Second-generation Global Imager (SGLI) on GCOM-C1

Algorithms for aerosol retrieval based on radiance and polarization with GCOM / SGLI

I. Sano, S. Mukai, and SGLI WG

Aerosol-clouds workshop in Kyoto1999

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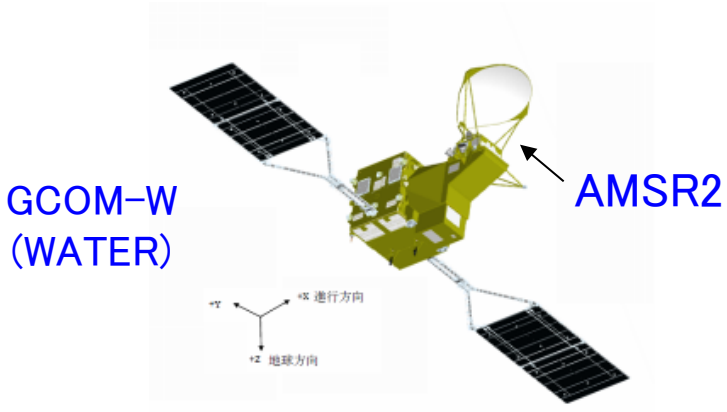
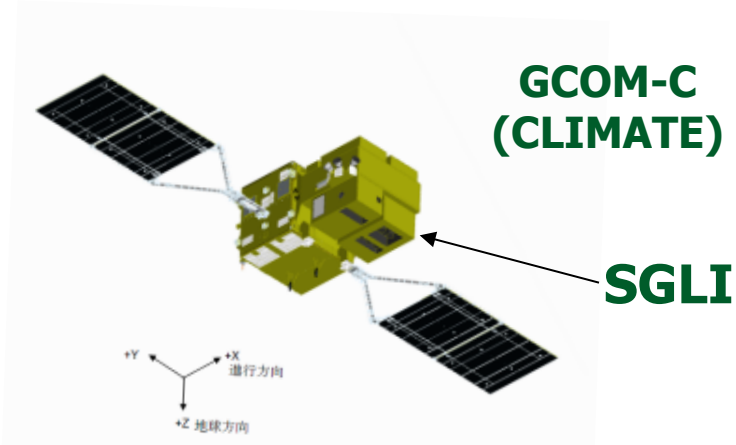
Global Change Observation Mission (GCOM)

2 satellite series for 5 years, total 13 years observation.

- ✓ **GCOM-W** AMSR2 (AMSR-E follow on microwave radiometer) for **WATER CYCLE**
- ✓ **GCOM-C** SGLI (GLI follow on) for **RADIATION BUDGET** and **CARBON CYCLE**



Sensor	Advanced Microwave Radiometer 2 (AMSR2) Passive Microwave Observation Water vapor, soil moisture etc

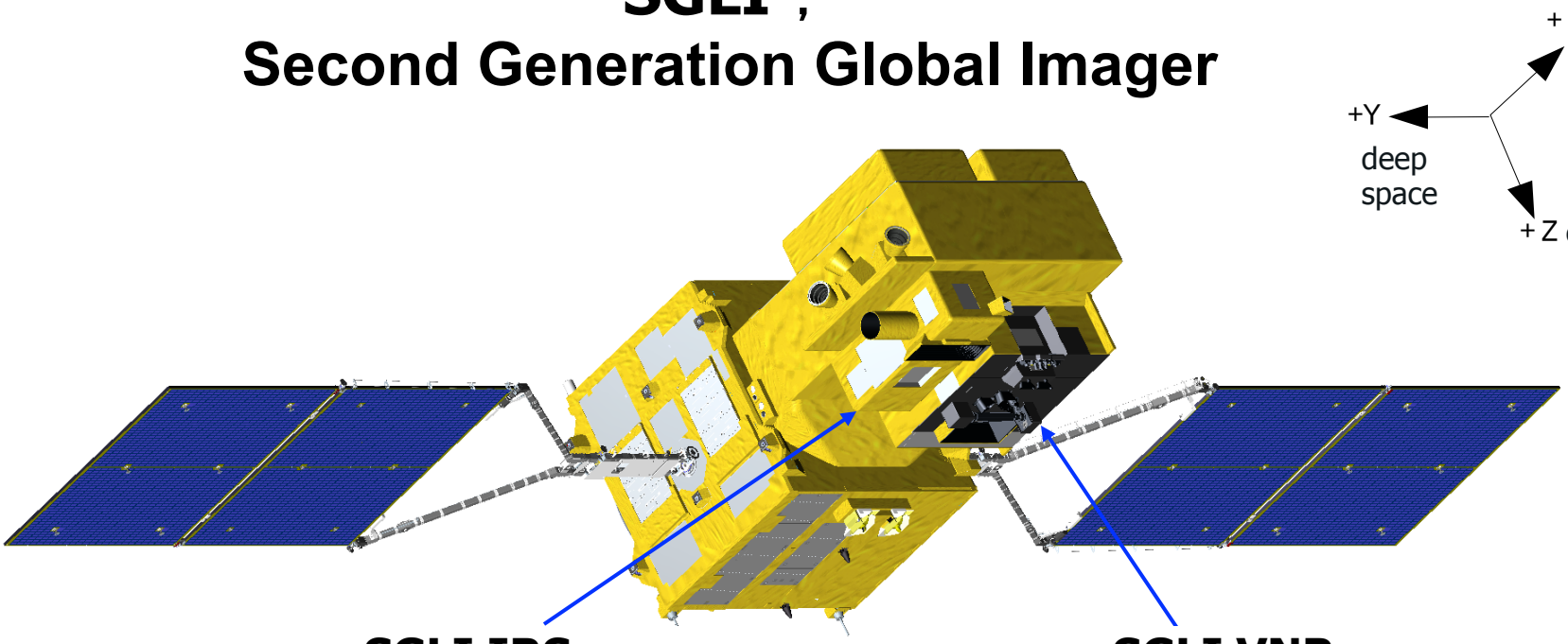


Sensor	Second Generation Global Imager (SGLI) Optical Observation 380nm – 12 micron Cloud, Aerosol, Vegetation, Chrolophl etc

Courtesy of Dr. Tanaka (JAXA/EORC)

SGLI on GCOM-C1 satellite

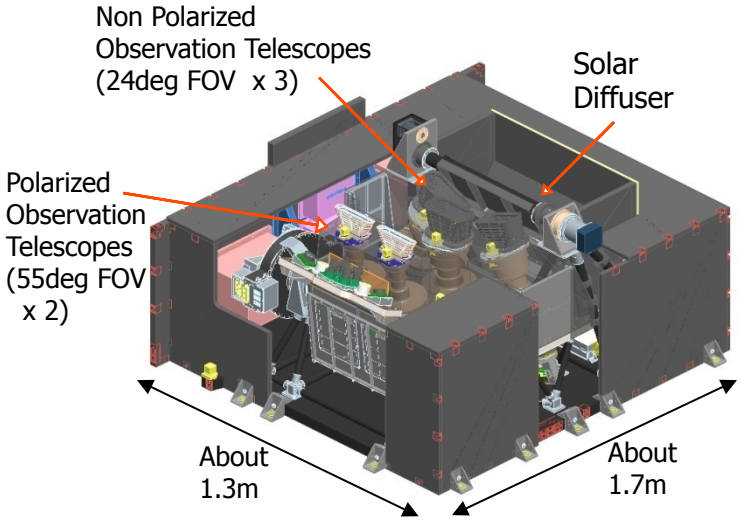
SGLI ;
Second Generation Global Imager



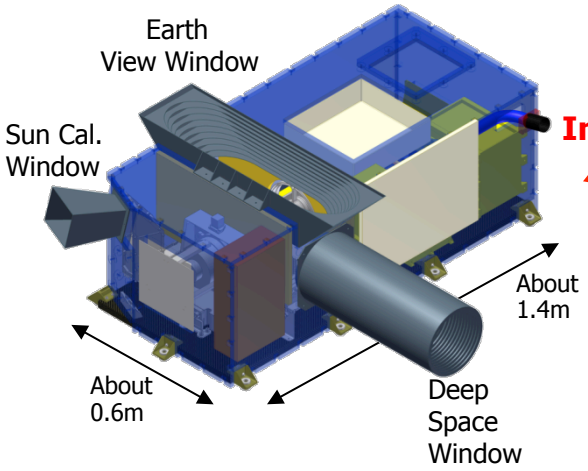
Mission Life	> 5 years
Solar Paddle	> 4000w（End of Life）
Mass	about 2,000kg

Courtesy of Dr. Tanaka (JAXA/EORC)

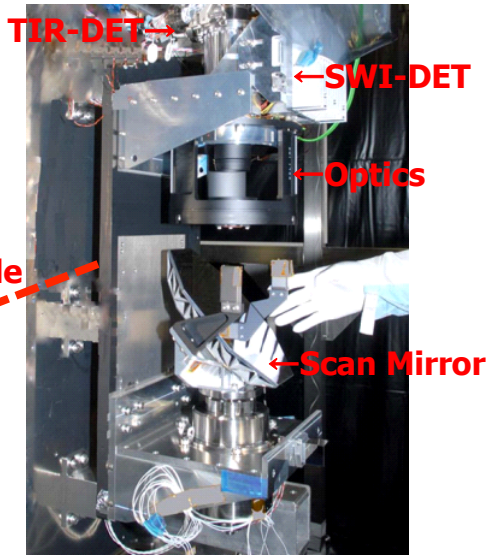
SGLI : *Second Generation Global Imager*



Visible and Near Infrared Radiometer
(SGLI-VNR)



Infrared Scanning Radiometer
(SGLI-IRS)



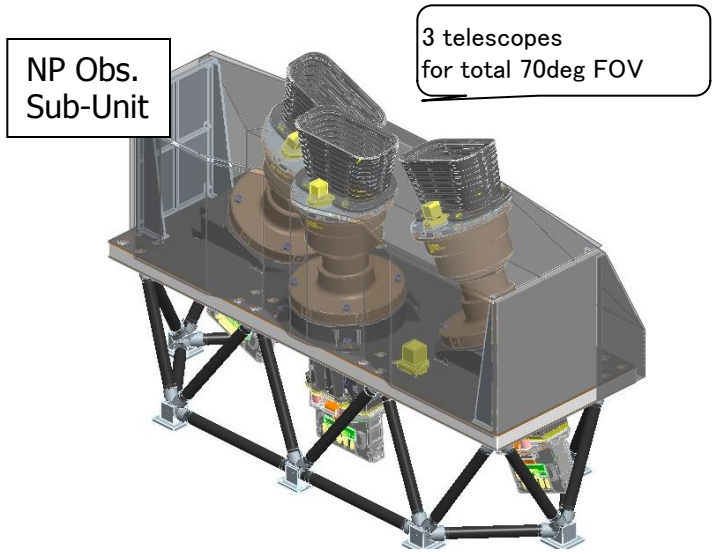
SGLI IRS
Bread Board Model

Sensor Unit	features
SGLI VNR	Non Polarized Observation (11ch), IFOV 250 m, Swath 1150 km Polarized Observation(2ch), IFOV 1km, Swath 1150 km
SGLI IRS	Shortwave Infrared (SWI 4ch), IFOV 250m/1km, Swath 1400km Thermal Infrared (TIR:2ch), IFOV 500m, Swath 1400km

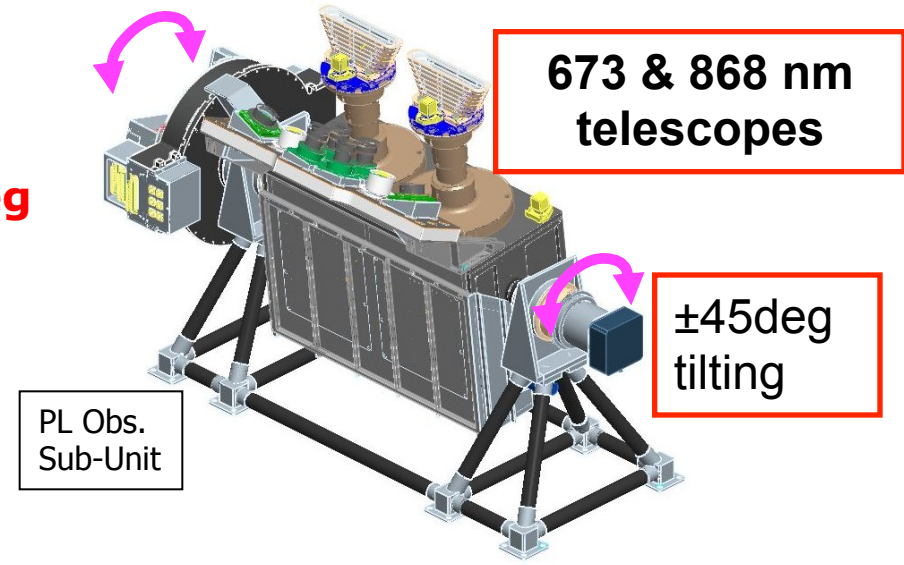
Courtesy of Dr. Tanaka (JAXA/EORC)

Visible and Near infrared radiometer SGLI-VNR

- **VNR non Polarized Obs. (NP)**
  - 3 telescopes with 24deg FOV realize the total 70 deg FOV Observation (1,150km)
  - Wide wavelength range Observation from **380** to 868 nm.



- **VNR Polarized Obs. (PL)**
  - 2 telescopes with 55deg FOV each for **673** and **868** nm Observation.
  - **AT tilting** mechanism for **+ / - 45deg**
  - 55 deg FOV with 45 deg tilting corresponds to 1,150 km swath.



AT : Along Track Direction
CT : Cross Track Direction

Courtesy of Dr. Tanaka (JAXA/EORC)

SGLI Specification

- The SGLI features are **250m (VNR-NP & SW3) and 500m (TIR) spatial resolution** and **polarization/along-track slant view** channels (VNR-PL), which will improve land, coastal, and aerosol observations.

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

GCOM-C SGLI characteristics	
Orbit	Sun-synchronous (**descending local time: 10:30**) Altitude 798km, Inclination 98.6deg
Mission Life	5 years (3 satellites; total 13 years)
Scan	**Push-broom electric scan (VNR)** Wisk-broom mechanical scan (IRS)
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, LED, Lunar cal maneuvers, and dark current by masked pixels and nighttime obs. SW: Solar diffuser, LED, Lunar, and dark current by deep space window T: Black body and dark current by deep space window

Multi-angle obs. for 674nm and 869nm

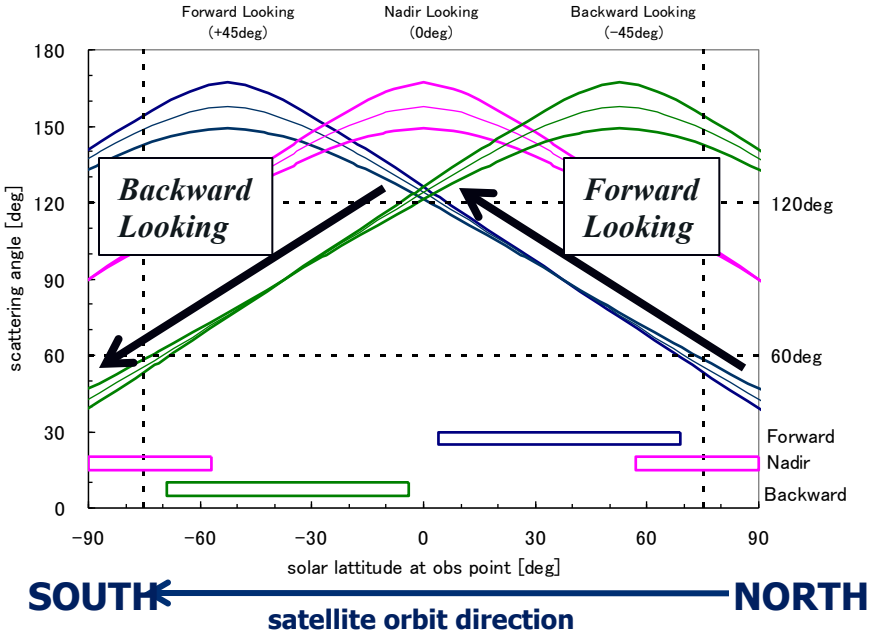
SGLI channels						
CH	λ VN, P, SW: nm T: μm	Δλ	L_{std} VN, P: W/m²/sr/μm T: Kelvin	L_{max}	SNR at Lstd VN, P, SW: SNR T: NEΔT	IFOV m
VN1	**380**	10	60	210	250	250
VN2	412	10	75	250	400	250
VN3	443	10	64	400	300	250
VN4	490	10	53	120	400	250
VN5	530	20	41	350	250	250
VN6	565	20	33	90	400	250
VN7	*673.5*	*20*	23	62	400	250
VN8	***673.5***	20	25	210	250	250
VN9	763	12	40	350	1200	250/1000
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	250/500
T2	12.0	0.7	300	340	0.2	250/500

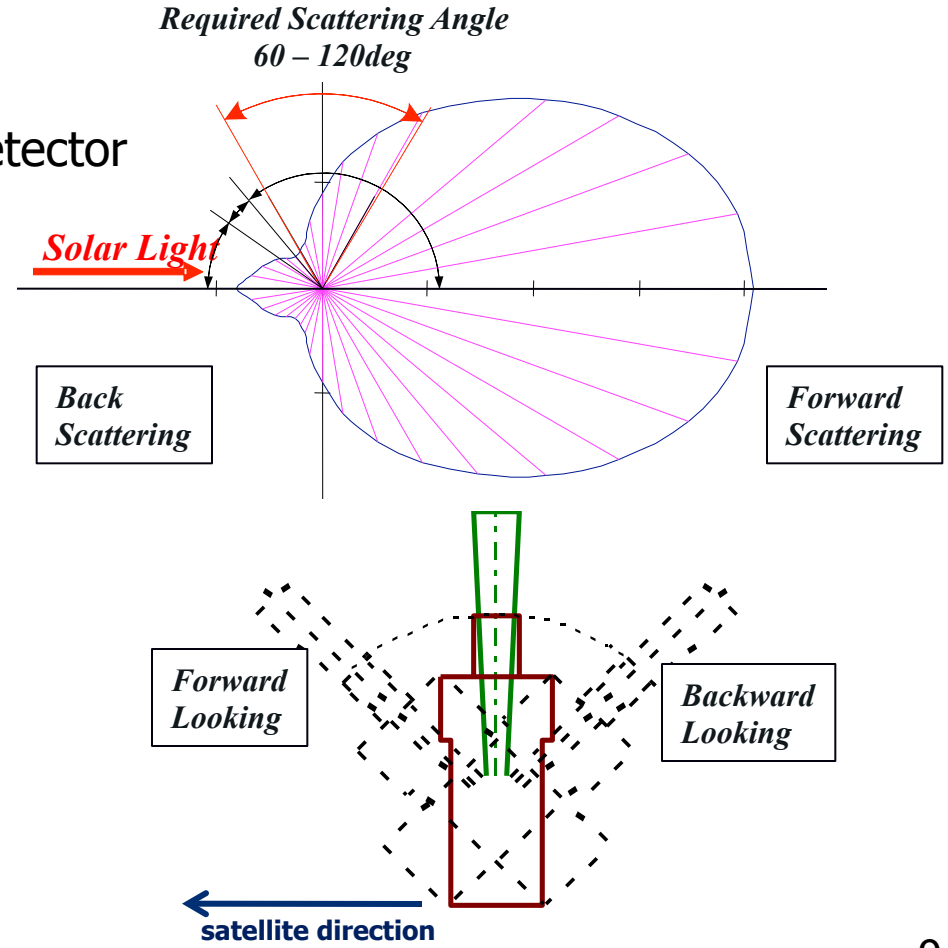
option

Courtesy of Dr. Tanaka (JAXA/EORC)

VNR Polarization Observation

- Intermediate scattering direction (60-120deg) should be observed for aerosol retrieval with +/- 45deg tilting radiometer. Tilt angle will be switched by command depending on this scattering angle requirement.
  - ✓ Backward Looking
  - ✓ Forward Looking
  - ✓ Nadir Looking (optional)
- 3 directional linear polarizer on each detector realize Stokes parameter observation (I, Q, U components)

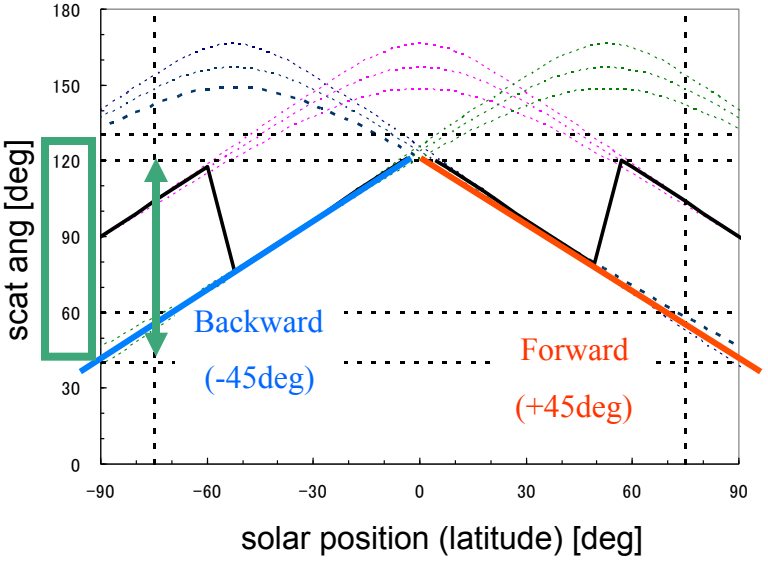




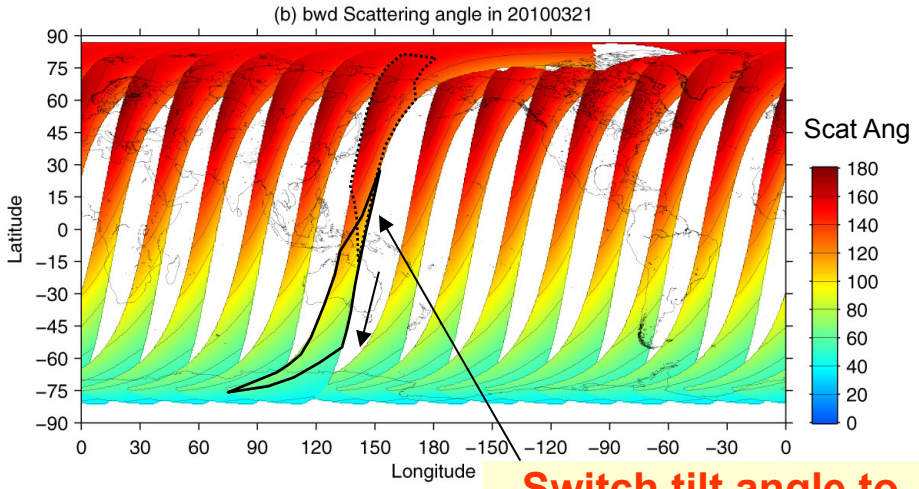
Courtesy of Dr. Tanaka (JAXA/EORC)

SGLI polarization measurements (tilting operation)

- SGLI has a tilting feature to measure the atmospheric light at the scattering angle from ~60 to ~120. The angle (+45 or -45) is selected

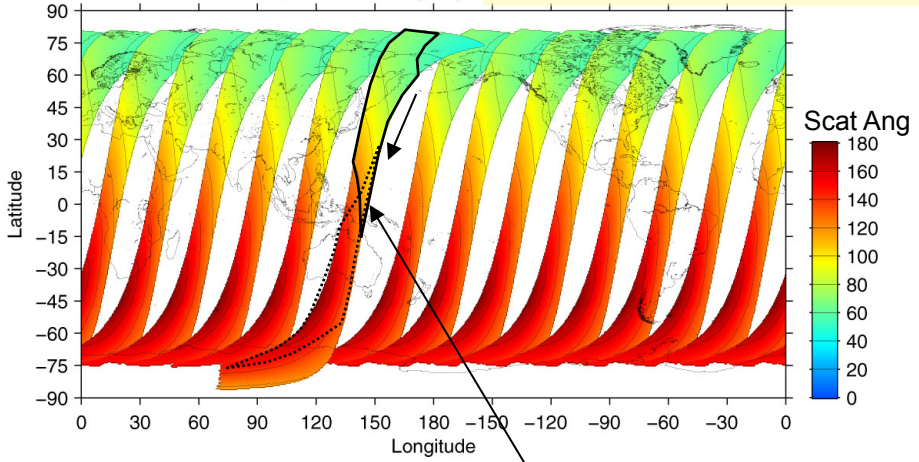


(-45 direction; backward)



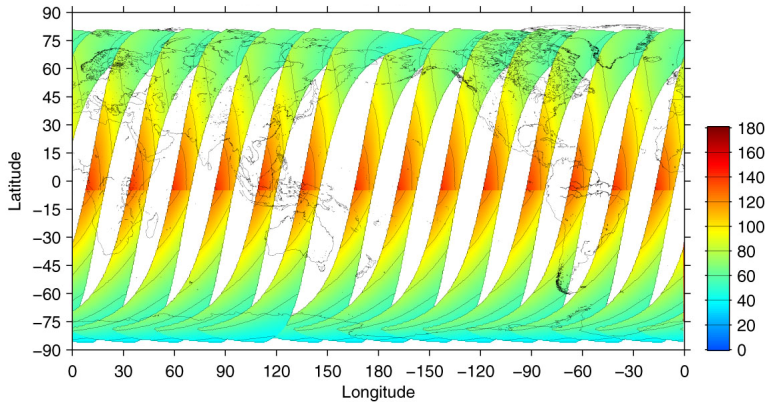
Switch tilt angle to forward

(+45 direction; forward)

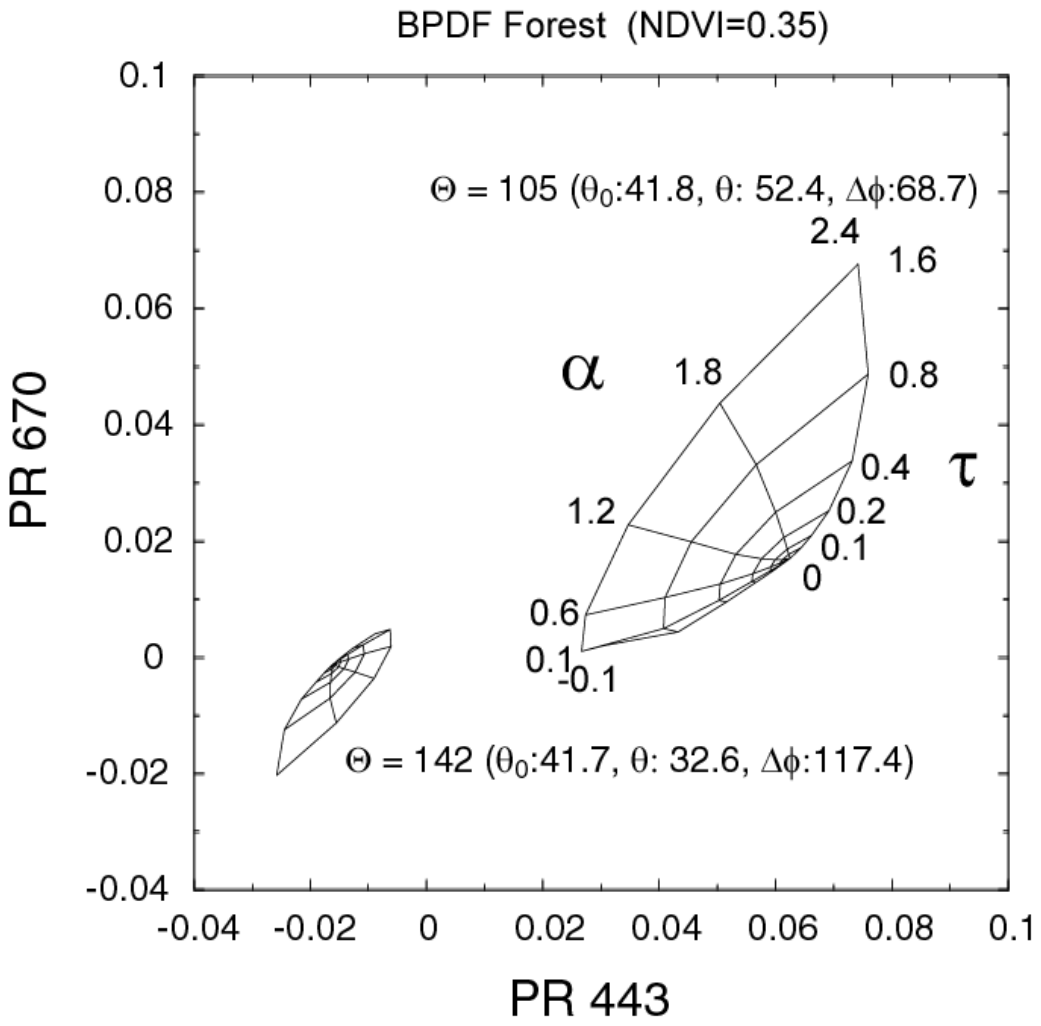


Switch tilt angle to backward

SGLI simulated scattering angle image



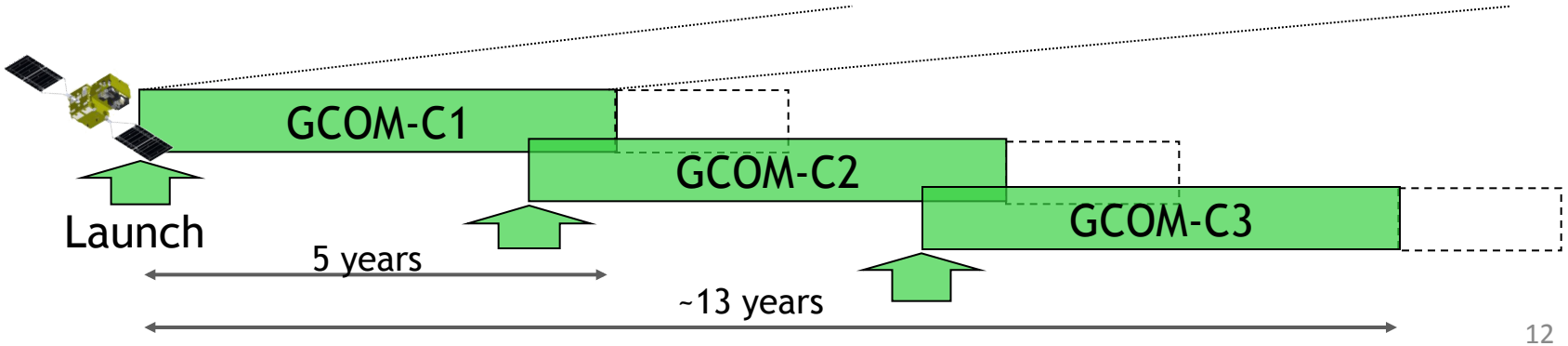
Selection of observational angle



Impremention Plan : Milestone

Japanese Fiscal Year Apr~	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Sensor development & calibration	1. Design and trial manufacturing		2. Sensor manufacturing & tests				3. Initial calibration	4. Operation phase				
	BBM		EM		PFM						C2 Launch♦	
	Phase-A	Phase-B	Phase-C		Phase-D							
	♦Project start		♦System PDR		♦System CDR		GCOM-C1 launch♦	♦Data Release			♦Mission result evaluation	
Research Announcement	RA#1♦					♦RA#2			♦RA#3			
Product version ups & Software implementation					Selection	Ver.0	Ver.1	Ver.2	Ver.2.5	Ver.3 for C-1&2		
	Analysis using existing satellite data				Inplementation-1 Performance test	Imple. -2 Operation test	Intensive Cal/Val phase	Improvement with product version up		Implement for C2	Version-ups & improvement	
Algorithm development & improvement	1. Initial development		2.Performance development		3. Operational algorithm		4. Post-launch development and improvement phase					
	• Preparation study • Investigation of candidates		• Theoretical performance and applicability		• Selection & development of operational algorithm		• Achievement of GCOM-C science targets • New algorithm and usage • Succession to the GCOM-C2					

Development of algorithm performance and operational code



Courtesy of Dr. Murakami (JAXA/EORC)

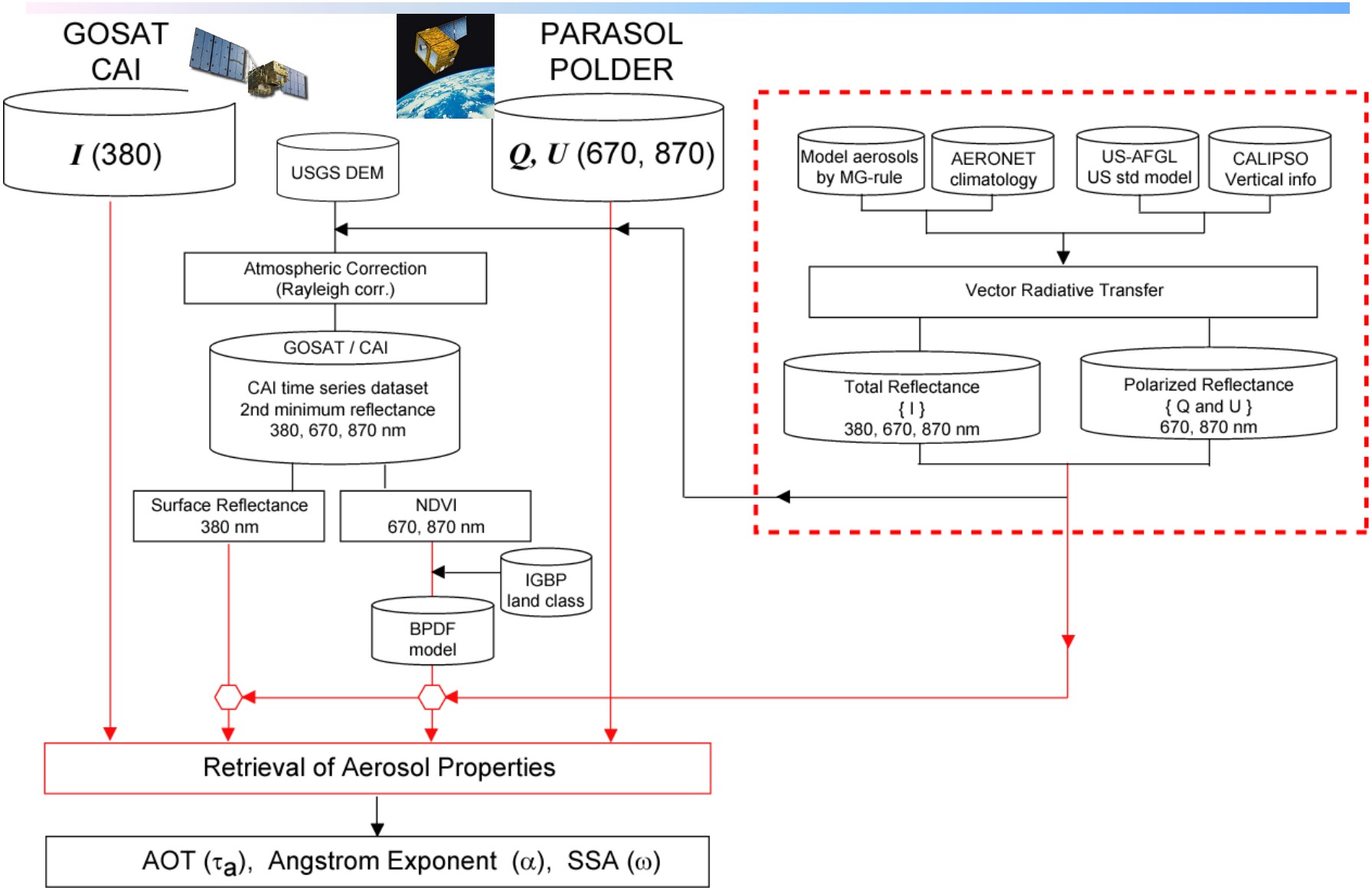
Global Change Observation Mission

Second-generation Global Imager (SGLI) on GCOM-C1

Algorithms for aerosol retrieval based on radiance and polarization with GCOM / SGLI

Optical properties of biomass burning aerosols during Russian forest fire events in 2010

Retrieval flow for BBA



TANSO - CAI on GOSAT

CAI – *Cloud Aerosol Imager*

a complimentary sensor for Fourier Transform Spectrometer (FTS) launched on 23rd January, 2009.

Four observing wavelengths : 380, 670, 870, 1600 nm.

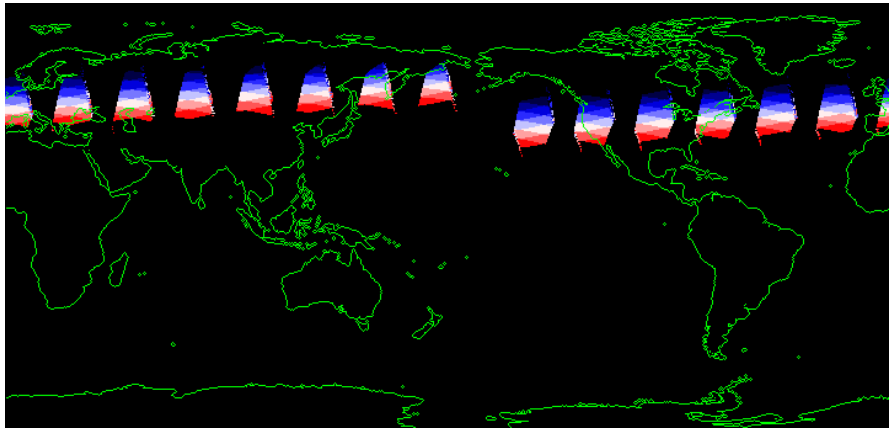
Level 1 data provide us with the TOA reflectance of the Earth.

	Band 1	Band 2	Band 3	Band 4
Spectral coverage (μm)	0.370-0.390 (0.380)	0.664-0.684 (0.674)	0.860-0.880 (0.870)	1.56-1.65 (1.60)
Targeted substances	Cloud and aerosol			
Swath (km)	1000	1000	1000	750
Spatial resolution at nadir (km)	0.5	0.5	0.5	1.5

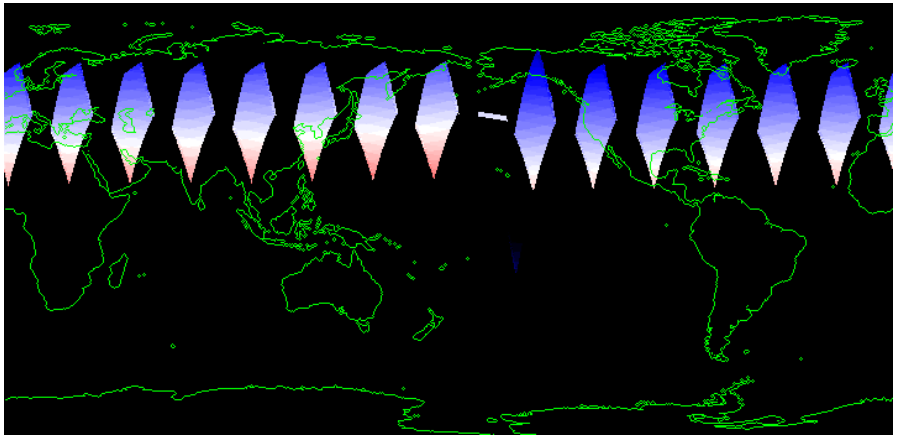
Collocated dataset of POLDER and CAI : time difference

Apr. 25, 2009

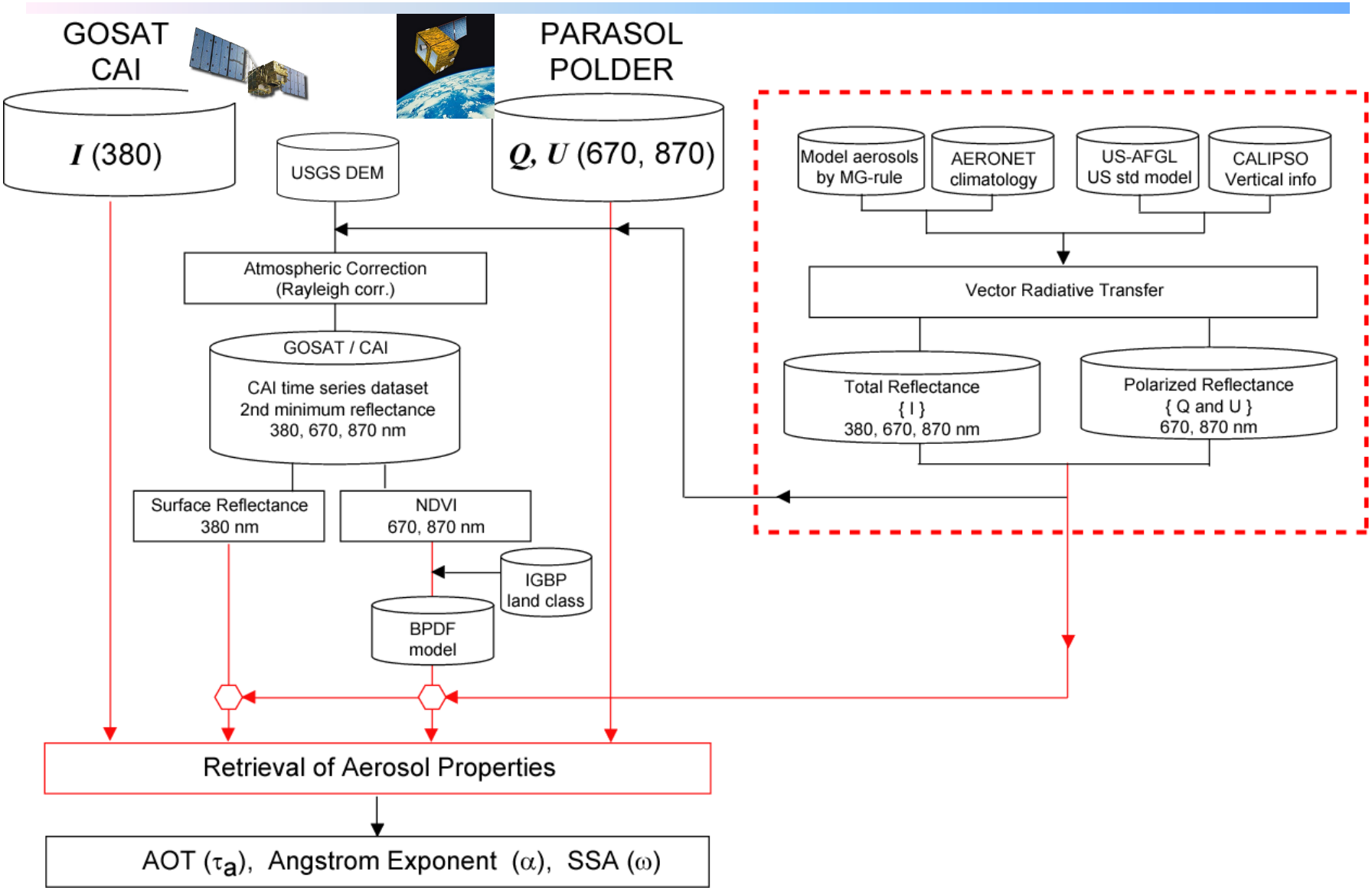
± 5 min



± 30 min

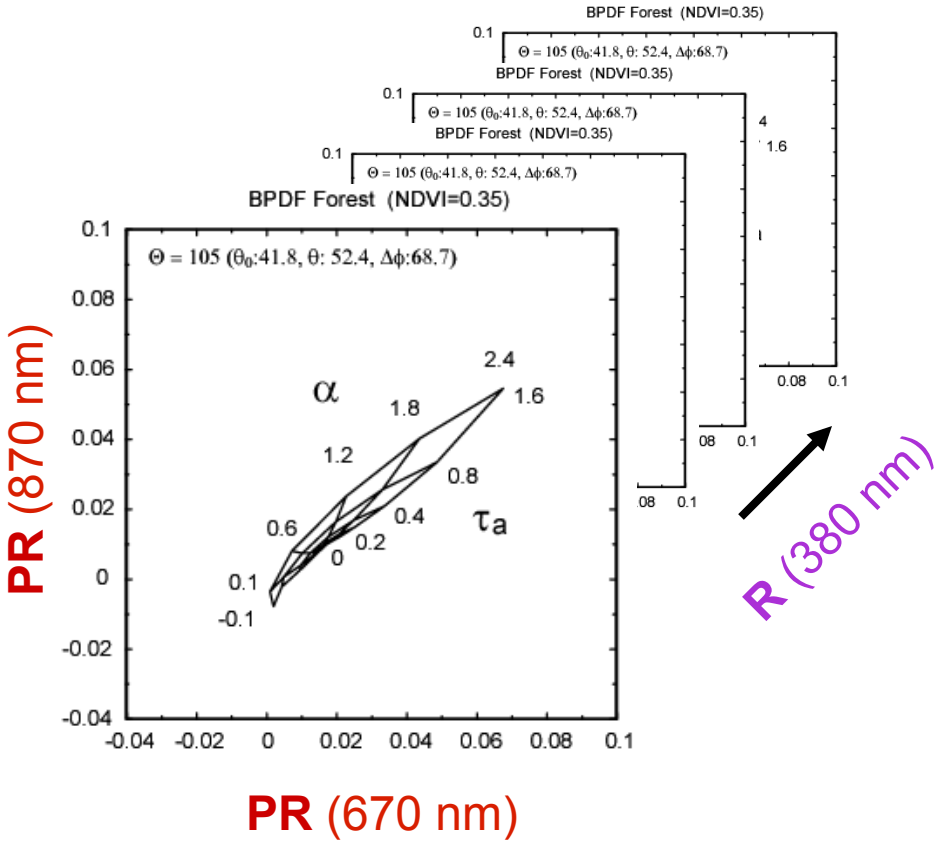


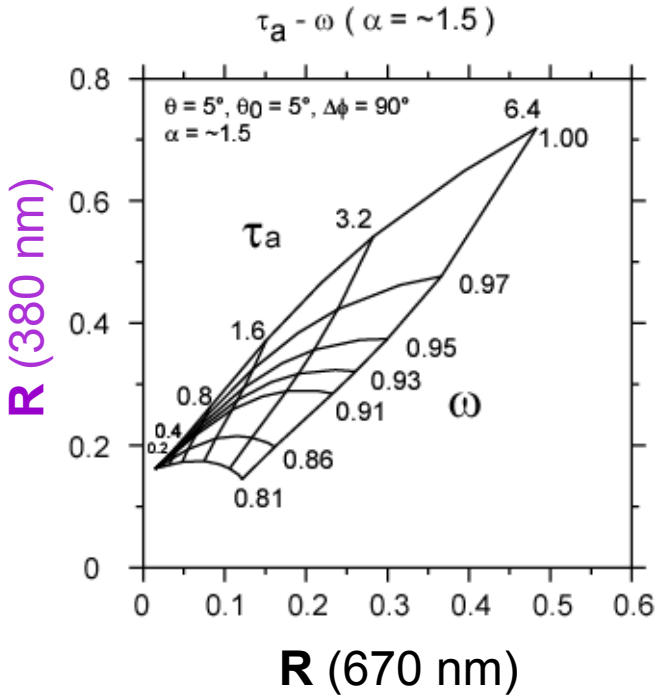
Retrieval flow for BBA



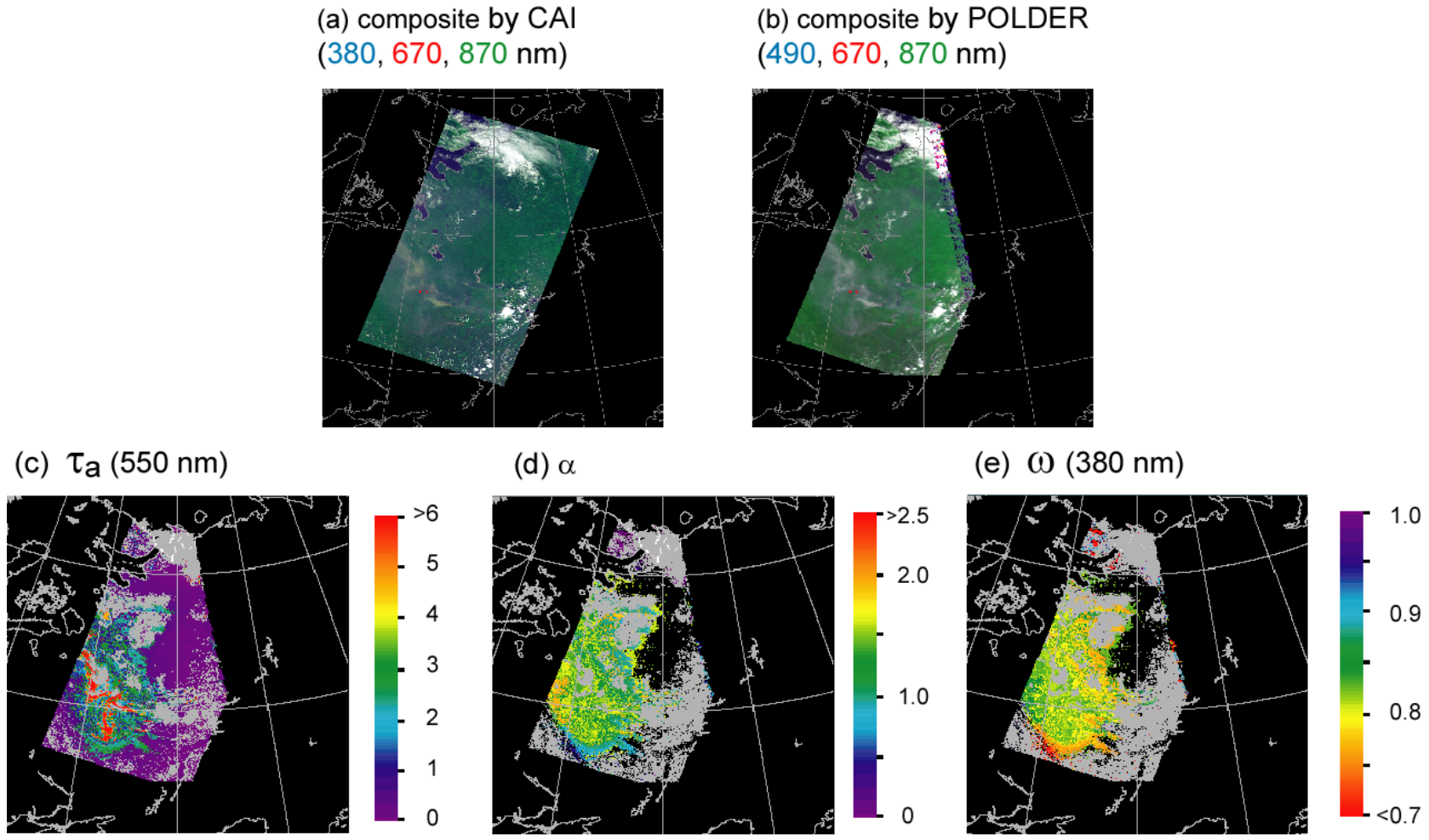
Retrieval process in practice

A set of τ_a , α and ω is retrieved for each aerosol model based on POLDER Q U (670, 870) and GOSAT CAI I (380)





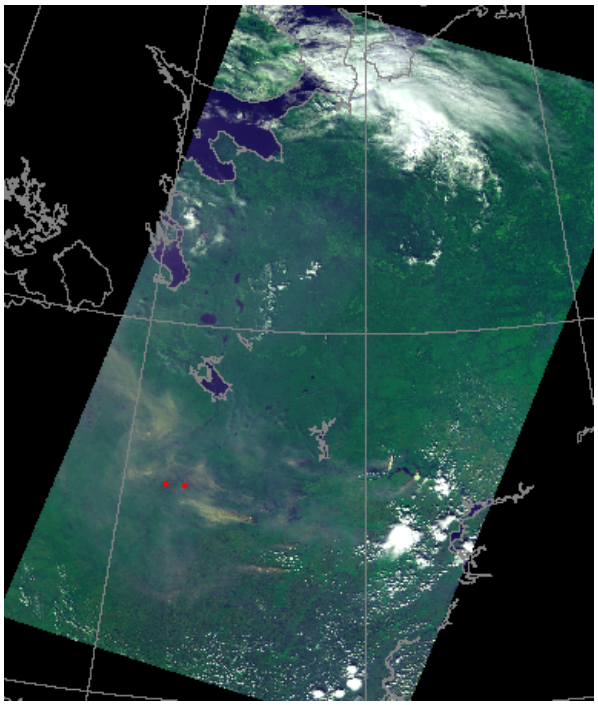
Aerosol properties over Central Russia on August 8, 2010

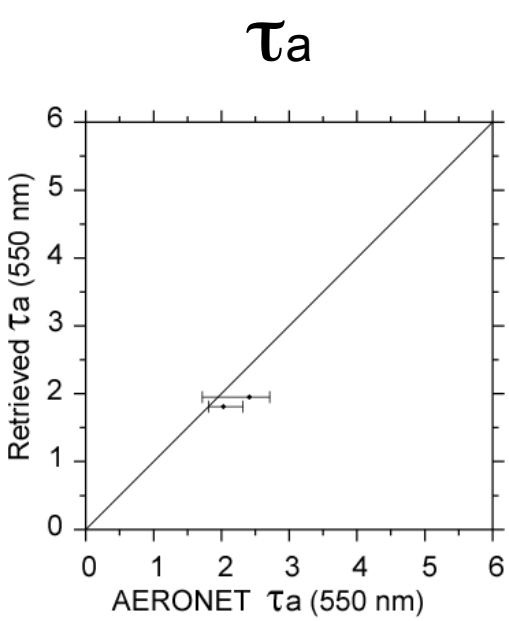


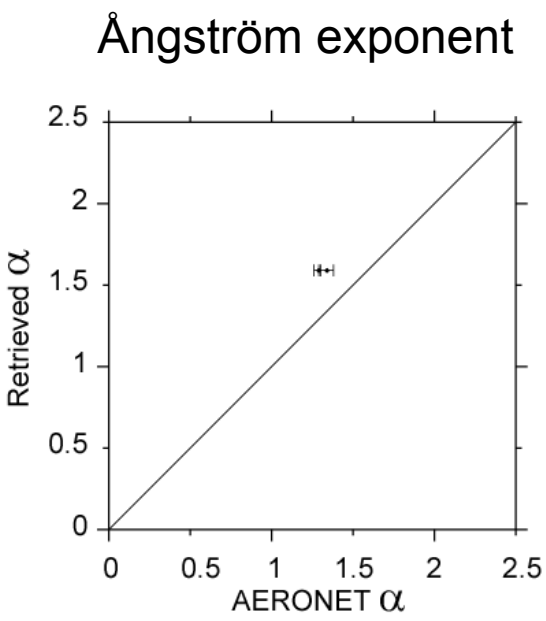
Retrieved results of aerosol properties over Central Russia on August 8, 2010.

Validation of retrieved results

The AERONET AOT and Angstrom data are selected during the ± 30 min against the satellite overpass.
Error bars : Min and max values of the measurements.







Scattergram of retrieved values τ_a, α against AERONET data.

Summary

SGLI on GCOM-C1 to be launched in 2014 is composed of

VNR (250 m / 1 km resolution) :

Non Pol : (11ch) 380 nm to 870 μm

SWIR : (4ch) 1.05 to 2.2 μm

Pol : (2ch) 670 and 870 nm (±45 deg tilting)

ISR (500 m resolution) :

TIR (2ch) : 10.8 and 12 μm.

Combination of near-UV radiance

& polarized radiance in the near-IR

has a potential to retrieve the carbonaceous aerosols.

Acknowledgement

The authors thank to

NIES GOSAT team, CNES PARASOL team,

Dr. Natalia Chubarova, and NASA AERONET team for operations of their instrument and data distributions.

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GCOM-C1 SGLI project by JAXA.