



International Ocean Colour Science Meeting 2025

Advancing Global Ocean Colour Observations

GCOM-C SGLI polarization

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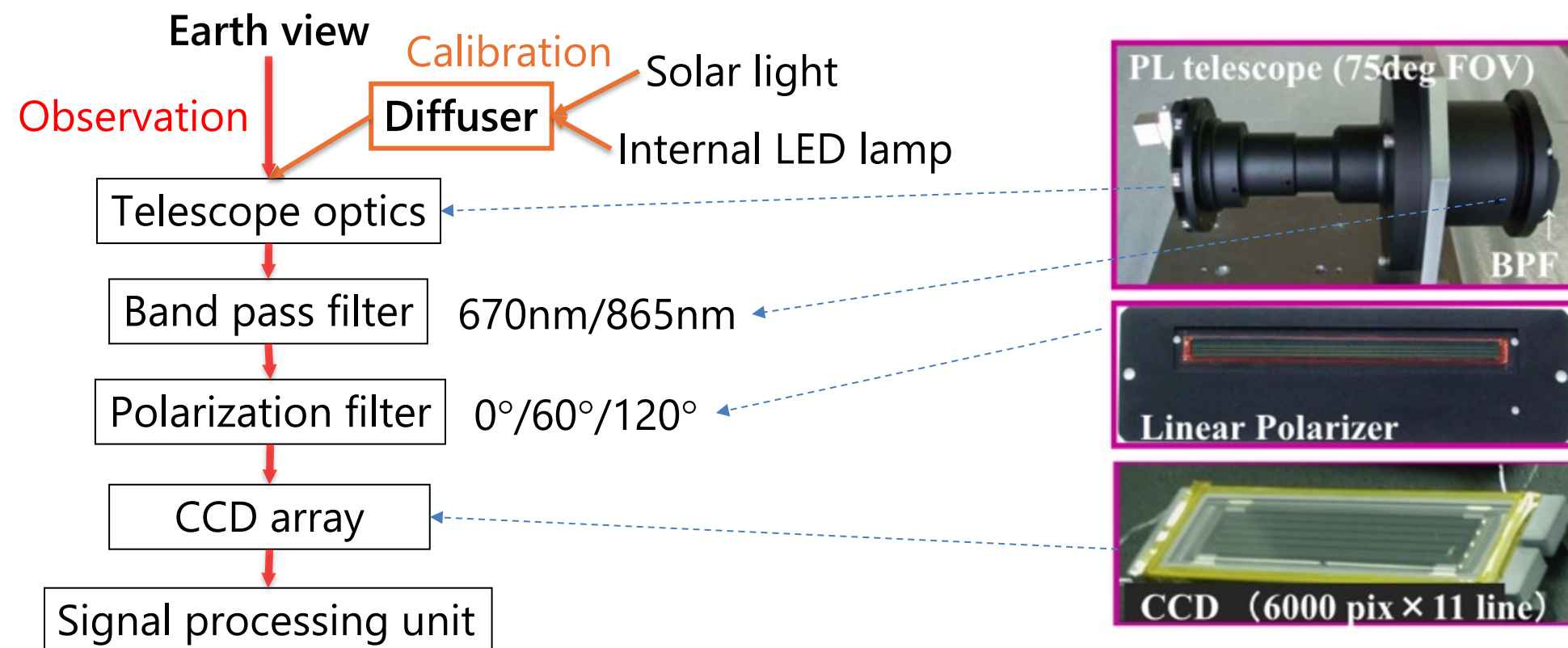


Fig.1 Block chart of SGLI polarimetry

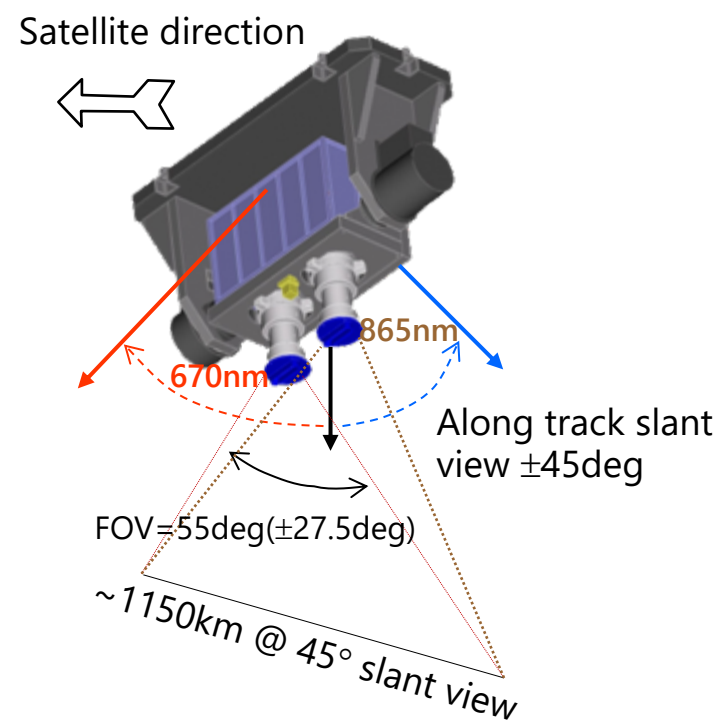


Fig.2 SGLI field of view and tilt

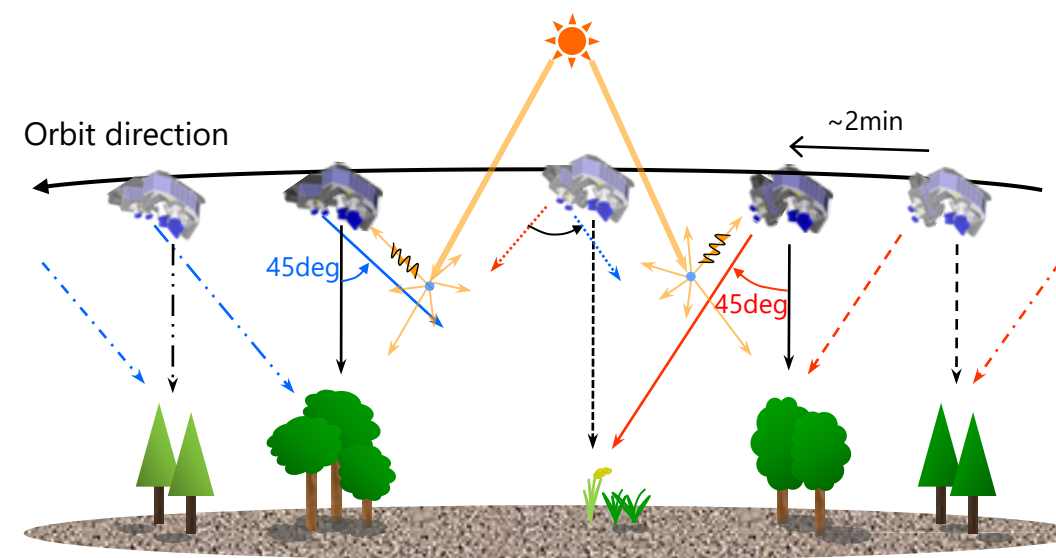


Fig.3 Operation pattern of SGLI polarimetry

Polarization observation with along-track $\pm 45^\circ$ tilt is designed to obtain the atmospheric light by scattering angle around 60° - 120° (\sim forward looking)

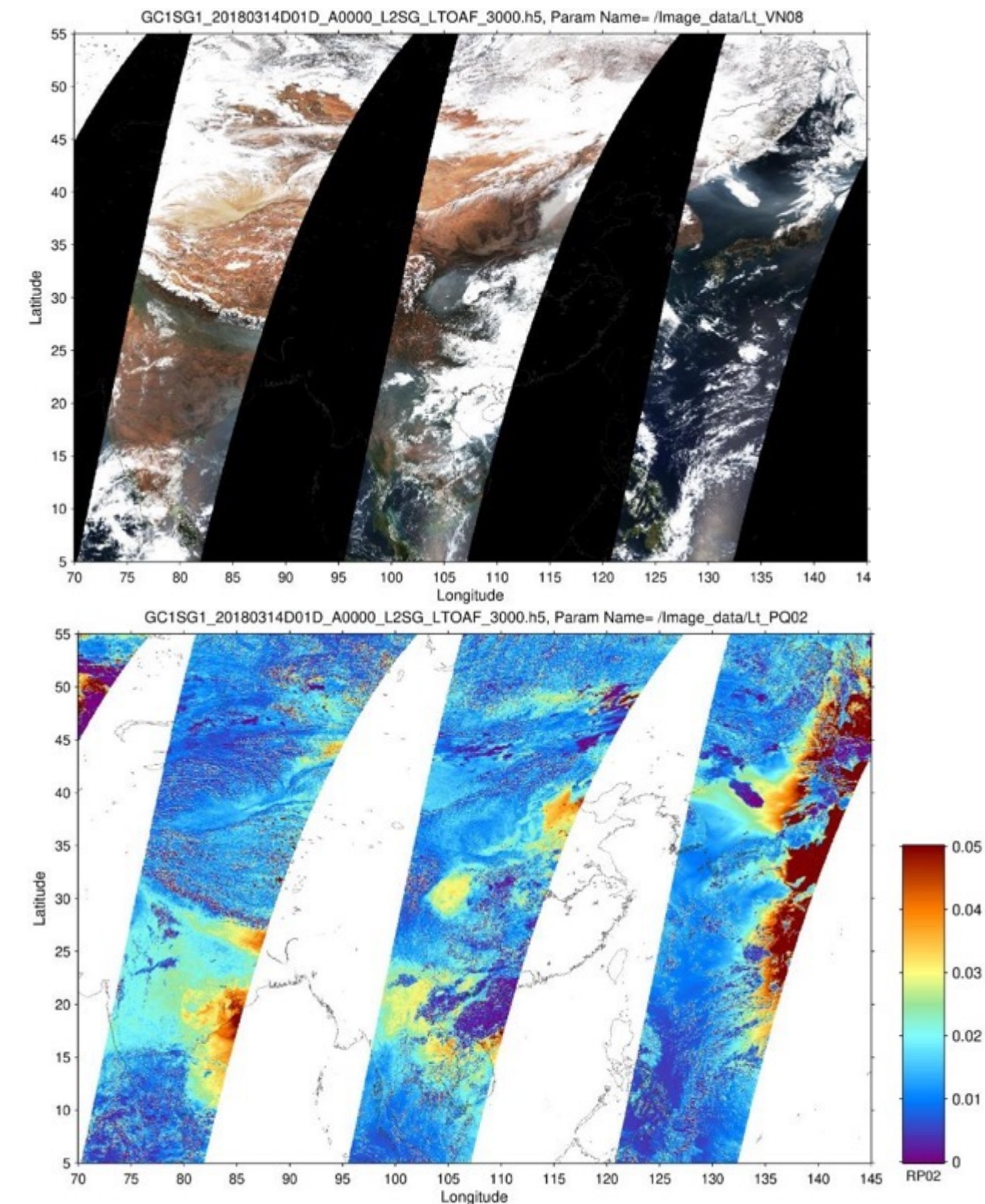
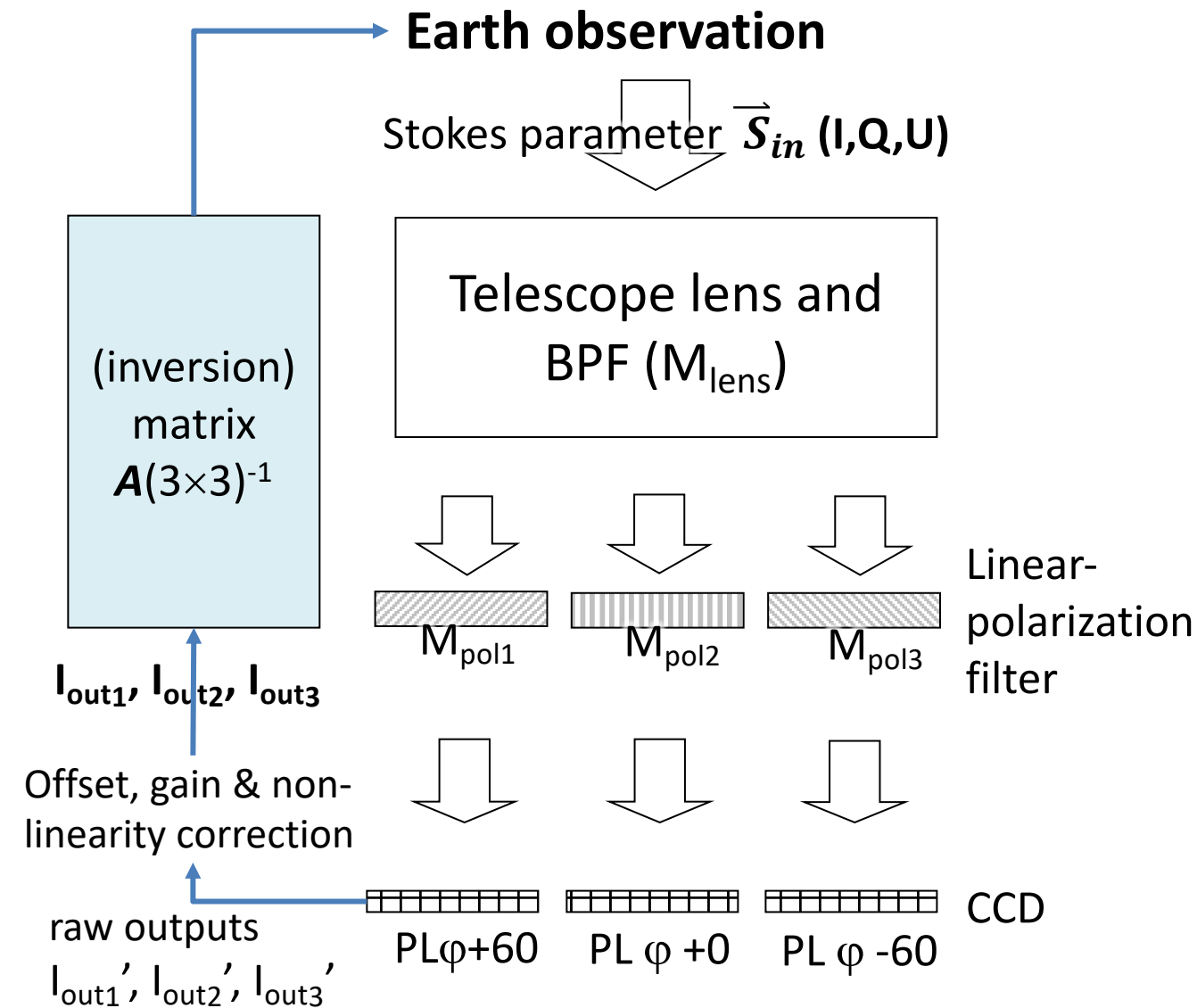


Fig.4 SGLI RGB image (the upper image) and polarization radiance at 867nm (the lower image) on 14 March 2018



$$I_{out,\phi} = (1 \quad 0 \quad 0) M_{Pol,i} M_{Lens} \vec{S}_{in}$$

$$M_{Pol,i} = (1 - a_i) \begin{pmatrix} 1 & \cos 2\phi_i & \sin 2\phi_i \\ \cos 2\phi_i & \cos^2 2\phi_i & \sin 2\phi_i \cos 2\phi_i \\ \sin 2\phi_i & \sin 2\phi_i \cos 2\phi_i & \sin^2 2\phi_i \end{pmatrix} + a_i \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix},$$

$$M_{Lens} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos 2\phi_l & \sin 2\phi_l \\ 0 & -\sin 2\phi_l & \cos 2\phi_l \end{pmatrix}$$

M_{pol} and M_{lens} are Muller matrixes of linear polarization filter and lens system respectively. M_{lens} considers only polarization angle rotation ϕ_l by the lens system.

a_i is depolarization ratio, and $\phi_i (i=1,2,3)$ are polarization angles of +60, 0, and -60.

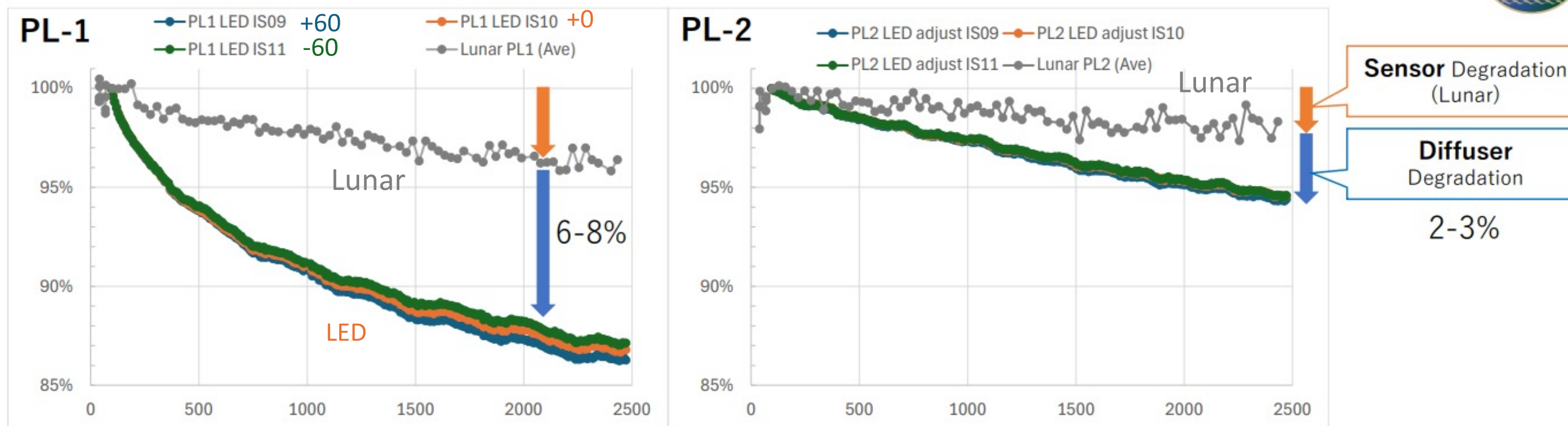
In the processing, they can be integrated as follows.

$$\vec{S}_{in} = \begin{pmatrix} I_{in} \\ Q_{in} \\ U_{in} \end{pmatrix} = A \begin{pmatrix} I_{out1} \\ I_{out2} \\ I_{out3} \end{pmatrix}^{-1}$$

$$A = \begin{pmatrix} 1 & (1 - a_{P,1}) \cos 2(\phi_l + \phi_1) & (1 - a_{P,1}) \sin 2(\phi_l + \phi_1) \\ 1 & (1 - a_{P,2}) \cos 2(\phi_l + \phi_2) & (1 - a_{P,1}) \sin 2(\phi_l + \phi_2) \\ 1 & (1 - a_{P,3}) \cos 2(\phi_l + \phi_3) & (1 - a_{P,1}) \sin 2(\phi_l + \phi_3) \end{pmatrix}^{-1}$$

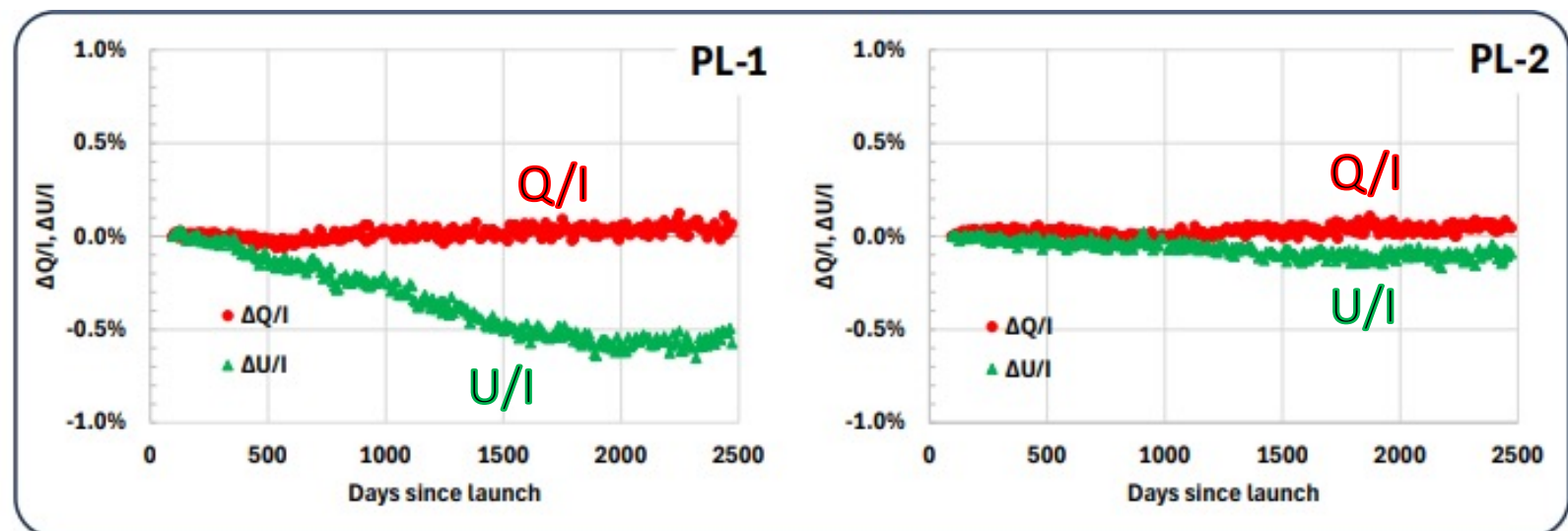
- Polarization sensitivity has characterized by Muller matrix (M_{pol} and M_{lens}) in the pre-launch tests (The circle polarization is eliminated here)
- The process was simplified according the pre-launch tests and error analysis

Temporal On-orbit performance check with LED cal.



- ⇒ Almost same temporal change is observed for 3 sensor output which are bigger than Lunar calibration temporal change.
- ⇒ Lunar calibration temporal change are observed for both Non-Polarized (NP) and Polarized (PL) observation.
- ⇒ Difference between Lunar and LED calibration can be explained by **diffuser degradation** **because of unexpected UV exposure to diffuser panel.**

Observed polarization of onboard diffuser illuminated by LED lamp

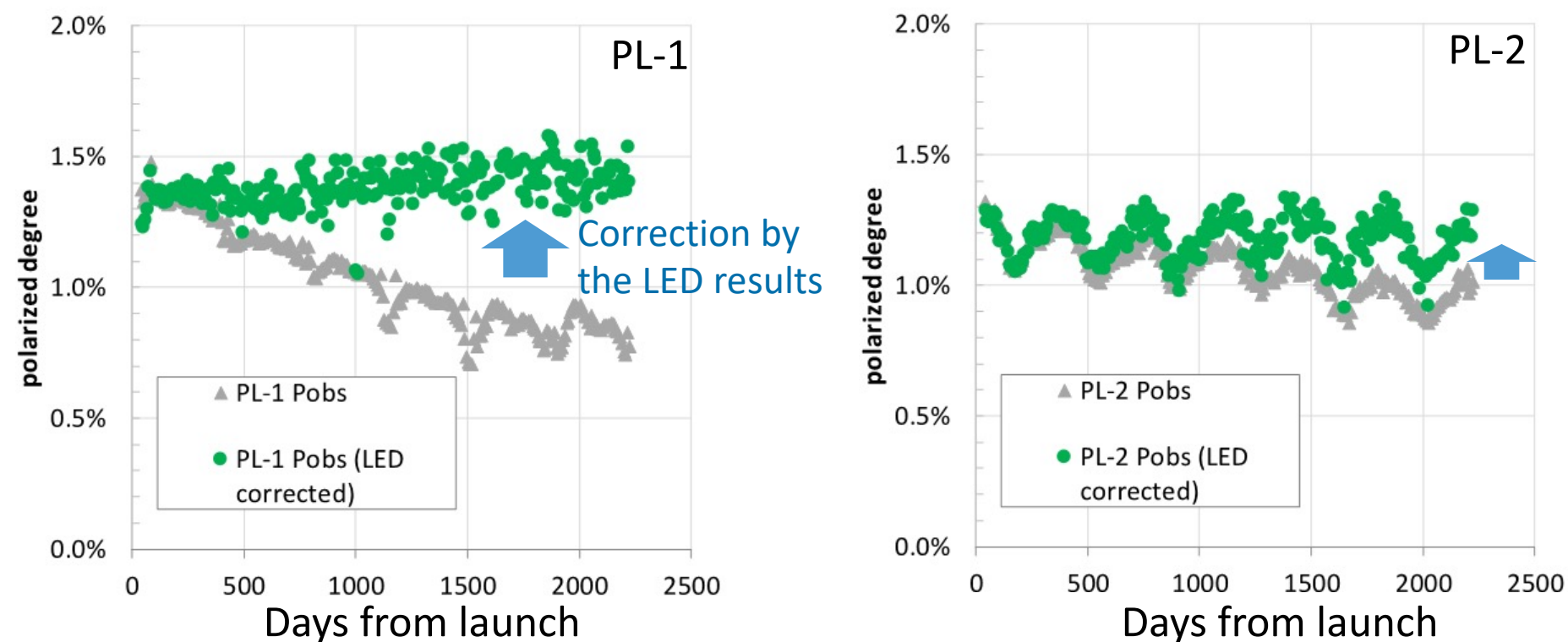


b. Q/I and U/I monitoring

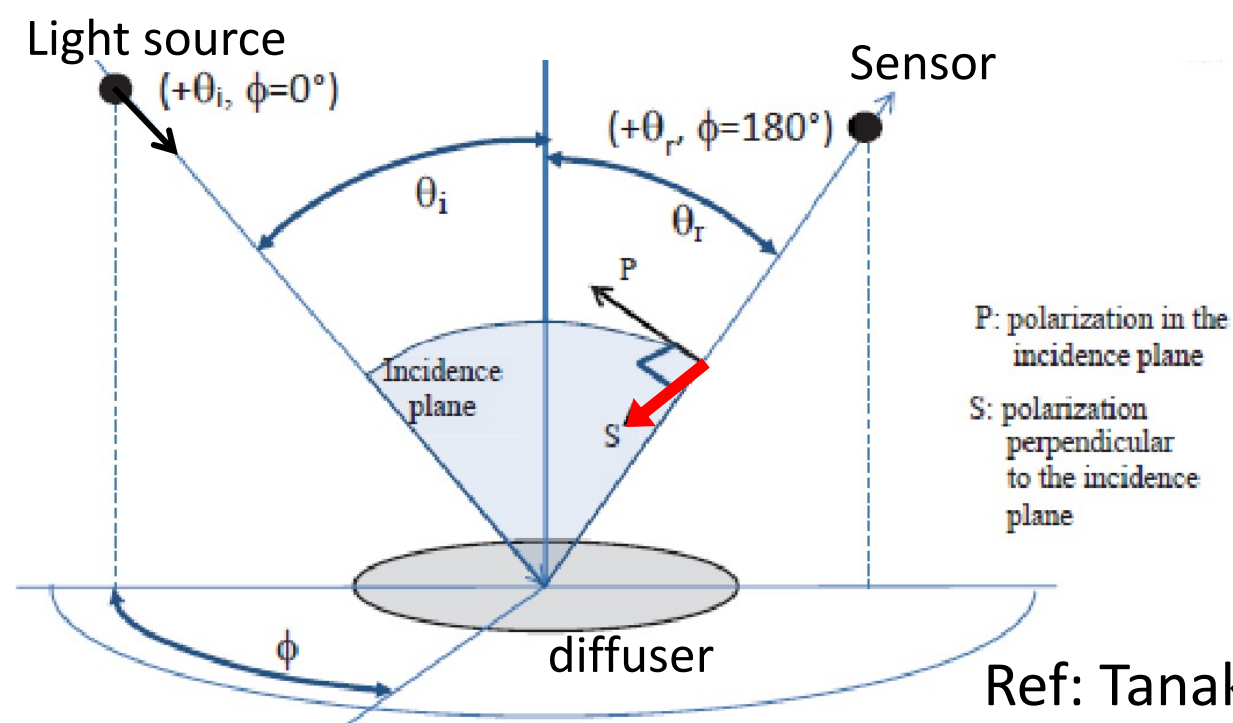
→ Only U/I degradation in PL-1 is observed.

→ Diffuser degradation?

Polarization degrees of onboard diffuser in the solar calibration



- Direction of diffuser polarization agrees with an assumption that scattering light from diffuser was **S-direction** polarized.
 - Deviation of polarization in solar cal can be decreased to $\sim 0.2\%$ after the diffuser correction using LED results.
- Changes of U/I is due to change of diffuser S-polarization?

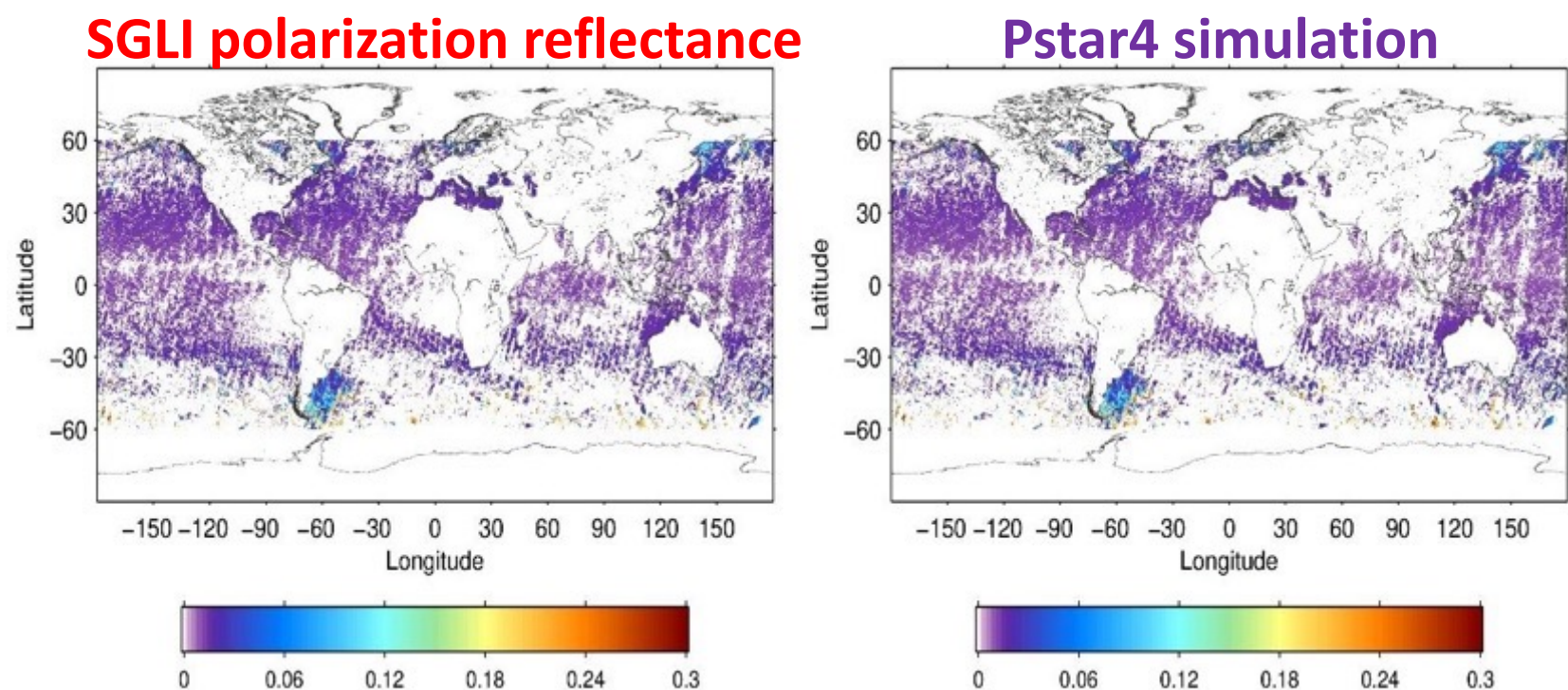


Ref: Tanaka, K., 2024, Over 6 years observation of GCOM-C/SGLI sensor (APOLO-2024, November 18, 2024)

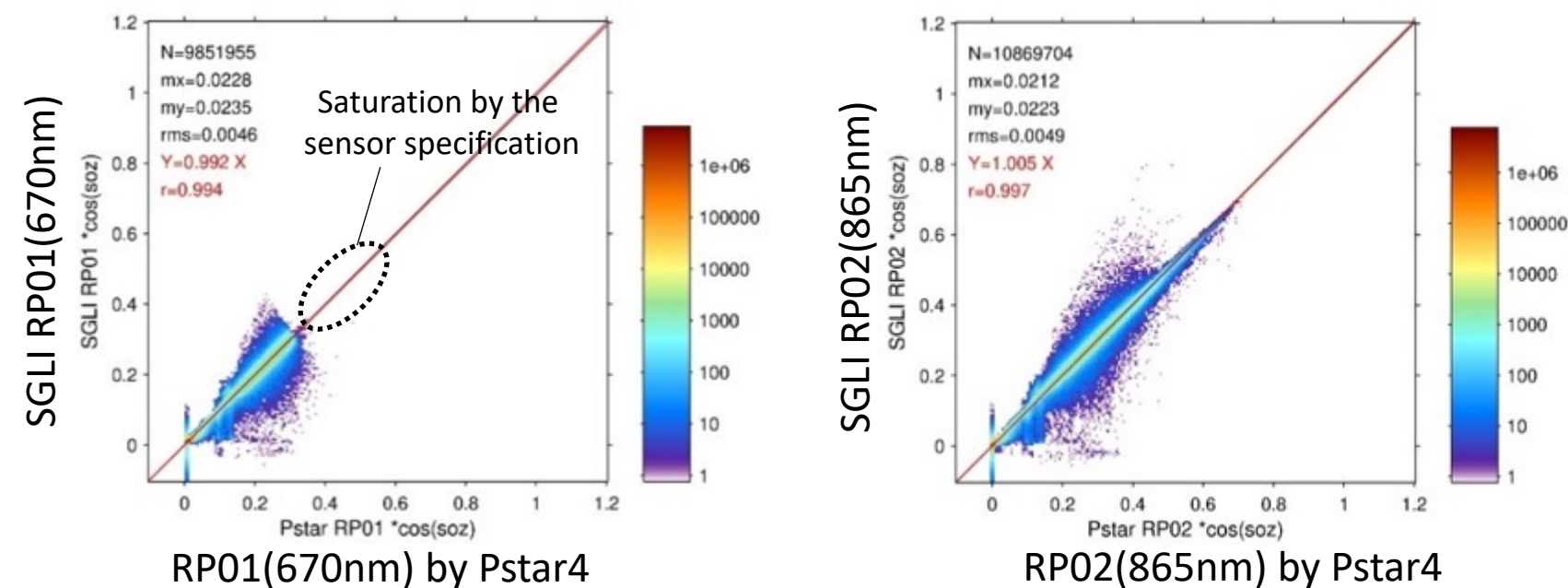
https://suzaku.eorc.jaxa.jp/GCOM_C/resources/files/SGLI_Polarization_20241118.pdf

- **SGLI polarimetry with 45-deg slant-view** at 670nm and 865nm (P01 and P02) is evaluated by the polarization reflectance simulated by the radiative transfer code (Pstar4*) using **SGLI non-polarization nadir-view observation**
- Method:
 1. **Aerosol properties** (AOT and aerosol-types) are estimated **by the non-polarization nadir-view** at 670nm and 865nm
 2. **Sunlint reflectance** at the slant-view is estimated from **I component by polarimetry** and the **aerosol properties**
 3. **TOA polarization reflectance** are simulated by **Pstar4*** using the **sunlint reflectance** and the **aerosol properties** in areas of $AOT < 0.1$

* Ota Y, Higurashi A, Nakajima T, Yokota T (2010) Matrix formulations of radiative transfer including the polarization effect in a coupled atmosphere-ocean system. J Quant Spectrosc Radiat Transfer 111:878–894. <https://doi.org/10.1016/j.jqsrt.2009.11.021>.



Examples of SGLI and Pstar4 polarization reflectance at 670nm in Sep. 2022



Examples of comparison between SGLI and Pstar4 polarization reflectance in Sep. 2022

✓ **Global averages of SGLI/Pstar4 ratios from Apr. 2018 to Aug. 2024 (68 times): 670nm: 1.005 (RMSD=0.007), 865nm: 1.015 (RMSD=0.008)**



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Thank you!

Questions and Answers