JAXA Earth Observation

- EarthCARE, GCOM, GOSAT, SMILES -

Atmospheric Composition Forecasting Working Group:
Aerosol Observability Meeting

April 27-29, 2010

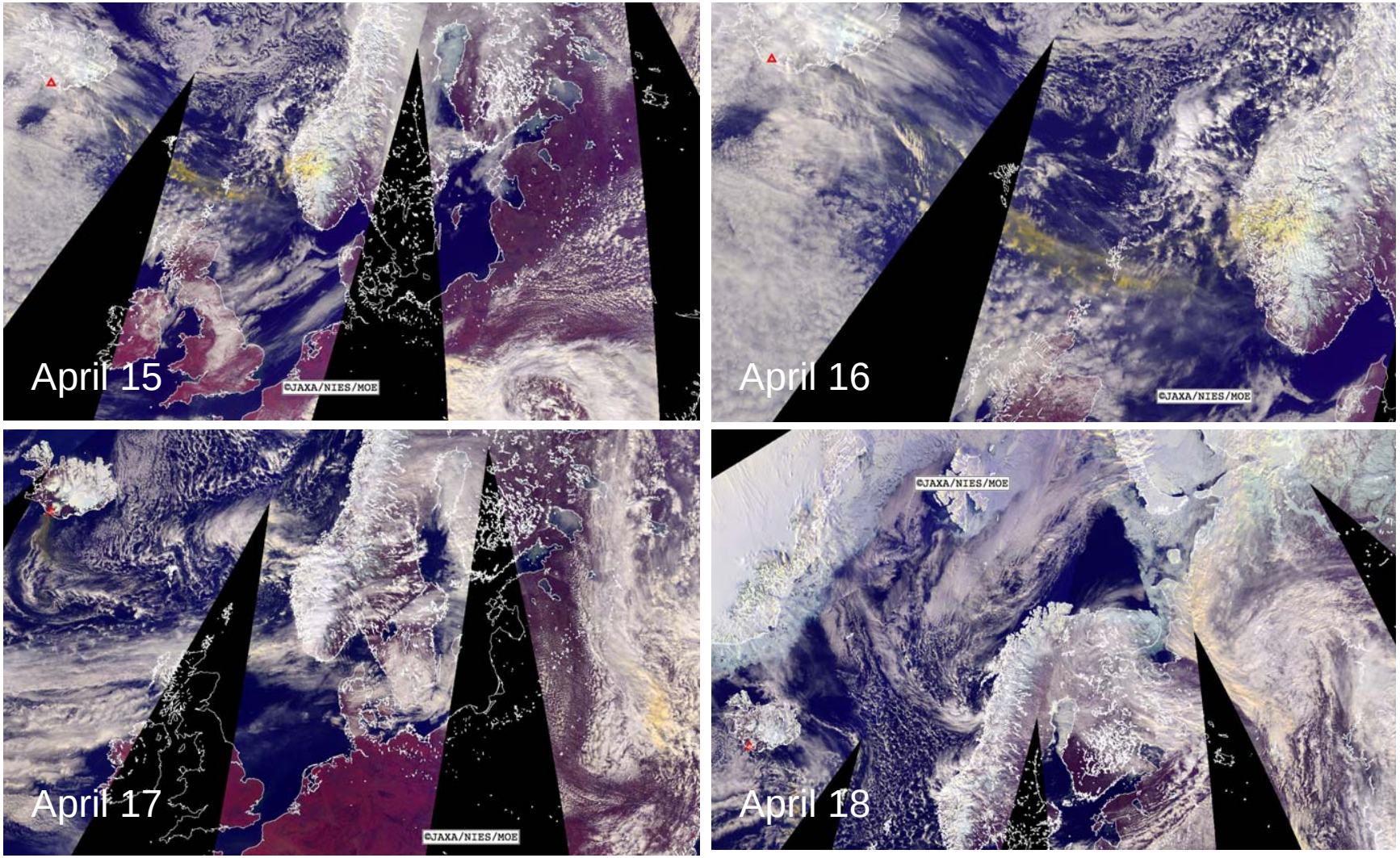
Monterey, CA. Casa Munras Hotel

JAXA/EORC

Tamotsu Igarashi

GOSAT/TANSO-CAI image: Europe and Siberia

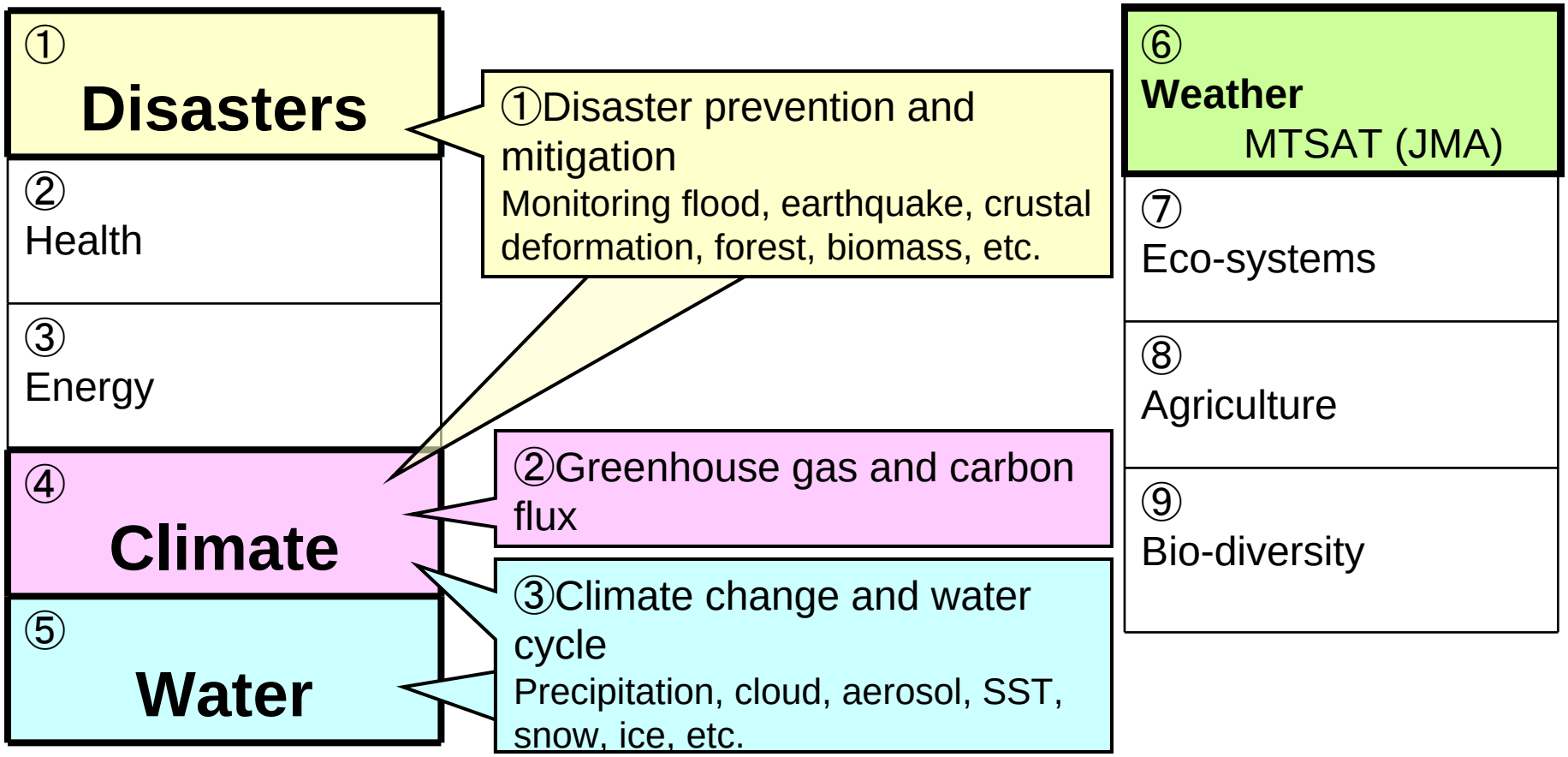
λ = 870nm, 678nm, 380nm, April 15,16,17 and 18, 2010



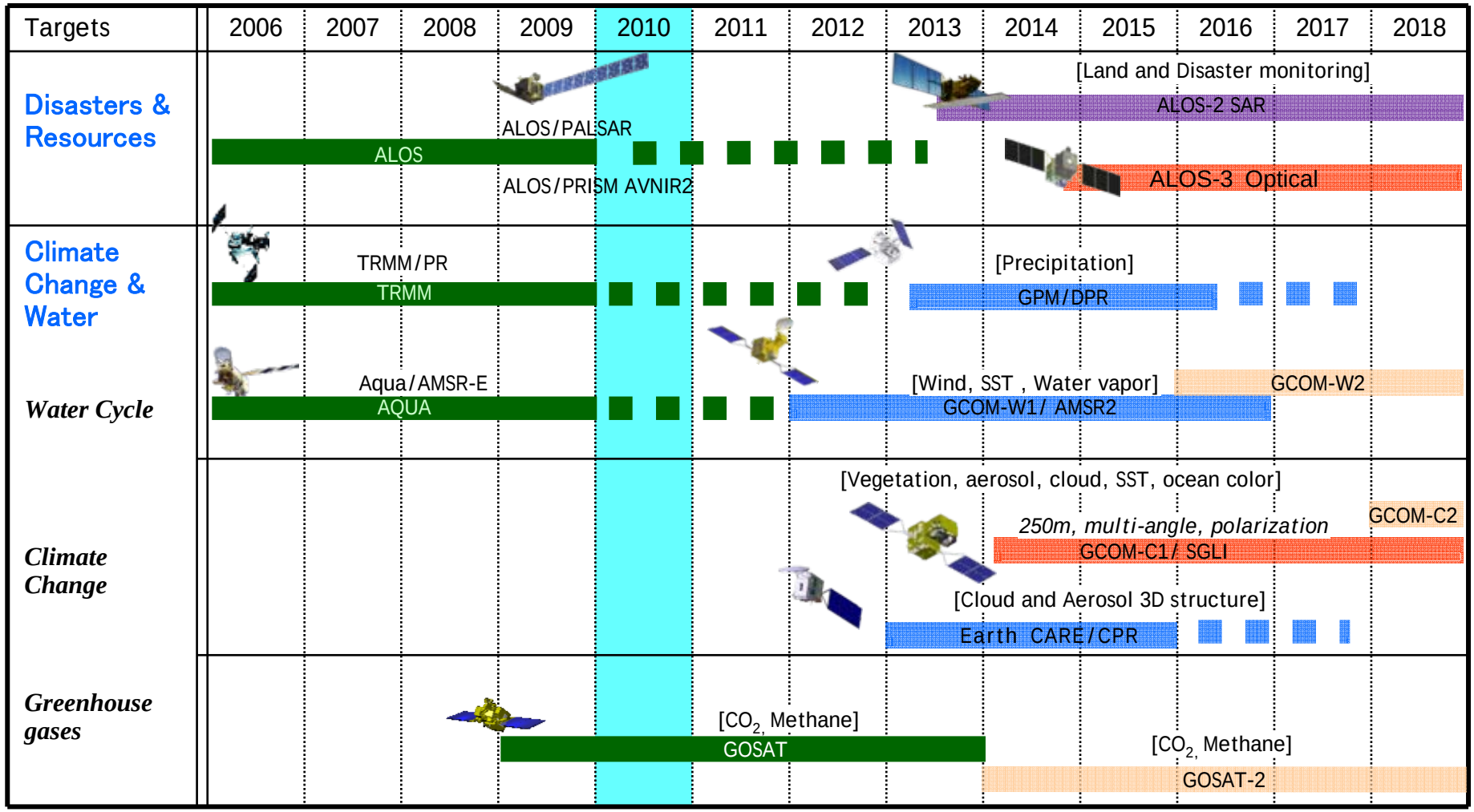
White: Cloud, Snow and Sea Ice; Red: Land Vegetation; Yellow: Volcanic Smoke

Japanese Main Activities of Earth Observation

GEOSS 10 years implementation plan



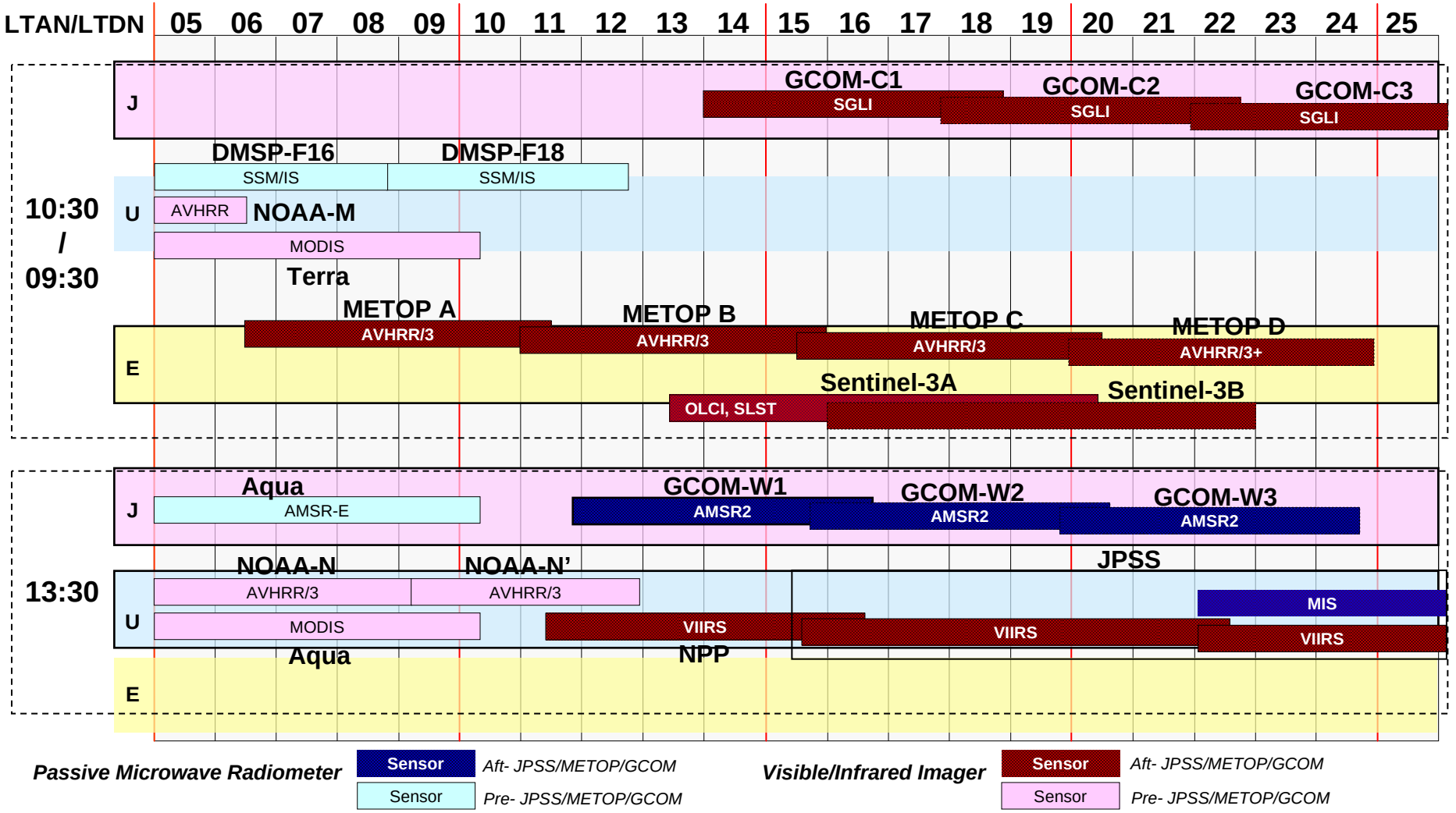
Long-Term Plan of JAXA Earth Observation



Mission status

On orbit | Phase C/D | Phase B~ | Phase A | Pre-Phase A | Extension

International Cooperation with operational satellites



OCEAN COLOUR IMAGERY FROM LEO

Instrument	Satellite	LST	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
VIIRS	JPSS 2&4	05:30									(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)	(X)
MSS-BIO	Meteor-M 3	09:30					X	X	X	X	X	X								
OCS	Meteor-M 3	09:30					X	X	X	X	X	X								
MERIS	Envisat	10:00	X	X	X	X	X	X												
OLCI	Sentinel-3 A	10:00					X	X	X	X	X	X	X	X						
OLCI	Sentinel-3 B	10:00								X	X	X	X	X	X	X	X			
MERSI	FY-3 A/C/E/G	10:00	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
SGLI	GCOM-C 1	10:30							X	X	X	X	X	X						
SGLI	GCOM-C 2&3	10:30													(X)	(X)	(X)	(X)	(X)	(X)
MODIS	EOS-Terra	10:30	X	X																
COCTS	HY-1 B & C	10:30	X	X	X	X	X	X												
SeaWiFS	SeaStar	12:00	X	X																
OCM	OceanSat-1	12:00	X	X																
OCM	OceanSat-2	12:00		X	X	X	X	X	X											
MODIS	EOS-Aqua	13:30	X	X																
COCTS	HY-1 D	13:30			X	X	X	X												
VIIRS	NPP, JPSS 1&3	13:30				X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MERSI	FY-3 B/D/F	14:00		X	X	X	X	X	X	X	X	X	X	X	X	X	X			

Instrument class	Channels with λ < 1 μm: < 10 All bandwidths > 10 nm	Channels with λ < 1 μm: > 10 Most bandwidths ~ 10 nm	Channels with λ < 1 μm: > 10 Some bandwidths < 10 nm

(Courtesy of Dr. Bizzarri, WMO)

EarthCARE/Cloud Profiling RADAR

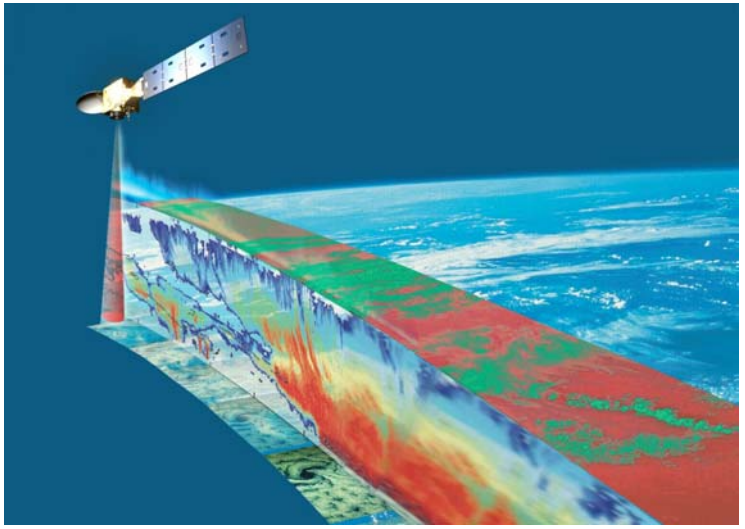
Climate monitoring of earth radiation, cloud and aerosol
Cooperation between ESA and Japan (JAXA/NICT)

- Mission
  - Vertical profile of clouds, aerosol
  - Interaction between clouds and aerosol
  - Cloud stability and precipitation
- Orbit
  - Sun synchronous
  - Equator crossing time 13:45
  - Altitude 400km
- Instrument
  - CPR (Cloud Profile Radar)
  - ATLID (Atmospheric LIDAR)
  - MSI (Multi-Spectral Imager)
  - BBR (Broad Band Radiometer)
- Task sharing
  - JAXA/NICT (CPR)
  - ESA (ATLID, MSI, BBR, Spacecraft)
- Launch target
  - JFY2013

Global / 3D distributions of clouds and aerosols with EarthCARE and numerical models.

Aerosols Retrieval with ATLID and MSI

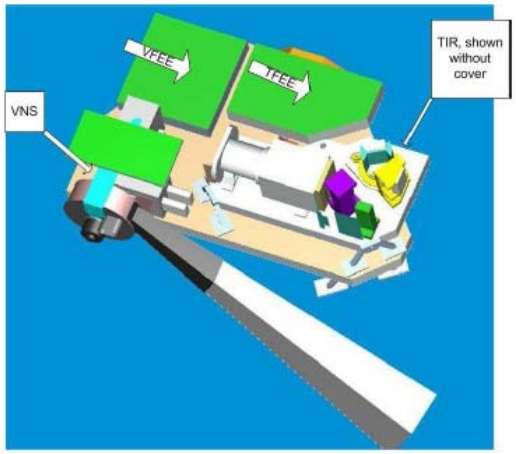
- Optical / Microphysical / Radiative properties (Extinction, Size distribution, Single scattering albedo, Optical thickness, Ångström Exponent)
- Type (Soil Dust, Carbonaceous, Sulfate, Sea Salt)
- Component (Dust, Sea-salt, black carbon, etc)



MSI

MSI Configuration

- Visible/Infrared Imager
- 150km across track swath
- 500m Ground Sampling Distance
- Cloud and Aerosol detection
- Contextual information for CPR/ATLID processing
- Two optical heads: VNS and TIR



Band		Centre wavelength [μm]	Dynamic range [%]	SNR at 100% TOA reflectivity		Goal values at low TOA reflectivity	
						SNR	Reference signal [Wm²sr⁻¹μm⁻¹]
1	VIS	0.67, +/- 0.01	0 – 110	500		75	30
2	NIR	0.865, +/- 0.01	0 – 110	500		65	17
3	SWIR1	1.65, +/- 0.015	0 – 102	250		18	1.5
4	SWIR2	2.21, +/- 0.015	0 – 100	250		21	0.5
Band		Centre wavelength [μm]	Dynamic range [K]	NEDT		Goal requirements	
				NEDT at 220K	NEDT at 293K	NEDT at 220K	NEDT at 293K
5	TIR 1	8.8, +/- 0.05	170 – 350	0.8	0.25	0.6	0.1
6	TIR 2	10.8, +/- 0.05	170 – 350	0.8	0.25	0.7	0.15
7	TIR 3	12.0, +/- 0.05	170 – 350	0.8	0.25	0.8	0.2

Strategy for MSI data analysis in Japan

2-channel method for aerosol *over ocean*

→ aerosol optical thickness and Ångström exponent
(with Cloud flag, Ancillary data, LUTs, and Screening data)

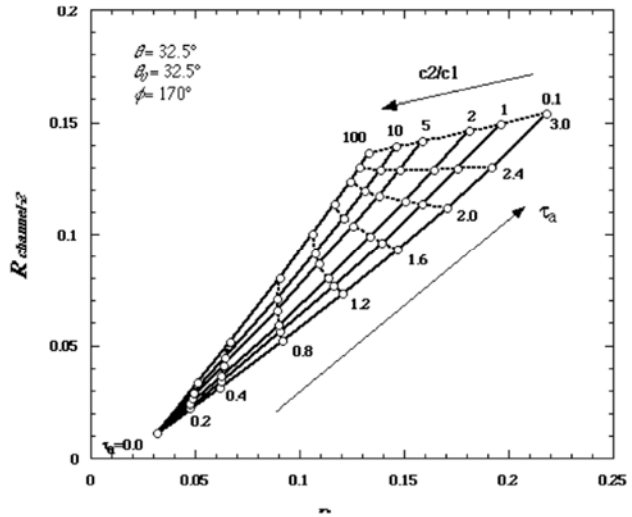


Fig. 1 Relationship between visible and near-IR apparent reflectances for various optical thickness and peak ratio.

3-channel method for aerosol *over land*

→ aerosol optical thickness
with Ground albedo, NDVI, Ancillary data, LUTs, and Screening data

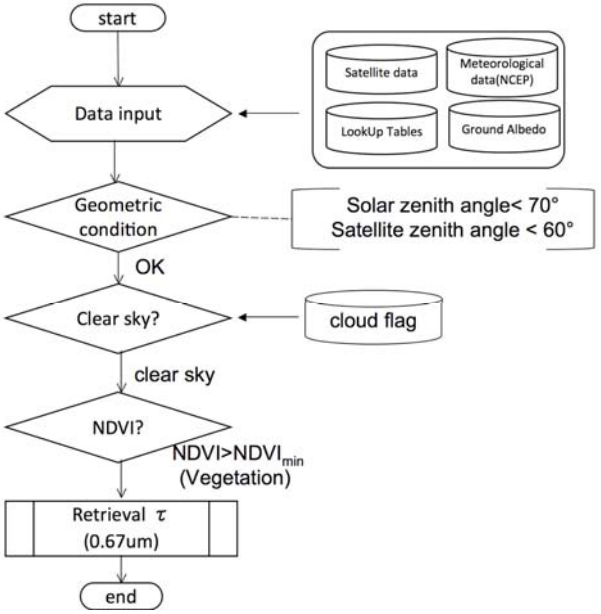
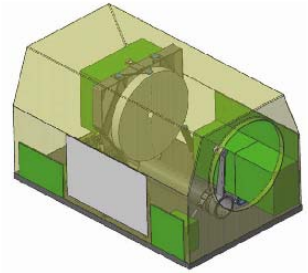


Fig. 2 flow chart of the aerosol optical depth retrieval algorithm (land)

Synergistic analysis with ATLID retrieval

ATLID

ATLID Configuration



355 nm High Spectral Resolution lidar (HSRL)

3 channels:

- Mie scattering co-polar channel
- Mie scattering cross-polar channel
- Rayleigh scattering channel

- Particle extinction coefficient (α)
- Particle backscattering coefficient (β)
- Particle depolarization ratio (δ)

Strategy for ATLID data analysis in Japan

ATLID 3ch. data

- Particle extinction (α)
- Particle backscattering (β)
- Particle depolarization (δ)

Classify main aerosol components in the atmosphere
(Water-soluble, Dust, Sea-salt, soot etc)
Retrieve vertical profiles of extinction coefficient for each aerosol component
(T.Nishizawa/N.Sugimoto,NIES)

Global 3D distribution of each aerosol component

+ Cloud properties (H.Okamoto,Tohoku-U, T.Y.Nakajima,Tokai-U)
→ Cloud-Aerosol interaction

→ Evaluation and Input data for numerical models
(e.g., aerosol transport model, cloud resolving model)
Models: NICAM CCSR.U-Tokyo, JAMSTEC; MIROC CCSR.U-Tokyo, etc.

JAXA Aerosol Product

Standard Products (Aerosol)

Sensor(s)	Processing Level	Product Name	Primary Parameters	Product Resolution		Release Accuracy	Standard Accuracy	Target Accuracy
				Horizontal	Vertical			
ATLID	L2a	Feature Mask Product	Feature Mask	200m	100m	100%	40%	10%
		Target Products	Target Mask	1km 10km	100m 100m	100%	40%	10%
		Aerosol Product	Ext. & Backscat. Coeff. and Lidar & Depolarization Ratio	10km	100m	±60%, 90%, 150%, 150%	±40%, 70%, 110%, 130%	±20%, 50%, 70%, 100%
		Cloud Products	Ext. & Backscat. Coeff. and Lidar & Depolarization Ratio	1km 10km	100m 100m	±50%, 90%, 140%, 150%	±30%, 70%, 100%, 100%	±15%, 50%, 65%, 100%
		Atmospheric Boundary Layer	Planetary Boundary Layer Height	1km 10km	100m 100m	±500m	±300m	±100m

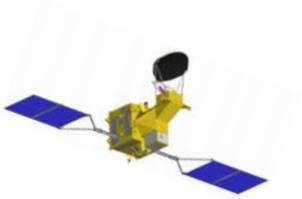
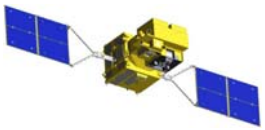
Research Products (Aerosol)

Sensor(s)	Processing Level	Product Name	Primary Parameters	Product Resolution	
				Horizontal	Vertical
ATLID	L2a	Aerosol Extinction Products	Aerosol Extinction Coefficient (Water Soluble)	1km 10km	100m 100m
			Aerosol Extinction Coefficient (Dust)		
			Aerosol Extinction Coefficient (Sea Salt)		
			Aerosol Extinction Coefficient (Black Carbon)		
ATLID + MSI	L2b	Aerosol Component Products	Aerosol Extinction Coefficient (Water Soluble)	10km	100m
			Aerosol Extinction Coefficient (Dust)		
			Aerosol Extinction Coefficient (Sea Salt)		
			Aerosol Extinction Coefficient (Black Carbon)		
			Aerosol Size information (Fine-mode) -> mode radius		
			Aerosol Size information (Fine-mode) -> mode radius		
MSI	L2a	Aerosol Products	Aerosol Optical Thickness (Ocean & Land)	500m	-
			Angstrom Parameter (Ocean)		

Global Change Observation Mission (GCOM)

Main Mission

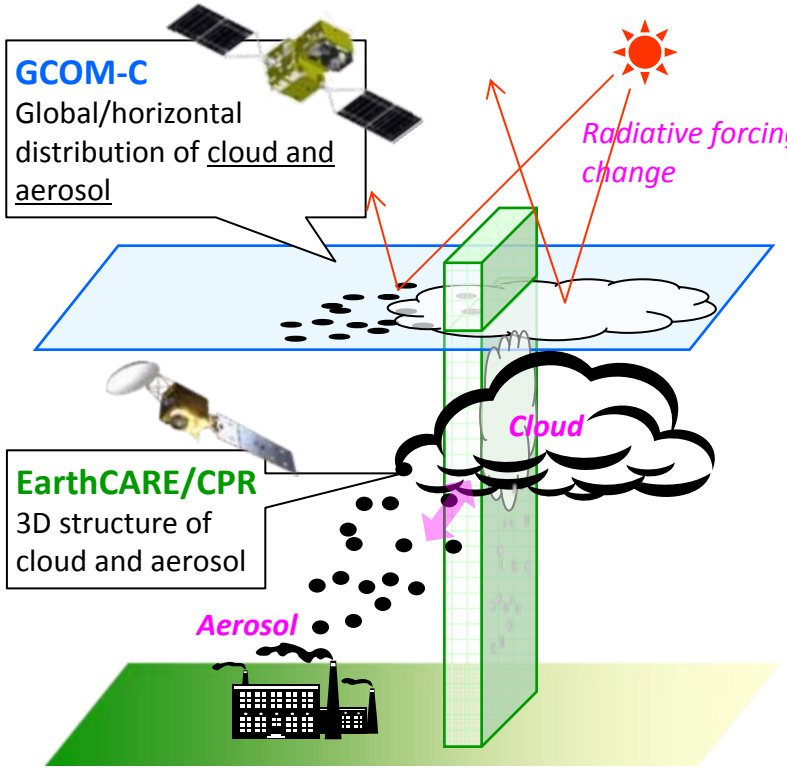
- Establish and demonstrate the global and long-term Earth observing system (contribute to GEOSS)
- Contribute to improving climate change prediction in concert with climate model research institutions

	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	• Global Imager follow-on instrument (SGLI)
Launch	JFY 2011	JFY 2014

Last October, GCOM-W1's participation to "A-Train", afternoon orbit constellation led by NASA/GSFC, and its orbit place was permitted.

GCOM-C Science targets

Radiation budget of the atmosphere-surface system



Today's the most significant factor: atmospheric CO_2

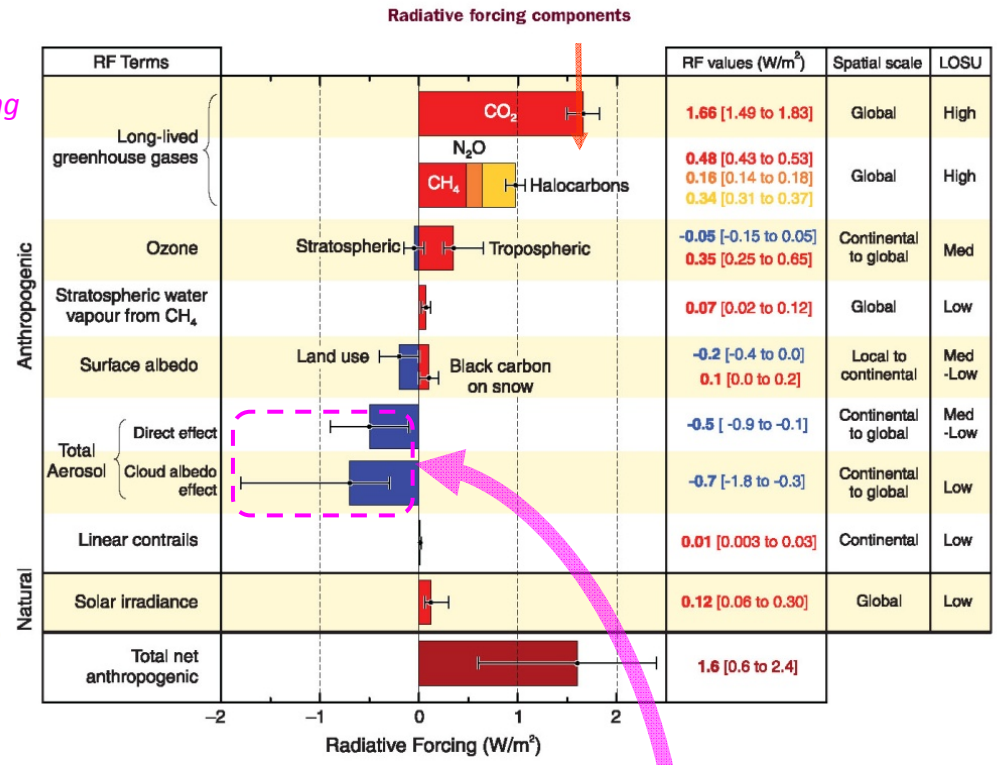


Figure 2.4. Global average radiative forcing (RF) in 2005 (best estimates and 5 to 95% uncertainty ranges) with respect to 1750 for CO_2, CH_4, N_2O and other important agents and mechanisms, together with the typical geographical extent (spatial scale) of the forcing and the assessed level of scientific understanding (LOSU). Aerosols from explosive volcanic eruptions contribute an additional episodic cooling term for a few years following an eruption. The range for linear contrails does not include other possible effects of aviation on cloudiness. {WGI Figure SPM.2}

Monitoring and process investigation about **cloud and aerosol by GCOM-C & EarthCARE**

Improvement

Evaluation of model outputs and process parameterization

Climate models
present and future cloud and aerosol roles in the global warming scenarios

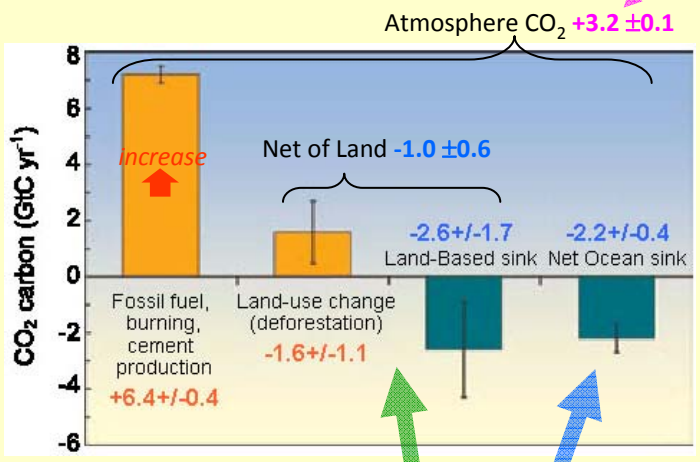
Today's the most significant uncertainty of Radiative forcing is direct/indirect role of cloud-aerosol system

GCOM-C Science targets

Carbon cycle in the Land and Ocean

Today's Carbon budget

Today's the most significant factor

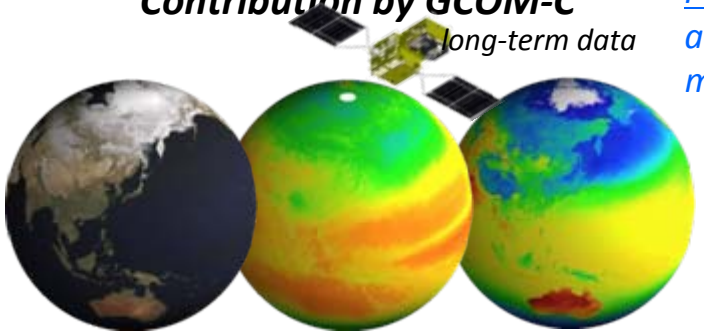


Modified from the 4th IPCC report FAQ7.1

Monitoring of primary production

Contribution by GCOM-C

long-term data



Process study and diagnosis with model researches

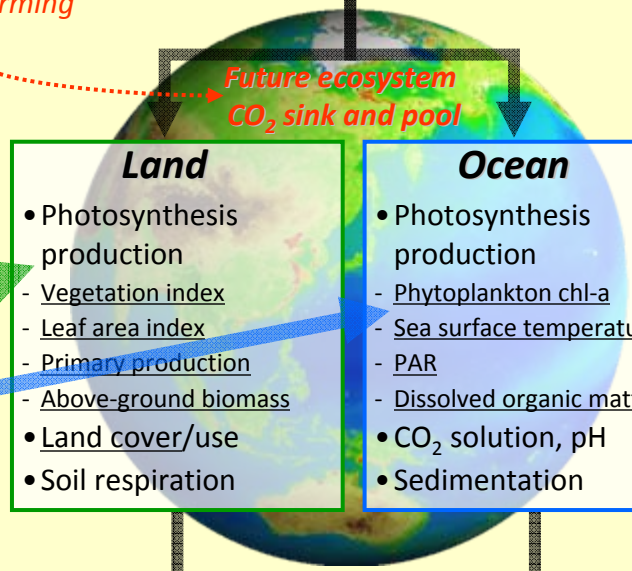
Future Carbon cycle

CO_2 increase and Global warming

Global environmental change
(irradiance, temperature, CO_2, precipitation)

Several tens of % uncertainty in the global warming prediction

Future ecosystem CO_2 sink and pool



Land
- Photosynthesis production
  - Vegetation index
  - Leaf area index
  - Primary production
  - Above-ground biomass
- Land cover/use
- Soil respiration

Ocean
- Photosynthesis production
  - Phytoplankton chl-a
  - Sea surface temperature
  - PAR
  - Dissolved organic matter
- CO_2 solution, pH
- Sedimentation

Feedback

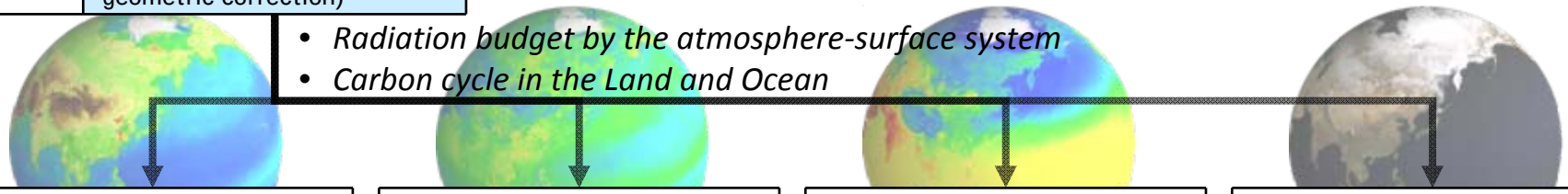
Change of atmosphere CO_2

GCOM-C Observation Products

Standard and research products

Common	
Radiance	• TOA radiance (including system geometric correction)

- *Radiation budget by the atmosphere-surface system*
- *Carbon cycle in the Land and Ocean*



Land	
Surface reflectance	• Precise geometric correction
	• Atmospheric corrected reflectance
Vegetation and carbon cycle	• Vegetation index
	• Above-ground biomass ECV
	• Vegetation roughness index
	• Shadow index
	• Fraction of Absorbed Photosynthetically available radiation ECV
	• Leaf area index ECV
Temp.	• Surface temperature
Application	Land net primary production
	Water stress trend
	Fire detection index ECV
	Land cover type ECV
	Land surface albedo ECV

Atmosphere	
Cloud ECV	• Cloud flag/Classification
	• Classified cloud fraction
	• Cloud top temp/height
	• Water cloud optical thickness /effective radius
	• Ice cloud optical thickness
	Water cloud geometrical thickness
Aerosol ECV	• Aerosol over the ocean
	• Land aerosol by near ultra violet
	• Aerosol by Polarization
Radiation budget ECV	Long-wave radiation flux
	Short-wave radiation flux

Ocean	
Ocean color ECV	• Normalized water leaving radiance
	• Atmospheric correction parameter
	• Photosynthetically available radiation
	Euphoric zone depth
In-water	• Chlorophyll-a conc.
	• Suspended solid conc.
	• Colored dissolved organic matter
In-water	Inherent optical properties
Temp.	• Sea surface temp. ECV
Application	Ocean net primary productivity
	Phytoplankton functional type
	Redtide
	multi sensor merged ocean color
	multi sensor merged SST

Cryosphere	
Area/ distribution	• Snow and Ice covered area ECV
	• OKhotsk sea-ice distribution
	Snow and ice classification
	Snow covered area in forest and mountain
Surface properties	• Snow and ice surface Temperature
	• Snow grain size of shallow layer
	Snow grain size of subsurface layer
	Snow grain size of top layer
	Snow and ice albedo ECV
	Snow impurity
	Ice sheet surface roughness
Boundary	Ice sheet boundary monitoring ECV

Blue: standard products

Red: research products

GCOM-C Observation Products

Products and SGLI channels

CH	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR	IFOV*3
-	VN, P: nm T: μm		VN, P: W/m²/sr/μm T: Kelvin		at L_{std} VN, P: - T: NEΔT	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	673.5	20	23	62	400	250
VN8	673.5	20	25	210	250	250
VN9	763	12	40	350	1200	1000
VN10	868.5	20	8	30	400	250
VN11	868.5	20	30	300	200	250
P1	673.5	20	25*1	250*1	250*1	1000
P2	868.5	20	30*1	300*1	250*1	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	1630	200	3	50	57	250
SW4	2210	50	1.9	20	211	1000
T1	10.8*2	0.7*2	300	180~340	0.2	500*4
T2	12.0*2	0.7*2	300	180~340	0.2	500*4

Land

CH	Precise Geometrically Corrected Image	Atmospherically Corrected Land surface Reflectance	Vegetation Index including NDVI and EVI	Vegetation Roughness Index including BSI_P and BSI_V	Shadow Index	Land Surface Temperature	Fraction of Absorbed Photosynthetically Active Radiation	Leaf Area Index	Above-Ground BIOmass	Land Net Primary Production	Water Stress trend	Fire Detection Index	Land Cover Type	Land surface ALBedo
VN1	U	U												
VN2	U	T	U		U	U	I	I	I	U			U	U
VN3	U	T	U		U	U	I	I	I	U			U	U
VN4														
VN5	U	T			U	U	I	I	I	U			U	U
VN6														
VN7														
VN8	E	T	M	M	U	U	I	I	I	E			E	I
VN9														
VN10														
VN11	U	T	U	U	U	U	I	I	I	U			U	U
P1	U	U		U	R		I	I	I	R			R	R
P2	U	U		U	R		I	I	I	R			R	R
SW1														
SW2														
SW3	U	T				U				U	R	U	E	U
SW4	U	T				U						U	U	
T1	U					U					U	U		
T2	U					M					U	U		

Atmosphere

CH	CLoud FlaG including Cloud Classification and Phase	Classified CLoud Fraction	Cloud Top Temperature and Height	Water Cloud Optical Thickness and Particle Effective Radius	Ice Cloud Optical Thickness	Water Cloud Geometrical Thickness	AeRosol over the ocean by Visible and near infrared	Land AeRosol over the land by near Ultra violet	AeRosol by Polarization	LongWave Radiation Flux	ShortWave Radiation Flux
VN1								U		I	I
VN2							U	E		I	I
VN3							U			I	I
VN4											
VN5	U	C	C	C	C	C	C	C	C		
VN6											
VN7							U			I	I
VN8	U	C	C	C	C	C	C	C	C		
VN9						M				I	I
VN10							U			I	I
VN11	U	C	C	C	C	C	C	C	C		
P1									E		
P2									E		
SW1	M	C	C	M	C	U				I	I
SW2	U										
SW3	U	C	C		C						
SW4				M		U				I	I
T1	U	C	U		U	U				I	I
T2	U	C	U		U					R	R

Ocean

CH	Normalized Water Leaving Radiance	Atmospheric Correction Parameters	Ocean Photosynthetically Available Radiation	Euphotic Zone Depth	CHLorophyll-A concentration	Suspended Solid concentration	absorption coefficient of Colored Dissolved Organic Matter	Inherent Optical Properties	Sea Surface Temperature	Ocean Net Primary Productivity	PHytoplankton Functional Type	Red TIDe	multi sensor Merged Ocean Color parameters	multi sensor Merged Sea Surface Temperature
VN1	T	E			I	I	U	U		I	R	R	U	
VN2	T		U				E	U		I	R	R	U	
VN3	T		U	U	E		E	U		I	U	U	U	
VN4	T			U	M	U		U		I	U	U	U	
VN5	T		U	U	E			U	C	I	R	R	U	C
VN6	T			U	M	E	U	U		I	U	U	U	
VN7	T	M		I	I	E	I	U		I	R	R	U	
VN8		R	U						C	I			R	C
VN9														
VN10		M		I	I	I	I			I			U	
VN11		R	U						C	I			R	C
P1		R	R											
P2		R												
SW1		R	C							I				
SW2														
SW3		R												
SW4		R												
T1									M	I		R		M
T2									E					E

Cryosphere

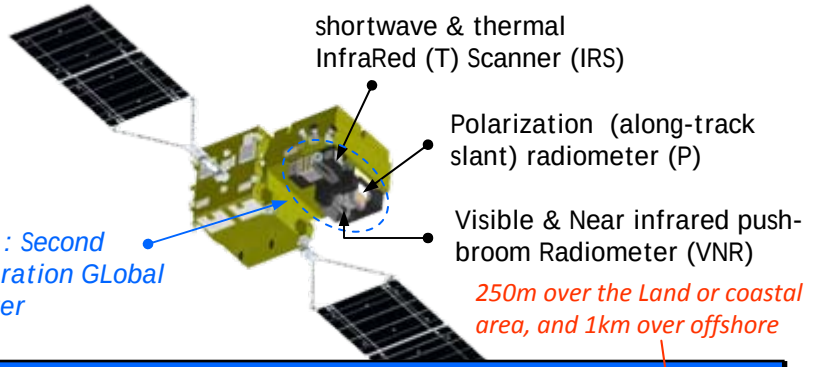
CH	Snow and Ice Covered Area	OKhotsk sea-Ice Distribution	Snow and Ice Classification	Snow Covered Area in Forest and Mountain	Snow and Ice Surface Temperature	SNow Grain Size of shaLlow layer	SNow Grain Size of Subsurface layer	SNow Grain Size of Top layer	Snow and Ice ALBedo	SNow ImPurity	Ice Sheet surface RouGHness	Ice Sheet Boundary Monitoring
VN1						U	I		U	M		
VN2									R	R		
VN3	U	U	U	U	S	U	U	S	U	M	S	U
VN4												
VN5	U	U	U	U	S	S	S	S	E	S	S	U
VN6												
VN7												
VN8	U	U	U	U	S	S	S	S	U	S	R	U
VN9	R											
VN10												
VN11	U	U	U	U	S	M	S	S	U	U	R	U
P1			R								R	
P2			R								R	
SW1	U	U	U	U	S	S	R	S	U	S	S	U
SW2	M	U	C	C	C	C	C	C	C	C	C	
SW3	M	U	U	U	C	C	C	R	U	C	C	U
SW4	U			U								
T1	U	U	U	U	M	S	S	S	S	S	S	
T2	U		R		M							

M: Most essential, **E**: essential, U: used channel, T: correction targets, R: future research, I: indirect use, C: cloud detection, S: Snow detection
*1: defined as intensity of non-polarized light, *2 :Unit is μm, *3: 1km in the open ocean, *4: 250m mode possibility
Green: Succession of GLI standard products, Red: New standard products, and White: research products.

GCOM-C Observation Products

Orbit and SGLI specification

The SGLI features are finer spatial resolution (250m (VNI) and 500m (T)) and polarization/along-track slant view channels (P), which will improve land, coastal, and aerosol observations.



GCOM-C SGLI characteristics (Current baseline)	
Orbit	Sun-synchronous (descending local time: 10:30) Altitude: 798km, Inclination: 98.6deg
Launch Date	Jan. 2014 (HII-A)
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 P
Along track direction	Nadir for VN, SW and T, +45 deg and -45 deg for P
On-board calibration	VN: Solar diffuser, Internal lamp (PD), Lunar by pitch maneuvers, and dark current by masked pixels and nighttime obs. SW: Solar diffuser, Internal lamp, Lunar, and dark current by deep space window T: Black body and dark current by deep space window All: Electric calibration

Multi-angle obs. for 674nm and 869nm

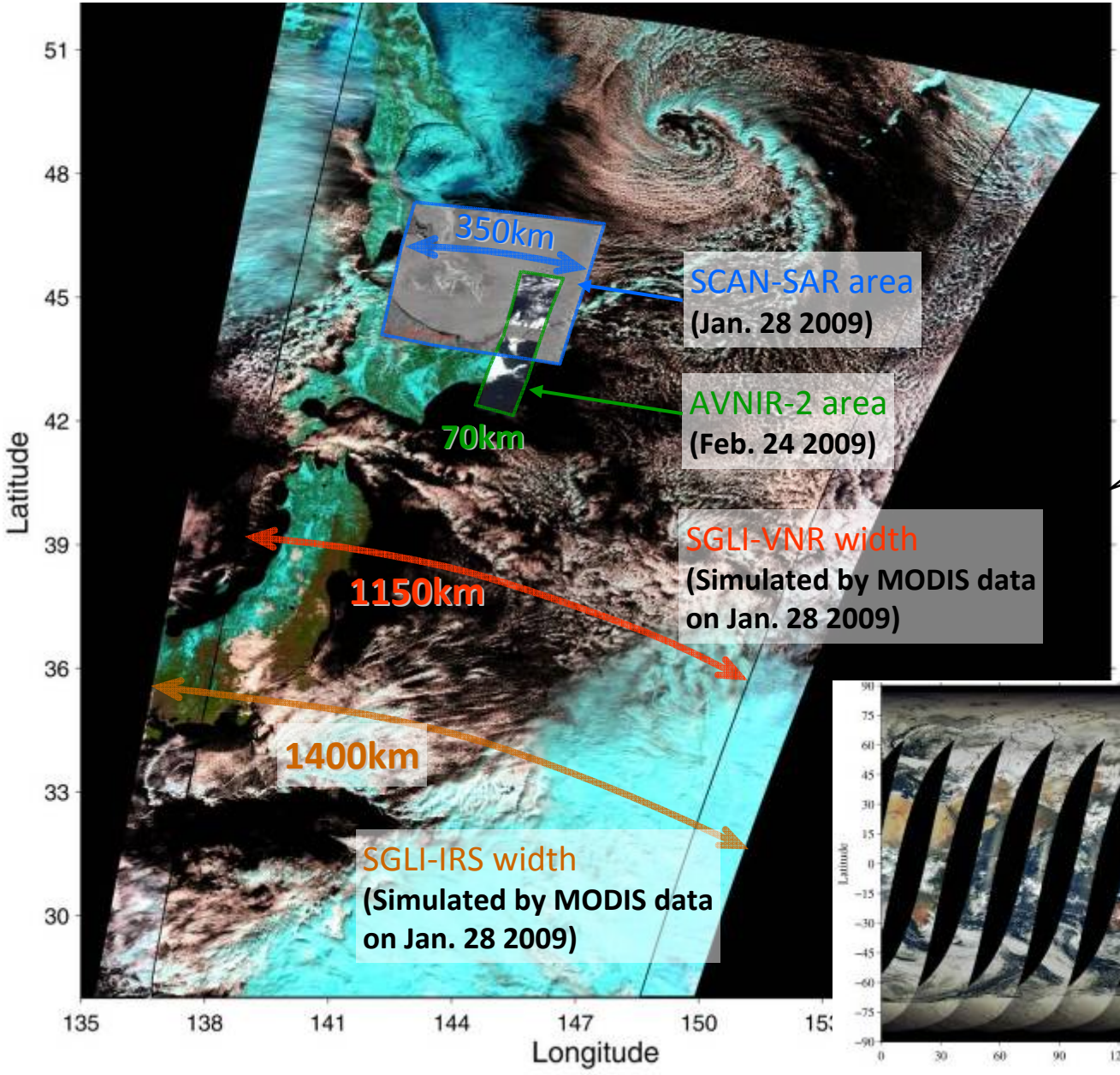
250m over the Land or coastal area, and 1km over offshore

SGLI channels						
CH	λ VN, P, SW: nm T: μm	Δλ	L_{std} VN, P: W/m²/sr/μm T: Kelvin	L_{max}	SNR at Lstd VN, P, SW: - T: NEΔT	IFOV 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	*673.5*	*20*	23	62	400	250
VN8	*673.5*	20	25	210	250	250
VN9	763	*12*	40	350	*1200*	1000
VN10	*868.5*	20	8	30	400	250
VN11	*868.5*	20	30	300	200	250
P1	*673.5*	20	25	250	250	1000
P2	*868.5*	20	30	300	250	1000
SW1	1050	20	57	248	500	1000
SW2	1380	20	8	103	150	1000
SW3	*1630*	200	3	50	57	250
SW4	2210	50	1.9	20	211	1000
T1	10.8	0.7	300	340	0.2	500
T2	12.0	0.7	300	340	0.2	500

250m-mode possibility ~15min /path (TBC)

GCOM-C Observation Products

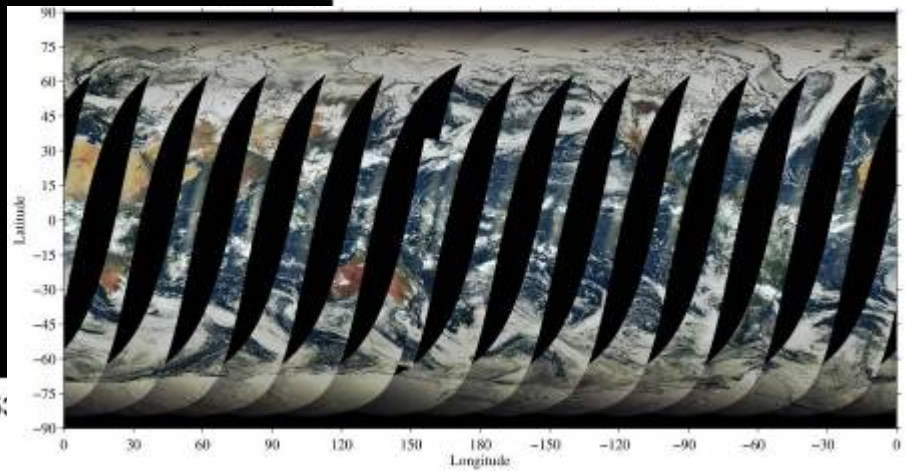
Swath width of SGLI (observation frequency)



Optimized for detecting seasonal change of land cover, vegetation and ocean color:

Higher (250-m) resolution multi-band & frequent (once/2-3days) observation

Daily coverage of SGLI VNR (Simulated by GLI data on 20 March 2003)

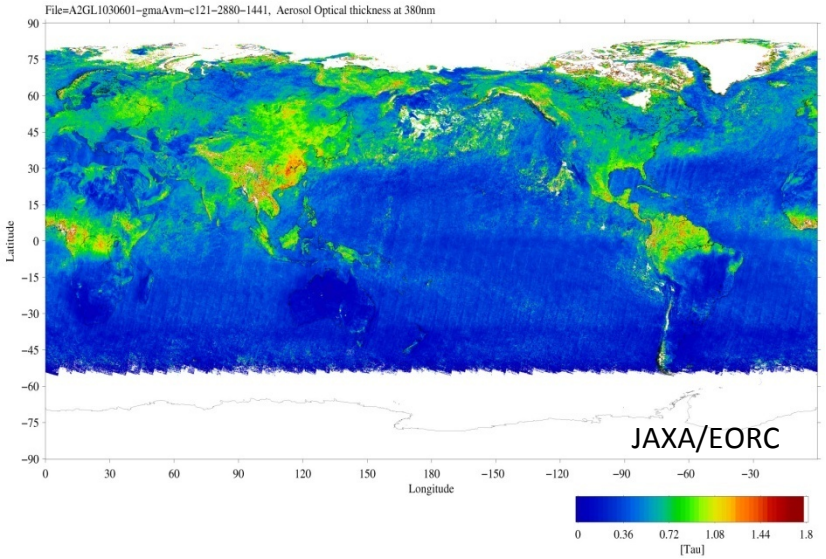


GCOM-C Observation Products

Land aerosol by Near-UV and polarization

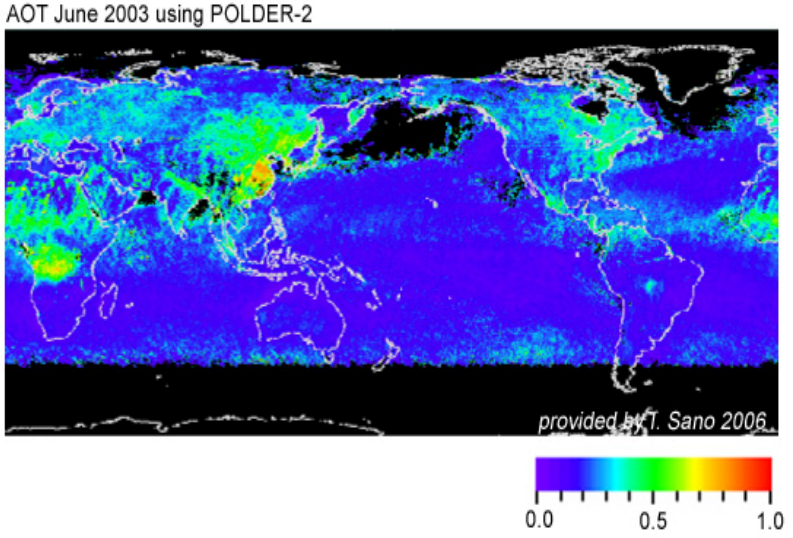
- *Not only over the ocean, SGLI will estimate land-area aerosols using near-UV (380nm) and polarization channels which are more sensitive to atmosphere scattering rather than land surface reflection.*
- *Combination of aerosol absorption by Near-UV and fine-mode aerosol properties by polarization.*

Near-UV aerosol



Global aerosol optical thickness in June 2003 using the GLI Near-UV (380nm) channel (NIR is used for the ocean area)

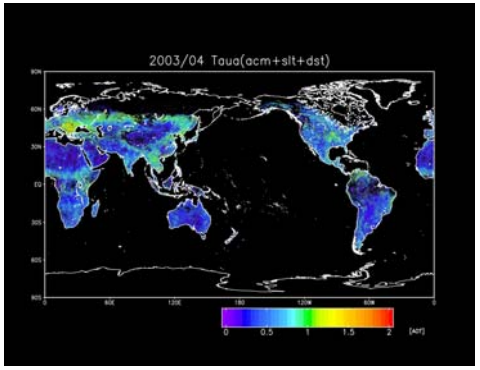
Polarization aerosol



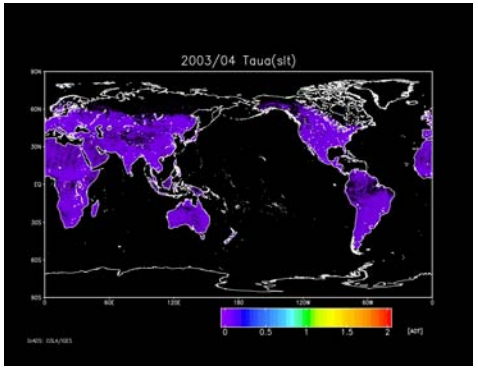
Global aerosol optical thickness in June 2003 using POLDER-2 polarization reflectance (provided by T. Sano, Kinki Univ.)

GLI/ADEOS-II Aerosol on April 2003

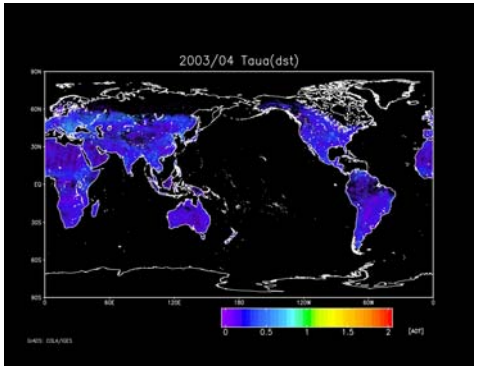
Aerosol optical thickness of three mode aerosols and soot ratio
Get Data from F:\GLI aerosol properties by Higurashi & Nakajima.htm



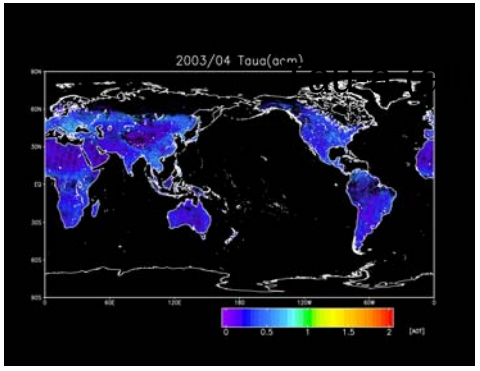
Tau-a (all)



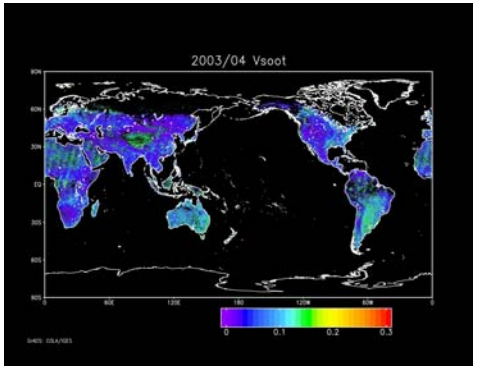
Tau-a (sea salt)



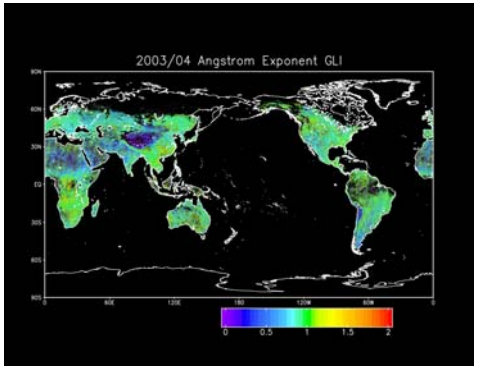
Tau-a (dust)



Tau-a (acc. mode)



Tau-a (soot ratio)

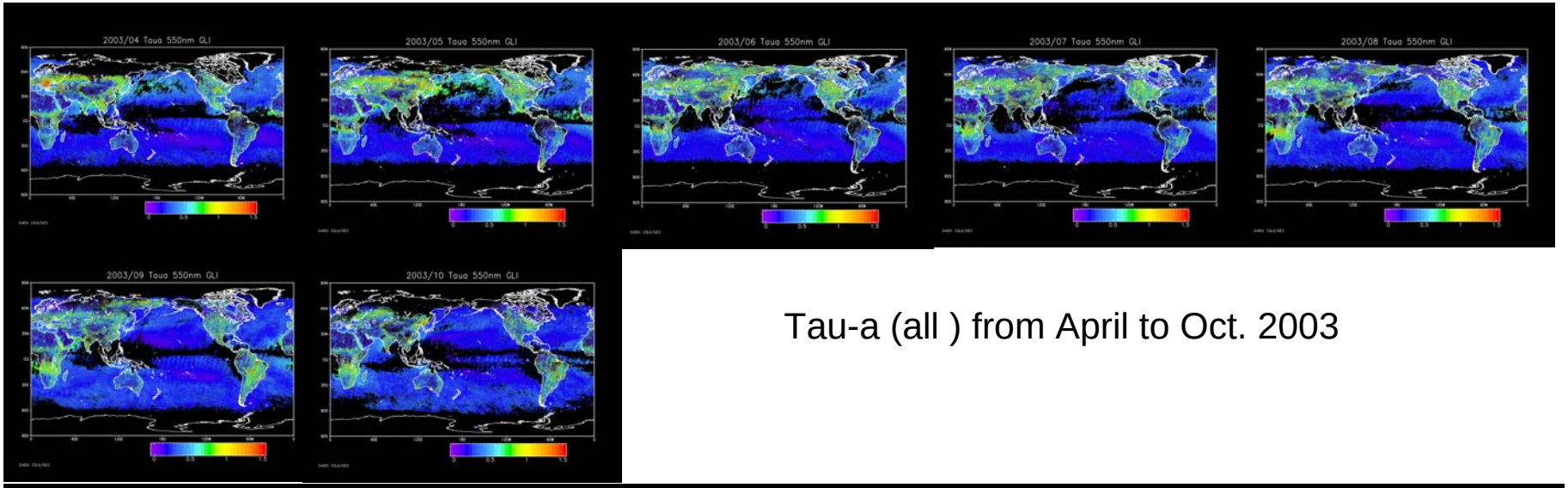


Angstrom exponent

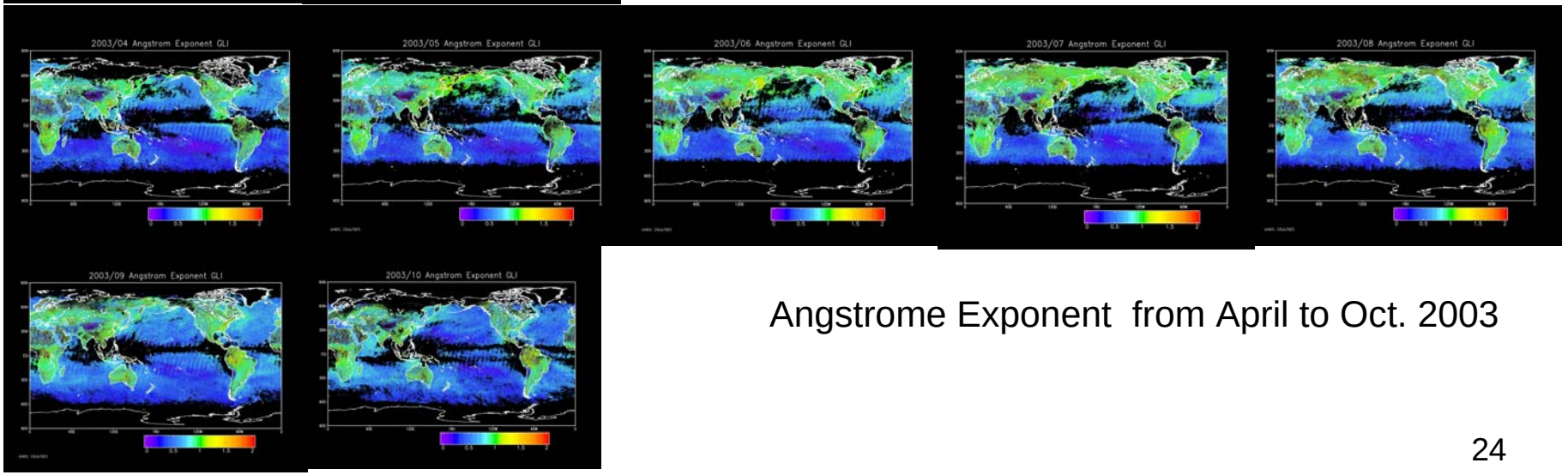
- GLI has NUV channel at λ = 380nm, which has advantage to extract land aerosol with little affect from land surface albedo.
- These data are derived from GLI observation data, using MAP method (Rodgers, 2000) based on three mode (accumulation (= soot+salfate), dust, sea salt) assumption.
- Using this wavelength sensitive to aerosol absorption, volume mixing ratio of soot in accumuration mode areosol is derived. (CCSR/UT, S. Fukuda, T. Nakajima, 2008)

GLI/ADEOS-II Aerosol

Monthly composite image of land (MAP method) and ocean (Higurashi and Nakajima, 2002) aerosols



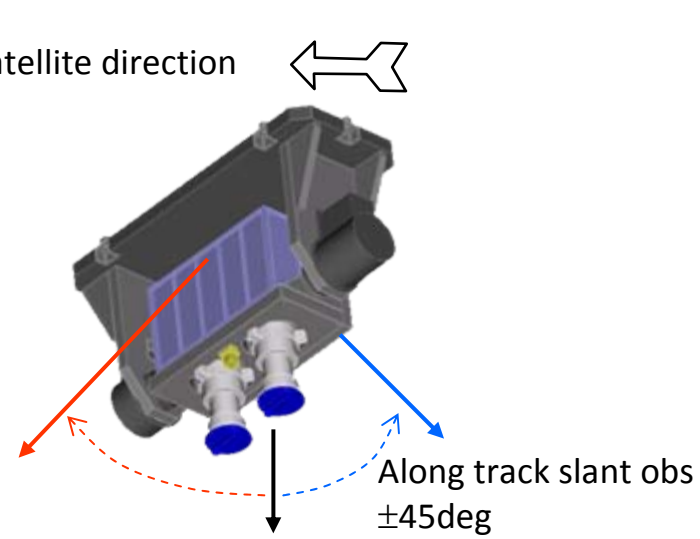
Tau-a (all) from April to Oct. 2003

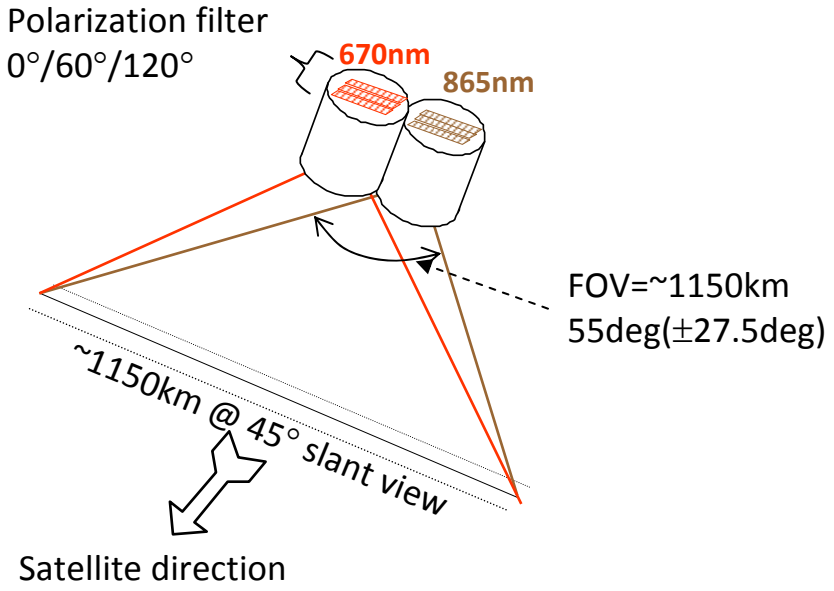


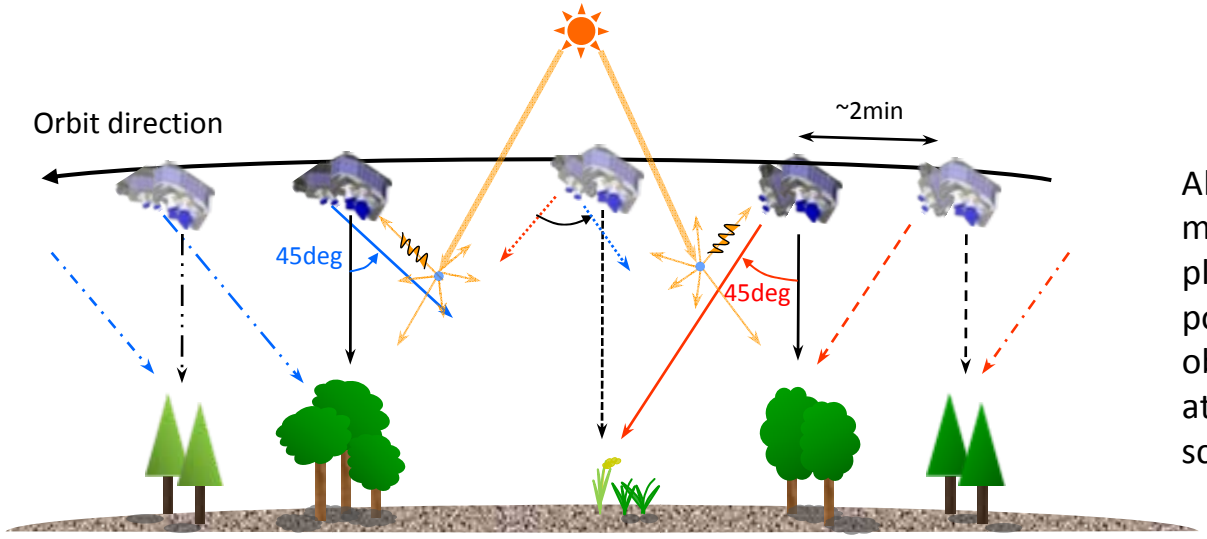
Angstrome Exponent from April to Oct. 2003

GCOM-C Observation Products

SGLI Polarimetry







Along-track ±45deg modes will be planned for polarization observation of the atmospheric scattering

GCOM-C Observation Products

Sensor operation and data distribution policy

- **Sensor operation**
  - ✓ Regular yearly pattern will be prepared considering intensive areas and seasonality before launch
  - ✓ Irregular tilt angles of polarimetry, 1km/250m resolution, and calibration modes will be planned more than three months before the operation
  - ✓ All data will be received at the Svalbard station; near-real time data at a station in Japan
- **Free of charge for internet acquisition**
  - ✓ The standard products (including Levels 1, 2 and 3) will be distributed with free of charge from EORC information system which is a common system for several other missions (Search & download, and FTP directory: TBD)
  - ✓ Re-distribution by users is limited to pre-defined users (to identify users by JAXA)

SGLI basic operation modes*

Basic modes	VN1-8,10-11	VN9, SW1-2	SW3	SW4	T1-2	P1-2	
Day-land/coast	250m	1km	250m	1km	500m *250m***	1km	+45° –45°
Day-offshore/polar	1km	1km	1km	1km	1km	1km	+45° –45°
Night-land	OFF	OFF	250m	1km	500m *250m***	OFF	
Night-coast	OFF	OFF	OFF	OFF	500m *250m***	OFF	
Night-offshore/polar	OFF	OFF	OFF	OFF	1km	OFF	

Band	λc
VN1	380nm
VN2	412nm
VN3	443nm
VN4	490nm
VN5	530nm
VN6	565nm
VN7	673.5nm
VN8	673.5nm
VN9	763nm
VN10	868.5nm
VN11	868.5nm
P1	673.5nm
P2	868.5nm
SW1	1050nm
SW2	1380nm
SW3	1630nm
SW4	2210nm
T1	10.8um
T2	12.0um

**: Other modes for cal/val and special requests will be planned more than three months before the operation*

***: 250m mode is limited by downlink data volume per a path*

GCOM-C Observation Products

GCOM-C products accuracy targets (Standard-1)

Area	group	Product	Day/night	Grid size	Release threshold[*1]	Standard accuracy[*1]	Target accuracy[*1]
Common	radiance	TOA radiance (including system geometric correction)	TIR and land 2.2μm: both Other VNR,SWI: daytime (+special operation)	VNR,SWI Land/coast: 250m, offshore: 1km, polarimetory:1km TIR Land/coast: 500m, offshore: 1km	Radiometric 5% (absolute[*3])[*5] Geometric<1pixel	VNR,SWI: 5% (absolute[*3]), 1% (relative[*4]) TIR: 0.5K (@300K) Geometric<0.5pixel	VNR,SWI: 3% (absolute[*3]), 0.5% (relative[*4]) TIR: 0.5K (@300K) Geometric<0.3pixel
Land	Surface reflectance	Precise geometric correction	both	250m	<1pixel[*6]	<0.5pixel[*6]	<0.25pixel[*6]
		Atmospheric corrected reflectance (incl. cloud detection)	Daytime	250m	0.3 (<=443nm), 0.2 (>443nm) (scene) [*7]	0.1 (<=443nm), 0.05 (>443nm) (scene) [*7]	0.05 (<=443nm), 0.025 (>443nm) (scene)[*7]
	Vegetation and carbon cycle	Vegetation index		250m	Grass:25%(scene), forest:20%(scene)	Grass:20%(scene), forest:15%(scene)	Grass:10%(scene), forest:10%(scene)
		Above-ground biomass		1km	Grass:50%, forest: 100%	Grass:30%, forest:50%	Grass:10%, forest:20%
		Vegetation roughness index		1km	Grass&forest: 40% (scene)	Grass& forest:20% (scene)	Grass&forest:10% (scene)
		Shadow index		250m, 1km	Grass&forest: 30% (scene)	Grass& forest:20% (scene)	Grass&forest:10% (scene)
		fAPAR		250m	Grass:50%, forest: 50%	Grass:30%, forest:20%	Grass:20%, forest:10%
		Leaf area index		250m	Grass:50%, forest: 50%	Grass:30%, forest:30%	Grass:20%, forest:20%
	temperature	Surface temperature	Both	500m	<3.0K (scene)	<2.5K (scene)	<1.5K (scene)

Common note:

*1: The “release threshold” is minimum levels for the first data release at one year from launch. The "standard" and "research" accuracies correspond to full- and extra success criteria of the mission respectively. Accuracies are shown by RMSE basically.

Radiance data note:

*2: TOA radiance is derived from sensor output with the sensor characteristics, and other products are physical parameters estimated using algorithms including knowledge of physical, biological and optical processes

*3: absolute error is defined as offset + noise

*4: relative error is defined as relative errors among channels, FOV, and so on.

*5: Release threshold of radiance is defined as estimated errors from vicarious, onboard solar diffuser, and onboard blackbody calibration because of lack of long-term moon samples

Land data note:

*6: Defined as RMSD from GCP

*7: Defined with land reflectance~0.2, solar zenith<30deg, and flat surface. Release threshold is defined with AOT@500nm<0.25

GCOM-C Observation Products

GCOM-C products accuracy targets (Standard-2)

Area	Group	Product	Day/night	Grid size	Release threshold[*1]	Standard accuracy[*1]	Target accuracy[*1]
Atmosphere	Cloud	Cloud flag/Classification	Both	1km	10% (with whole-sky camera)	Incl. below cloud amount	Incl. below cloud amount
		Classified cloud fraction	Daytime	1km (scene), 0.1deg (global)	20% (on solar irradiance)[*8]	15%(on solar irradiance)[*8]	10%(on solar irradiance)[*8]
		Cloud top temp/height	Both		1K[*9]	3K/2km (top temp/height)[*10]	1.5K/1km (temp/height)[*10]
		Water cloud OT/effective radius	Daytime		10%/30% (CloudOT/radius) [*11]	100% (as cloud liquid water[*13])	50%[*12] / 20%[*13]
		Ice cloud optical thickness			30%[*11]	70%[*13]	20%[*13]
	aerosol	Aerosol over the ocean			0.1(Monthly τa_670,865)[*14]	0.1(scene τa_670,865)[*14]	0.05(scene τa_670,865)
		Land aerosol by near ultra violet			0.15(Monthly τa_380)[*14]	0.15(scene τa_380)[*14]	0.1(scene τa_380)
		Aerosol by Polarization			0.15(Monthlyτa_670,865)[*14]	0.15(scene τa_670,865)[*14]	0.1(scene τa_670,865)
Ocean	Ocean color	Normalized water leaving radiance (incl. cloud detection)	Daytime	250m (coast) 1km (offshore) 4~9km (global)	60% (443~565nm)	50% (<600nm) 0.5W/m^2/str/um (>600nm)	30% (<600nm) 0.25W/m^2/str/um (>600nm)
		Atmospheric correction param			80% (AOT@865nm)	50% (AOT@865nm)	30% (AOT@865nm)
		Photosynthetically available radiation			20% (10km/month)	15% (10km/month)	10% (10km/month)
	In-water	Chlorophyll-a concentration			–60~+150% (offshore)	–60~+150%	–35~+50% (offshore), –50~+100% (coast)
		Suspended solid concentration			–60~+150% (offshore)	–60~+150%	–50~+100%
		Colored dissolved organic matter			–60~+150% (offshore)	–60~+150%	–50~+100%
	temperature	Sea surface temperature	Both	500m (coast) 1km (offshore) 4~9km (global)	0.8K (daytime)	0.8K (day&night time)	0.6K (day&night time)
Cryosphere	Area/ distribution	Snow and Ice covered area (incl. cloud detection)	Daytime	250m (scene) 1km (global)	10% (vicarious val with other sat. data)	7%	5%
		OKhotsk sea-ice distribution		250m	10%	5%	3%
	Surface properties	Snow and ice surface Temperature		500m (scene) 1km (global)	5K (vicarious val with other sat. data and climatology)	2K	1K
		Snow grain size of shallow layer		250m (scene) 1km (global)	100%(vicarious val with climatology between temp-size)	50%	30%

Atmosphere note:

*8: Comparison with in-situ observation on monthly 0.1-degree

*9: Vicarious val. on sea surface and comparison with objective analysis data

*10: Inter comparison with airplane remote sensing on water clouds of middle optical thickness

*11: Release threshold is defined by vicarious val with other satellite data (e.g., global monthly statistics in the mid-low latitudes)

*12: Comparison with cloud liquid water by in-situ microwave radiometer

*13: Comparison with optical thickness by sky-radiometer (the difference can be large due to time-space inconsistence and large error of the ground measurements)

*14: Estimated by experience of aerosol products by GLI and POLDER

GCOM-C Observation Products

GCOM-C products accuracy targets (Research)

Area	Group	Product	Day/night	Grid size	Release threshold[*1]
Land	Application	Land net primary production	Daytime	1km	30% (yearly)
		Water stress trend	N/A	500m	10% [*15] (error judgment rate)
		Fire detection index	Both	500m	20% [*16] (error judgment rate)
		Land cover type	Daytime	250m	30% (error judgment rate)
		Land surface albedo		1km	10%
Atmosphere	Cloud	Water cloud geometrical thickness	Daytime	1km (scene), 0.1deg (global)	300m
	Radiation budget	Long-wave radiation flux			Downward 10W/m2, upward 15W/m2 (monthly)
		Short-wave radiation flux			Downward 13W/m2, upward 10W/m2
Ocean	Ocean color	Euphotic zone depth	Daytime	250m (coast), 1km (offshore), 4~9km (global)	30%
	In-water	Inherent optical properties			a(440): RMSE<0.25, bbp(550): RMSE<0.25
	Application	Ocean net primary productivity		500m (coast), 1km (offshore), 4~9km (global)	70% (monthly)
		Phytoplankton functional type		250m (coast), 1km (offshore), 4~9km (global)	error judgment rate of large/ small phytoplankton dominance<20%; or error judgment rate of the dominant phytoplankton functional group <40%
		Redtide			error judgment rate <20%
		multi sensor merged ocean color		250m (coast), 1km (offshore)	−35~+50% (offshore), −50~+100% (coast)
		multi sensor merged SST	Both	500m (coast), 1km (offshore)	0.8K (day&night time)
Cryosphere	Area/ distribution	Snow and ice classification	N/A	1km	10%
		Snow covered area in forest and mountain	Daytime	250m	30%
	Surface properties	Snow grain size of subsurface layer		1km	50%
		Snow grain size of top layer		250m(scene), 1km (global)	50%
		Snow and ice albedo		1km	7%
		Snow impurity		250m(scene), 1km (global)	50%
		Ice sheet surface roughness	N/A	1km	0.05 (height/width)
	Boundary	Ice sheet boundary monitoring	N/A	250m	<500m

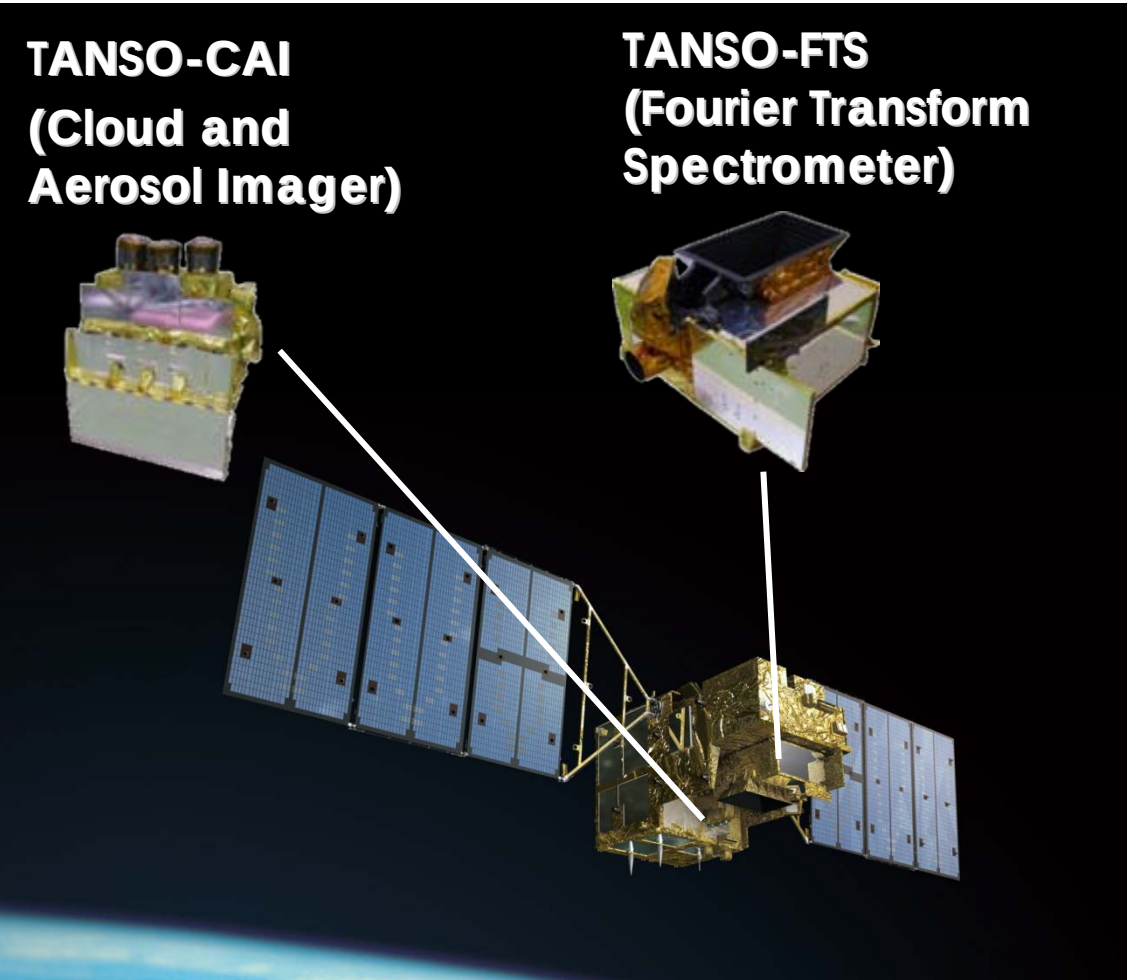
Research product note:

*15: Evaluate in semiarid regions (steppe climate etc.)

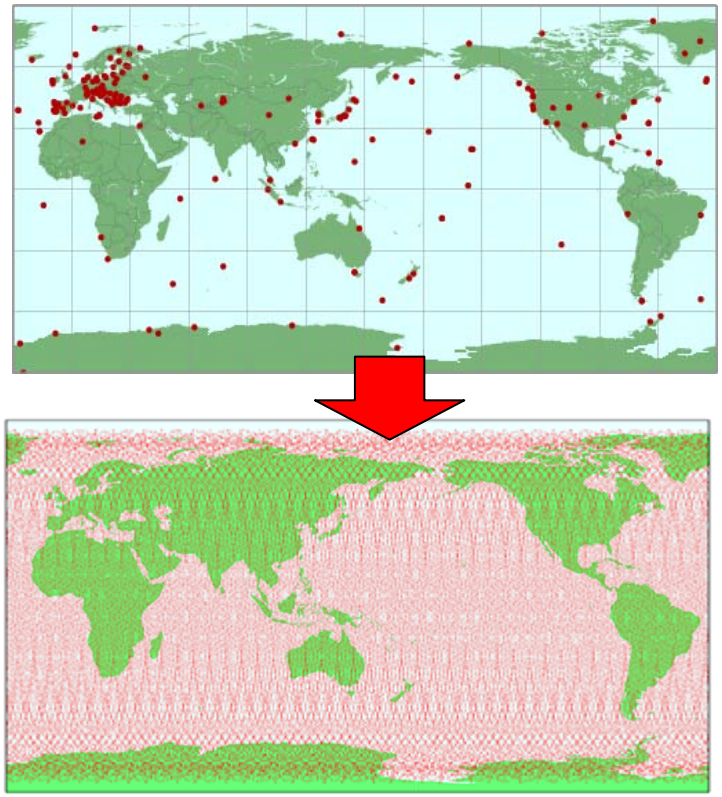
*16: Fires >1000K occupying >1/1000 on 1km pixel at night (using 2.2um of 1 km and thermal infrared channels)

Greenhouse Gases Observing Satellite (GOSAT)

GOSAT enables global (with 56,000 points) and frequent (at every 3 days) monitoring CO_2 and CH_4 column density. (Launched in Jan 2009)



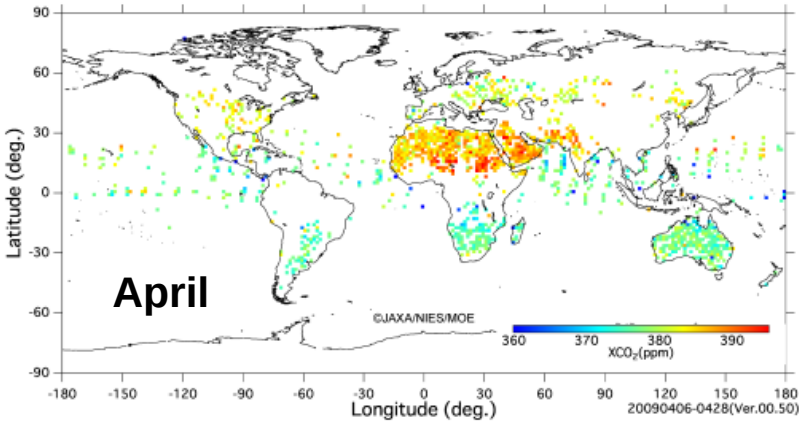
Current Ground-based Observation Points (320pts)
Provided by WMO WDCGG

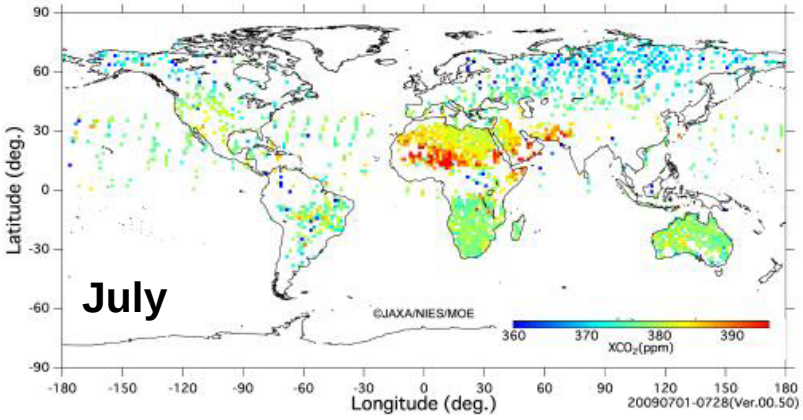


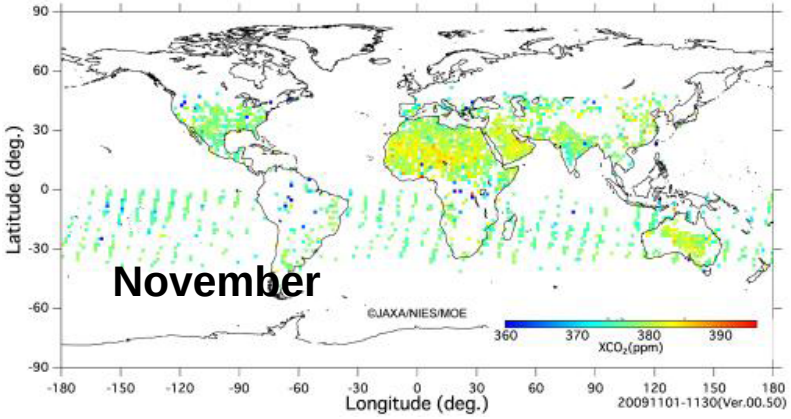
Increase of Observation Points using GOSAT (56,000pts)

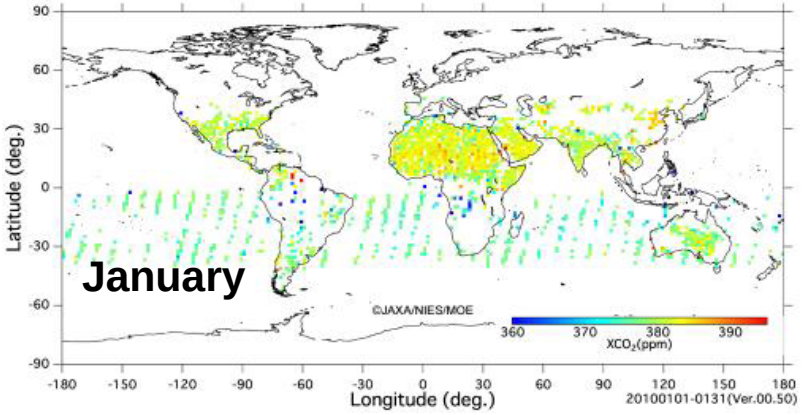
Column-averaged volume mixing ratios of CO_2

April, July and November, 2009 and January, 2010





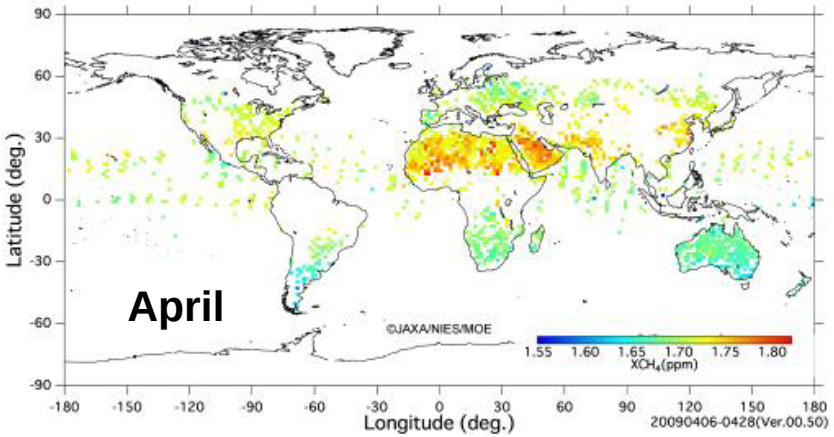


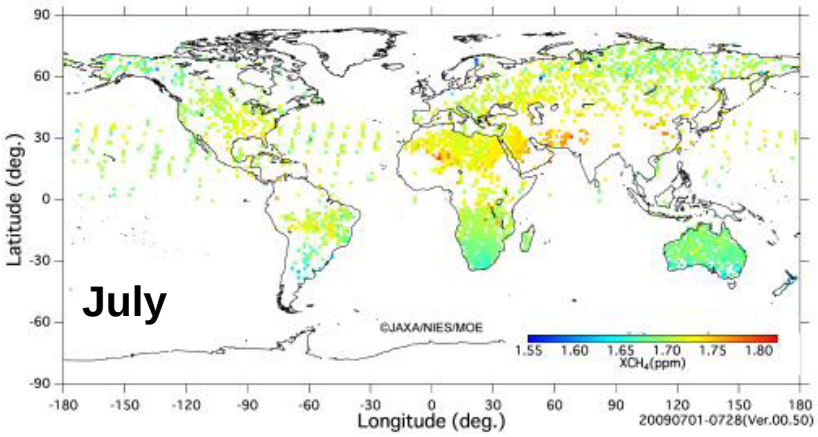


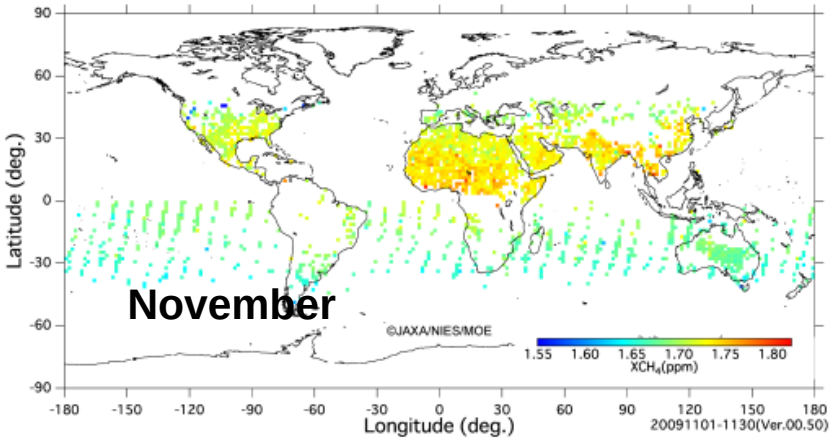
Available from Website of NIES, February 18, 2010:
http://www.gosat.nies.go.jp/eng/related/download/GOSAT_20100216_en.pdf

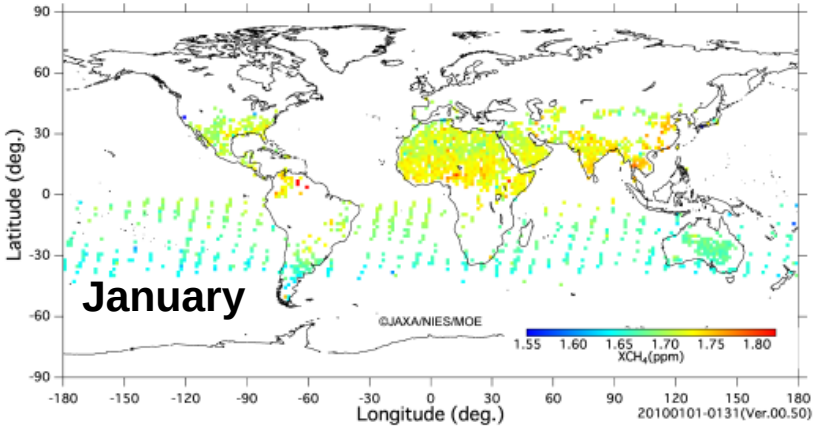
Column-averaged volume mixing ratios of CH_4

April, July and November, 2009 and January, 2010









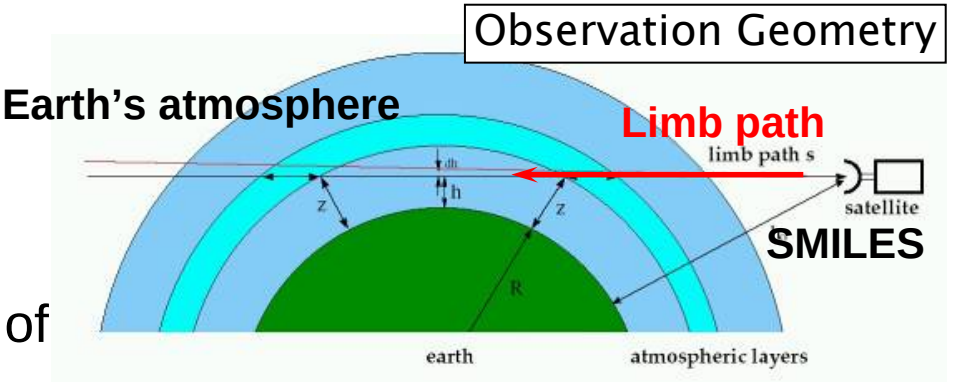
Available from Website of NIES, February 18, 2010:

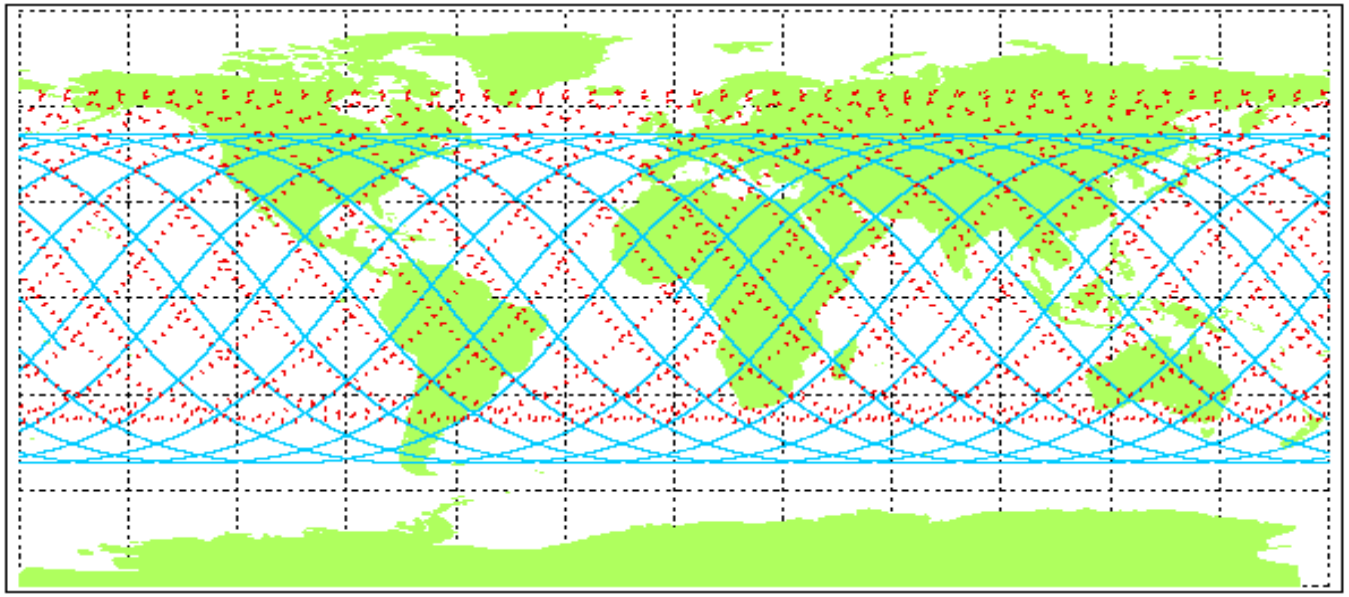
http://www.gosat.nies.go.jp/eng/related/download/GOSAT_20100216_en.pdf

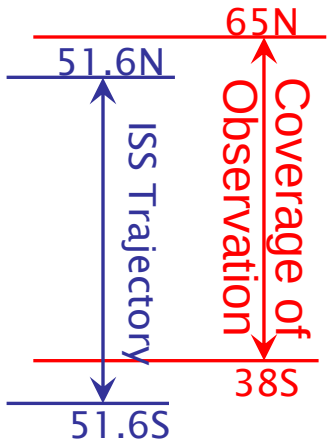
SMILES Observation Mission

SMILES (**S**uperconducting Sub**mi**llimeter-Wave **L**imb-**E**mission **S**ounder)

- High sensitivity in detecting atmospheric limb emission of the submillimeter wave range (624-650GHz)
- Vertical profiling (~3km) from JEM/ISS with latitudinal coverage of 65N to 38S



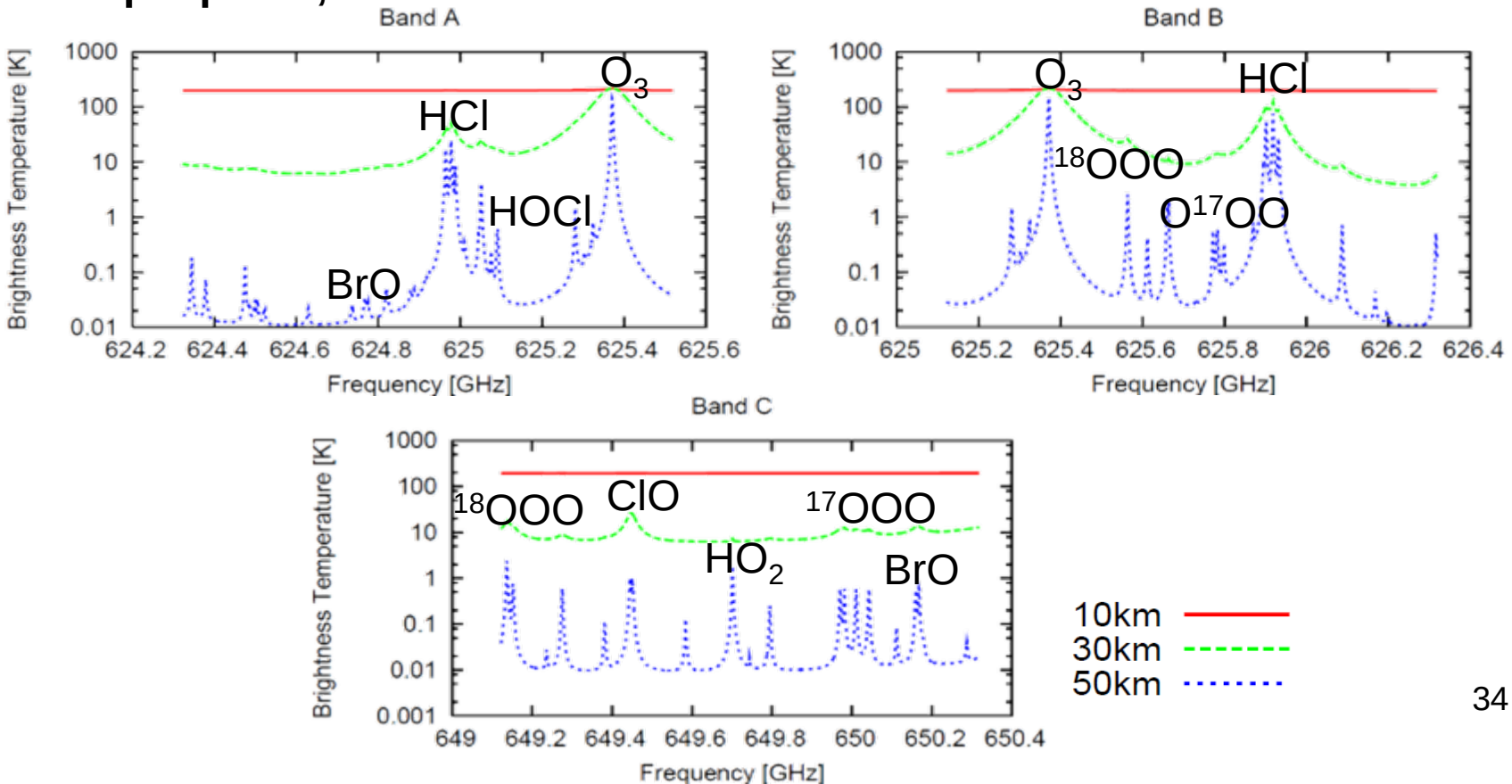




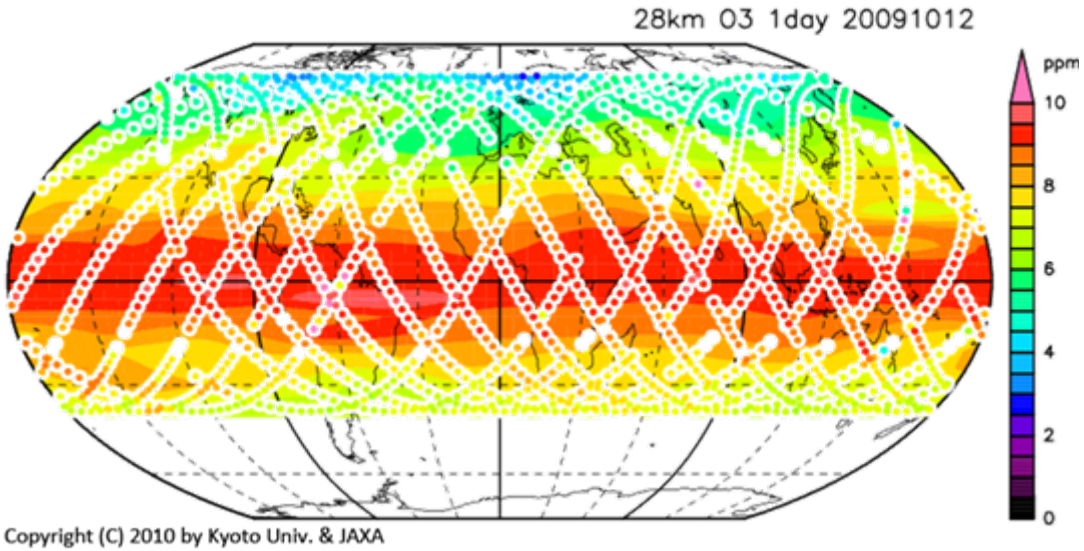
SMILES observations aim to radical components which play important roles in ozone chemistry.

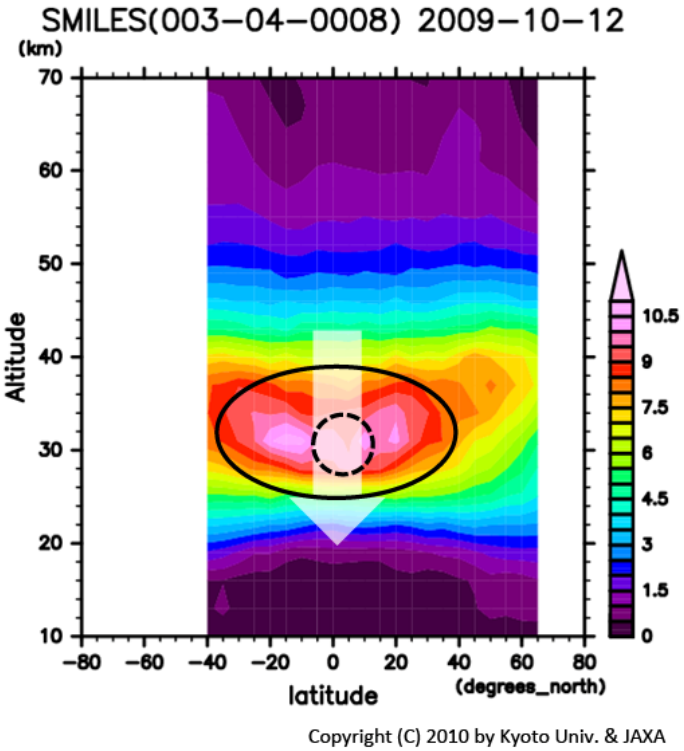
Target Species and Brightness Temperature Spectrum

- Standard products:
  - **Single-scan: O_3, HCl, ClO, CH_3CN, O_3 isotopes, HOCl, HNO_3**
  - **Multi-scan: HO_2, BrO**
    (* spectrum signals are too weak to retrieve in single-scan)
- Research products: **volcanic SO_2, H_2O_2, Humidity in upper-troposphere, ice clouds**



Early Results from SMILES onboard JEM/ISS, Oct. 12, 2009





- Global Ozone Layer Map at altitude 28km
- Ozone Latitude-Altitude Distribution

http://smiles.tksc.jaxa.jp/news/indexj.shtml
http://smiles.tksc.jaxa.jp/indexe.shtml

Summery

- GOSAT and SMILES are in operational phase, and observation data are available.
- ESA and Japan cooperative project of EarthCARE to be launched in FY2013, and JAXA will provide aerosol data sets.
- GCOM-C1/SGLI will be launched in Japanese FY2014, and will provide aerosol data sets.