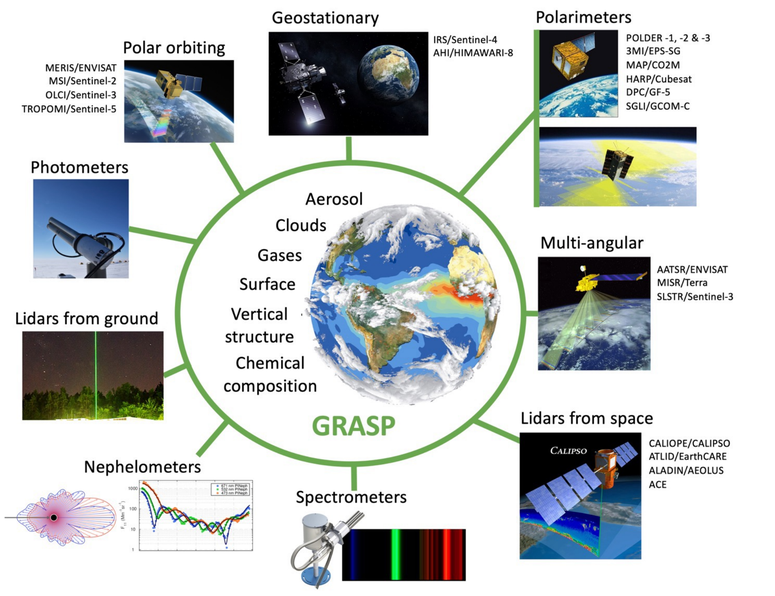
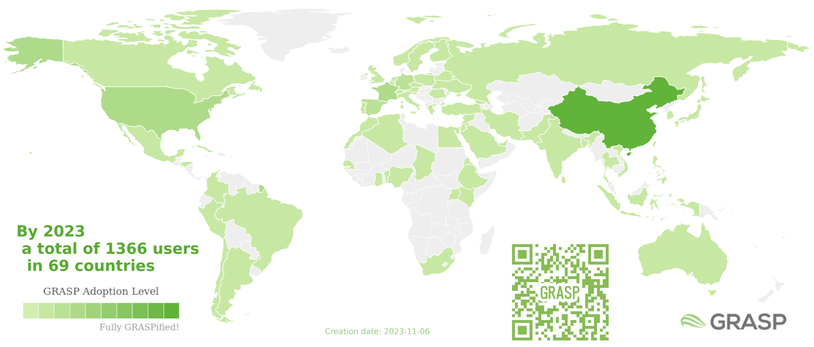
Recent updates of the generalized retrieval code "GRASP" and potential use in EarthCARE mission

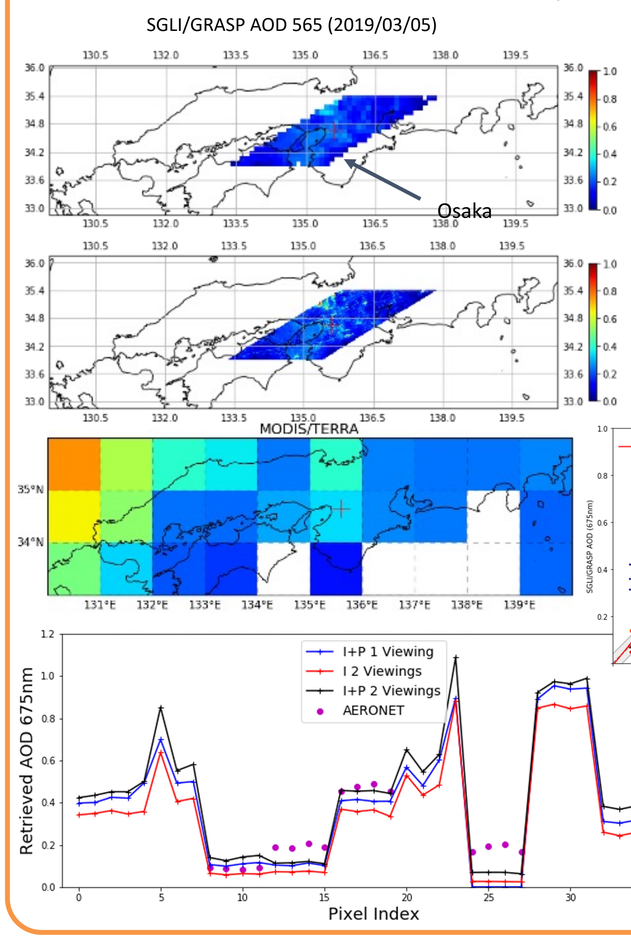
Masahiro Momoi, Oleg Dubovik, Milagros Herrera, Cheng Chen,
Anton Lopatin, Pavel Litvinov, Tatyana Lapyonok, Monica Campanelli, Kazuma Aoki, Teruyuki Nakajima





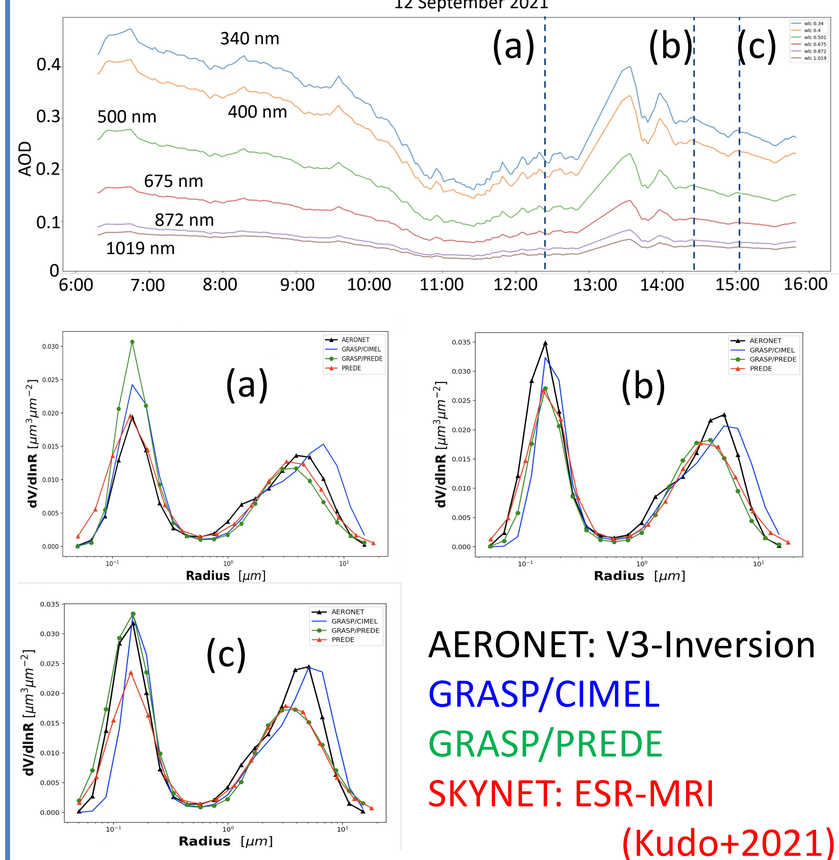
GRASP to JAXA satellite (GCOM-C/SGLI)

Collaborated with Dr. Itaru Sano, Sonoyo Mukai



New use of GRASP to Prede sky-radiometer

First try with sky-radiometer at Rome



AERONET: V3-Inversion
GRASP/CIMEL
GRASP/PREDE
SKYNET: ESR-MRI (Kudo+2021)

Recent main updates of GRASP RTM

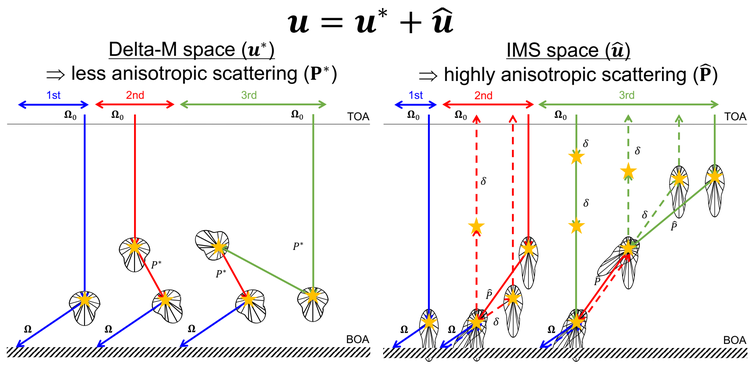
1. Truncation corrections

P^{n}IMS corrections (Momoi+2022ab)

=> from OpenCLASTR RTMs used in EarthCARE mission

- P^{n}IMS method is based on delta-M method and treats 2 orthogonal photon ray tracing spaces (delta-M and IMS spaces) (Momoi+2022b)

$$\boldsymbol{u} = \boldsymbol{u}^* + \hat{\boldsymbol{u}}$$



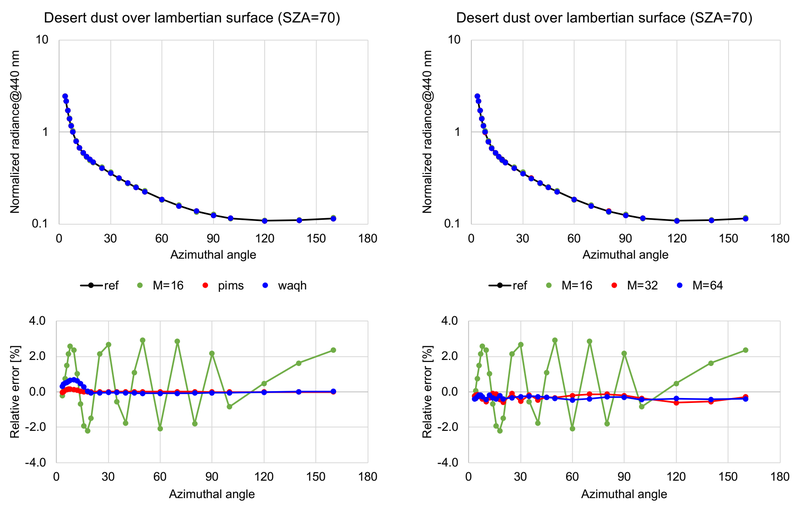
- The successive order scattering formulas of IMS space ($\hat{\boldsymbol{u}} = \hat{\boldsymbol{u}}_1 + \hat{\boldsymbol{u}}_2 + \hat{\boldsymbol{u}}_3 + \cdots$)

$\hat{u}_1 = \hat{\omega}\ \hat{\mathbf{P}}\ \mathbf{F}_{sol} h_1(\tau, \mu^*, \mu_0^*)$: P^1-IMS/TMS

$\hat{u}_2 = (1 - f\omega)\ \hat{\omega}^2[\hat{\mathbf{P}}^2 - 2\hat{\mathbf{P}}]\ \mathbf{F}_{sol} h_2(\tau, \mu, \mu_0^*, \mu_0^*)$: P^2-IMS/IMS

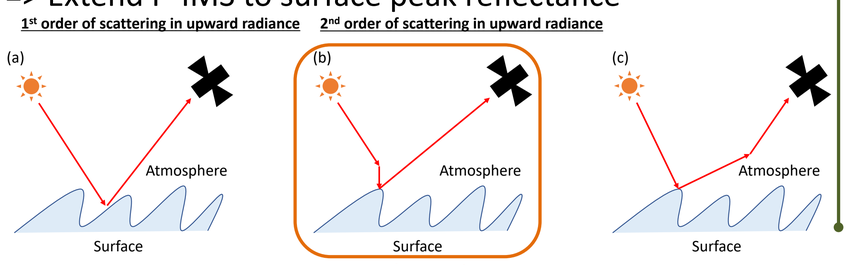
$\hat{u}_{n\geq 3} = (1 - f\omega)^{n-1}\hat{\omega}^n[\hat{\mathbf{P}}^n - 2\hat{\mathbf{P}}^{n-1} + \hat{\mathbf{P}}^{n-2}]\mathbf{F}_{sol} h_n(\tau, \mu, \ldots)$: P^n-IMS

⇒ TMS/IMS is proposed by Nakajima&Tanaka1988 under un-polarized approx



Sun (sky)-glint correction over ocean

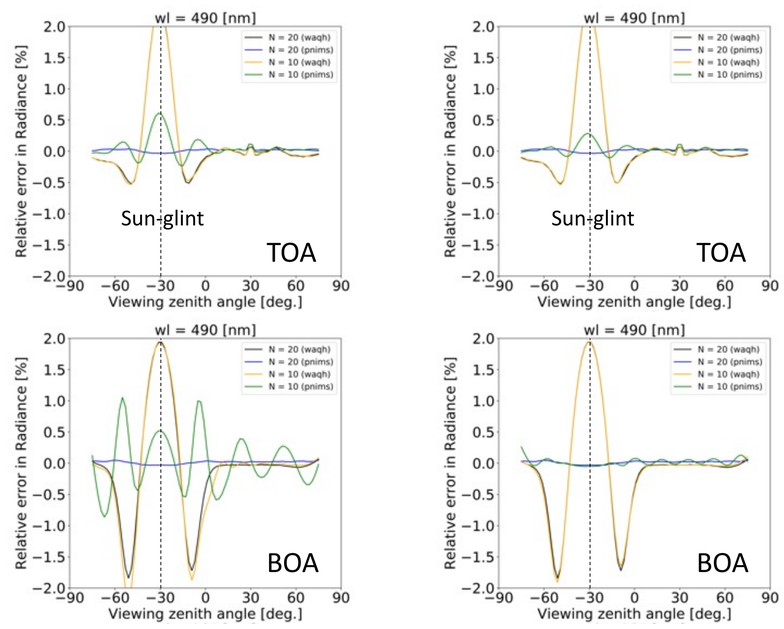
=> Extend P^{n}IMS to surface peak reflectance



2. Retrieval over ocean incl. sun-glint direction

Performance of sun-grint truncation correction

P^{n}IMS w/o sun-glint correction | P^{n}IMS w/ sun-glint correction

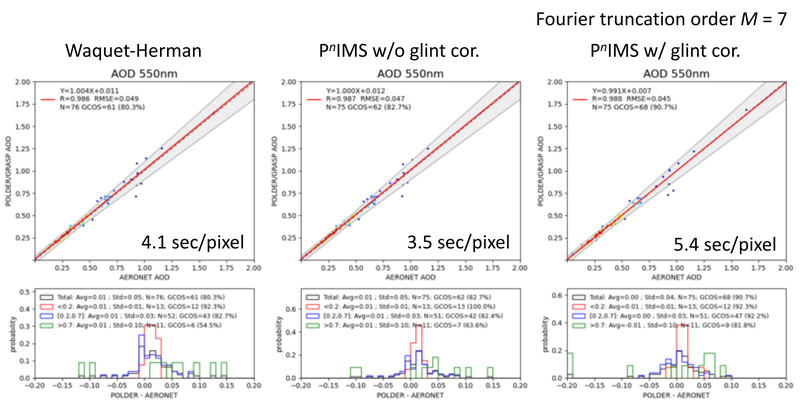


Waquet-Herman P^{n}IMS-method

Retrieval examples with POLDER observation over ocean

Abu_Al_Bukhoosh (2008)

Fourier truncation order M = 7



"P^{n}IMS w/ glint cor." improved R, RMSE, N. of GCOS criteria.

Computational time:

P^{n}IMS w/o glint < WaqH < P^{n}IMS w/ glint << High precision (*i.e.*, M=20 w/ TMS)

3. Potential study of aerosol & cloud retrieval

Performance of GRASP under cloud atmosphers

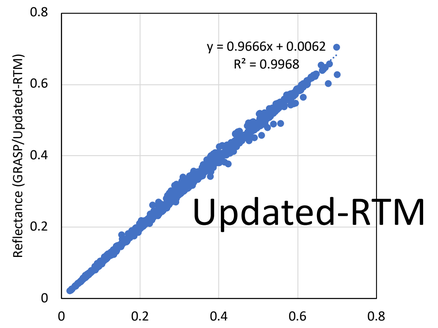
Reflectance (TOA; black surface) [vs OpenCLASTR/RPstar]

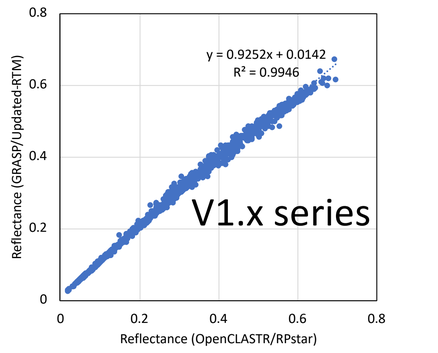
Gamma distribution
- Reff = 8.85 um
- Veff = 0.10
- COT: up to 20
- WL: 0.56 um

Geometry
- SZA: [0, 70]
- VZA: [0, 70]
- Azimuth: [0, 180]

OpenCLASTR/RPstar
- DO-MO method
- nda: 6 w/ TMS

GRASP RTM
- SOS method
- M (2*nda): 12 w/ TMS



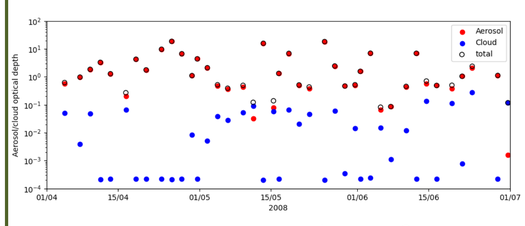


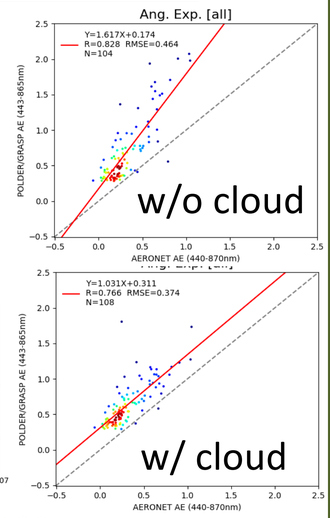
Preliminary examples of aerosol & cloud retrieval

POLDER obs. (Banizoumbou, 2008)

Performance of AE was improved by aerosol & cloud retrieval

AE: Angstrom exponent





4. Computational performance

Updated-RTM (V2.0.0) will be up to 2 times faster than current V1.1 series!

e.g., Chemical component approach with POLDER obs. [sec./pixel/iteration]
- Version 1.1.4: 0.555 (public ver.)
- Version 1.1.5: 0.531 (coming this year)
- Updated-RTM: **0.313** (V2.0.0; will come next year)

ORCID

Momoi+22a

Momoi+22b