JAXA Agency Report

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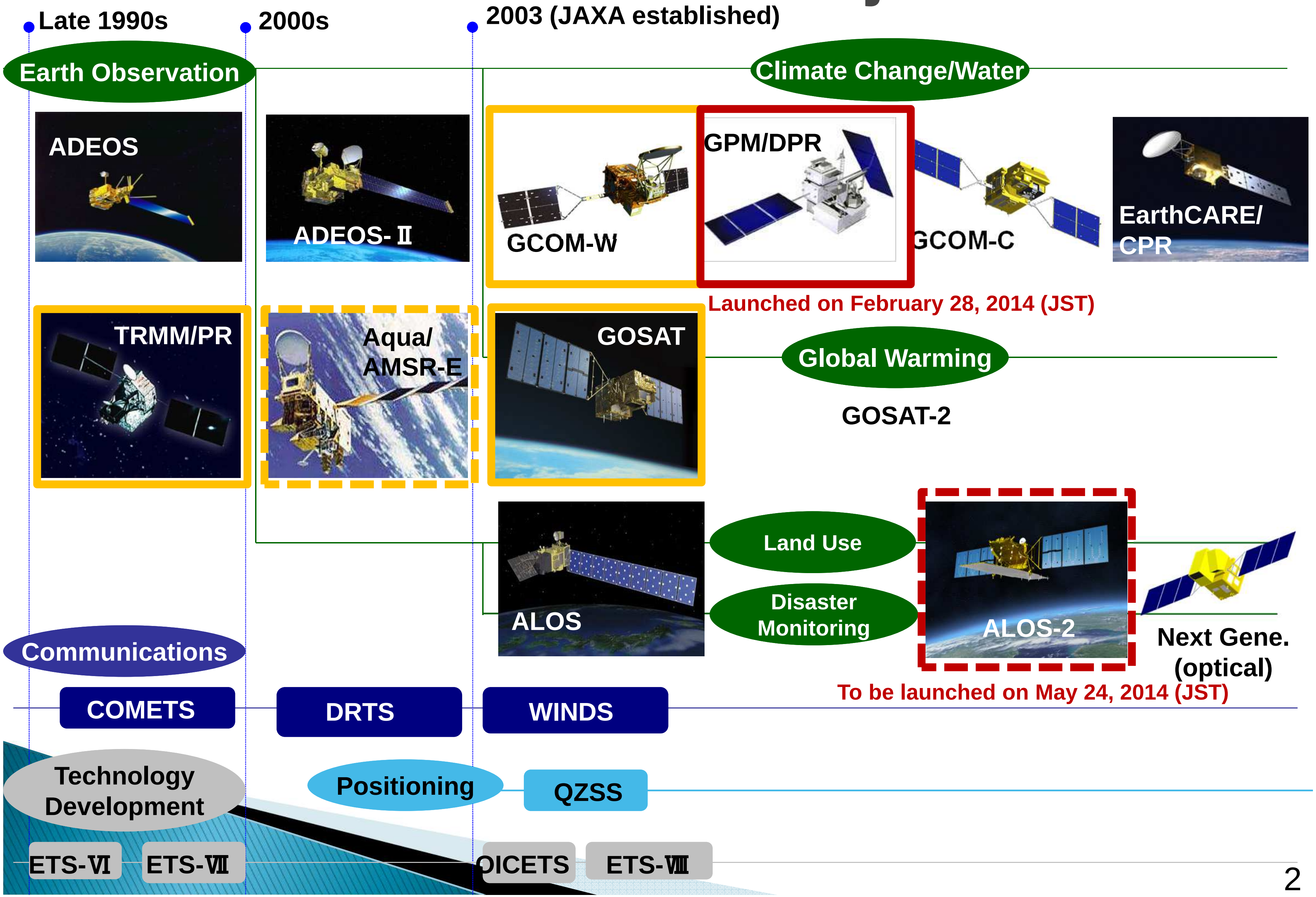
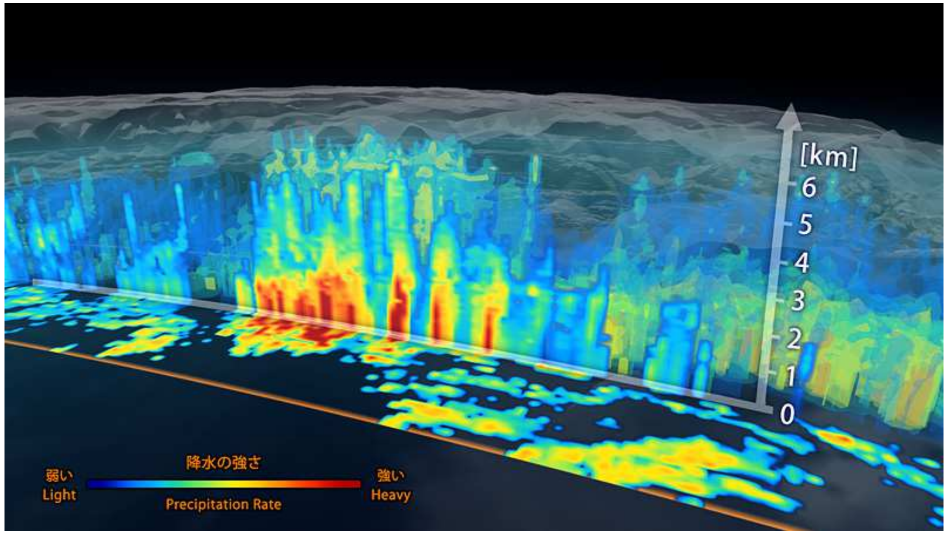
Japan Aerospace Exploration Agency (JAXA)

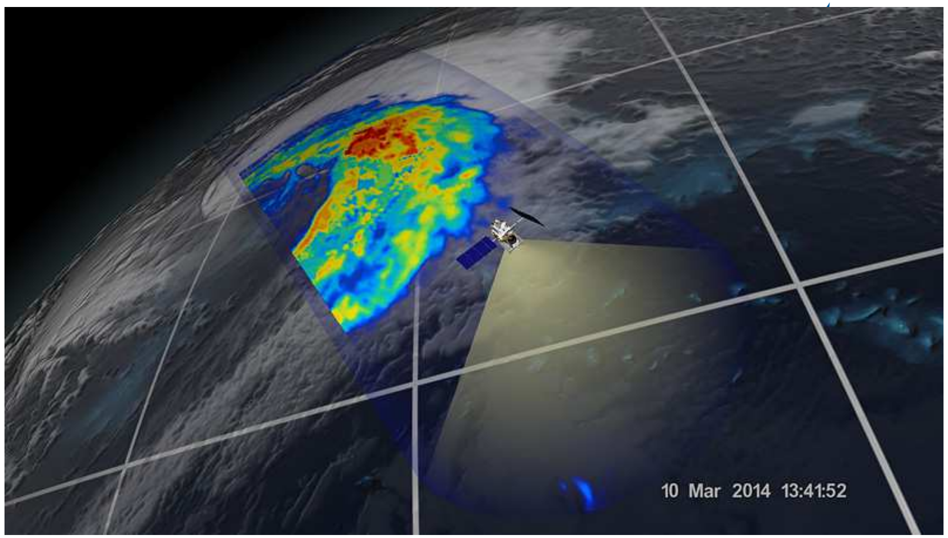
GSICS/GRWG Meeting
Darmstadt, Germany
March 25, 2014

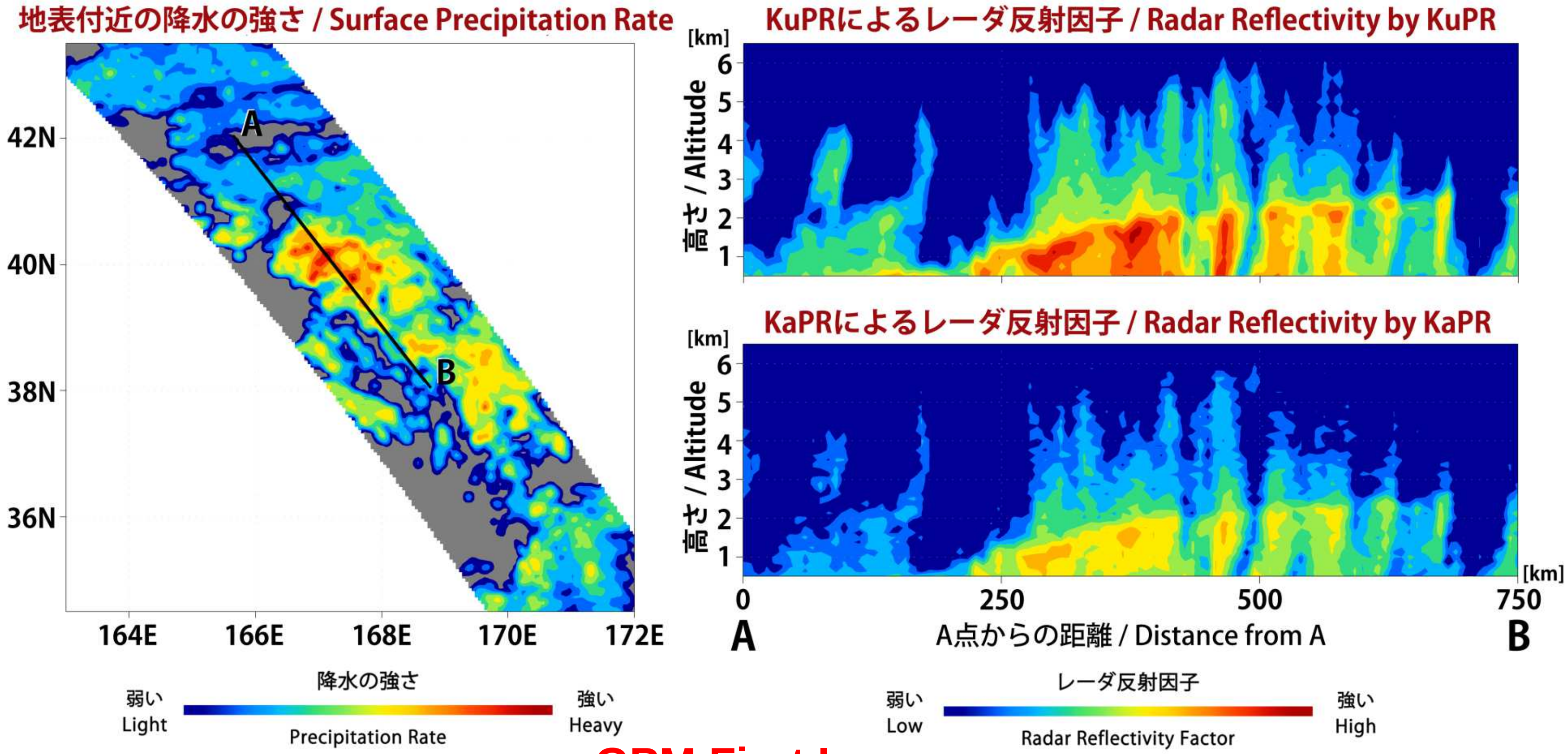
JAXA Satellite Projects



GPM Core Observatory was successfully launched on February 28, 2014 (JST)





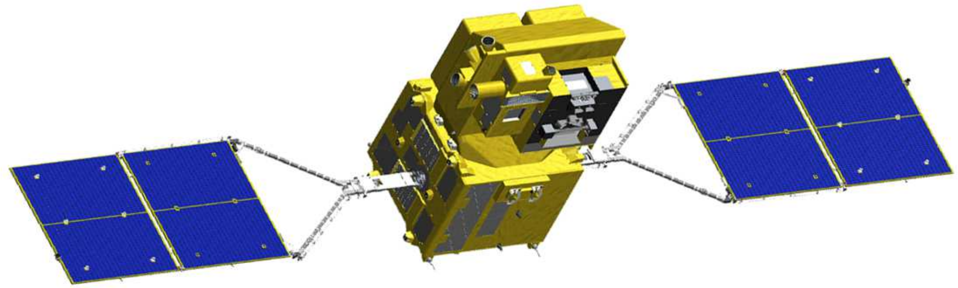


GPM First Images

GCOM 1st Generation Satellites

- 2 types of medium-sized satellites and 3 generations: 10-15 years observation

“SHIZUKU”



GCOM-W1 (Water)

Instrument	**Advanced Microwave Scanning Radiometer-2**
Orbit	Sun Synchronous orbit Altitude : 699.6km (on Equator) Inclination: 98.2 degrees Local sun time: 13:30+/-15 min
Size	5.1m (X) * 17.5m (Y) * 3.4m (Z) (on-orbit)
Mass	1991kg
Power gen.	More than 3880W (EOL)
Launch	May 18, 2012
Design Life	5-years

GCOM-C1 (Climate)

Instrument	**Second-generation Global Imager**
Orbit	Sun Synchronous orbit Altitude : 798km (on Equator) Inclination: 98.6 deg. Local sun time: 10:30+/- 15min
Size	4.6m (X) * 16.3m (Y) * 2.8m (Z) (on orbit)
Mass	2093kg
Power gen.	More than 4000W (EOL)
Launch	JFY 2016
Design Life	5-years

AMSR2 Instrument

- ✓Successor of AMSR-E on Aqua and AMSR on ADEOS-II.
- ✓Deployable main reflector system with 2.0m diameter (1.6m for AMSR-E).
- ✓Frequency channel set is identical to that of AMSR-E except 7.3GHz channel for RFI mitigation.
- ✓Two-point external calibration with improved HTS (hot-load).
- ✓Add a redundant momentum wheel to increase reliability.

GCOM-W1/AMSR2 characteristics	
Scan and rate	Conical scan at 40 rpm
Antenna	Offset parabola with 2.0m dia.
Swath width	1450km (effective > 1600km)
Incidence angle	Nominal 55 degrees
Digitization	12bits
Dynamic range	2.7-340K
Polarization	Vertical and horizontal

<table>
<tr><th colspan="5">AMSR2 Channel Set</th></tr>
<tr><th>Center Freq. [GHz]</th><th>Band width [MHz]</th><th>Pol.</th><th>Beam width [deg] (Ground res. [km])</th><th>Sampling interval [km]</th></tr>
<tr><td>6.925/ 7.3</td><td>350</td><td rowspan="6">V and H</td><td>1.8 (35 x 62)</td><td rowspan="5">10</td></tr>
<tr><td>10.65</td><td>100</td><td>1.2 (24 x 42)</td></tr>
<tr><td>18.7</td><td>200</td><td>0.65 (14 x 22)</td></tr>
<tr><td>23.8</td><td>400</td><td>0.75 (15 x 26)</td></tr>
<tr><td>36.5</td><td>1000</td><td>0.35 (7 x 12)</td></tr>
<tr><td>89.0</td><td>3000</td><td>0.15 (3 x 5)</td><td>5</td></tr>
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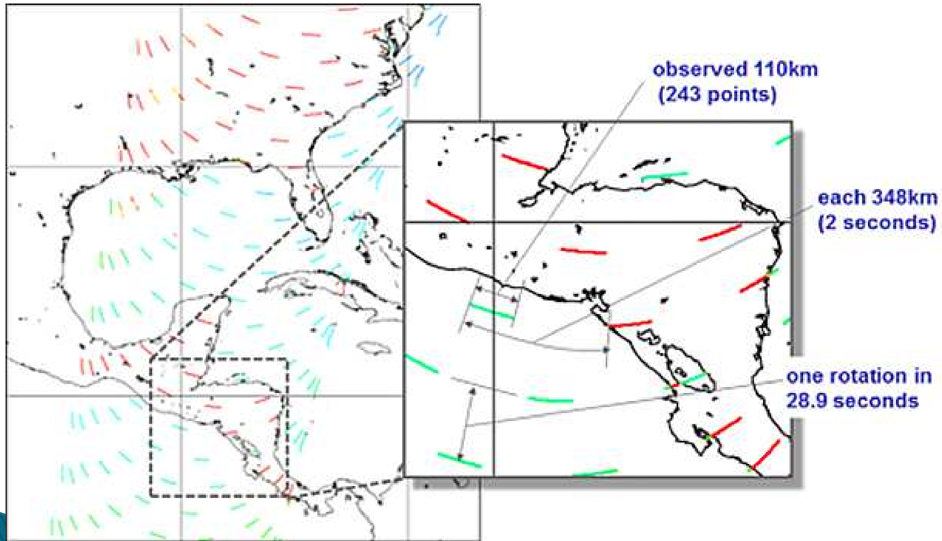
Status of AMSR2 Intercalibration

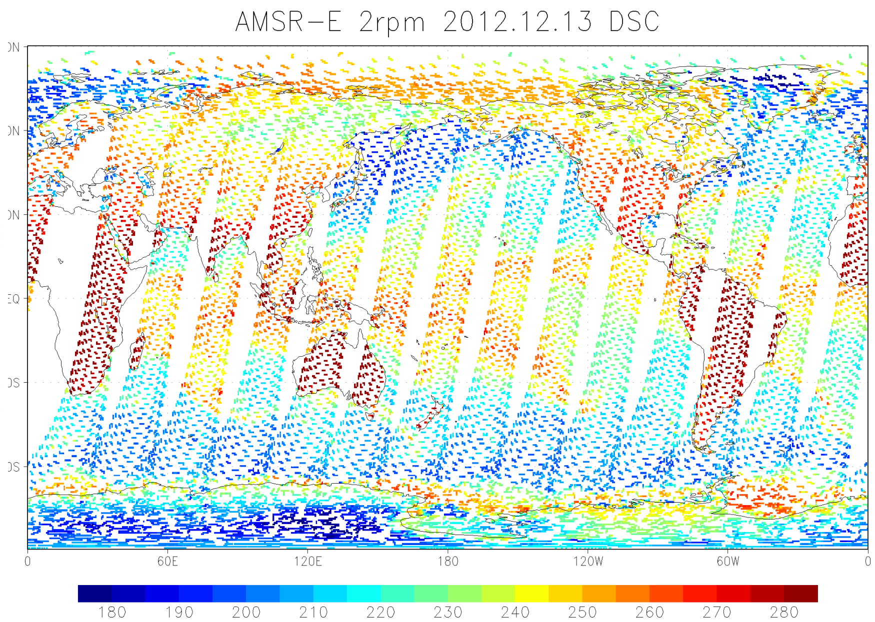
- Some updates in terms of used data period and AMSR-E slow rotation mode data.
- Status
  - Brightness temperatures (Tbs) of AMSR2 (Version 1.1) were intercalibrated with those of TMI and AMSR-E.
  - Differences were found between the calibration of AMSR2 and TMI/AMSR-E. The differences seem to be Tb-dependent.
  - Intercalibration coefficients (slope and intercept) were derived to compensate the calibration differences.
  - Investigation of the causes of the calibration differences are underway.
- Plans
  - Comparison with polar orbiting radiometers through TMI, or by polar region match-ups.
  - Intercomparison with GMI onboard GPM core observatory.

Direct comparison with AMSR-E

- Direct intercalibration between AMSR2 and AMSR-E:
  - Without significant corrections for center frequency, incidence angle, and observing local time.
  - Enables intercalibration in wide range of Tbs over land, ice, and ocean.
- AMSR-E slow rotation mode data (L1S) are available at:
  - http://sharaku.eorc.jaxa.jp/AMSR/products/amsre_slowdata.html



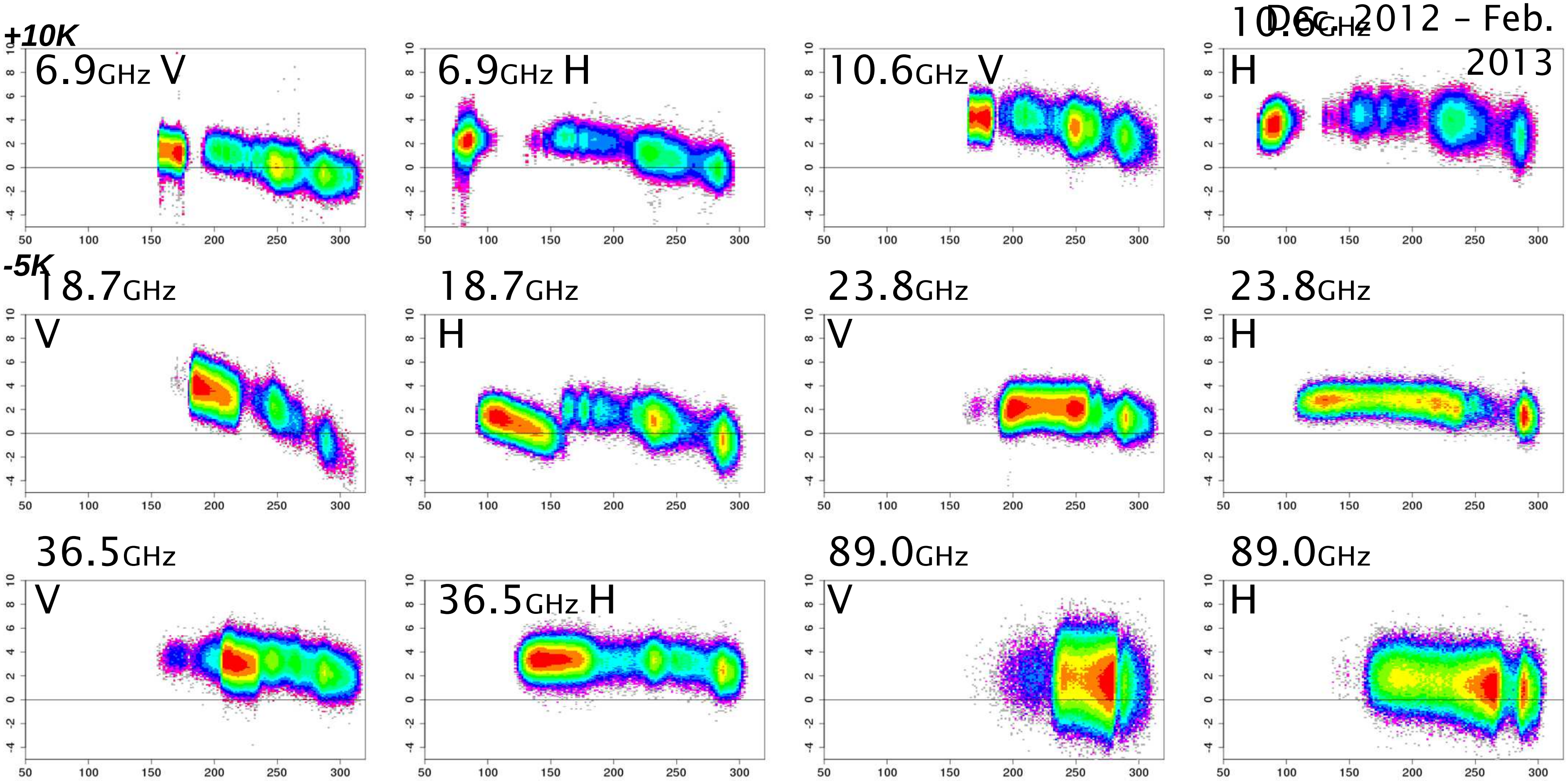
Observation geometry

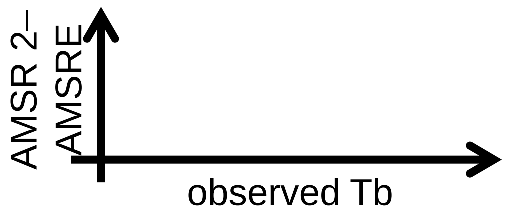


AMSR-E 2rpm 23V Descending

Intercalibration with AMSR-E (2rpm)

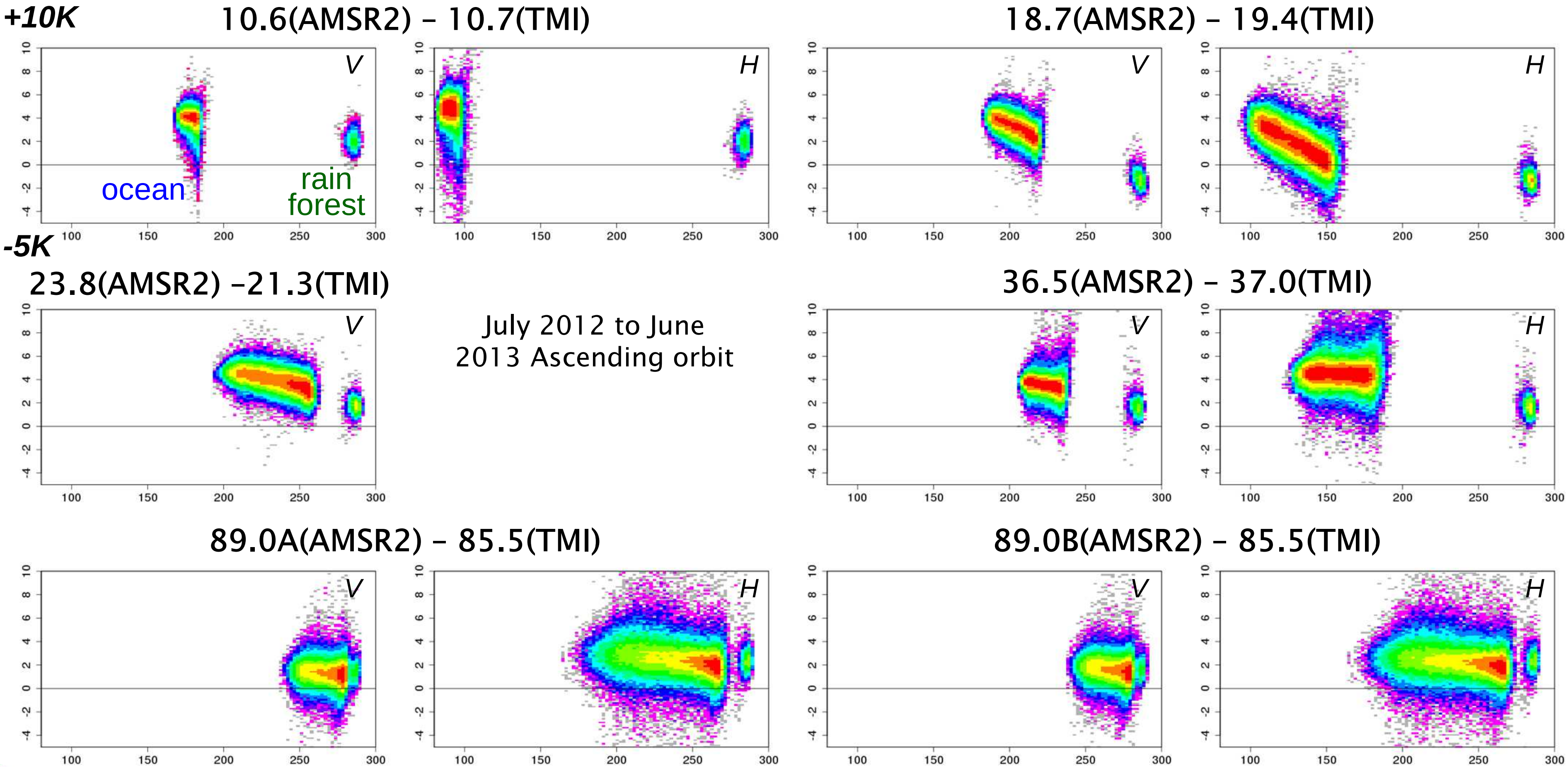
AMSR2 Ascending Passes

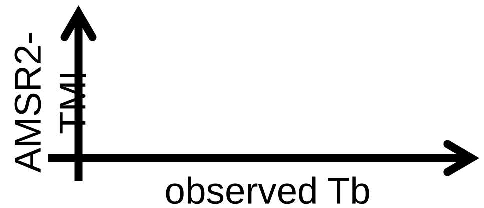




Intercalibration with TMI

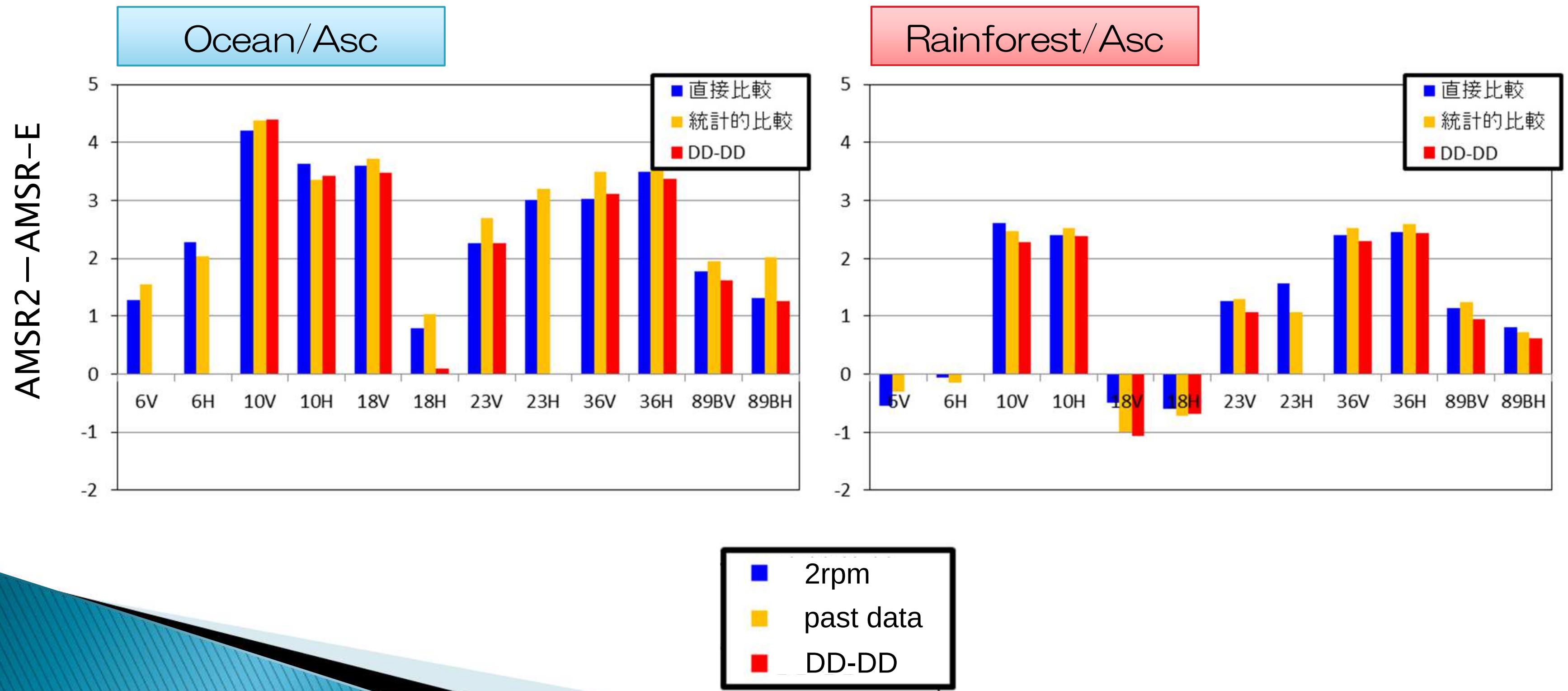
AMSR2 Ascending Passes





Consistency among methods

- Consistency among different intercalibration approaches
  - AMSR-E slow rotation mode (2rpm, L1S)
  - AMSR-E operational observation (past period, L1B)
  - Difference between DDs: DD(AMSR2-TMI) – DD(AMSRE-TMI)

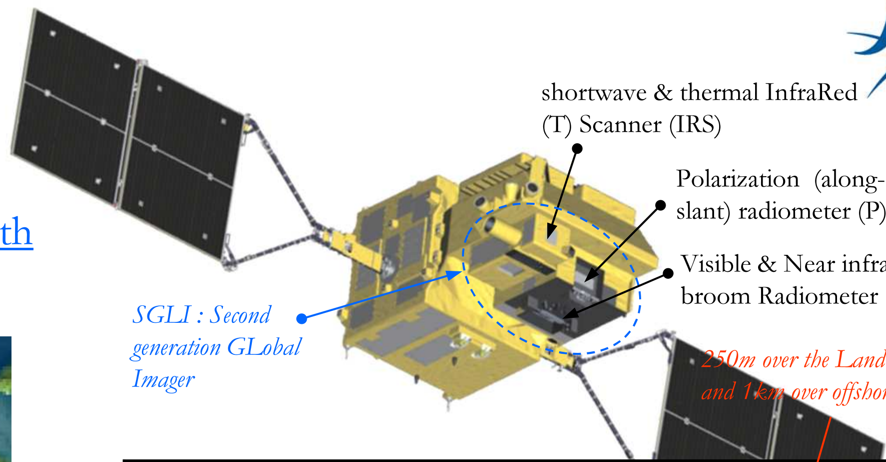


GCOM-C1/SGLI

Improvement of the land, coastal, and aerosol observations

✓ 250m spatial resolution with 1150~1400km swath

✓ Polarization/along-track slant view



GCOM-C SGLI characteristics (Current baseline)	
Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg
Launch Date	**JFY 2016 (TBD)**
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VNR: VN & P) Wisk-broom mechanical scan (IRS: SW & T)
Scan width	1150km cross track (VNR: VN & P) 1400km cross track (IRS: SW & T)
Digitalization	12bit
Polarization	3 polarization angles for POL
Along track tilt	Nadir for VN, SW and TIR, & +/-45 deg for P
On-board calibration	VN: Solar diffuser, Internal lamp (LED, halogen), Lunar by pitch maneuvers (~once/month), and dark current by masked pixels and nighttime obs. SW: Solar diffuser, Internal lamp, Lunar, and dark current by deep space window TIR: Black body and dark current by deep space window All: Electric calibration

Characteristics of SGLI spectral bands

CH	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR@L_{std}	IFOV	Tilt
	nm		W/m²/sr/µm K: Kelvin		- K: NEΔT	m	deg
VN1	380	10	60	210	250	250/1000	0
VN2	412	10	75	250	400	250/1000	0
VN3	443	10	64	400	300	250/1000	0
VN4	490	10	53	120	400	250/1000	0
VN5	530	20	41	350	250	250/1000	0
VN6	565	20	33	90	400	250/1000	0
VN7	673.5	20	23	62	400	250/1000	0
VN8	673.5	20	25	210	250	250/1000	0
VN9	763	12	40	350	1200*	250/**1000***	0
VN10	868.5	20	8	30	400	250/1000	0
VN11	868.5	20	30	300	200	250/1000	0
POL1	673.5	20	25	250	250	**1000**	±45
POL2	868.5	20	30	300	250	**1000**	±45
SW1	1050	20	57	248	500	**1000**	0
SW2	1380	20	8	103	150	**1000**	0
SW3	1630	200	3	50	57	250/1000	0
SW4	2210	50	1.9	20	211	**1000**	0
TIR1	10800	0.7	300K	340K	0.2K	250/**500**/1000	0
TIR2	12000	0.7	300K	340K	0.2K	250/**500**/1000	0

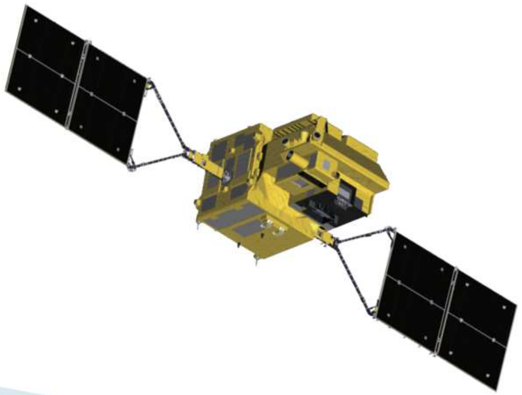
Multi-angle obs. for 674nm and 869nm

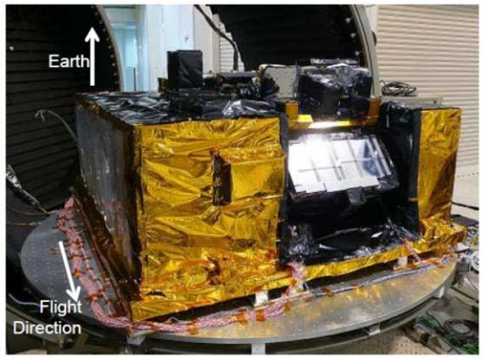
250m-mode possibility

Status of GCOM-C1/SGLI

- Critical Design Review (CDR) of SGLI and GCOM-C1 was held in 2013: PFM manufacturing was approved.
- Manufacturing of SGLI key flight parts, such as optics, filters, detectors or coolers, was almost finished and under the final inspection for the components assembly and tests.
- SRU sensor system integration is planned in the middle of 2014. Sensor-level pre-flight tests including both optical performance tests and environment tests will be done.
- Satellite level test will start in 2015 and planned for launch in JFY2016.

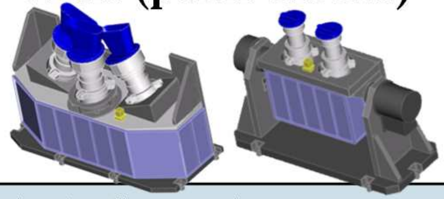
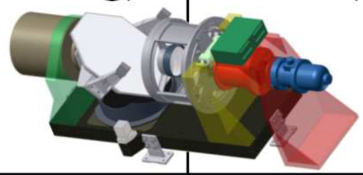
Engineering model of SGLI-IRS for vibration test configuration





Engineering model of SGLI-VNR for thermal vaccumm test configuration

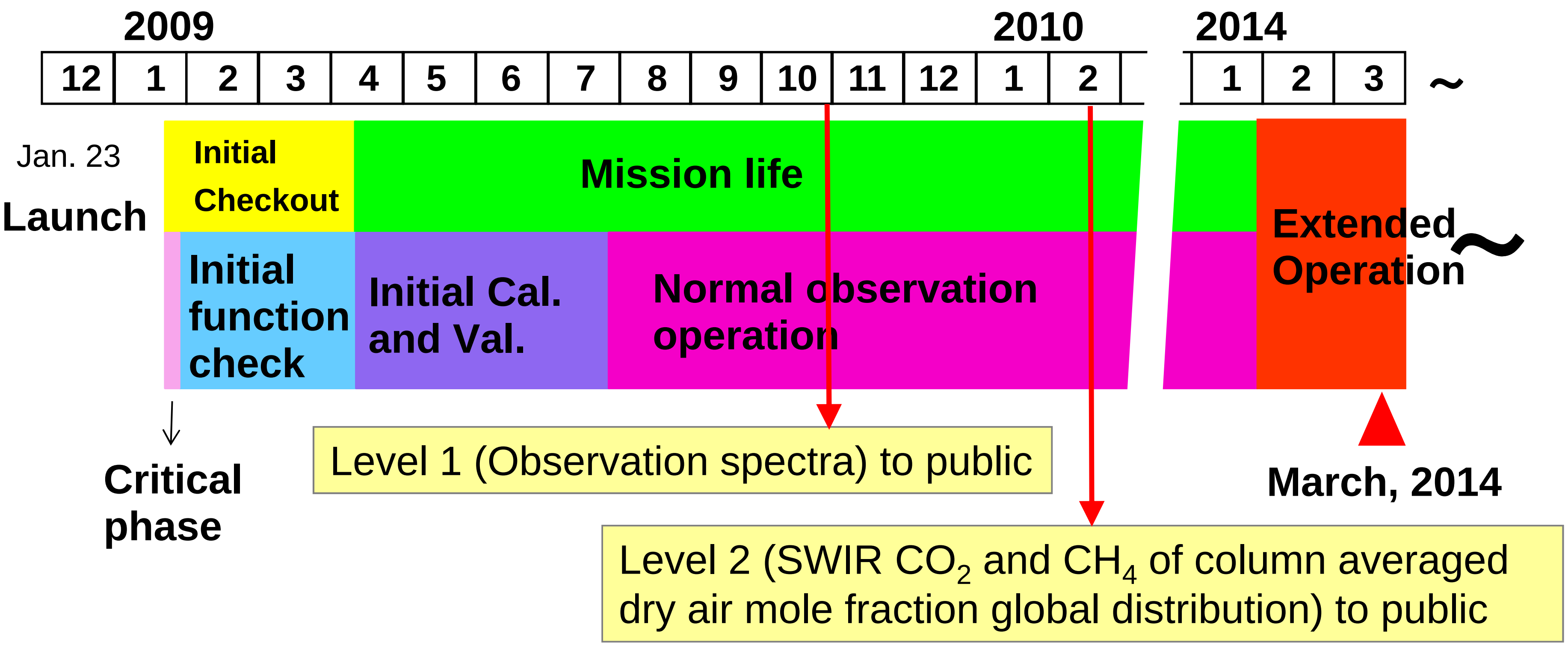
Calibration strategy integrating the calibration methods

Sensor component / Calibration target	VNR (push-bloom) 	SWIR (scanning) 	TIR (scanning)
Pre-launch characterization	Gain (radiometric sensor model), diffuser, RSR, linearity, polarization, MTF (PSF), ..		Gain, blackbody, RSR, linearity..
Functional check	Electric calibration, sensor telemetry monitoring..		
Offset	**Optical black** (every line), and nighttime observations	**Deep-space** or nighttime observations	**Deep-space** and pitch maneuver observations
Launch shift	**LED** to check change of **diffuser**	halogen lamp (+LED) to check diffuser change	**Black body** calibration
Short term gain change	solar light → **diffuser** (~once/week)	solar light → light guide → **diffuser** (every path)	
Long term change	Monthly **Moon** (7°) observations by pitch maneuver for evaluation of the diffuser degradation		Vicarious/cross calibration by SST
Vicarious adjustment	Vicarious calibration over the CEOS instrumented sites and ocean cruises	Vicarious calibration at the CEOS instrumented sites (land)	
Cross check and image quality	Vicarious & cross calibration over the CEOS invariant sites (Libya, Dome-C, TuzGolu..), stray light by moon, pol sensitivity by simultaneous VNR-PL..		

Primary source

These tasks will be led by the joint team of the JAXA GCOM-C hardware development and data-analysis & application groups

GOSAT mission schedule



Nov. 2010 Level 3 (SWIR CO_2 and CH_4 column averaged dry air mole fraction global distribution in monthly mean) to public

Mar. 2012 Level 2 (TIR CO_2 and CH_4 density profile global distribution) to public

Dec. 2012 Level 4A (CO_2 flux estimation) and Level 4B (Simulated CO_2 distribution) to public.

Status of GOSAT calibration

(1) TIR radiometric calibration (The latest L1B v161)

- Blackbody (BB) and Deep Space (DS) views for onboard calibration (2-time in dayside, 4-time in nightside)
- Polarization correction (mirrors, beamsplitter, dichroic filters)
- BB emissivity (EM evaluated by heated halo method at UW-Madison)
- Sensor background temperature estimation
- Vicarious calibration field campaign (with UW-Madison), Intercomparison with AIRS

(2) SWIR radiometric calibration (Radiometirc degradation factor)

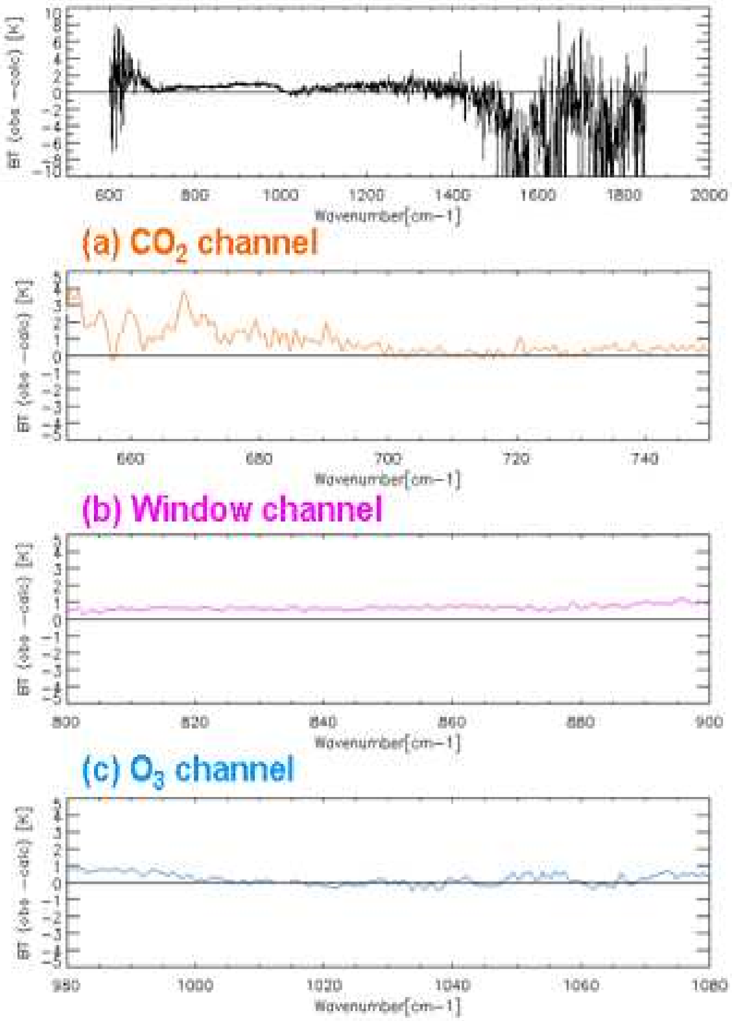
- Onboard solar diffuser monitoring per month
- Vicarious calibration field campaign (with NASA/OCO-2, Ames), Lunar calibration, Sahara desert monitoring

(3) Geometric correction (Estimated geolocation data)

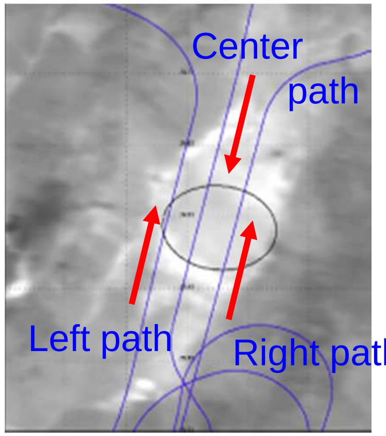
- Pointing anomaly evaluated by onboard IFOV camera
- Estimated geolocation after correction

GOSAT TIR vicarious calibration at Railroad Valley

Double difference
= TANSO-FTS residuals – S-HIS residuals



Railroad Valley



GOSAT

radiosonde

TANSO-FTS/S-HIS BT difference with STD [K]

	Left Path	Center Path	Right Path
CO_2 channel (650–750 cm^{-1})	0.48 (+/-0.66)	0.55 (+/-0.41)	0.60 (+/-0.75)
Window channel (800–900 cm^{-1})	0.47 (+/-0.08)	0.64 (+/-0.08)	0.18 (+/-0.08)
O_3 channel (980–1080 cm^{-1})	-0.54 (+/-0.53)	0.14 (+/-0.22)	-0.92 (+/-0.47)

Kataoka et al., 2013

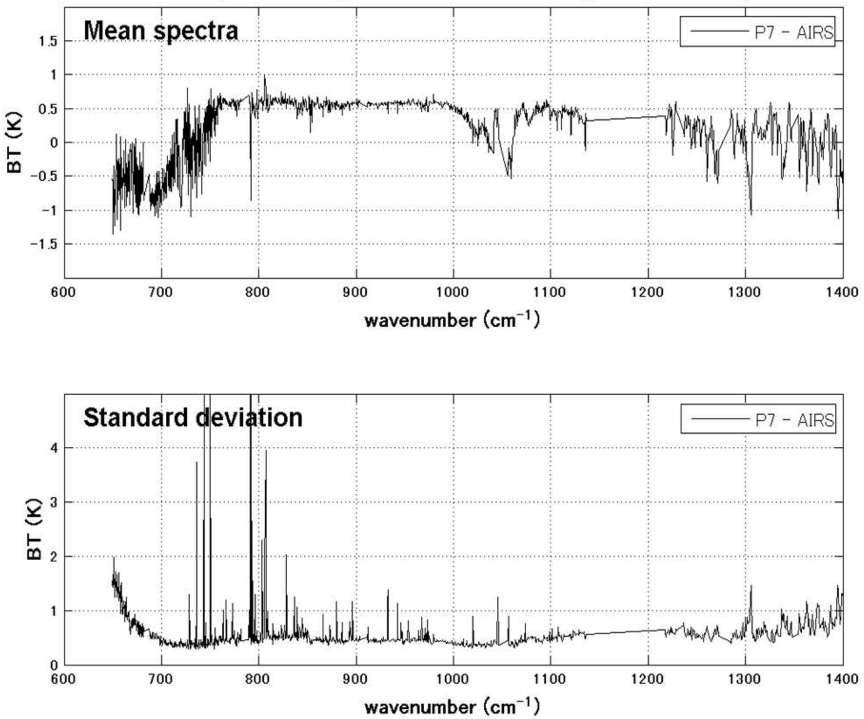
GOSAT TIR intercomparison

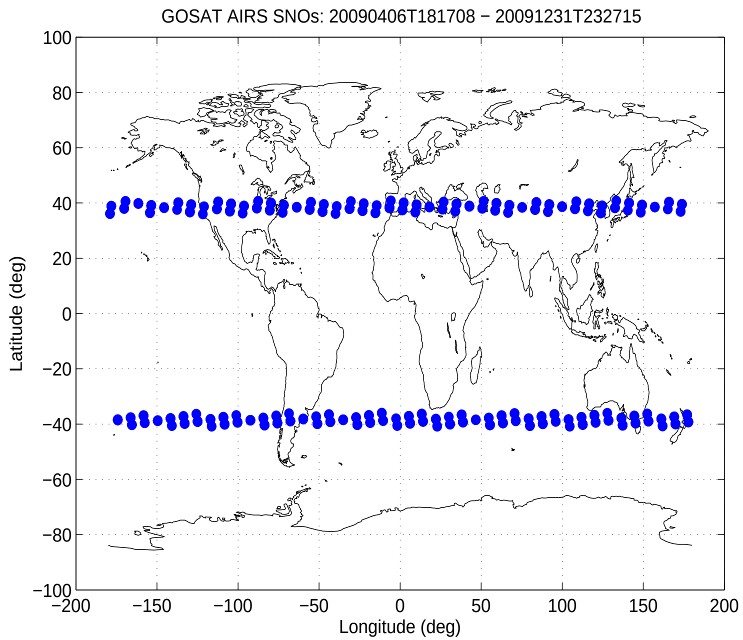
- The GOSAT TIR spectra are compared with Aqua/AIRS at Simultaneous Nadir Observations (SNOs).

  - This work is collaborated with SSEC, Univ. Wisconsin-Madison.

- The coincidences are located at mid-latitudes for AIRS. The spectral difference is evaluated in 0.5 K.

Sample SNO, 51 nadir scene (2009-2012)





GOSAT summary

- GOSAT is normally operated over 5 years and acquires fine absorption spectra in SWIR to TIR regions with cloud/aerosol imager.
- Radiometric calibration on orbit in 5 years
  - TIR inter-comparison by Simultaneous Nadir Observations (SNOs) with AIRS
  - SWIR vicarious calibration field campaign with in-situ measurements and aircraft over-flight collaborated with NASA OCO-2 and Ames
  - Continuous operations of lunar calibration and solar diffuser
- Ongoing work
  - Long-term inter-comparison the latest v161 with AIRS
  - Simultaneous Off-Nadir Observations (SONOs) for scan angle dependency evaluation