# JAXA Agency Report

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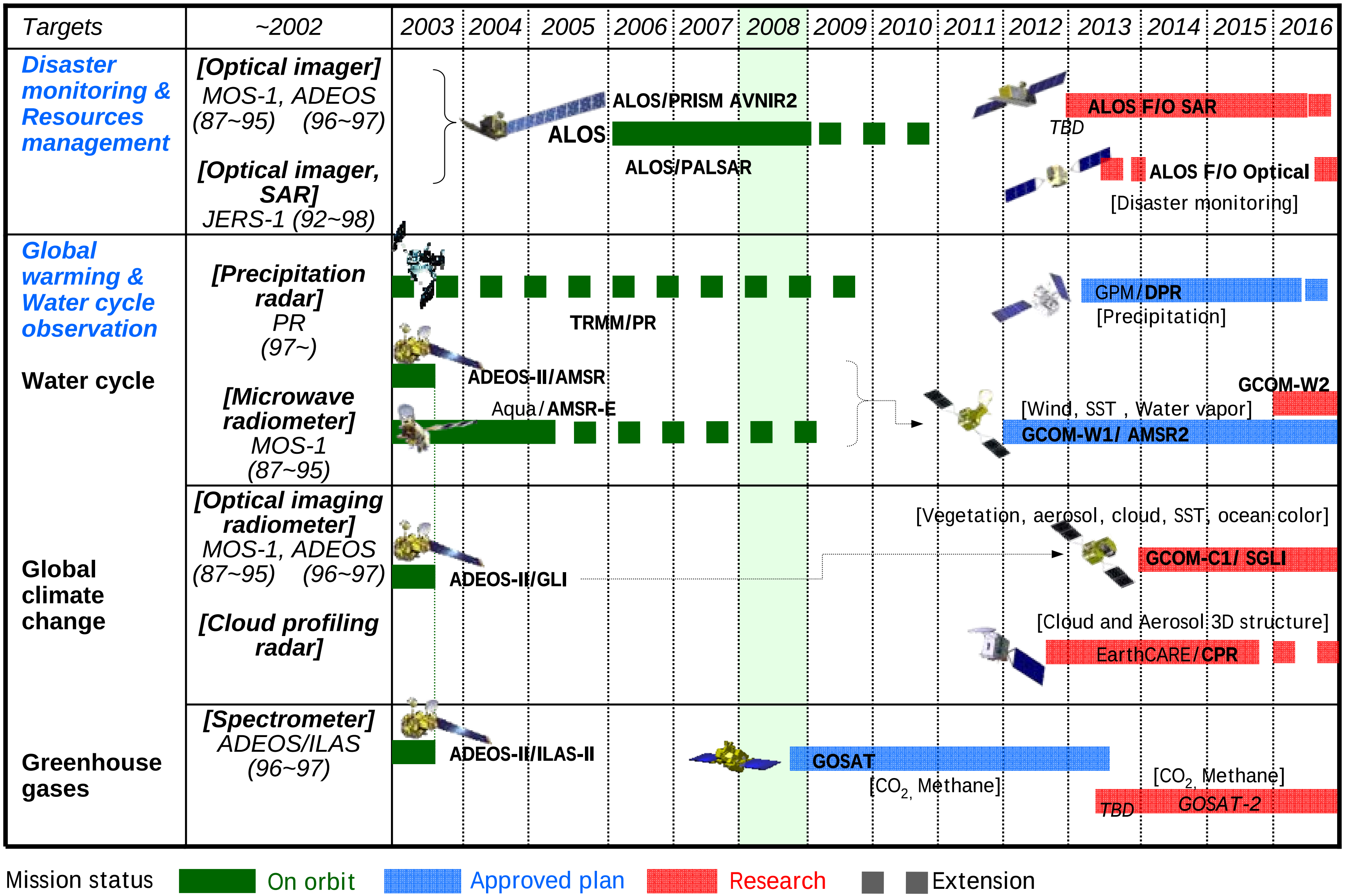
*Earth Observation Research Center*
*Japan Aerospace Exploration Agency*

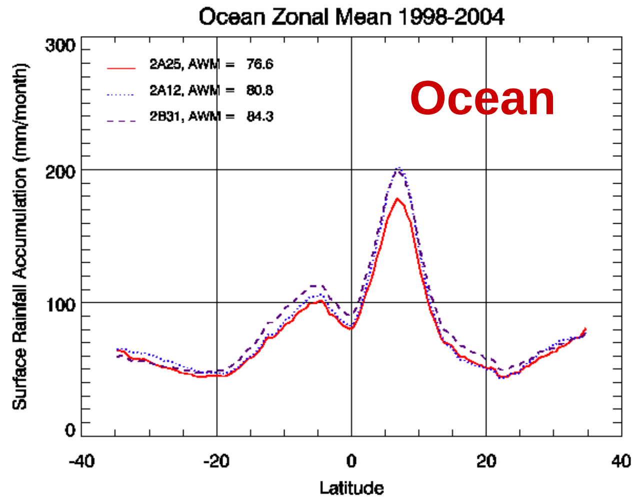
*28th CEOS-WGCV*
*February 28, 2008*
*Sanya, China*

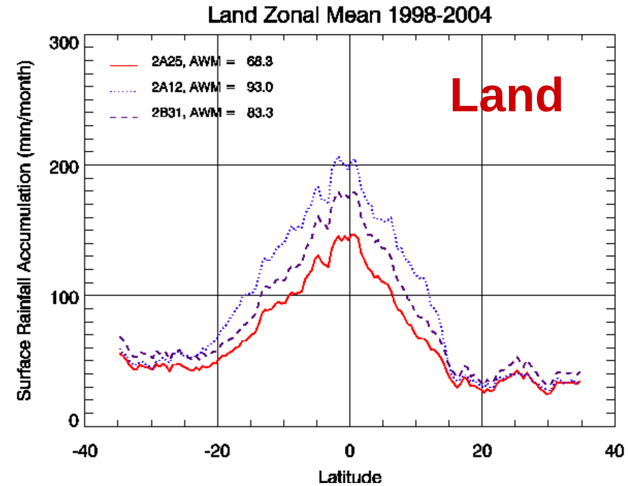
# JAXA Earth observation plan



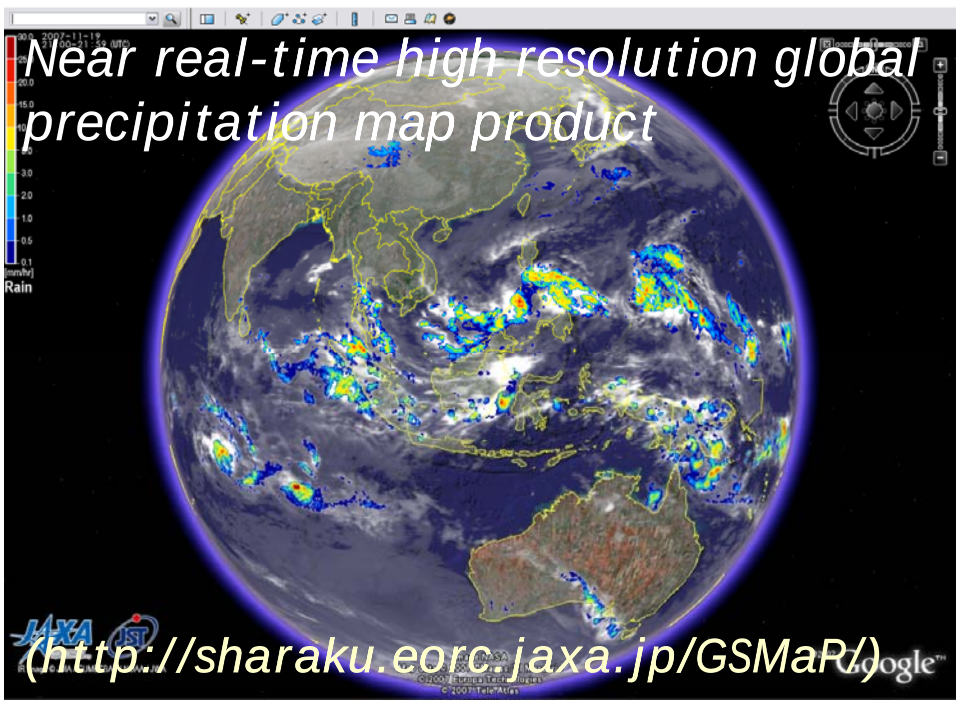
# TRMM

*Accurate observation of rainfall by the multiple sensors*


Longitudinal average of rainfall of V6. Red: PR, Blue: TMI. （J. Stout, NASA/GSFC）




- *TRMM is continuing long-term observation beyond 10 years and providing uniform and good quality data.*
- *Near real-time high resolution global precipitation map is now available using PR, multiple microwave radiometers, and geo-stationary satellites.*

# *Status of PR instrument*

## Characteristics of PR

- **Use of solid-state power amplifiers (SSPA) in the transmitter.**
  - **No high-voltage power supply required.**
- **Active phased array antenna for fast scanning.**
  - **No mechanical component in the system**

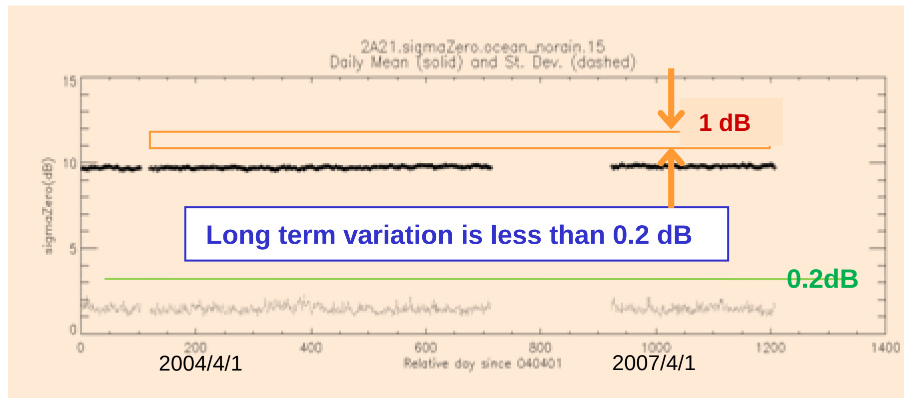
## Monitoring the PR calibration factor and its long term variation

- **Monitoring the health of PR's various components by using the internal calibration and operation analysis mode, and transmitting power monitor**
  **⇒All components including the 128 T/R elements are working properly.**
- **External calibration of the over-all performance by using an active radar calibrator (ARC) twice a year.**
  **⇒PR's absolute calibration accuracy is better than ±1 dB**

PR is extremely stable. PR's long term stability that is estimated from the variation of sea surface scattering cross sections in no rain conditions is better than 0.2 dB.

PR can be used as a flying radar calibrator that realizes intercomparisons between ground-based radars.

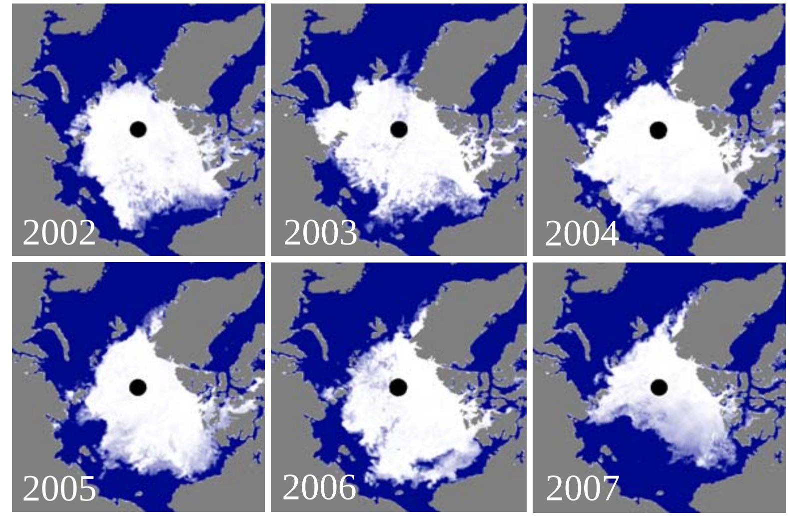
Variation of daily averages of the sea surface scattering cross section in no-rain conditions at the incidence angle of 6.4 degrees



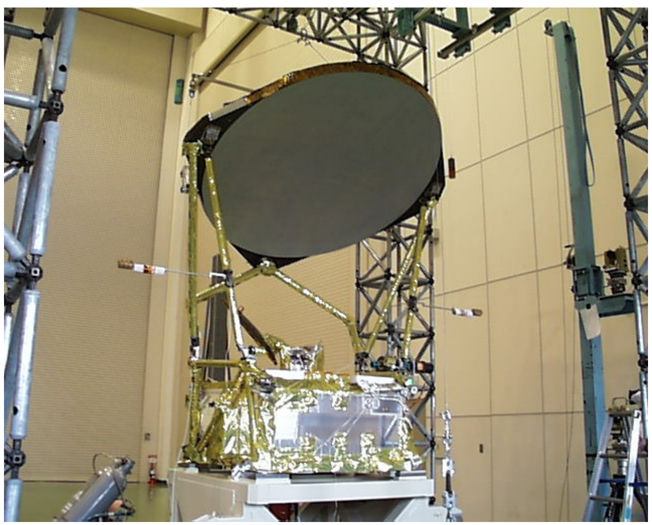

For more than 10 years, PR has been working flawlessly. All components including the 128 elements of the T/R system have shown no sign of trouble. It has provided high quality three-dimensional rain data steadily. It is used as a intercalibration tool for ground-based radars.

# Aqua/AMSR-E

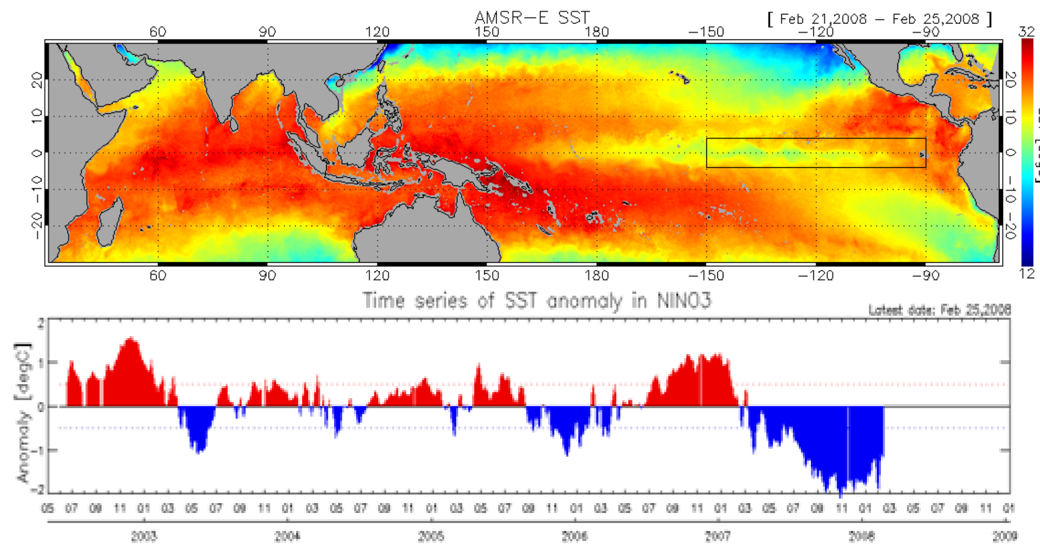
- Mission outline
  - Continuous stable observation for almost 6-years after the launch on May 4, 2002 onboard NASA's EOS Aqua satellite.
- Instrument characteristics
  - Multi-frequency microwave radiometer with dual polarization capability (developed by JAXA).
  - High-spatial resolution compared to existing instruments by large size antenna.
  - C-band (6.9GHz) channels for estimating SST and soil moisture.
  - Afternoon (1:30 pm) equatorial crossing time that is currently unique for microwave radiometers.




*Monitoring of summer sea ice extent over northern polar region*



*Pre-launch AMSR-E photo in Tsukuba Space Center*



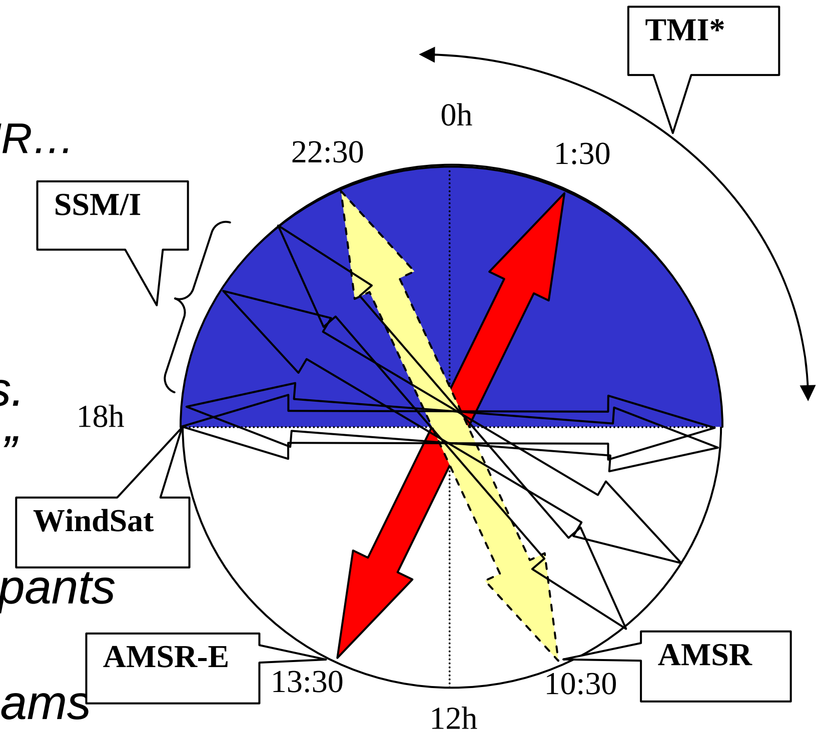

*Example of El-Nino monitoring by AMSR-E.*

# *Cross-calibration activity*

- *Microwave radiometer cross-calibration*
  - *Growing importance with increase of number of microwave radiometers.*
  - *Available instruments:*

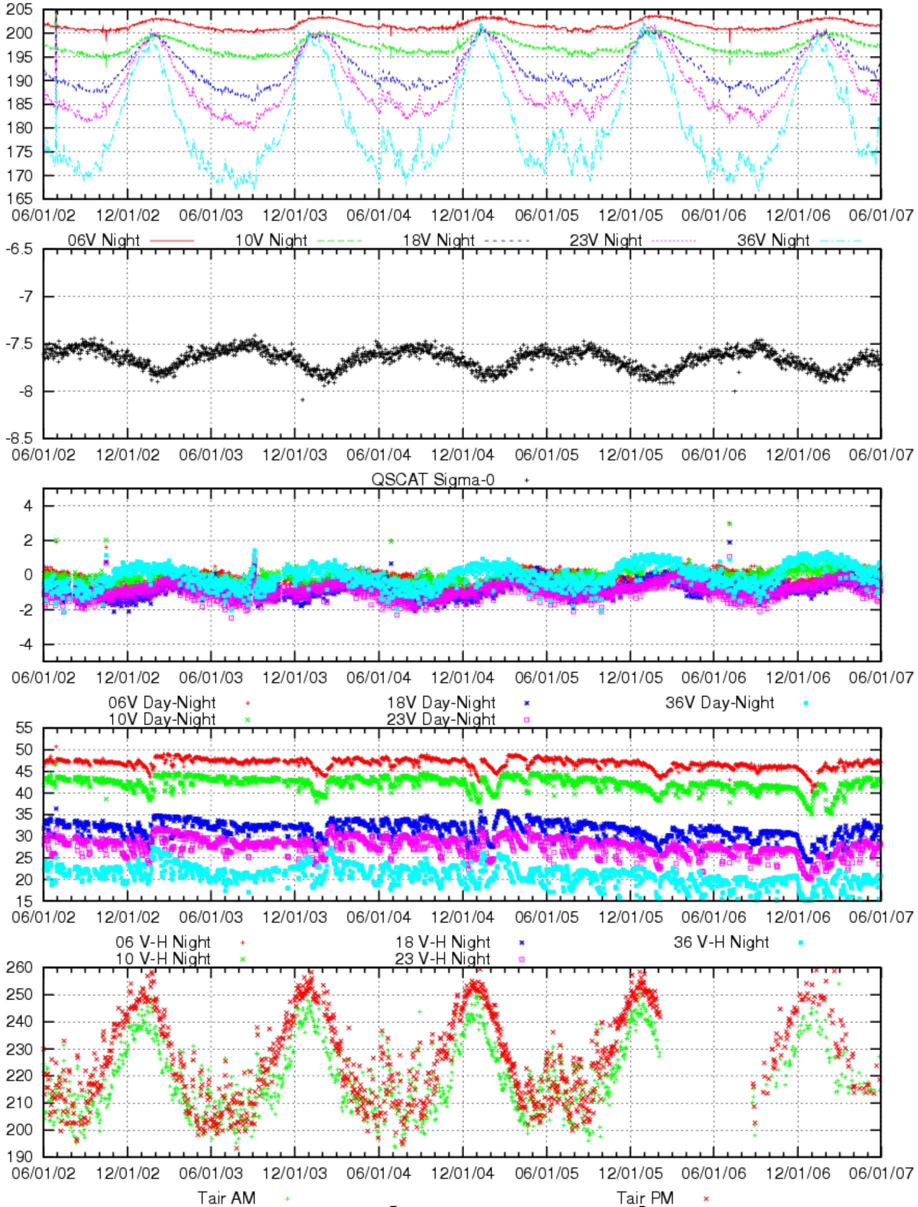
    *Current : SSM/I, TMI, AMSR-E, WindSat, SSM/IS, MSMR…*

    *Future : AMSR2, GMI, MIS, MWRI, MADRAS …*
- *Current situations*
  - *Calibration of each radiometer by sensor provider.*
  - *Cross-calibration activities by many data providers.*
  - *May need cross-comparison of “cross-calibrations”*
- *Example of activities: X-CAL*
  - *X-CAL Working Group in GPM community. Participants include 4-5 international teams.*
  - *Provide identical dataset and models to several teams and compare the results to see consistency.*
  - *Try to use TMI as a transfer radiometer in space.*
  - *Over ocean and tropical forest areas.*
  - *Dataset include TMI, SSM/I-F13, F14, and WindSat.*
  - *Models include surface emissivity and atmospheric absorption coefficients.*

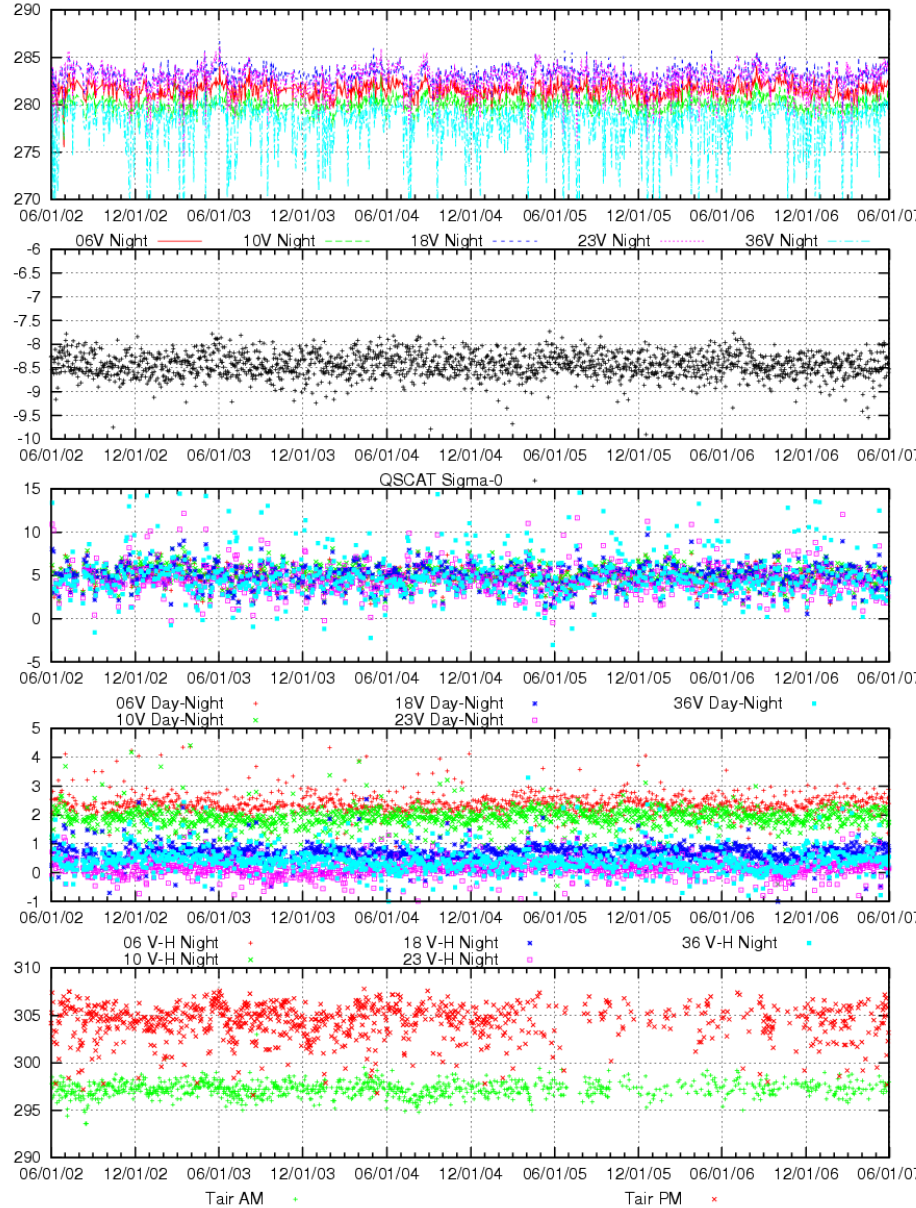



* TMI covers various local time by its non sun synchronous orbit.

# AMSR-E Tb time series over sites

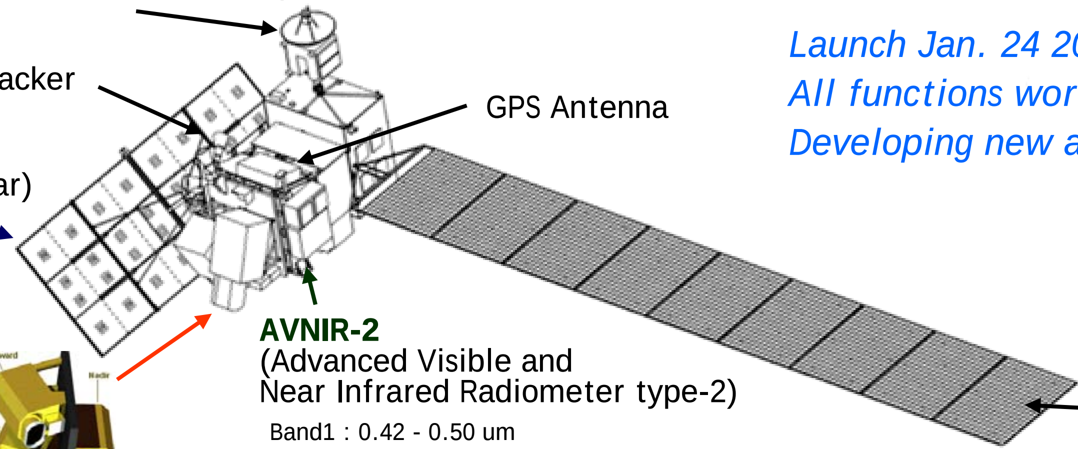



**Dome C (WMO-89828)**

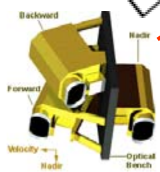



**Putusibau (WMO-96565)**

# ALOS




**PRISM** (Panchromatic
Remote-sensing Instrument
for Stereo Mapping)



*Launch Jan. 24 2006*
*All functions working on orbit*
*Developing new applications*

*ALOS mission objectives are follows.*

*(1) Provide and update maps for Japan and other countries including those in the Asian-Pacific region (Cartography),*

*(2) Perform regional observation for "sustainable development," harmonization between Earth environment and development (Regional Observation),*

*(3) Conduct disaster monitoring around the world (Disaster Monitoring),*

*(4) Survey natural resources (Resources Surveying), and*

*(5) Develop technology necessary for future Earth observing satellites (Technology Development).*

| ***ALOS Characteristics*** | |
|---|---|
| **Launch Date** | *Jan. 24, 2006* |
| **Launch Vehicle** | *H-IIA* |
| **Launch Site** | *Tanegashima Space Center* |
| **Spacecraft Mass** | *Approx. 4 tons* |
| **Generated Power** | *Approx. 7 kW (at End of Life)* |
| **Design Life** | *3 -5 years* |
| **Orbit** | *Sun-Synchronous (descending local time 10:30)* |
| | *Repeat Cycle: 46 days*<br>*Sub Cycle: 2 days* |
| | *Altitude: 691.65 km (at Equator)* |
| | *Inclination: 98.16 deg.* |
| **Attitude Determination Accuracy** | *2.0 x $10^{-4}$ deg.(with GCP)* |
| **Position Determination Accuracy** | *1m (off-line)* |
| **Data Rate** | *240 Mbps (via Data Relay Technology Satellite)*<br>*120 Mbps (Direct Transmission)* |
| **Onboard Data Recorder** | *Solid-state data recorder (90Gbytes)* |

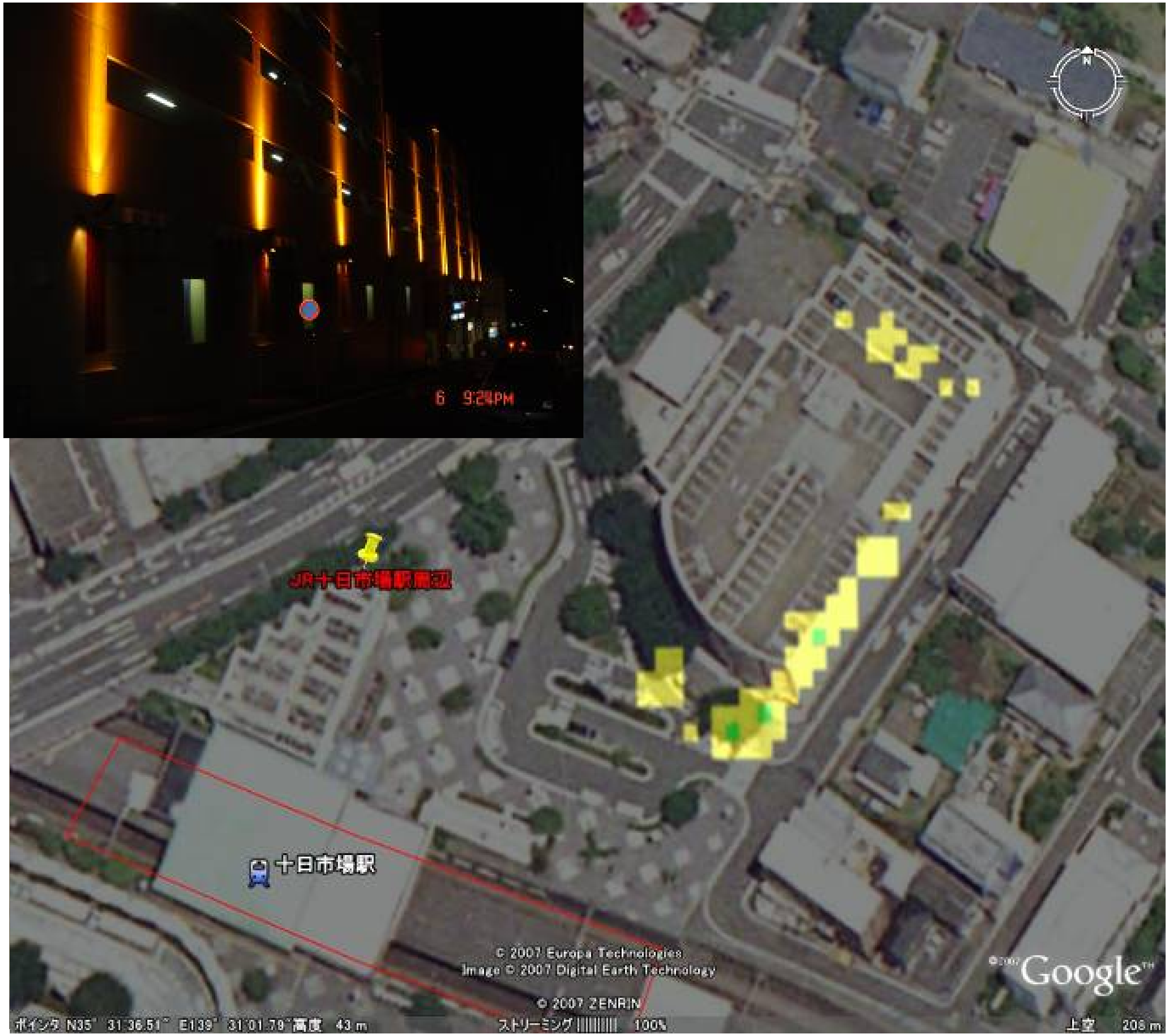
# PRISM/AVNIR-2 Cal (as of Sep. 29, 2007)

| Standard Product | Target Accuracy | Results as of Sep. 29, 2007 |
|---|---|---|
| PRISM 1B2 | Radiometry<br>Relative Accuracy 5% (1 σ)<br>Absolute Accuracy 10% (1 σ)<br>Geometry<br>Absolute Accuracy (without GCP)<br>2.0m (1 σ)<br>for Nadir-looking radiometer with the Precise Pointing Geolocation Determination System (PPDS) | Radiometry (RMS)<br>Relative Accuracy less than 0.4% (1DN)<br>→Strip noise reduction is applied from Oct. 19<br>Absolute Accuracy less than 4.6%<br>Geometry<br>Absolute Accuracy: using 1,390 GCPs in the world<br>→Pointing alignment evaluation<br>Pixel (X) / Line (Y) / Distance (RMS)<br>Nadir: **6.5m** / **7.3m** / **9.8m**<br>Forward: 8.0m / 14.7m / 16.7m<br>Backward: 7.4m / 16.6m / 18.1m<br>Relative Accuracy (1 σ)<br>3 radiometers: 1.9m / 2.3m / 3.0m |
| AVNIR-2 1B2 | Radiometry<br>Relative Accuracy 5% (1 σ)<br>Absolute Accuracy 10% (1 σ)<br>Geometry<br>Absolute Accuracy without GCP<br>94.6m (1 σ)<br>Relative Accuracy with GCP<br>2.6m (1 σ)<br>at 0 degree pointing angle | Radiometry (RMS)<br>Relative Accuracy less than 0.4% (1DN）<br>Absolute Accuracy 3.8% (B1), 4.6% (B2), 2.2%(B3), 15.6% (B4) < 50% contributes by water vapor<br>Geometry (-41.5 to +41.5 deg.. pointing)<br>Pixel (X) / Line (Y) / Distance<br>Absolute Accuracy (RMS): **106m** / **19m** / **108m**<br>Relative Accuracy (1 σ): 4m / 4m / 6m |

*** Latest ALOS calibration result can be find at**
**http://www.eorc.jaxa.jp/hatoyama/satellite/data_tekyo_setsumei/alos_hyouka_e.html in English**
**http://www.eorc.jaxa.jp/hatoyama/satellite/data_tekyo_setsumei/alos_hyouka.html in Japanese**

# *PRISM Alignment Parameter*

- Nighttime GCP collection: Tokyo and Yokohama measured on June 6, 2007



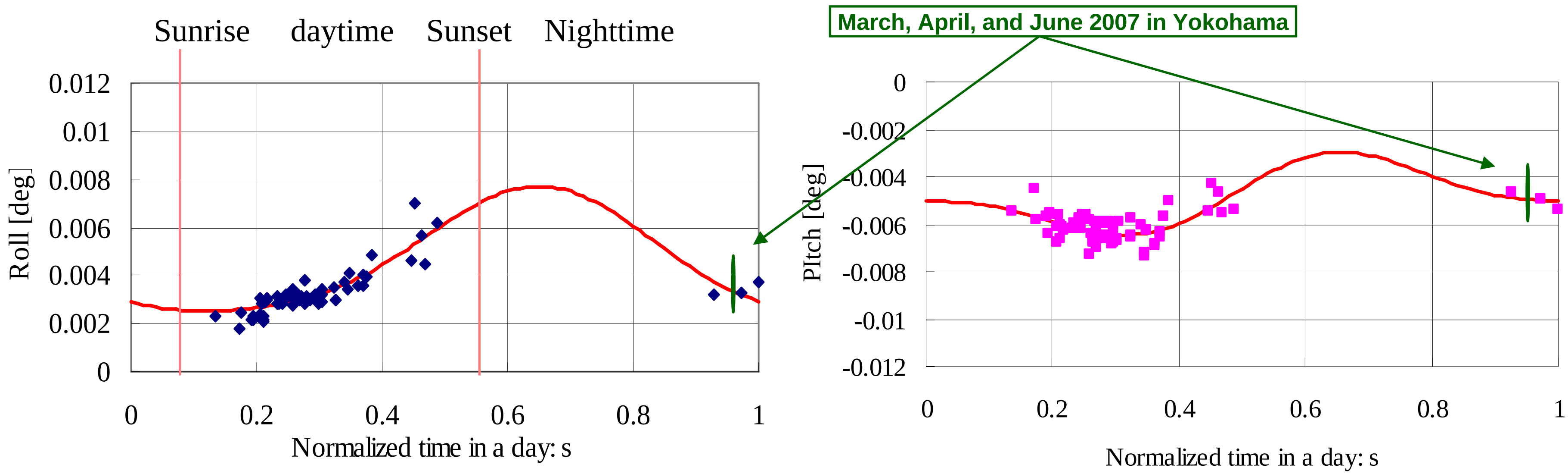

PRISM image acquired in ascending node on April 26 2007 were overlaid to Google-Earth.

PRISM image were colored by yellow and green that corresponds less then 200 DN. We have been measured there location by VRS-GPS.

These GCPs can be operationally used when images acquired without cloud covers; Mar, Apr, and Jun. 2007 were already obtained.

# PRISM Alignment Parameter

- Sensor alignment variation estimation into recurrent using nighttime GCPs




**Alignment profiles estimation during recurrent for nadir-looking radiometer.**

**Alignment profiles estimation: under investigation**

✓ To estimate pointing alignment precisely, alignment variation profiles should be determined during a recurrent of the satellite

✓ GCPs are used to estimate the profiles

✓ The profiles will be shown as a function of thermal condition of the PRISM
The number of GCPs is increased at mid-northern lat; still poor at high lat and nighttime

✓ Precise alignment estimation can be obtained after validation of profiles

# PALSAR calibration results (summary)

| items | values | NOD | spec | remarks |
|---|---|---|---|---|
| geometry | 9.3m(RMS:distance)*** | 615 | 100m | all modes |
| radiometry | 0.64dB****/0.17dB* | 478/16 | 1.5dB | all modes |
| polarimetry | VV/HH amp ratio(dB) ：0.02dB(0.04)<br>VV/HH phase diff.(deg) ：0.321(1.01)<br>cross talk ：31~40dB | 79<br>79<br>79 | 0.2dB<br>5deg<br>30dB | POL |
| NESZ | -34dB | | -23dB | all modes |
| resolution(m) | azimuth ：4.49m(0.1m)<br>range(14MHz) ：9.6m(0.1m)<br>range(28MHz) ：4.7m(0.1m) | 478<br>478<br>478 | 4.5m<br>10.7m<br>5.4m | all modes |
| side lobe(dB) | PSLR(azimuth) ： -16dB<br>PSLR(range) ： -12.5dB<br>ISLR ： -8.6dB | 478<br>478<br>478 | -10dB<br>-10dB<br>-8dB | all modes |
| ambiguity | azimuth ：zero<br>range ：~23dB@ image end | | 16dB**<br>16dB | all modes |

note)all the values are average ，value in blanket is a standard deviation, * is at Sweden site,,**70km swath,***1m improved,****：0.1dB improved

# Daichi

Advanced Land Observing Satellite (ALOS)

# PALSAR ANTARCTICA MAPPING
# From 2006 - 2007

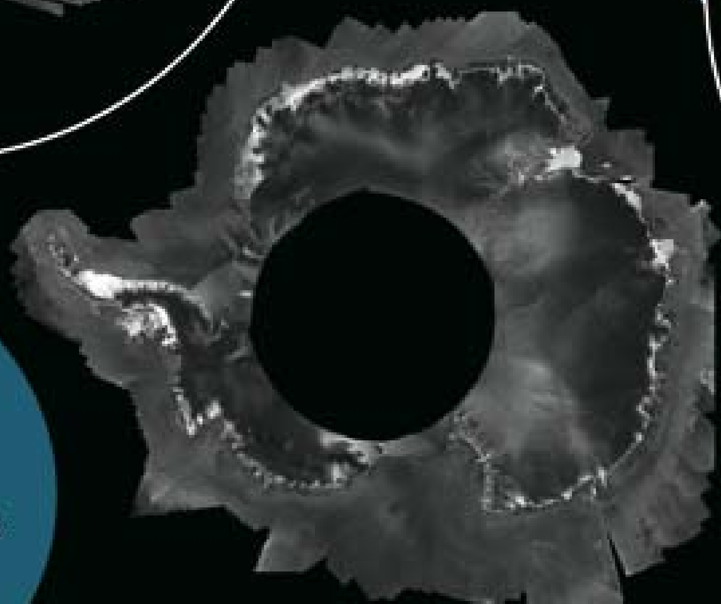
JAXA

## Cycle 8

Path Number : RSP 3 ~ 669
Acquisition Date :
2006/12/05 ~ 2007/01/19
Mode : FBS 34.3

## Cycle 14

Path Number : RSP 1 ~ 671
Acquisition Date :
2007/09/07 ~ 2007/10/22
Mode : FBS 34.3

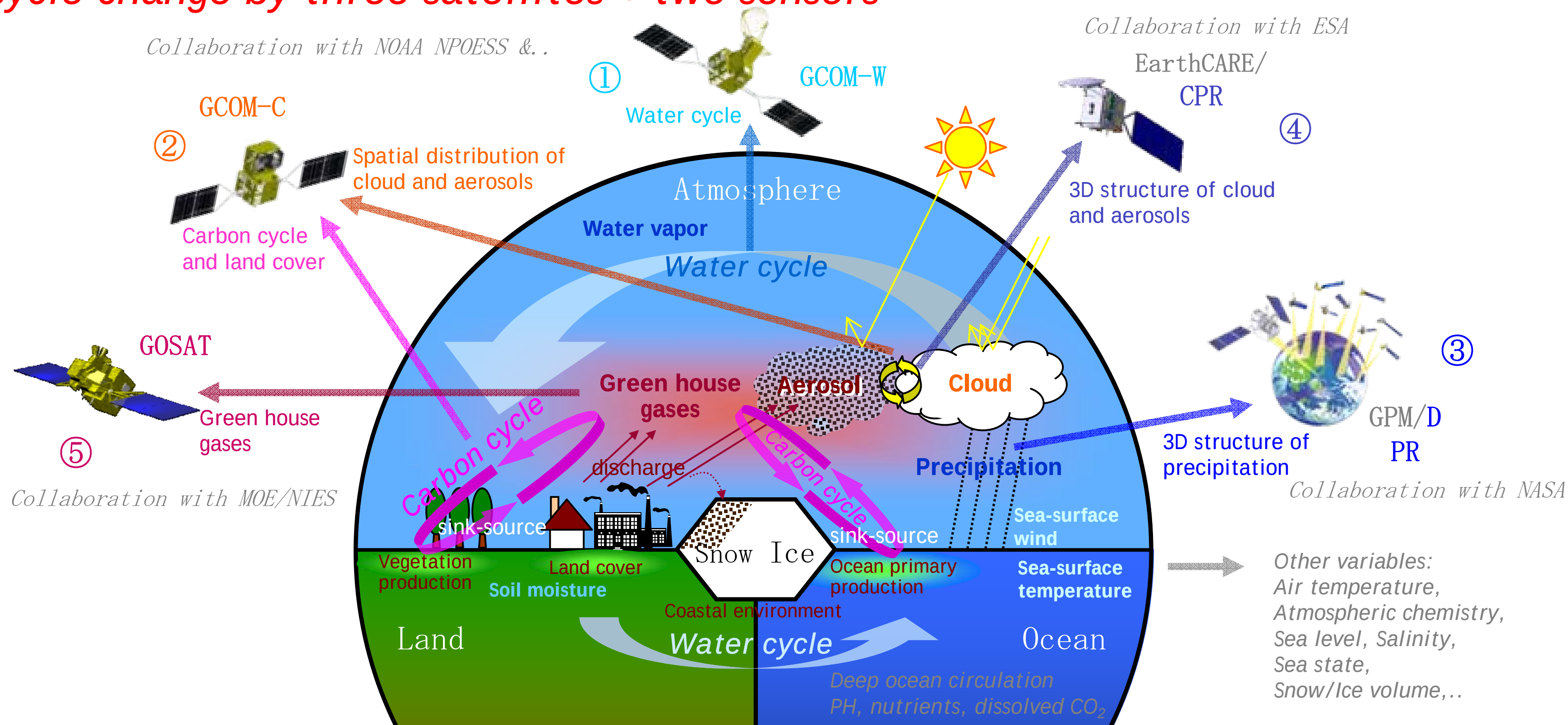


## Cycle 13

Path Number : RSP 1 ~ 670
Acquisition Date :
2007/07/23 ~ 2007/09/06
Mode : WB1 5beam

# Future mission

*Contribution to study and prediction of global warming and water cycle change by three satellites + two sensors*




⑤ GOSAT: direct observation of distribution of CO2 in the atmosphere which brings about global warming

② GCOM-C: Long-term observation about ecosystem absorption and discharge of CO2 which is one of the main error factors of climate change prediction

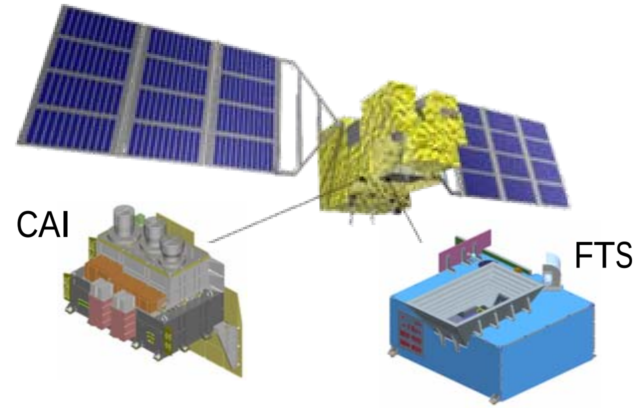
④ EarthCARE/CPR & GCOM-C:
observation of the distribution of clouds and aerosol and their interaction which brings about a cooling and is another main error factor

① GCOM-W: Long-term observation about water cycle change such as reduction of the snow and sea-ice coverage accompanying a climate change, an increase of water vapor, and a sea-surface temperature rise

③ GPM/DPR: Accurate and frequent observation of precipitation including condensation latent heat of rain and 3D structure

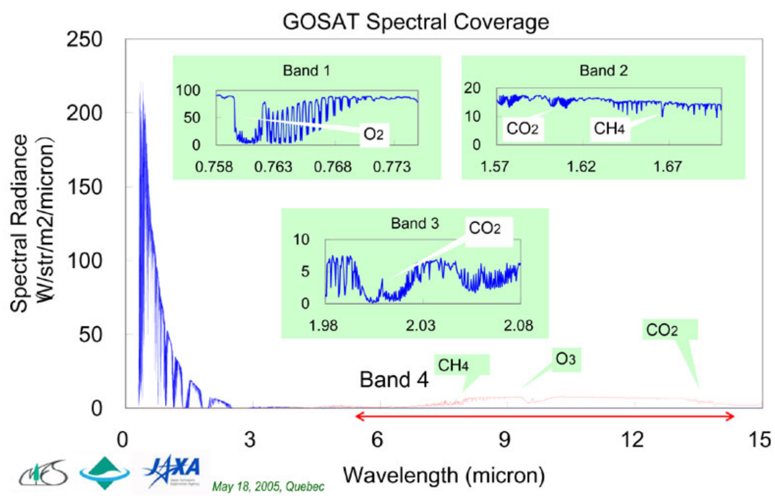
# GOSAT

- Target: monitoring distribution of the density of greenhouse gases
- GOSAT has been developed by JAXA, Japan's Ministry of the Environment (MOE), and National Institute for Environmental Studies (NIES).
- GOSAT carries Thermal And Near infrared Sensor for carbon Observations (TANSO) consists of the Fourier Transform Spectrometers (FTS) and the Cloud and Aerosol Imager (CAI).
- **GOSAT will be launched in 2008**



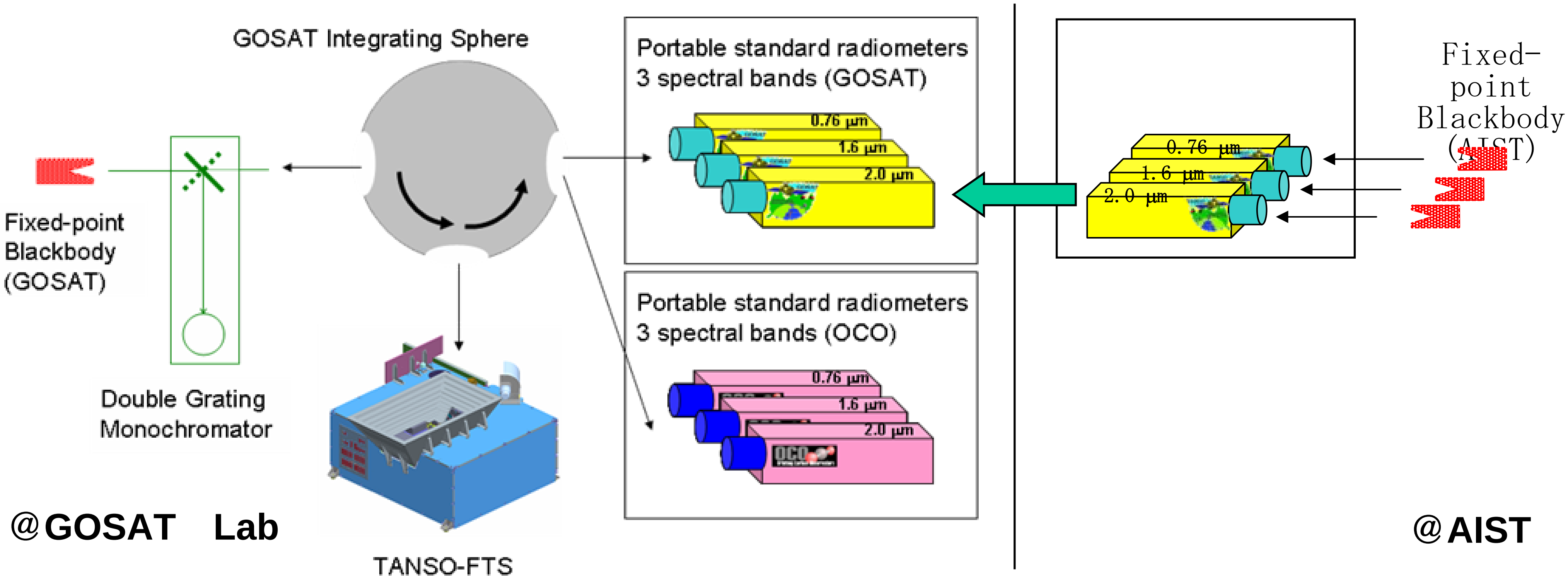

**Mission Target**

1. <u>To observe global greenhouse gas (GHG) density distribution</u>
   - $CO_2$ and $CH_4$ column density observation
   - at 100-1000km spatial scale
   - with relative accuracy of 0.3-1% for $CO_2$ (1-4ppm) and 0.6-2% for $CH_4$
   - during the Kyoto Protocol's first commitment period (2008 to 2012).
2. <u>To reduce the annual flux estimation error in the sub-continental scale</u>
   - CO2 annual flux estimation errors by half to 1/5 (0.54 to 0.27 GtC/yr).
3. <u>To develop technologies for GHG measurement from space</u>
   - by developing SWIR (short wave infrared) and TIR (thermal infrared) Fourier Transform Spectrometer (FTS) and highly reliable and robust satellite system.




| GOSAT characteristics | |
|---|---|
| Orbit | Sun synchronous orbit, local time 13:00±15 |
| Inclination | 98deg, Re-visit 3 days |
| Altitude | 666km |
| Mission Instrument | Thermal And Near infrared Sensor for carbon Observations (TANSO)<br>- SWIR and TIR Fourier Transform Spectrometers (FTS)<br>- Cloud and Aerosol Imager (CAI) |
| Swath width | FTS: 790km (changed by sampling mode)<br>CAI: 1000km (380-865nm) / 750m (1.62um) |
| Resolution | FTS: 10.5km<br>CAI: 500m (380-870nm) /1500m (1.61um) |
| Spectral coverage | FTS<br>1: 12900~13200cm$^{-1}$ (0.75~0.78um)<br>2: 5200~6400cm$^{-1}$ (1.56~1.72um)<br>3: 4800~5200cm$^{-1}$ (1.92~2.08um)<br>4: 660~2000cm$^{-1}$ (5.5~14.3um)<br>(resolution 1: 0.5, 2: 0.2, 3: 0.2, 4: 0.2cm$^{-1}$)<br>CAI<br>1: 380, 2: 678, 3: 870, and 4: 1610nm<br>(width 1: 20, 2: 20, 3: 20, 4: 90nm) |
| Launch Date | 2008 (H-IIA) |
| Mission Life | 5 years |

# Methodology of Cross Calibration




- *Preparatory experiment : Aug., 2007*
  - *The GOSAT standard radiometers and integrating sphere are evaluated by comparison with AIST standard light sources.*
- *X-cal at JPL : Apr., 2008*
- *X-cal in Japan : May, 2008*

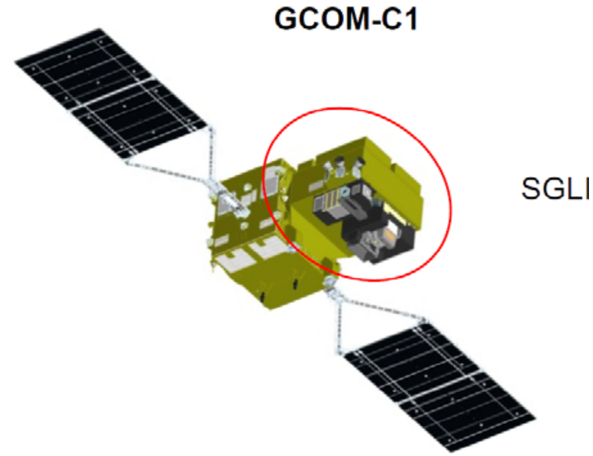
*Collaboration with AIST*

# GCOM-C/SGLI

*SGLI : Second Generation Global Imager*

- *Targets of GCOM-C are carbon cycle and radiation budget, and will carry SGLI.*
- SGLI will continue almost of the GLI observations (sea surface temperature, ocean color, aerosols, cloud, vegetation, snow/ ice, and so on).
- The new SGLI features (250m (VN) and 500m (T) channels and two polarization/ multi-direction channels (P)) will enable improvement of land and coastal monitoring and retrieval of land aerosols.

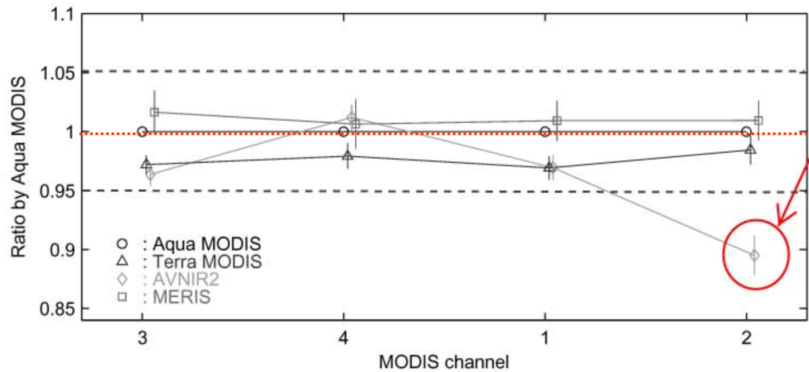
| GCOM-C SGLI characteristics | |
|---|---|
| Orbit (TBD) | Sun-synchronous<br>(descending local time: 10:30)<br>Altitude: 798km, Inclination: 98.6deg |
| Launch Date | early 2014 (JFY2013) |
| Mission Life | 5 years (3 satellites; total 13 years) |
| Scan | Push-broom electric scan (VN & P)<br>Wisk-broom mechanical scan (SW & T) |
| Scan width | 1150km cross track (VN & P)<br>1400km cross track (SW & T) |
| Digitalization | 12bit |
| Polarization | 3 polarization angles for P |
| Along track direction | +45 deg and -45 deg for P<br>Nadir for VN, SW and T |




**SGLI channels**

| CH | $\lambda$ | $\Delta\lambda$ | $L_{std}$ | $L_{max}$ | SNR at Lstd | IFOV |
|---|---|---|---|---|---|---|
| | VN, P, SW: nm<br>T: $\mu m$ | | VN, P: $W/m^2/sr/\mu m$<br>T: Kelvin | | VN, P, SW: -<br>T: $NE\Delta T$ | 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 |

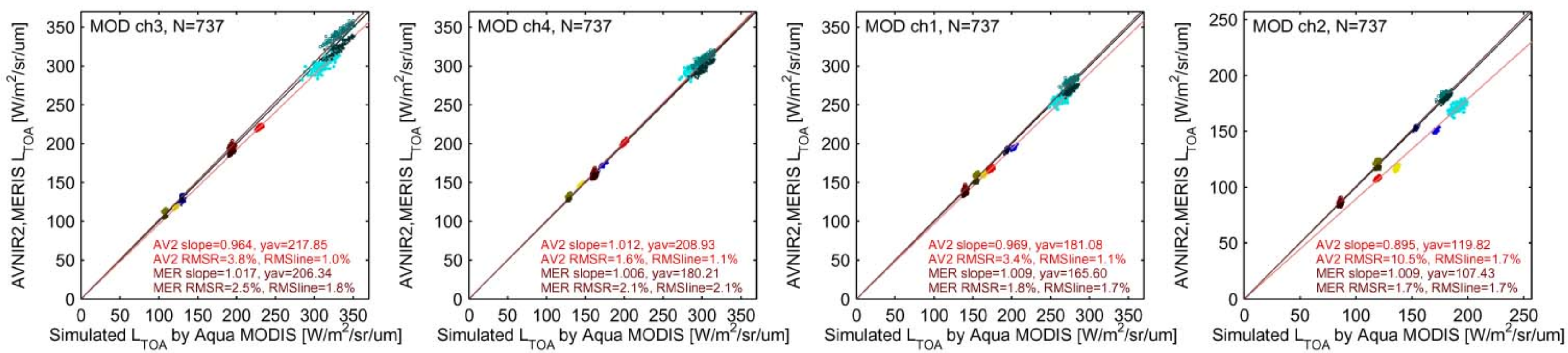
# AVNIR-2,MERIS,MODIS comparison




Summary plot of slopes from Aqua MODIS

Water vapor absorption is not considered in the AVNIR2 results
MERIS agrees well (~1%) to Aqua MODIS
Terra MODIS is 2~3% lower than Aqua MODIS

*The MERIS-Aqua/MODIS result support the previous MODIS-AVNIR2analysis*




| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lybie | 20060816, | 018, | 018, | 018, | 018, | 018, | 018, | 018, | 018, | 0.995, | 1.009, | 0.977, | 0.885, | 0.972, | 0.999, | 0.959, | 0.878 |
| Uyuni | 20060821, | 114, | 114, | 114, | 114, | 114, | 114, | 114, | 114, | 0.980, | 1.025, | 0.991, | 0.904, | 0.969, | 1.022, | 0.980, | 0.899 |
| Arizaro | 20060914, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000 |
| Rakhali | 20061102, | 094, | 094, | 094, | 094, | 094, | 094, | 094, | 094, | 1.009, | 1.047, | 1.011, | 0.889, | 0.966, | 1.021, | 0.973, | 0.859 |
| Antarc | 20070111, | 511, | 511, | 511, | 511, | 511, | 511, | 511, | 511, | 0.983, | 1.025, | 0.991, | 0.920, | 0.962, | 1.007, | 0.964, | 0.903 |
| Lybie | 20060816, | 018, | 018, | 018, | 018, | 018, | 018, | 018, | 018, | 1.046, | 1.005, | 1.015, | 1.005, | 1.022, | 0.996, | 0.994, | 0.998 |
| Uyuni | 20060821, | 114, | 114, | 114, | 114, | 114, | 114, | 114, | 114, | 1.052, | 1.036, | 1.042, | 1.022, | 1.026, | 1.019, | 1.014, | 1.017 |
| Arizaro | 20060914, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000 |
| Rakhali | 20061102, | 094, | 094, | 094, | 094, | 094, | 094, | 094, | 094, | 1.078, | 1.046, | 1.059, | 1.046, | 1.052, | 1.042, | 1.036, | 1.027 |
| Antarc | 20070111, | 511, | 511, | 511, | 511, | 511, | 511, | 511, | 511, | 1.040, | 1.020, | 1.038, | 1.024, | 1.008, | 0.993, | 1.000, | 0.998 |
| Lybie | 20060816, | 000, | 000, | 000, | 000, | 018, | 018, | 018, | 018, | 0.000, | 0.000, | 0.000, | 0.000, | 0.977, | 0.991, | 0.980, | 0.993 |
| Uyuni | 20060821, | 000, | 000, | 000, | 000, | 114, | 114, | 114, | 114, | 0.000, | 0.000, | 0.000, | 0.000, | 0.976, | 0.984, | 0.973, | 0.995 |
| Arizaro | 20060914, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000, | 0.000 |
| Rakhali | 20061102, | 000, | 000, | 000, | 000, | 094, | 094, | 094, | 094, | 0.000, | 0.000, | 0.000, | 0.000, | 0.976, | 0.996, | 0.978, | 0.982 |
| Antarc | 20070111, | 000, | 000, | 000, | 000, | 511, | 511, | 511, | 511, | 0.000, | 0.000, | 0.000, | 0.000, | 0.970, | 0.973, | 0.963, | 0.974 |