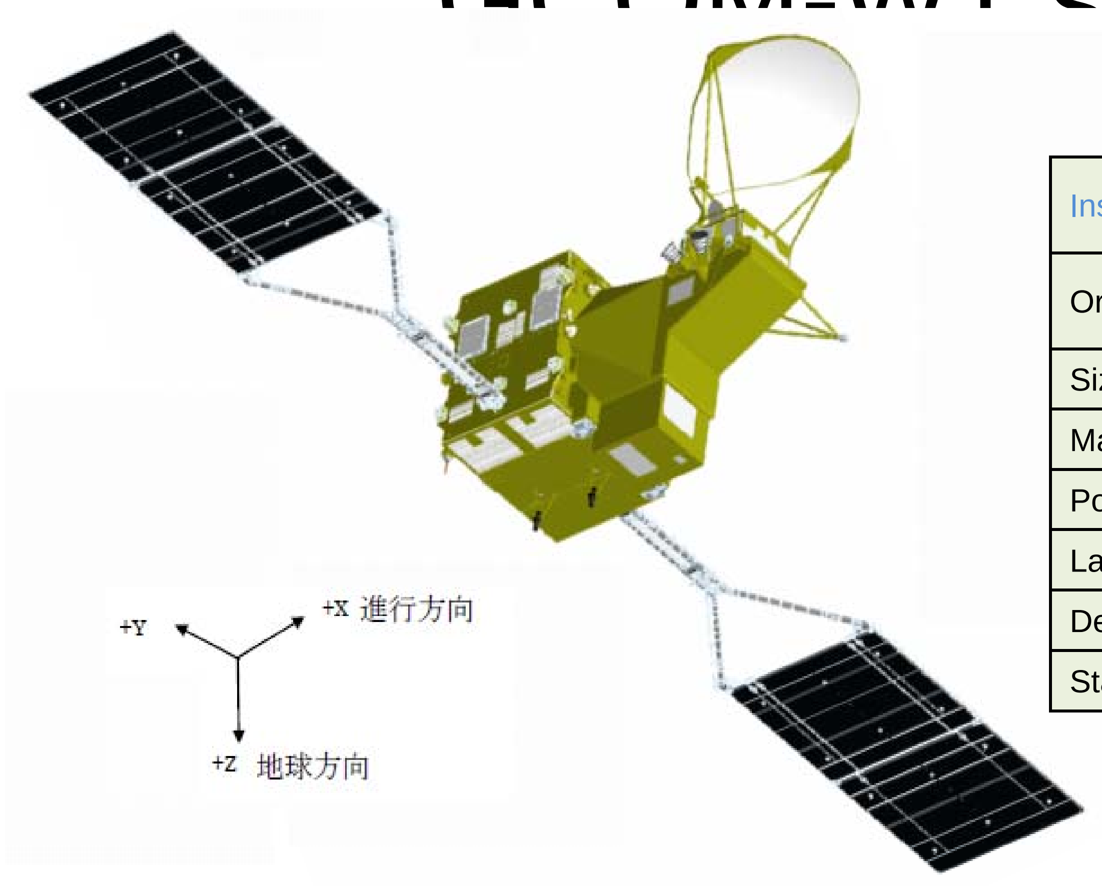
- After invitation to A-Train constellation from NASA, JAXA and A-Train members studied the possibility of participation of GCOM-W1 to A-Train.
- Participation of GCOM-W1 to A-Train was approved by A-Train members last October. The position of GCOM-W1 is ahead of Aqua.
- Benefits of joining the A-train are:
  - Precise inter-calibration between AMSR-E and AMSR2; and
  - Synergy with A-Train instruments for new Earth science research.



Downlink

- Freq : 8245MHz
- Polarization : RHCP
- Modulation : OQPSK
- Data Rate : 10Mbps (20Msps)
- Coding : CCSDS, Reed-Solomon, convolution

GCOM-W1 satellite



GCOM-W (Water)

Instrument	Advanced Microwave Scanning Radiometer-2
Orbit	Sun Synchronous orbit Altitude：699.6km (over the equator)
Size	5.1m (X) * 17.5m (Y) * 3.4m (Z)
Mass	1880kg
Power	Over 4050W
Launch	JFY2011 (CY2012 Winter)
Design Life	5-years
Status	Preliminary Design started in JFY2007

– *GCOM-W1/AMSR2 will contribute to long-term observation of global water and energy cycle.*
– *Continue AMSR-E observation (high spatial resolution, low-frequency channels,etc.).*
– *Construct reliable long-term dataset to contribute for understanding and monitoring of climate change.*
– *Contribute to operational use by providing continuous cloud-through SST, frequent and quantitative storm observation to maintain precipitation forecast accuracy.*

Basic requirements for AMSR 2

- Minimum modifications from AMSR on ADEOS-II to reduce risks/cost and keep the earliest launch date.
- Several essential improvements.
  - Improvement of calibration system including warm load calibration target.
  - Consideration to C-band radio frequency interference (RFI).
- Combination with SeaWinds-type scatterometer is highly desired.

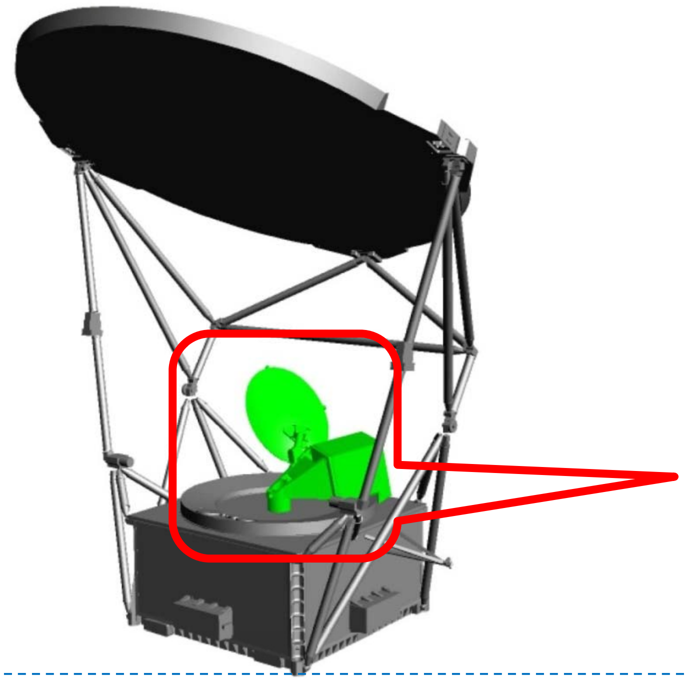
Basic requirements for AMSR 2

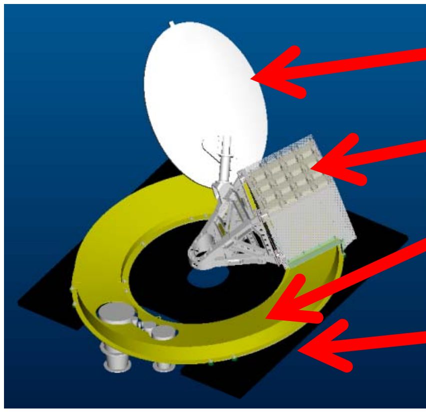
- Antenna : 2.0m, offset parabolic antenna
- Channel sets
  - Identical to AMSR-E (no O_2 band channels)
  - 6.925,7.3, 10.65, 18.7, 23.8, 36.5, 89.0GHz
  - Dual polarization
- Calibration
  - Improvements of hot load etc.
  - Enhance pre-launch calibration testing
- Orbit
  - A-Train
- Mission life
  - 5 years

Improvement of HTS(Hot Load)

AMSR2

Sensor Unit (SU)





CSM: Cold Sky Mirror, HTS: High Temperature noise Source, TCP: Thermal Control Panel

HTS and CSM

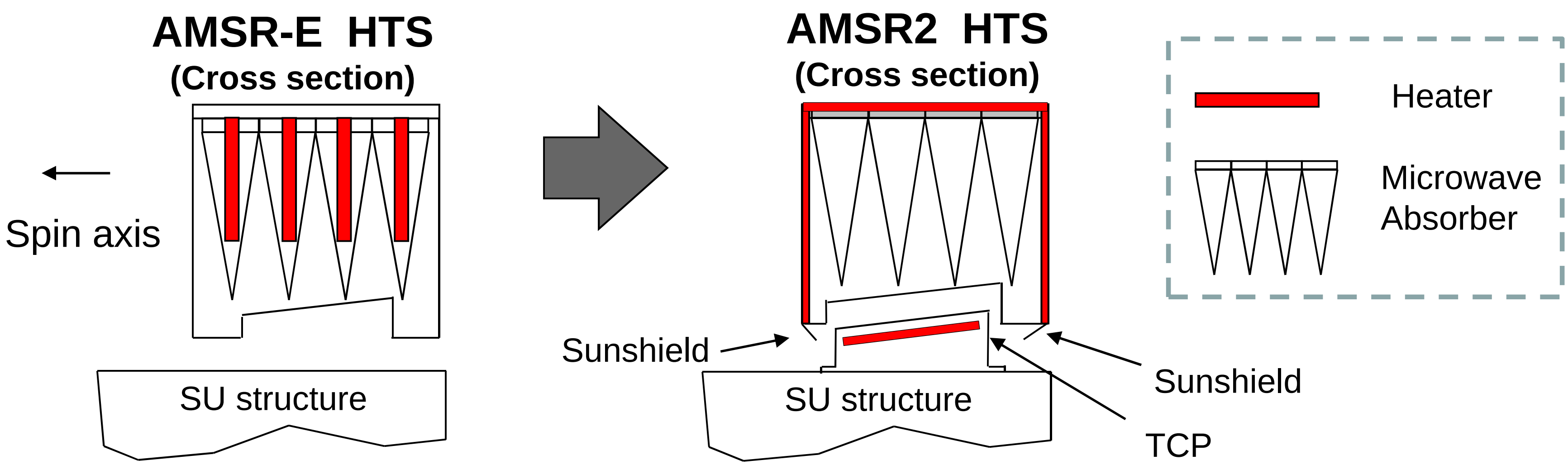
Proto Flight Model

under vibration test(Dec. 2009)

Improvement of HTS(Hot Load)

(1) Temperature inside HTS is kept constant (= 20 degrees C) using heaters on 5 walls of HTS and TCP.
(2) Sunshields attached to HTS and TCP minimize the sun light reflection into HTS.
(3) TCP thermally isolates HTS from SU structure (much colder than HTS).

HTS: High Temperature noise Source, TCP: Thermal Control Panel, SU: Sensor Unit



- **Maximum temperature difference inside HTS : less than 2K**
- **Estimated brightness temperature accuracy :**
  - **0.2 K (Variable bias during orbit, season, design life)**
  - **0.1 K (Random due to quantization)**

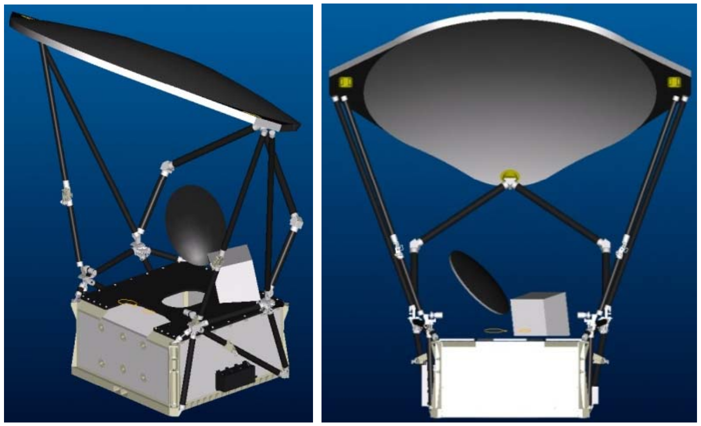
Hot Load performance

- The largest temperature difference within hot load is less than 2K.
- The estimated absolute accuracy of brightness temperature is less than 0.2K with the aid of improved temperature sensor.

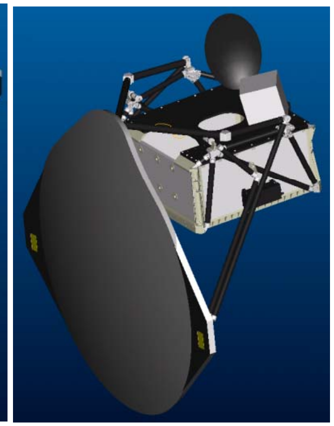
Temperature Resolution

Frequency	Resolution(target)
6.925	<0.34(0.3)
7.3	<0.43
10.65	< 0.7(0.6)
18.7	< 0.7(0.6)
23.8	< 0.6(0.55)
36.5	< 0.7(0.65)
89.0	< 1.2(1.1)

Overview of AMSR2 instrument



Deployed



Stowed

- 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.
- Two-point external calibration with the improved HTS (hot-load).
- Deep-space maneuver will be considered to check the consistency between main reflector and CSM.

GCOM-W1/AMSR2 characteristics	
Orbit	Sun Synchronous with 699.6km altitude (over the equator)
Launch	JFY2011
Design-Life	5-years
Local time	13:30 LTAN
Swath width	1450km
Antenna	2.0m offset parabola
Incidence angle	Nominal 55 degree

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

products	IFOV	std. accr.	dynamic range
brightness temp.	5-50km	±1.5K	2.7-340K
total prec. water	15km	±3.5kg/m^3	0-70kg/m^3
cloud liq. water	15km	±0.05kg/m^2	0-1.0kg/m^2
precipitation	15km	Ocean: 50% Land:±120%	0-20mm/h
SST	50km	±5 °C	-2-35°C
sea surf. winds	15km	±1m/s	0-30m/s
sea ice conc.	15km	±10%	0-100%
snow depth	30km	±20cm	0-100cm
soil moisture	50km	±10%	0-40%

Characterization and Calibration

- Pre-Launch
  - Measurements of radiometer noise, antenna pattern (main reflector and CSM), detector non-linearity, sensor alignment, etc.

- Post-Launch
  - Deep space calibration is scheduled just one time during the initial checkout phase to assess MREF-CSM consistency, cold scan bias, and so forth. It will be implemented by single orbit inertia-lock maneuver over open ocean areas.
  - Cross calibration with other radiometers and characterization such as scan biases.
  - Monitoring of radiometer sensitivity, radiometer gain stability, brightness temperatures at selected stable regions, etc.
  - Geometric calibration and determination of sensor alignment offsets.

Cross Calibration with AMSR-E

- AMSR-E and AMSR2 will remain in A-train at least 1 year.
- Cross calibration will be conducted during this 1 year period.
- New calibration parameters of AMSR-E will be determined.
- The whole AMSR-E products will be reprocessed using this new parameters.

International Cooperation

- Discussions on the cooperation with NPOESS is underway with NOAA
- AMSR2 is a part of GPM
- JAXA is proposing a joint science activity with NASA
- Provision of a scatterometer on GCOM-W2 is under discussion with JPL and NOAA

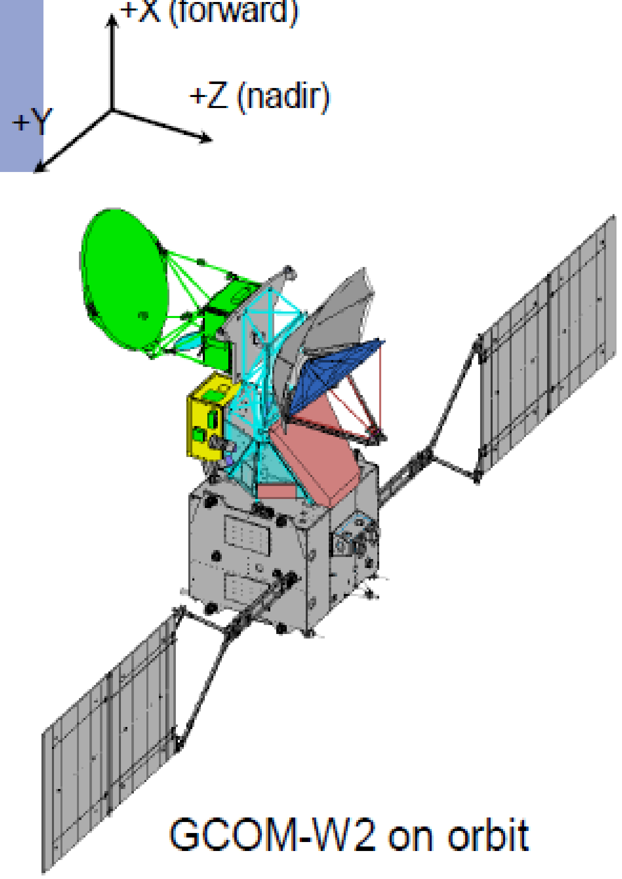
New Scatterometer on GCOM-W2

- Dual Frequency Scatterometer (DFS)
- Ku band and C band
- around 2m aperture
- All weather monitoring
- All wind speed monitoring

AMSR3 on GCOM-W2

- Addition of scatterometer
- Addition of high frequency channels (150-190GHz) for solid precipitation and water vapor sounding
- Also, join the A-train at least 1 year

GCOM-W2 Overview

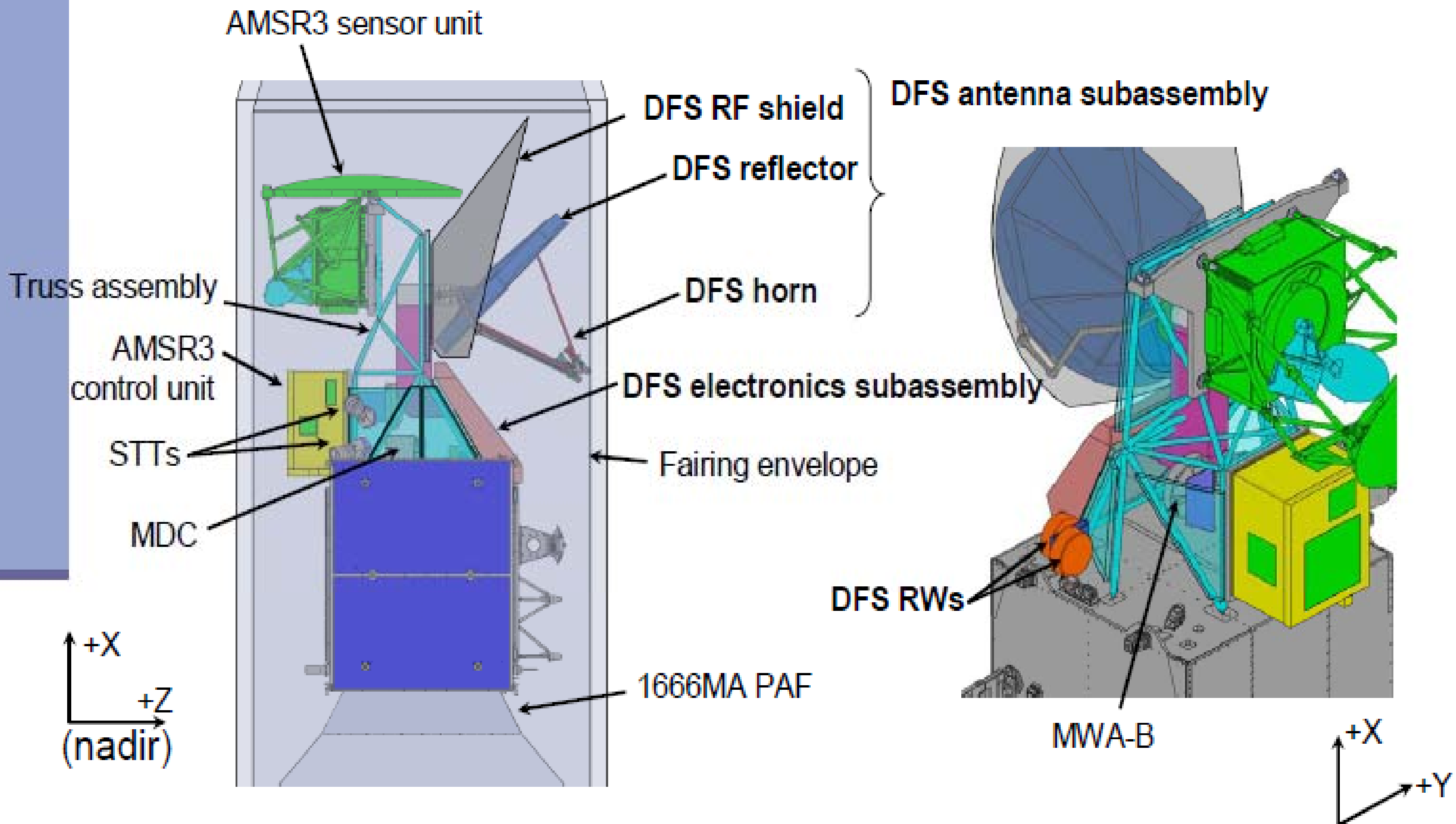


GCOM-W2 on orbit

GCOM-W2 Overview

Mission instruments	• Advanced Microwave Scanning Radiometer 3(AMSR3) • Dual Frequency Scatterometer (DFS)
Observation orbit	Sun Synchronous Orbit (A-train orbit) Altitude 699.6km, Inclination 98.186deg
Local sun time	13:30 (ascending)
Dimensions	5.6m(X), 17.6m(Y), 5.2m(Z)
Spacecraft mass	2515kg (BOL)
Generation power	4050W (EOL, two wings)
Launch year and launcher	January 2016 / H-IIA
Design lifetime	Five years

GCOM-W2 Configuration



GCOM-W2 in H-IIA 4S fairing

Conclusions

- AMSR2 will have the highest calibration capability within microwave imager.
- AMSR-E products will be reprocessed after the cross calibration with AMSR2.
- Long term high accuracy microwave imager products will be obtained.