GCOM-C/SGLI CalVal with AERONET-OC

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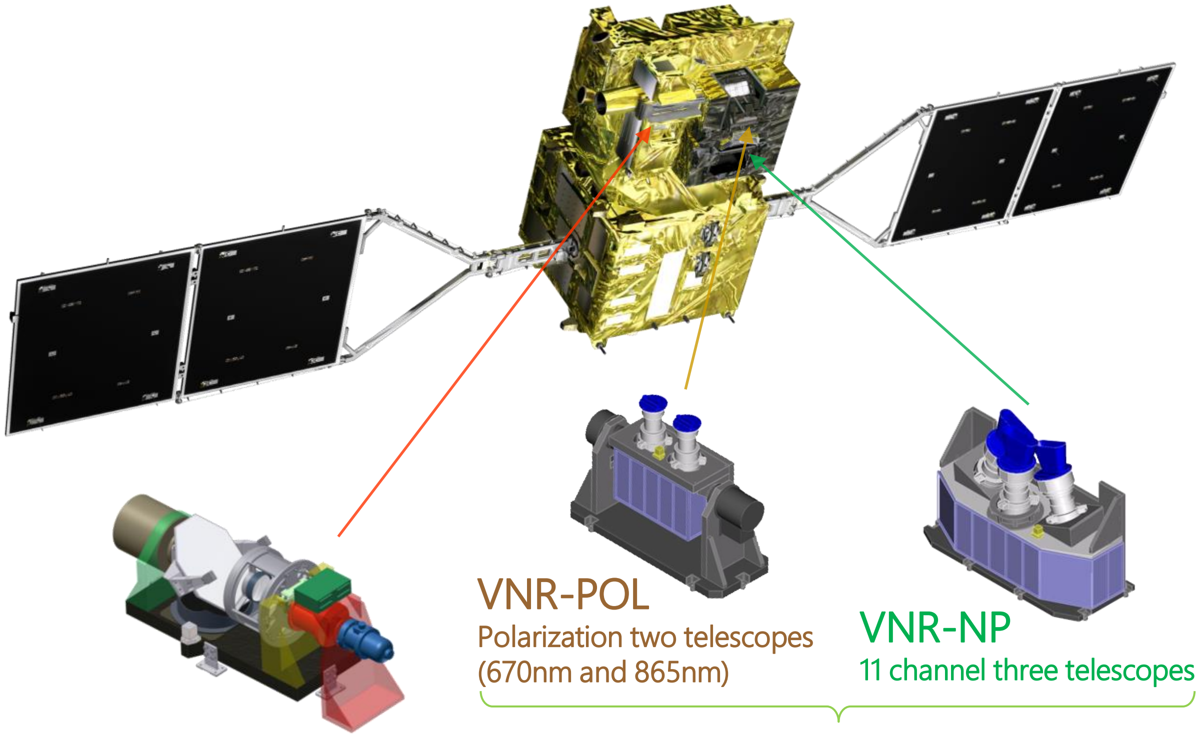
1. Introduction: GCOM-C/SGLI

Global Change Observation Mission – Climate (GCOM-C)
Second-generation Global Imager (SGLI)

GCOM-C characteristics	
Launch Date	23 Dec. 2017 (data since 1 Jan 2018)
Orbit	Sun-synchronous (descending local time: 10:30), Altitude: 798km, Inclination: 98.6deg



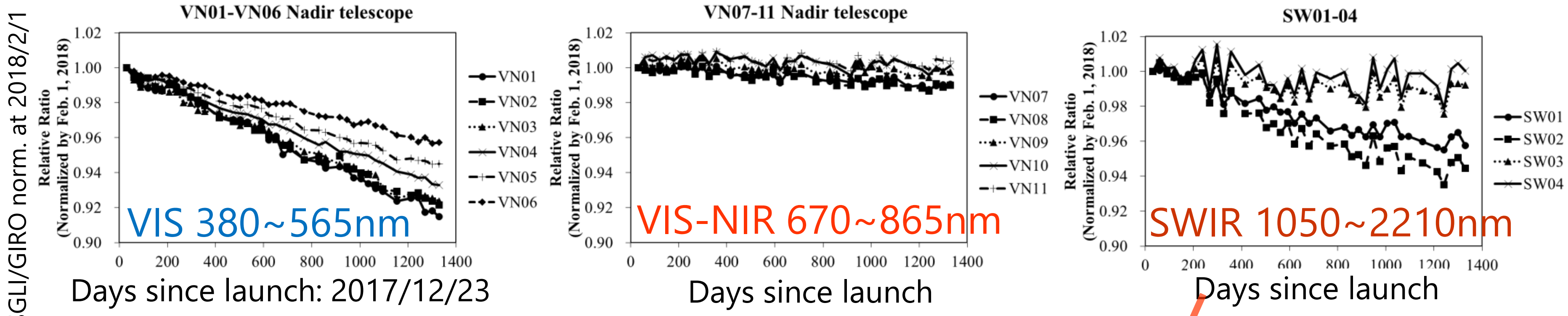
https://suzaku.eorc.jaxa.jp/GCOM_C/data/prelaunch/index.html

Specification of SGLI channels

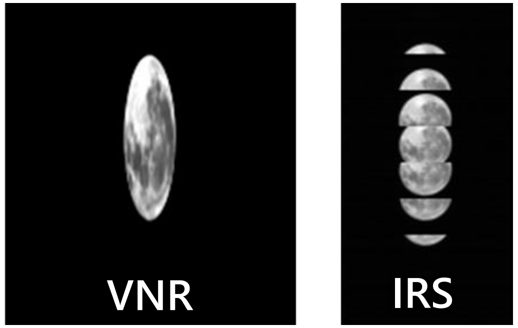
swath	CH	λ	$\Delta\lambda$	L_{std}	L_{max}	SNR@L_{std}	IFOV
km		nm		W/m^2/sr/μm K: Kelvin		- K: NEΔT	m
1150km (VNR: push-broom electric scan)	VN01	380.0	10.6	60	240-241	624-675	250 /1000
	VN02	412.5	10.3	75	305-318	786-826	250 /1000
	VN03	443.2	10.1	64	457-467	487-531	250 /1000
	VN04	489.8	10.3	53	147-150	858-870	250 /1000
	VN05	529.6	19.1	41	361-364	457-522	250 /1000
	VN06	566.2	19.8	33	95-96	1027-1064	250 /1000
	VN07	672.0	22.0	23	69-70	988-1088	250 /1000
	VN08	672.1	21.9	25	213-217	537-564	250 /1000
	VN09	763.1	11.4	40	351-359	1592-1746*	250 /1000*
	VN10	866.8	20.9	8	37-38	470-510	250 /1000
	VN11	867.1	20.8	30	305-306	471-511	250 /1000
	PL01	671.9	20.6	25	293	609	1000@nadir
	PL02	866.2	20.3	30	396	646	1000@nadir
1400km (IRS: wisk-broom)	SW01	1055	21.1	57	289.2	951.8	1000
	SW02	1385	20.1	8	118.9	347.3	1000
	SW03	1635	195.0	3	50.6	100.5	250 /1000
	SW04	2209	50.4	1.9	21.7	378.7	1000
	TI01	10793	756	300K	340K	0.08K	250/500/1000
	TI02	11956	759	300K	340K	0.13K	250/500/1000

1. Introduction: temporal change correction by Lunar CAL

- ✓ Temporal change of the SGLI L1B reflectance is calibrated by the monthly lunar observations (pitch maneuver) by using GIRO

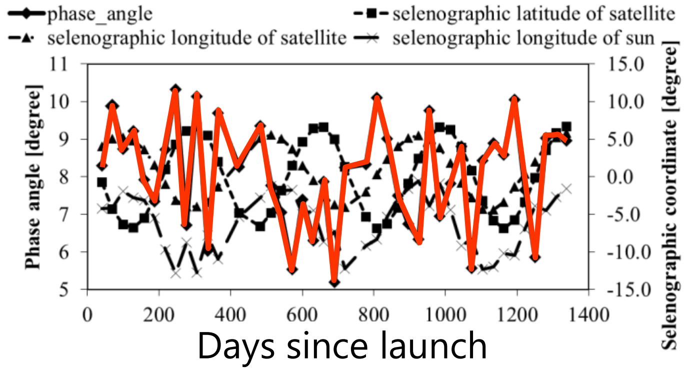


Time series of SGLI/GIRO trend (Normalized by 2018/2/1)

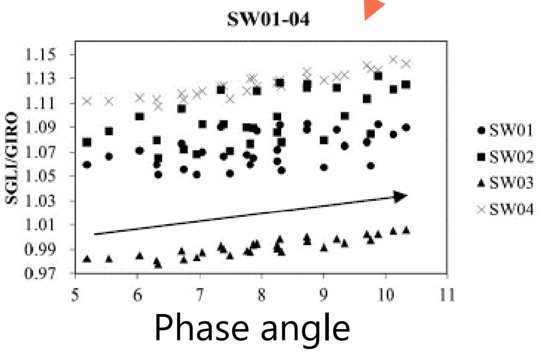


SGLI lunar images

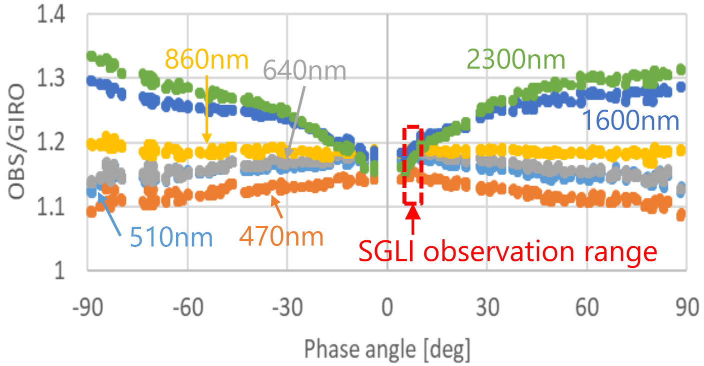
- ✓ The phase angle dependency was evaluated by AHI lunar observations at various phase angles



SGLI phase angle of the moon observations



Phase angle dependency (SGLI/SWIR)



Phase angle dependency (AHI in 2019)

Urabe et al. (2020). DOI: 10.3390/rs12010069; Urabe et al. (2019) DOI: 10.1109/IGARSS.2019.8897892

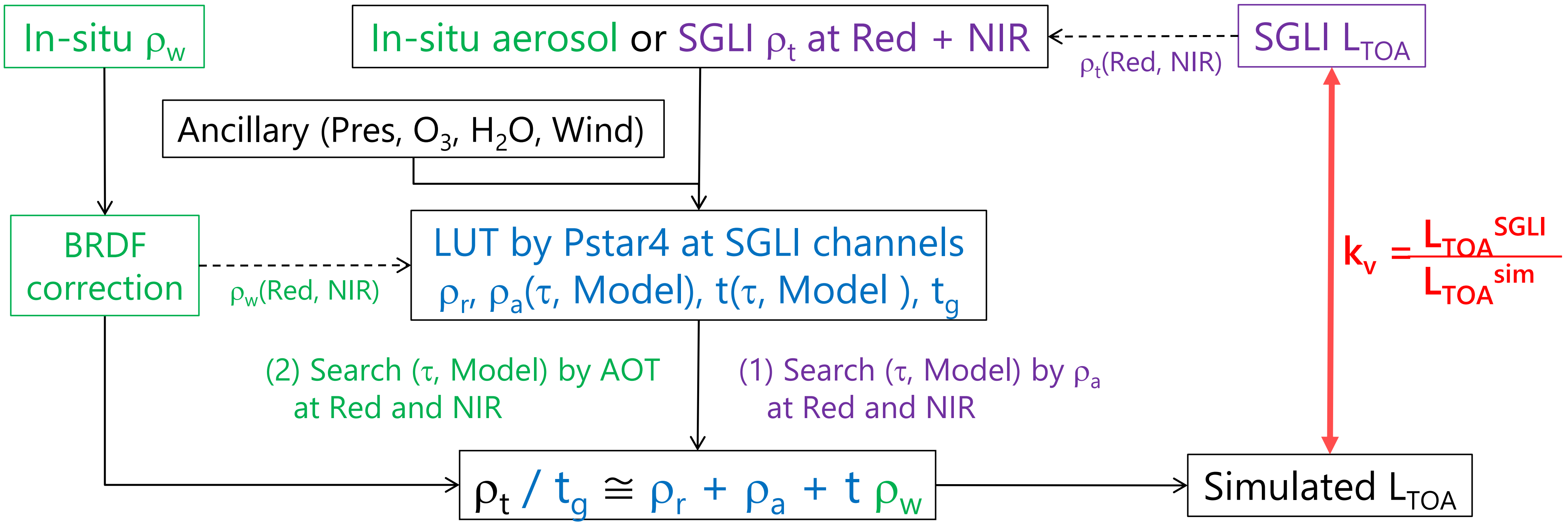
1. Introduction: objectives

Evaluate vicarious calibration gains (k_v) by MOBY+BOUSSOLE

- ✓ derived R_{rs}, AOT, and angstrom exponent (α)
- ✓ k_v evaluation
  - ✓ AOT and angstrom exponent ($\rightarrow$aerosol LUTs)
  - ✓ seasonal change/scattering angle dependency (after the lunar calibration)

2. Method: processing flow

- ✓ SGLI vicarious calibration is based on in-situ water-leaving radiance(L_{wn}) or reflectance (ρ_w) observation of MOBY (Clark et al., 2003) and BOUSSOLE (Antoine et al., 2006) with BRDF correction by Morel and Maritorena (2001)
- ✓ At each in-situ samples (clear sky and out of the sun-glint area), the aerosol reflectance and transmittance are calculated by SGLI red and NIR channels as same as the SGLI ocean-color atmospheric correction except for using in-situ ρ_w at the red and NIR channels



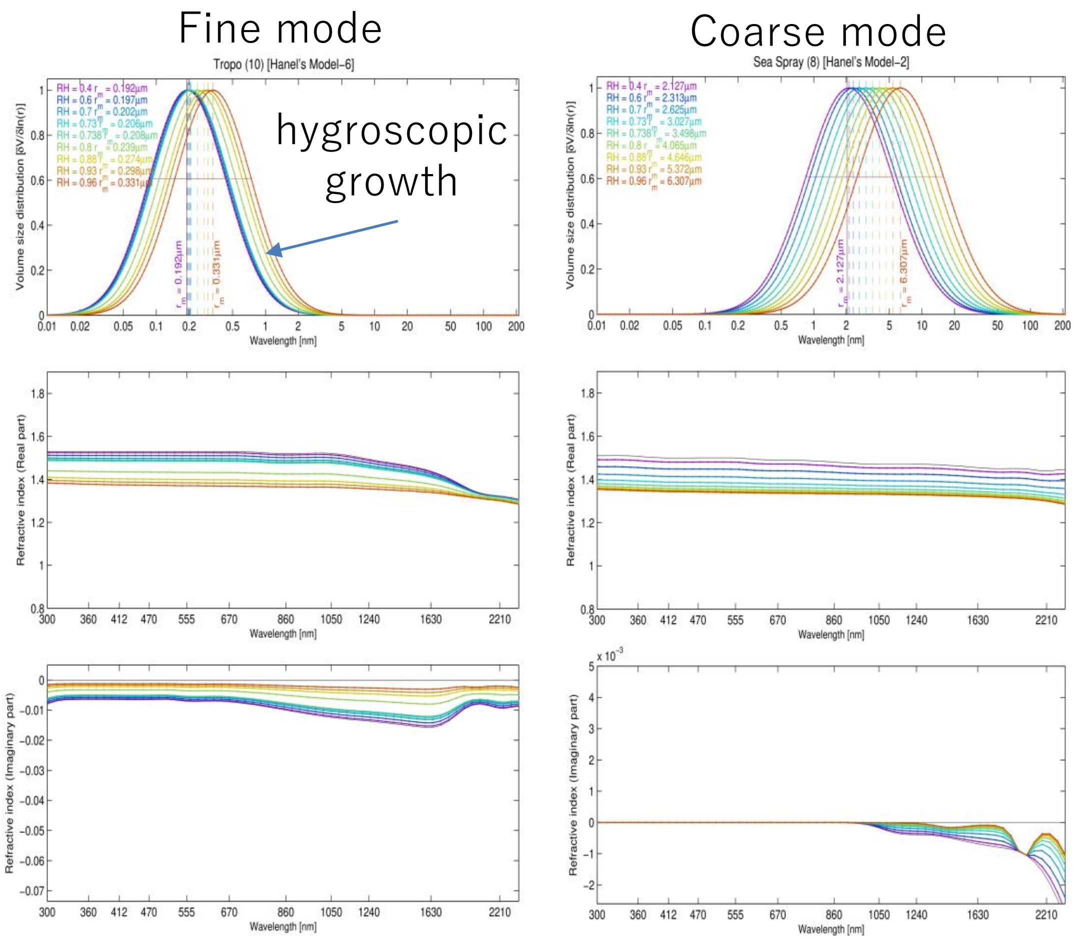
2. Method: aerosol models (LUT-1)

- Look up tables of the atmospheric reflectance and transmittance are calculated by Pstar4 (Ota et al., 2010) using aerosol size distribution of Shettle and Fenn, 1979

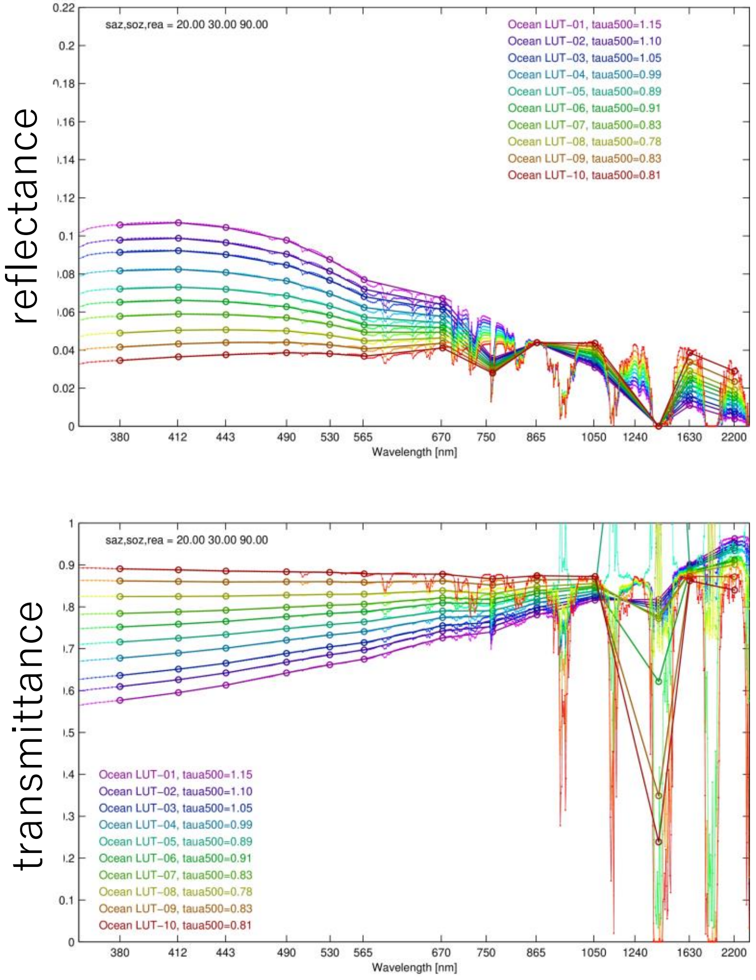
Size distribution

Refractive index (real)

Refractive index (imaginary part)



AOT@865=0.6



2. Method: aerosol models (LUT-2)

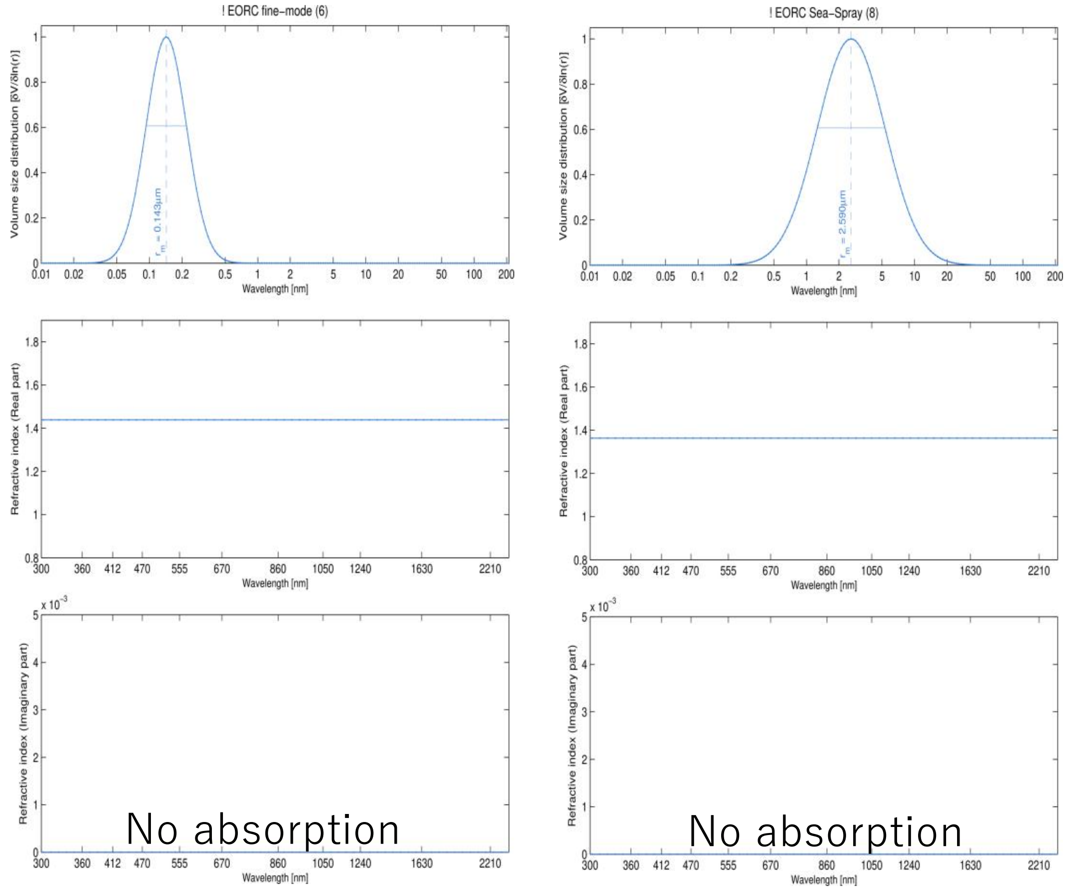
- Look up tables of the atmospheric reflectance and transmittance are calculated by Pstar4 (Ota et al., 2010) using aerosol size distribution of AERONET climatology (Omar et al., 2005) without absorption and hygroscopic growth

Fine mode | Coarse mode

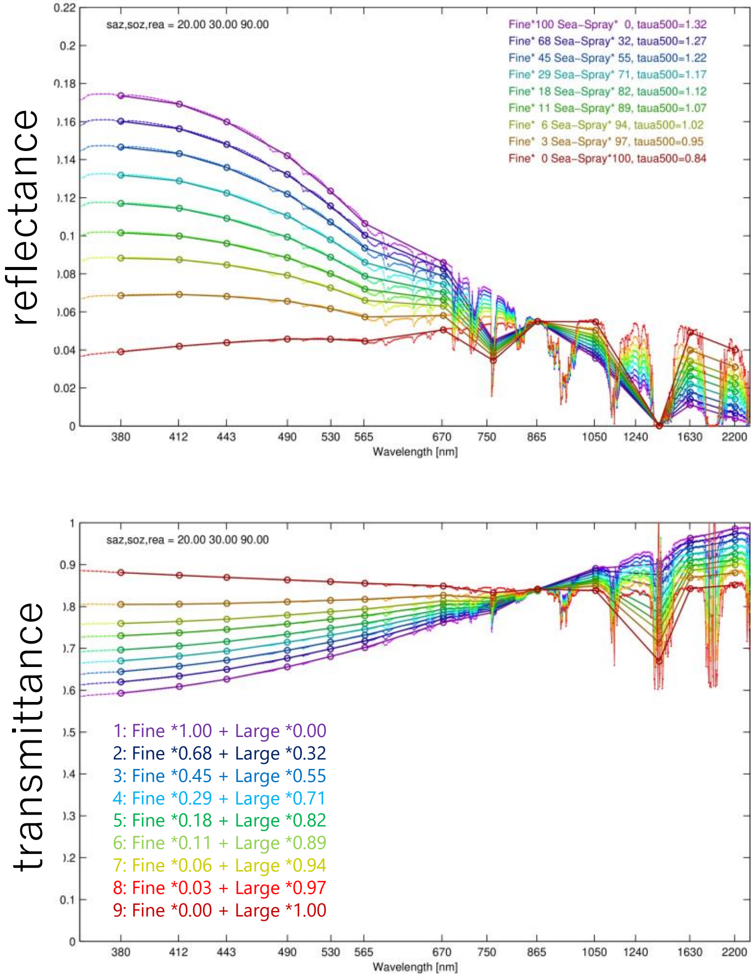
Size distribution

Refractive index (real)

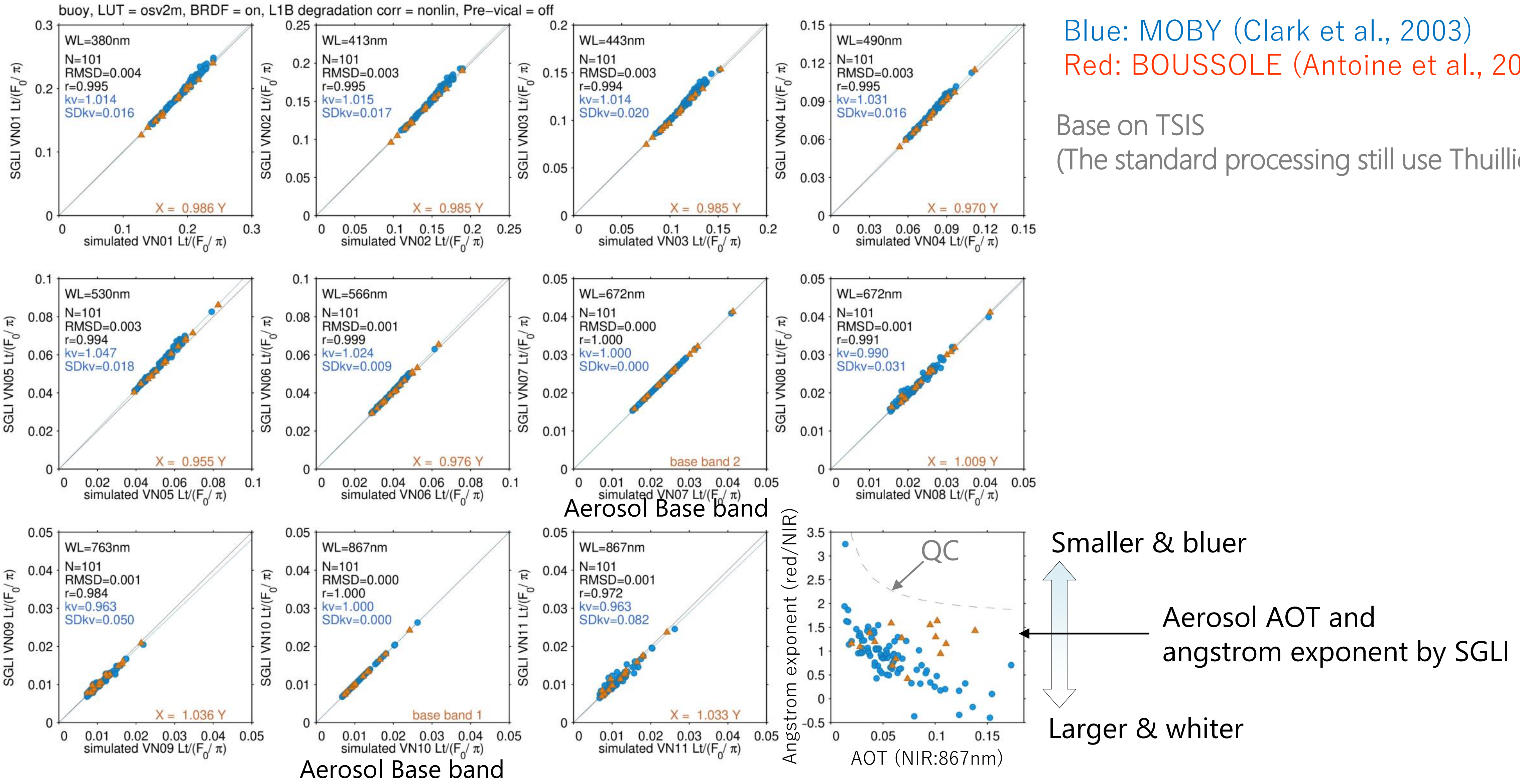
Refractive index (imaginary part)



AOT@865=0.6



2. Method: Vicarious calibration by MOBY+BOUSSOLE



Blue: MOBY (Clark et al., 2003)
Red: BOUSSOLE (Antoine et al., 2006)

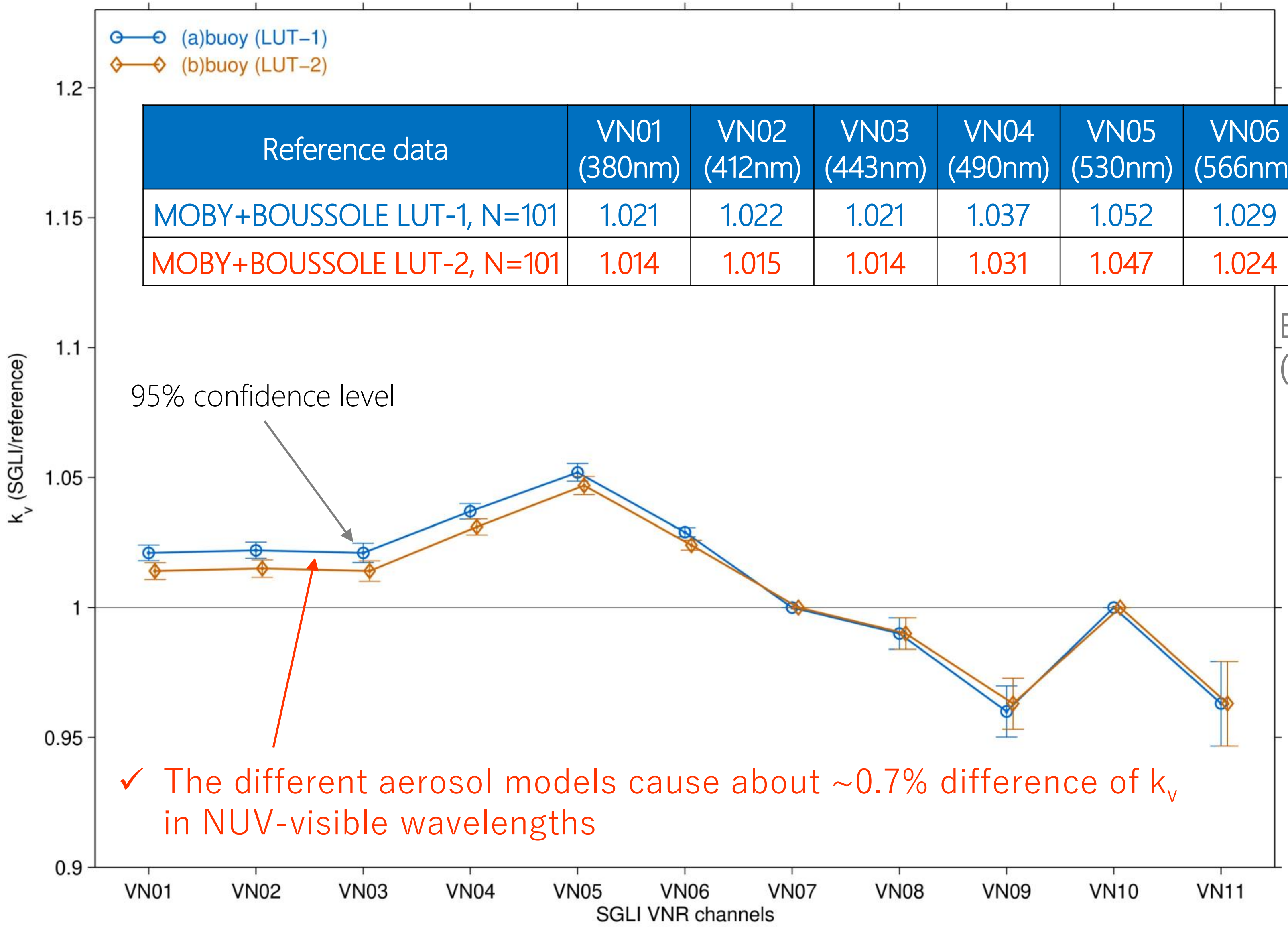
Base on TSIS
(The standard processing still use Thuillier 2003)

2. Method: Vicarious calibration by MOBY+BOUSSOLE

MOBY (Clark et al., 2003)
BOUSSOLE (Antoine et al., 2006)

Reference data	VN01 (380nm)	VN02 (412nm)	VN03 (443nm)	VN04 (490nm)	VN05 (530nm)	VN06 (566nm)	VN07 (672nm)	VN08 (672nm)	VN09 (763nm)	VN10 (867nm)	VN11 (867nm)
MOBY+BOUSSOLE LUT-1, N=101	1.021	1.022	1.021	1.037	1.052	1.029	1.000	0.990	0.960	1.000	0.963
MOBY+BOUSSOLE LUT-2, N=101	1.014	1.015	1.014	1.031	1.047	1.024	1.000	0.990	0.963	1.000	0.963

Base on TSIS
(The standard processing still use Thuillier 2003)



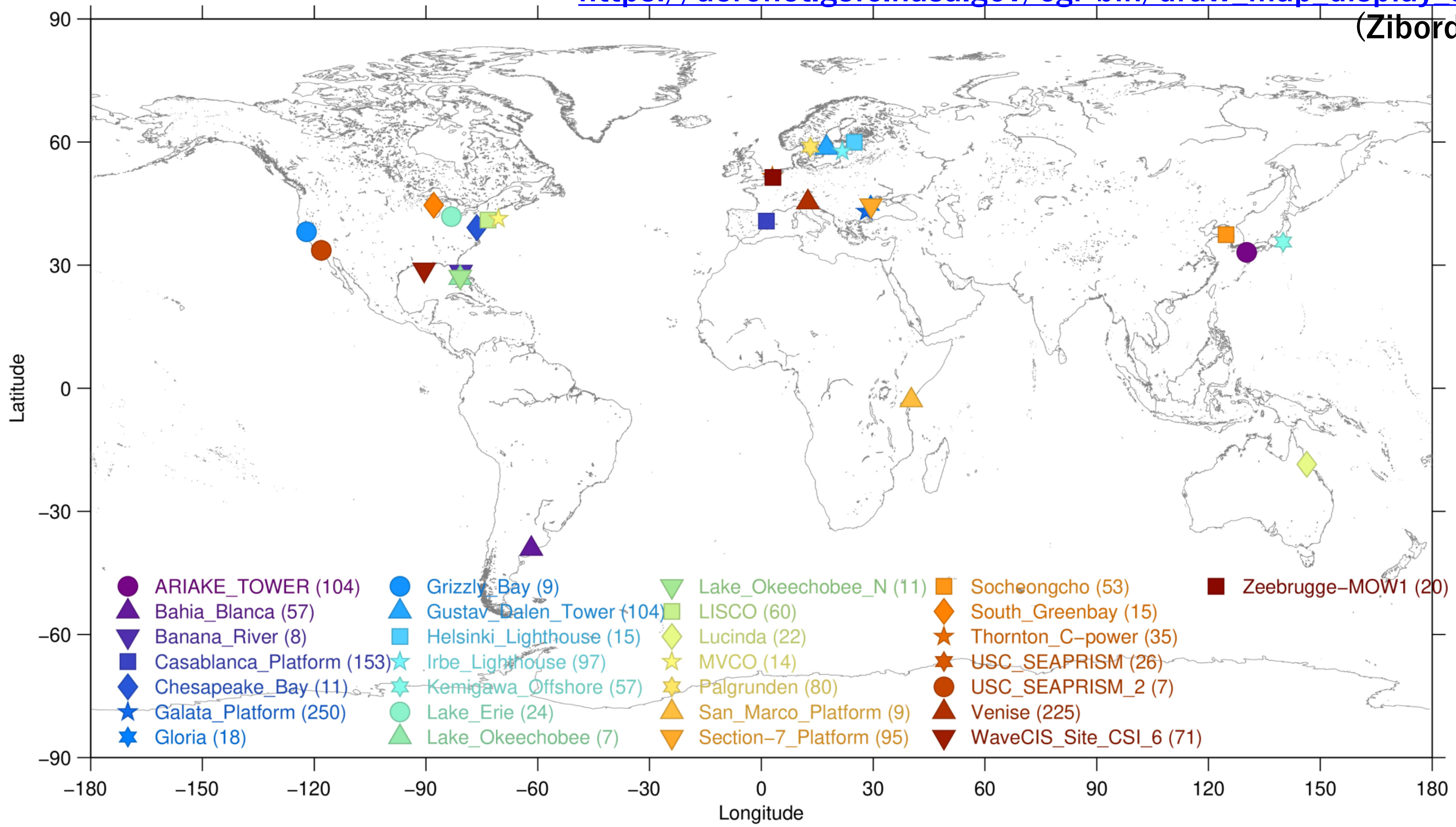
✓ The different aerosol models cause about ~0.7% difference of k_v in NUV-visible wavelengths

Ref. Murakami et al., 2022, System vicarious calibration of GCOM-C/SGLI visible and near-infrared channels, Journal of Oceanography, https://doi.org/10.1007/s10872-022-00632-x

2. Method: AERONET-OC

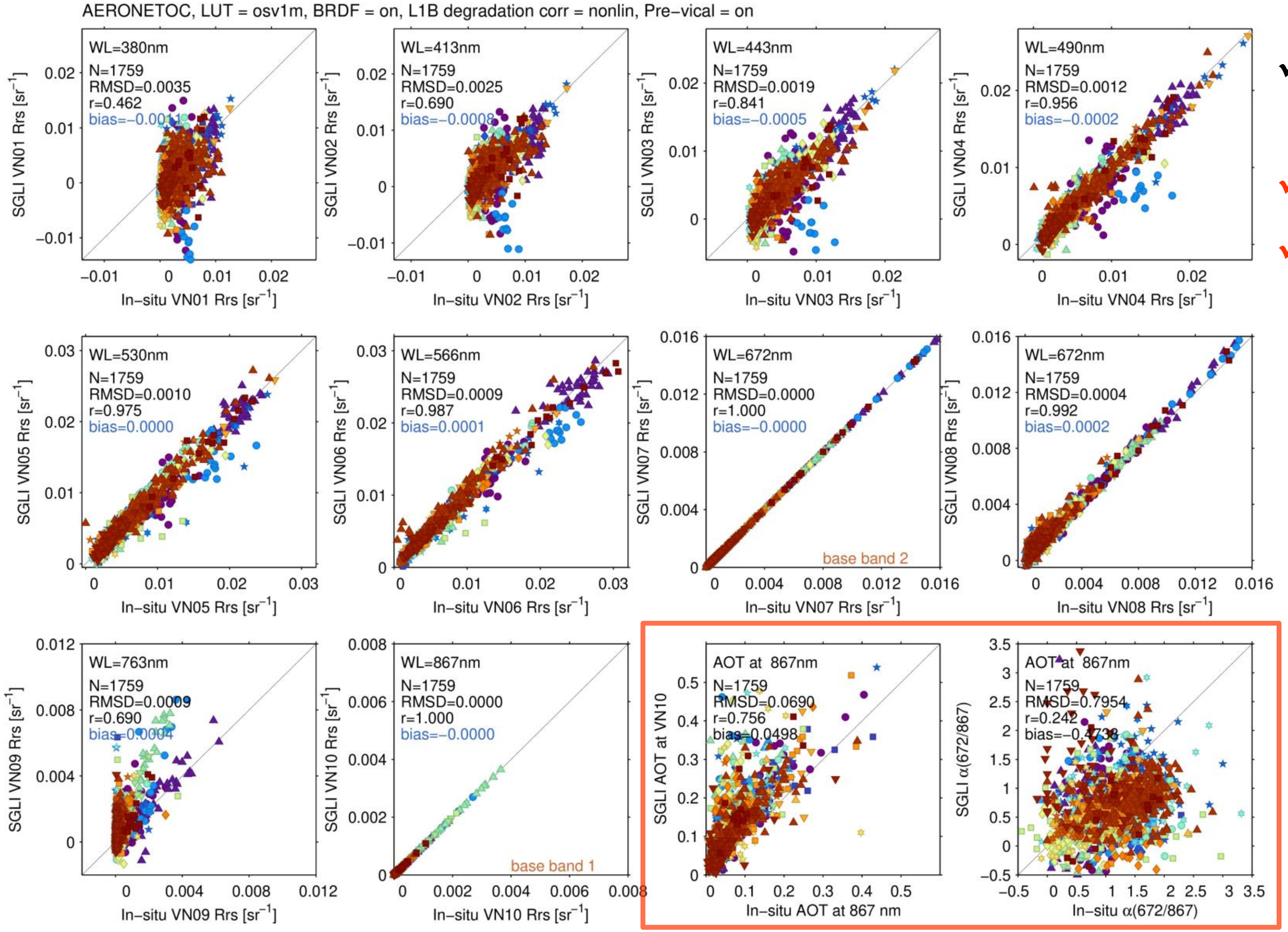
https://aeronet.gsfc.nasa.gov/cgi-bin/draw_map_display_seaprism_v3

(Zibordi et al. 2009)



Used AERONET-OC sites for the SGLI period 2018-2022. (##) shows number of the match-up samples

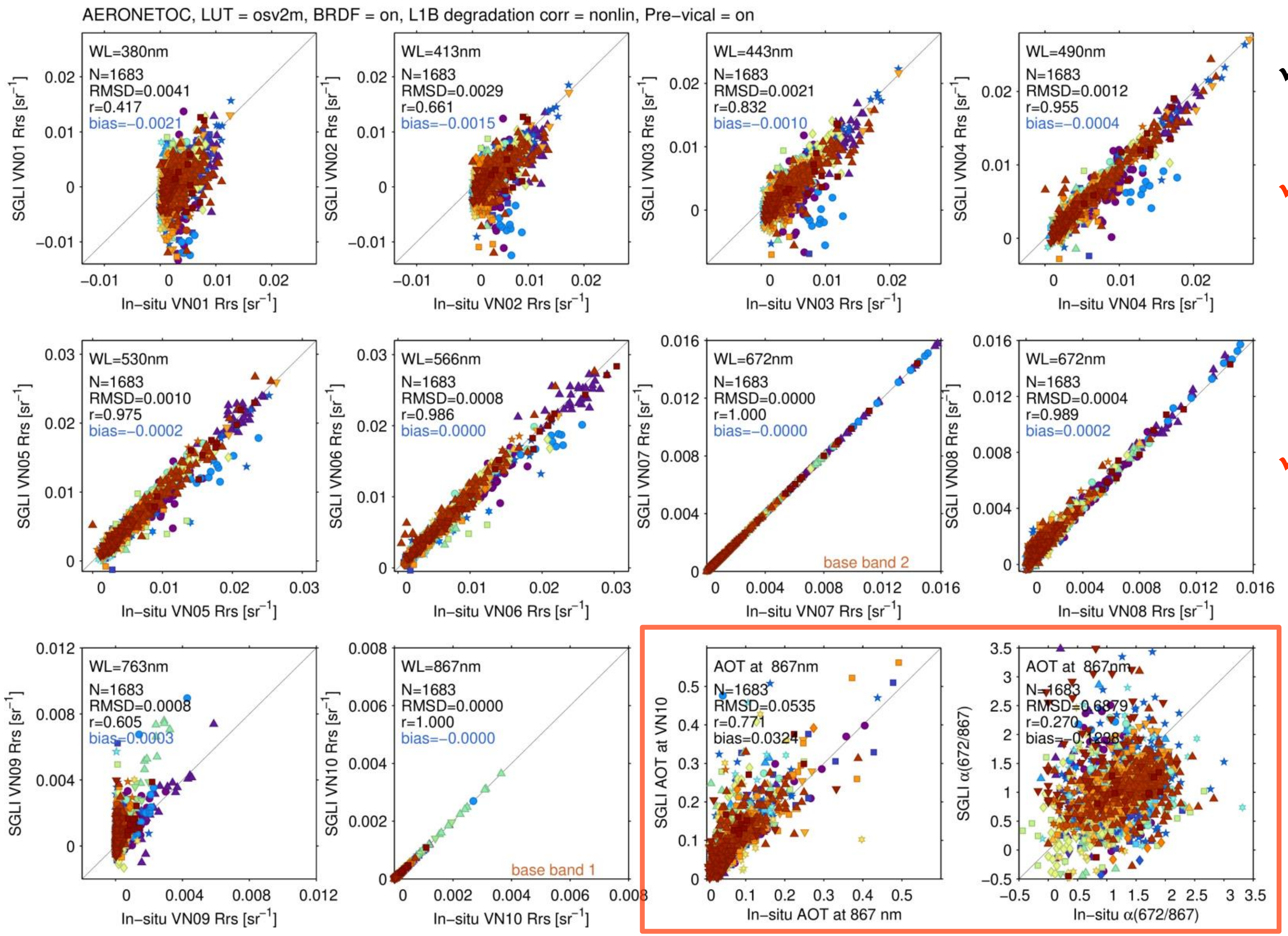
3. Results: Validation of Rrs & AOT, α (LUT-1)



- ✓ Rrs, AOT, and α calculated by SGLI ρ_t, in-situ red and NIR, and k_v
- ✓ Rrs agreed with in-situ data
- ✓ AOT is overestimated, and α is underestimated

SGLI match-up comparison with AERONET-OC (LUT-1)

3. Results: Validation of Rrs & AOT, α (LUT-2)

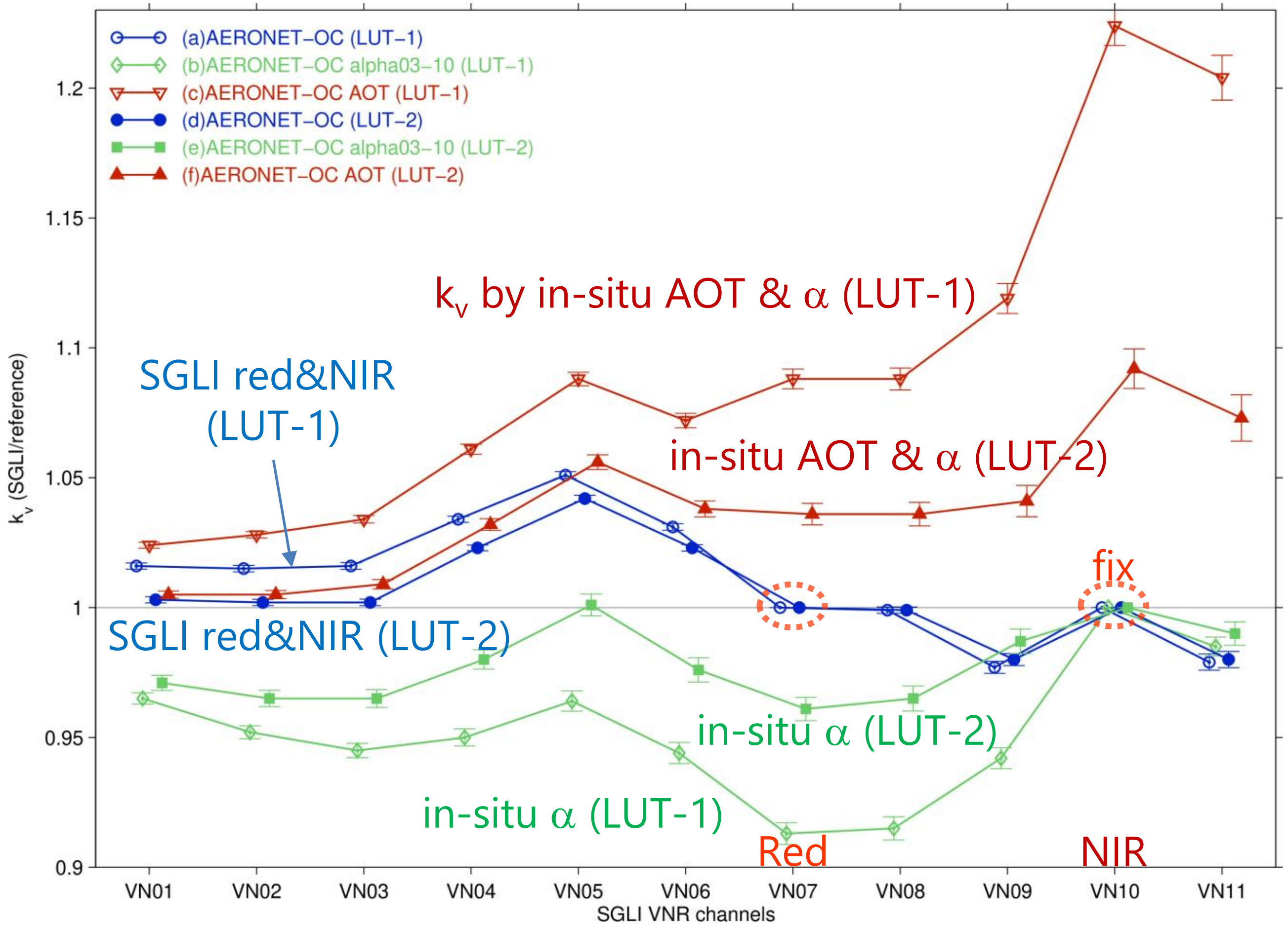


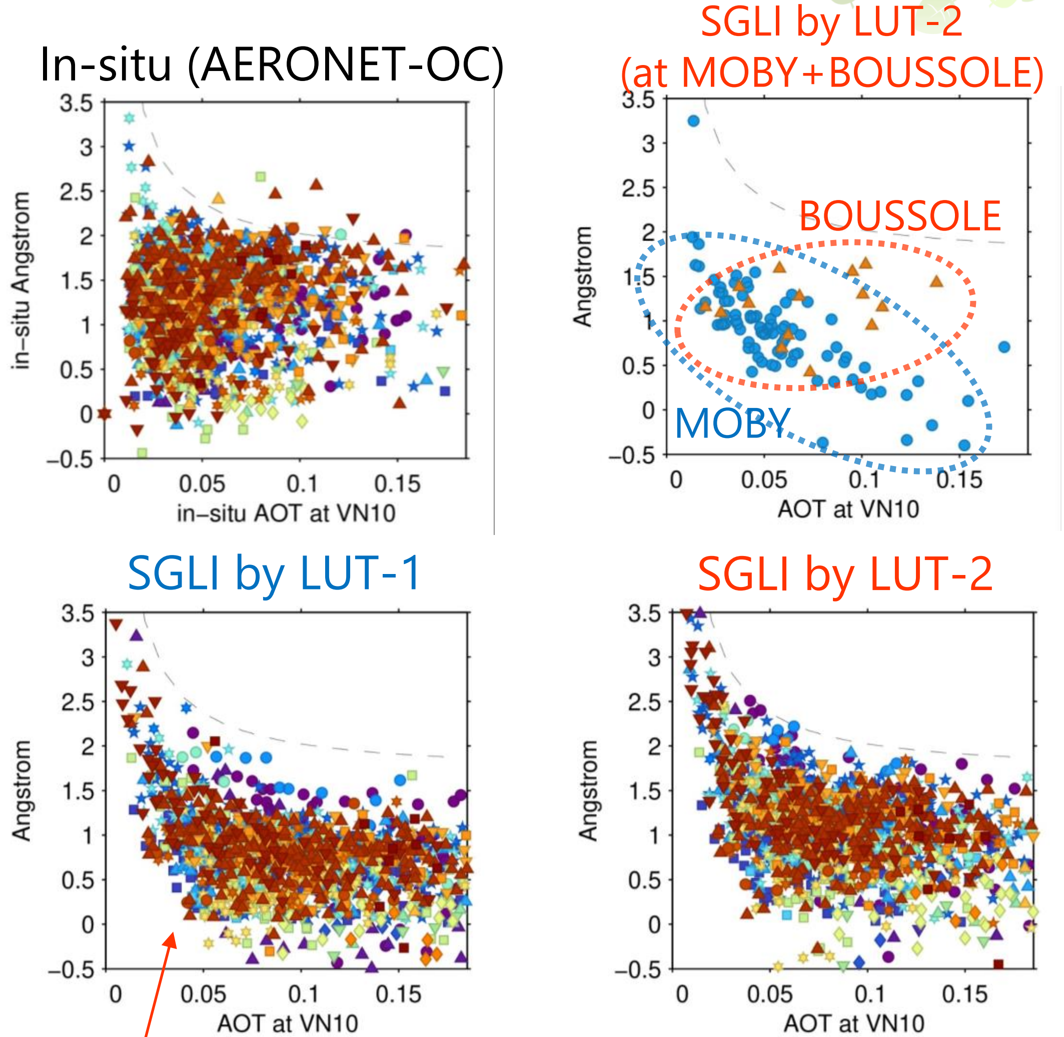
- ✓ Rrs, AOT, and α calculated by SGLI ρ_t, in-situ red and NIR, and k_v
- ✓ Rrs agreed with in-situ data as same as LUT-1, but deviation is slightly larger than ones of LUT-1 (due to the large slope of the aerosol reflectance)
- ✓ AOT and α are better than ones of LUT-1

Aerosol

SGLI match-up comparison with AERONET-OC (LUT-2)

3. Results: k_v by in-situ aerosol





Relation between AOT and α

- ✓ SGLI(NIR)>simulation(NIR) indicates the backscatter is too low in LUT (especially for LUT-1)
  - ← aerosol size distribution?

- ✓AOT and α estimated by LUT-1 is too high and too low
- ✓BOUSSOLE AOT and α are similar with AERONET-OC ones

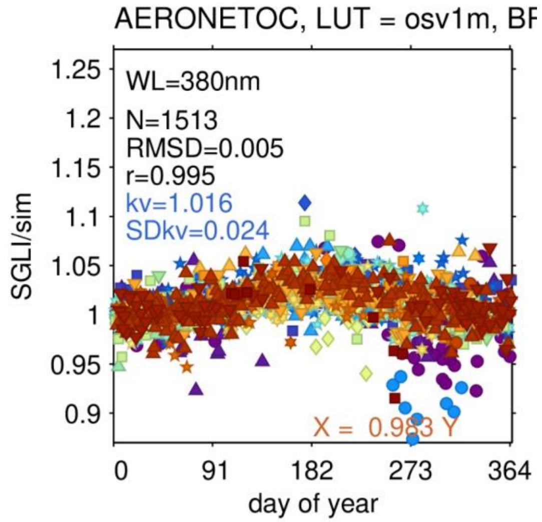
3. Results: seasonal change

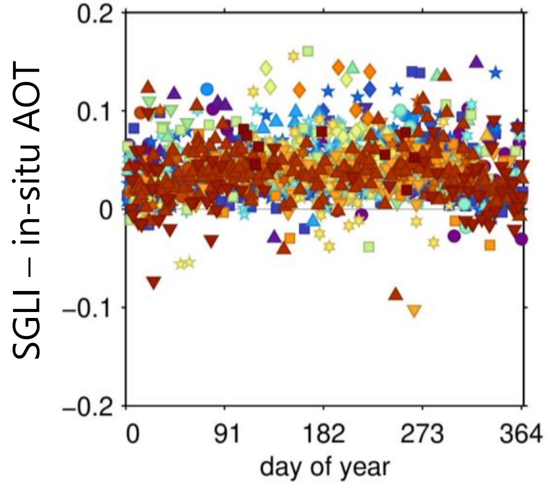
k_v(380nm)

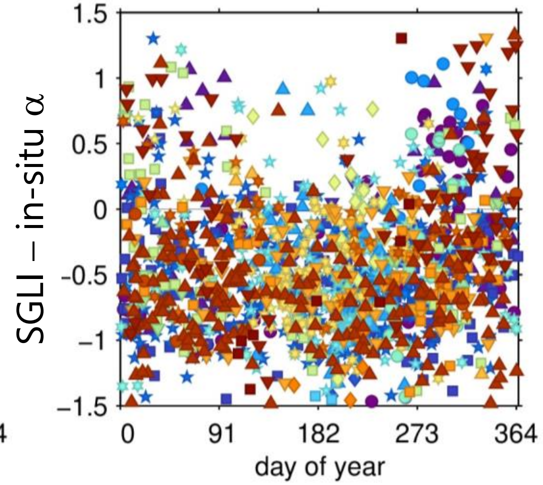
SGLI – in-situ AOT

SGLI – in-situ α

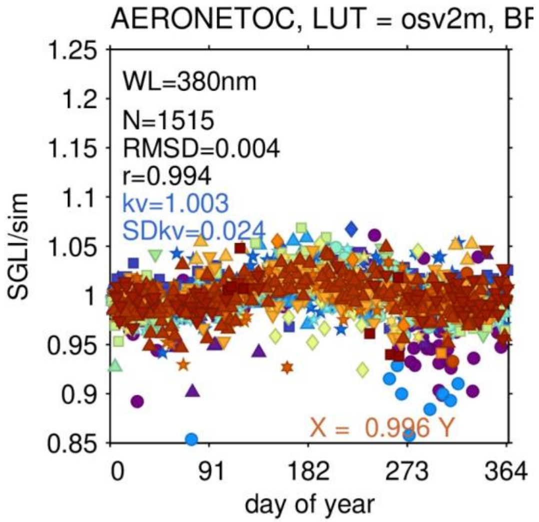
LUT-1

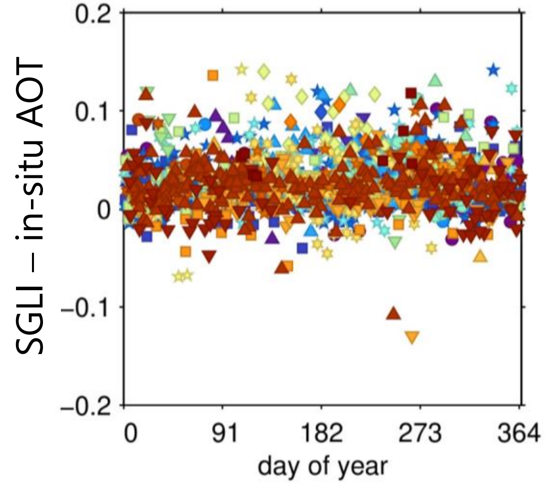


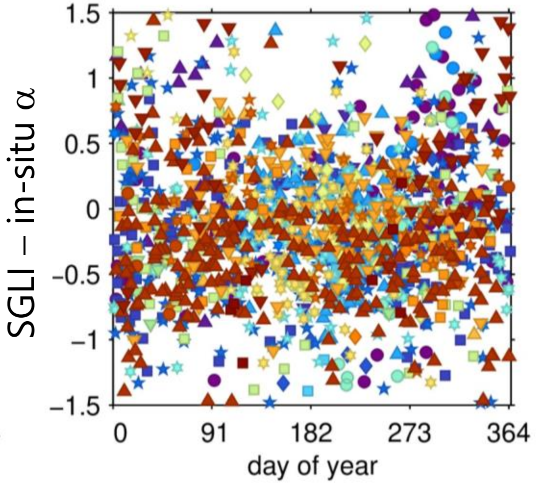




LUT-2







- ✓ Weak seasonal change of kv
- ✓ α of LUT-1 has the seasonal dependency?

3. Results: scattering angle dependency

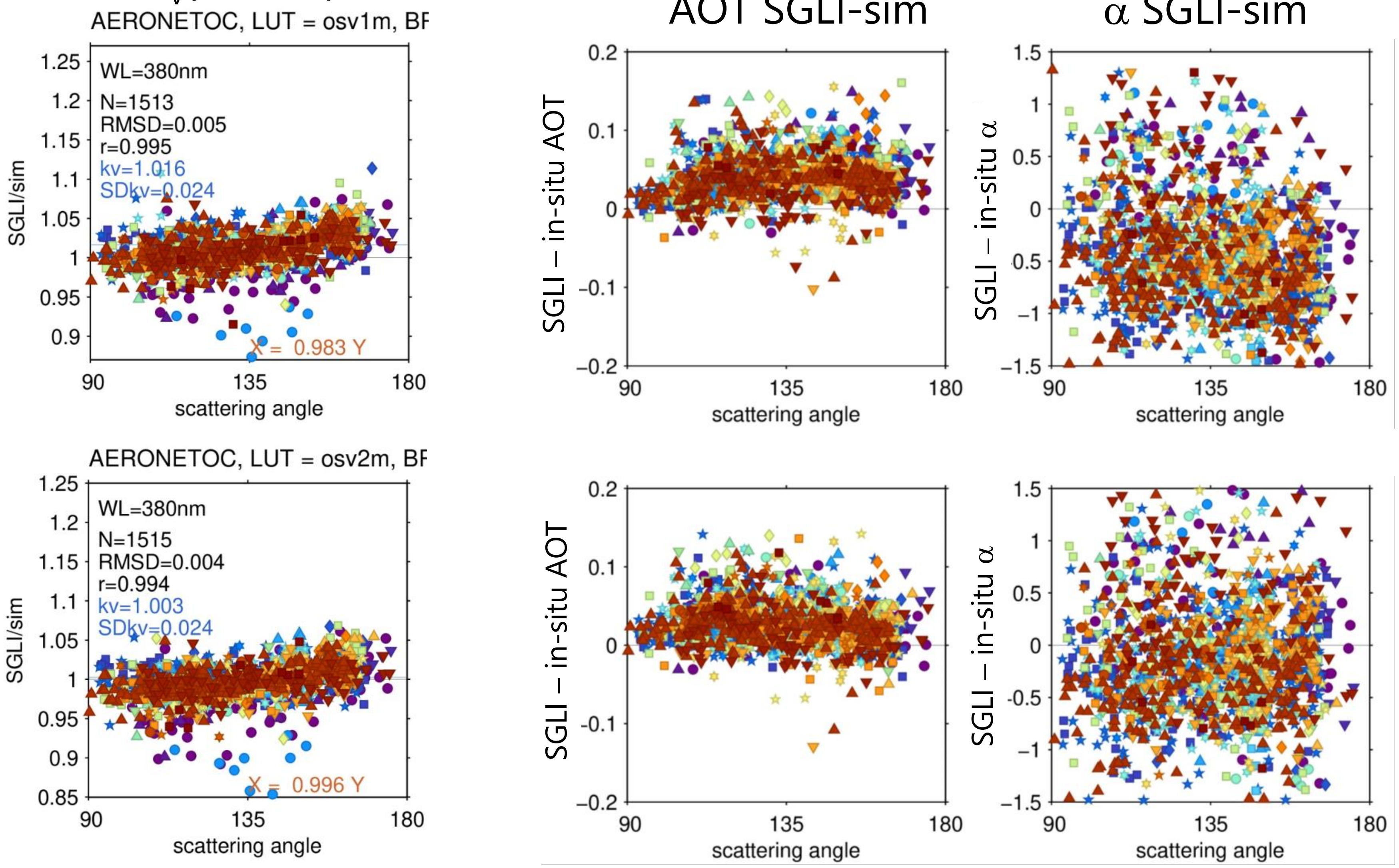
k_v(380nm)

AOT SGLI-sim

α SGLI-sim

LUT-1

LUT-2



- ✓ Weak scattering angle dependency
- ✓ AOT has the scattering angle dependency?

4. Summary

- ✓ Two sets of SGLI k_v (LUT-1 and LUT-2) derived by MOBY+BOUSSOLE are evaluated by AERONET-OC R_{rs} and aerosol measurements (AOT and α)
- ✓ Issues of the aerosol models (size distribution?) could be identified (LUT-2 is adopted for Ver.3 ocean color standard products)
- ✓ There may be remaining errors related with aerosol properties (e.g., seasonal and scattering angle dependency)
- ✓ The wide geographical coverage of AERONET-OC help us to investigate the error source of the global ocean color sensors