GCOM-C SGLI calibration and characterization

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Satellite instrument pre- and post-launch calibration

1. SGLI sensor system and onboard calibration system

Target: Improvement of the land, coastal, and aerosol observations

- ✓ 250m spatial resolution with 1150~1400km swath
- ✓ Polarization/along-track slant view

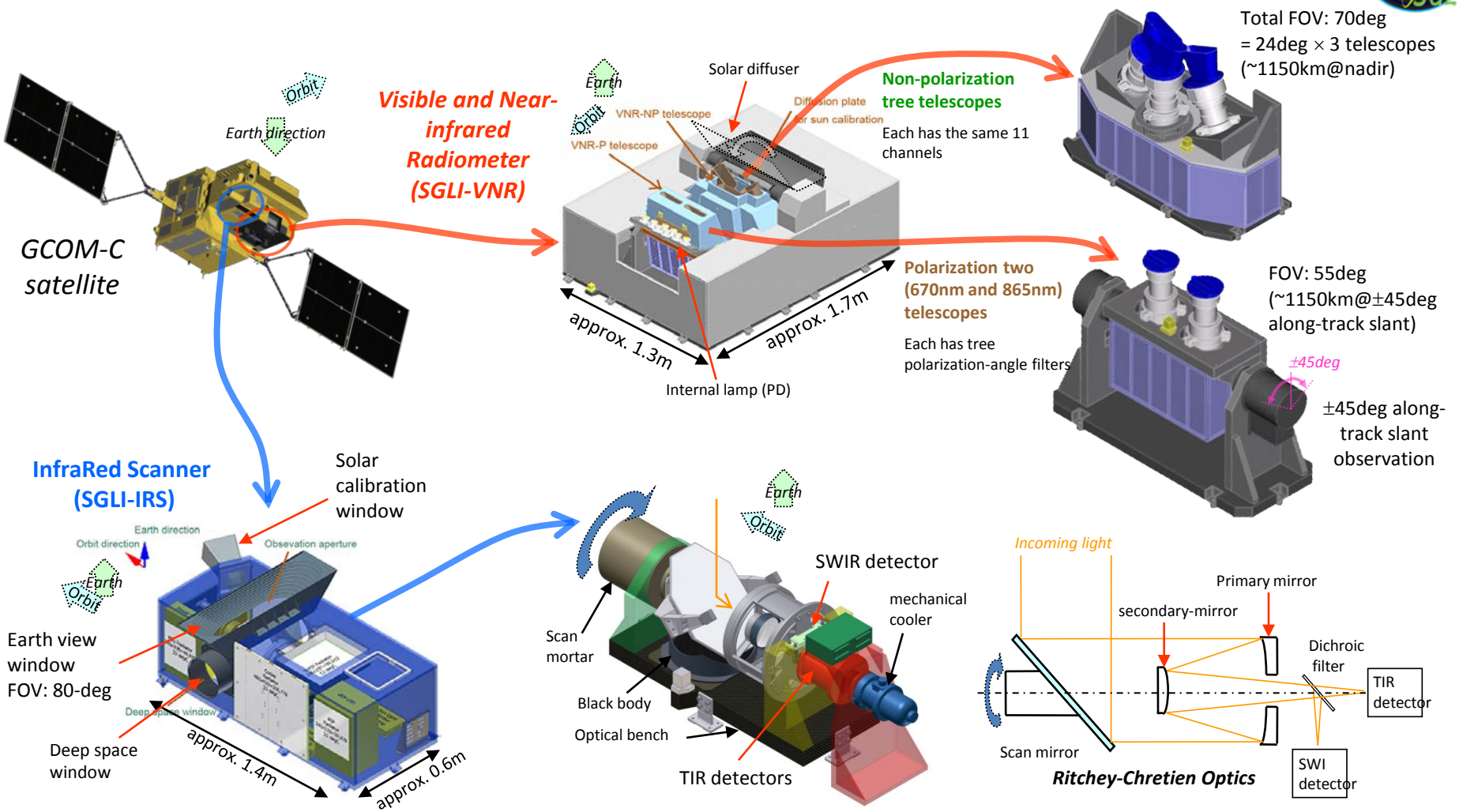
GCOM-C SGLI characteristics (Current baseline)	
Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg
Launch Date	JFY 2015 (TBD)
Mission Life	5 years (3 satellites; total 13 years)
Scan	Push-broom electric scan (VNR: VN & PL) Wisk-broom mechanical scan (IRS: SW & TIR)
Scan width	1150km cross track (VNR: VN & P) 1400km cross track (IRS: SW & TI)
Digitalization	12bit
Polarization	3 polarization angles for P
Along track tilt	Nadir for VN, SW and TIR, & +/-45 deg for PL
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

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: - 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(@1km)	250
VN10	868.5	20	8	30	400	250
VN11	868.5	20	30	300	200	250
PL1	673.5	20	25	250	250	1000
PL2	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
TIR1	10.8	0.7	300	340	0.2	500/250
TIR2	12.0	0.7	300	340	0.2	500/250

250m-mode possibility

1. SGLI sensor system and onboard calibration system

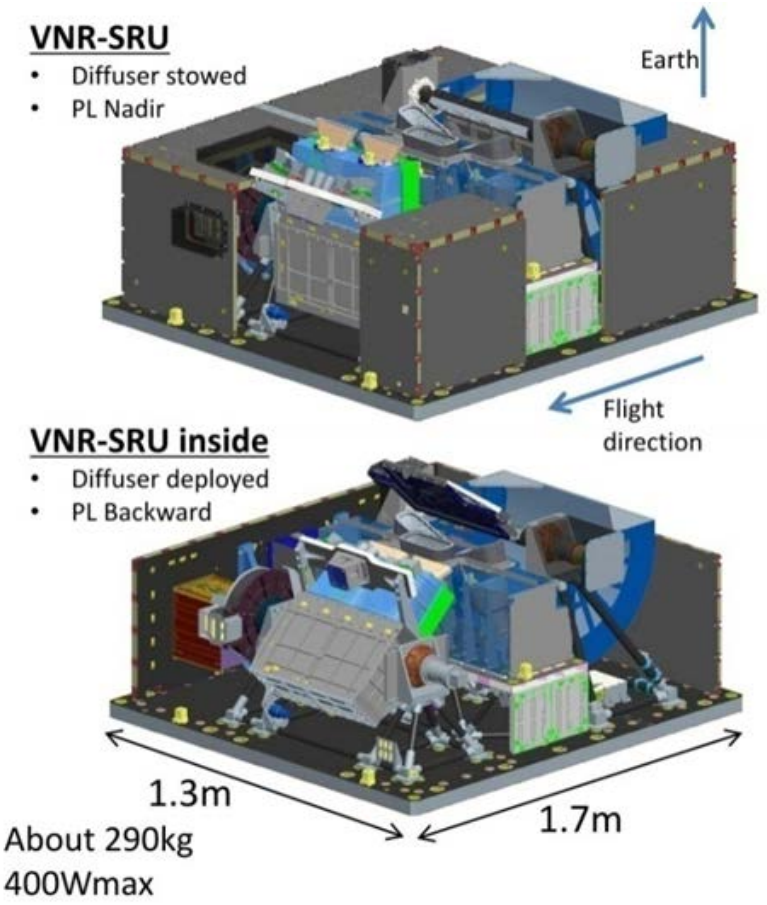


Engineering Model (EM) development & test

- Filters manufacturing: Spectral response of filters (uniformity of λc: 0.5-1.0nm in FOV, characterized by 0.1nm)
- CCD (EM) manufacturing: completed
- Stray Light : Telescope test with the CCD; Numerical correction method study with convolution technique
- Prelaunch calibration: Calibration by a Integrating sphere tracable to the national standards

1. SGLI sensor system and onboard calibration system

- SGLI VNR Non-Polarized observation sub unit (VNR-NP) has 11 bands with 250-m spatial resolution and 1150-km cross-track swath covered by three telescopes.
- Other two telescopes are mounted on the tilting bench (+/-45 degrees along track) and dedicated for the polarized light observation at two bands of red and NIR (VNR-PL).
- SGLI-VNR has multiple on-board calibration functions, diffuser for solar irradiance and lamp (LED) calibration.
- Maneuver observation is planned for evaluating BRDF of the solar diffuser after the launch.
- SGLI is planned to see the moon at a constant phase angle monthly by pitch maneuver of GCOM-C satellite



SGLI VNR sensor design
The calibration diffuser is deployed in the lower figure. Cited from “Operation Concept of Second-generation Global Imager (SGLI)”, K. Tanaka et al., SPIE-AP, Incheon, Oct. 13, 2010.

2. Pre-launch calibration and characterization

Flight model characterization (development of a sensor model) and radiometric gain calibration will be conducted by the similar way that has been done for the evaluation tests of the Engineering Model.

(1) Gain calibration

Radiometric gain including non-linearity at each pixel (VNR and IRS) and scan angle (IRS) by using the integration sphere which have to be traceable to the national standard through transfer instruments, e.g., spectro-radiometer and blackbody radiators.

(2) Signal to noise ratio (SNR)

SNR at the standard radiance level (depend on application targets) is evaluated in the optical tests. Noise of the dark target is also evaluated. SNR and dark noise will be monitored by the lamp calibration and night time data both before and after launch.

(3) Spectral response

Spectral response of band-pass filters and the total optical system will be measured. Field-Of-View (FOV) dependence of the line filters are carefully measured and characterized.

(4) Polarization sensitivity

Polarization sensitivity is measured at several points in the FOV for each band and sensor components, IRS and each telescope of VNR.

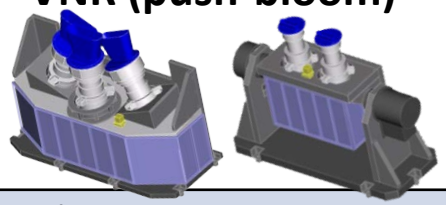
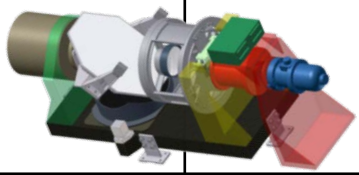
(5) Stray-light

Stray-light is often to be one of the serious problem for the imager. It can be caused by scatterings in the telescope and around the focal plane. Quantitative characterization and correction model will be investigated through the pre-launch tests.

(6) Geometric model

The geometric model depends on the sensor geometric design and optical characteristics. It will be measured in the pre-launch tests and revised after launch by the GCP matching analysis. The GPS receiver and the star-tracker will be used for the geometric (position and angle) correction on orbit.

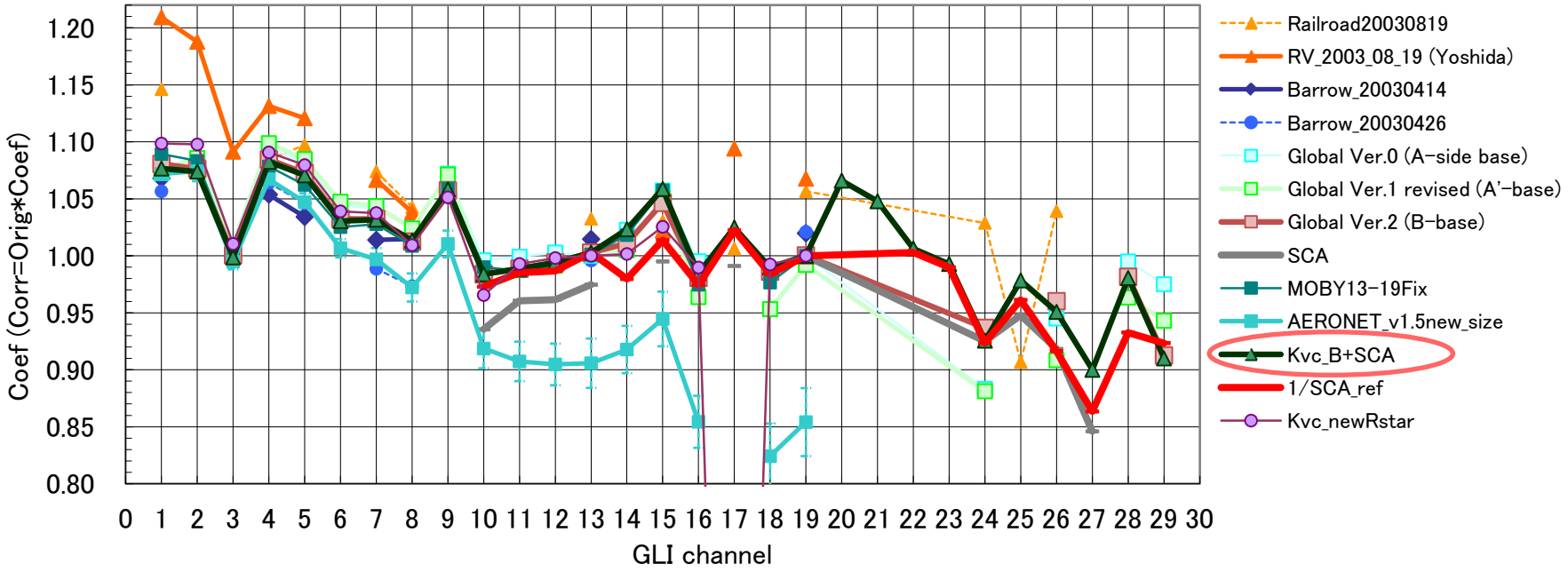
3. Calibration strategy integrating the calibration methods

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		***Primary source***
Vicarious adjustment	Vicarious calibration over the CEOS instrumented sites and ocean cruises	Vicarious calibration at the CEOS instrumented sites (land)	Vicarious/cross calibration by SST
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..		

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

3. Calibration strategy integrating the calibration methods

ADEOS-II/GLI Vicarious coefficients and solar cal results



Marge Global Kvc and SCA

Bands influenced by the gas absorption and limited coverage bands were interpolated using the Solar Calibration (SCA) results

ch	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
λ nm	380	400	412	443	460	490	520	545	565	625	666	680H	678	710H	710	749	763	865H	865	460	545	660	825	1050	1135	1240	1380	1640	2210
Kvc_B +SCA	1.077	1.074	0.999	1.083	1.071	1.030	1.032	1.013	1.058	0.984	0.989	0.994	1.003	1.023	1.059	0.985	1.025	0.990	**1.000**	1.066	1.048	1.006	0.993	0.926	0.978	0.951	0.900	0.981	0.910
1/SCA _ref	1.276	1.276	1.164	1.186	1.153	1.090	1.072	1.035	1.085	0.973	0.985	0.987	1.003	0.980	1.014	0.975	1.022	0.984	**1.000**	1.148	1.070	1.003	0.990	0.924	0.961	0.916	0.863	0.933	0.923

Not used due to diffuser degradation in blue~green

http://suzaku.eorc.jaxa.jp/GLI/cal/vcoef/index.html

4. Summary

- Evaluation tests of the Engineering Model (EM) of the Second-generation Global Imager (SGLI) on the Global Change Observation Mission (GCOM) is being reviewed in this winter-spring.
- The tests included radiometric gain, linearity, spectral response, stray light, polarization sensitivity, geometric characterization and so on.
- Manufacturing of the Pre-Flight Model (PFM) will reflects the results of EM design and its evaluation.
- SGLI has multiple on-board calibration methods using a solar diffuser, LED lamps, a thermal black body, and monthly pitch-maneuver for the lunar observation at the same phase angle
- We will evaluate the calibration accuracy through integration of the multiple results of the calibration methods