PROGRAMME OF THE EUROPEAN UNION

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EUMETSAT

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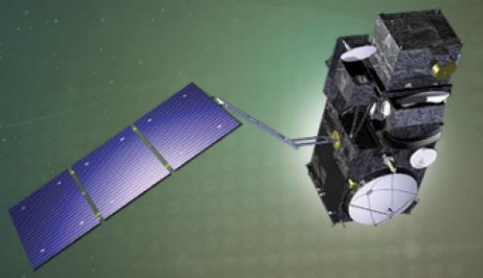


7th Sentinel-3 Validation Team Meeting 2022

18-20 October 2022 | ESA-ESRIN | Frascati (Rm), Italy

Revisiting S3/OLCI Ocean Colour Standard Atmospheric Correction: the EUMETSAT OC-SAC study

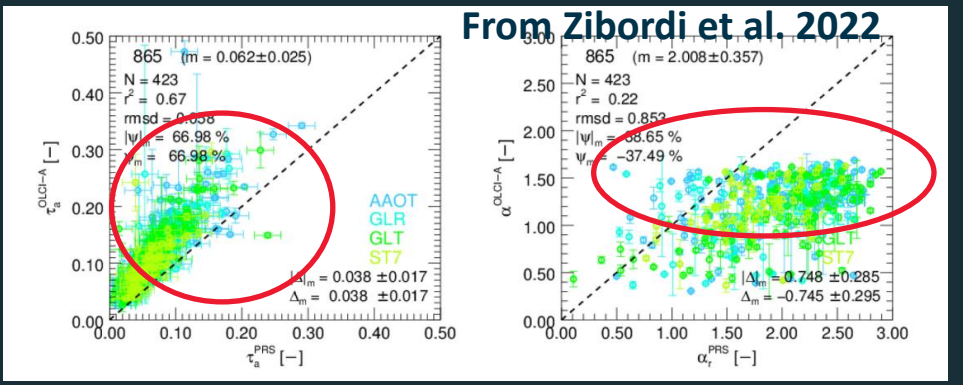
C. Mazeran[1], M. Compiègne[2], M. Moulana[2], D. Ramon[2], F. Steinmetz[2], R. Frouin[3], D. Dessailly[4], J. I. Gossn[4], E. Kwiatkowska[4]

[1]SOLVO, [2]HYGEOS, [3]Scripps Institution of Oceanography, [4]EUMETSAT

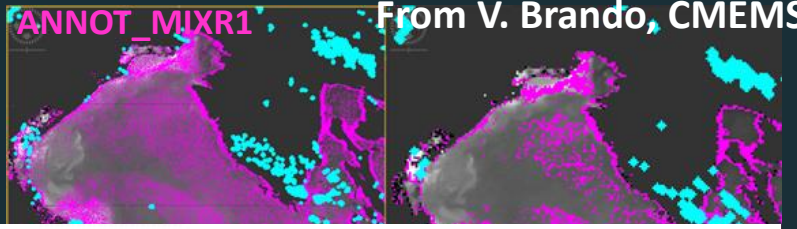
CONTEXT & OBJECTIVES OF EUMETSAT OC-SAC STUDY

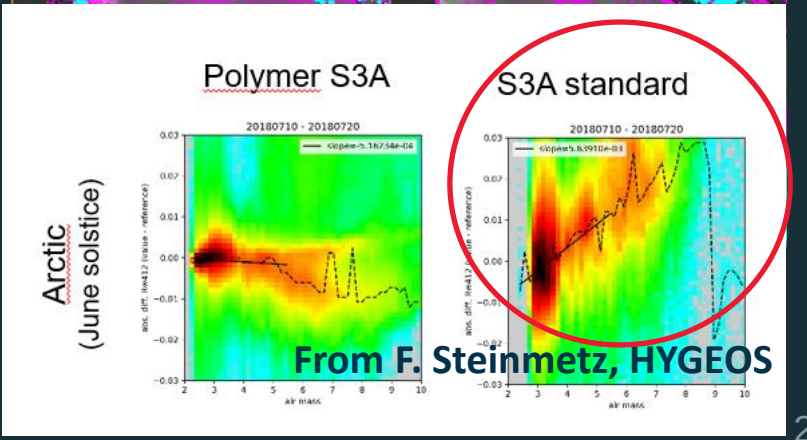
- Various weaknesses of current OLCI AC (Collection 3): erroneous AOT & Angstrom (e.g. Zibordi et al, 2022), spatial noise (uncertainty amplification, aerosol discontinuity), air mass dependence, many flagged data (negative reflectance, failure for absorbing aerosols, sensitivity to perturbations)

From Zibordi et al. 2022



From V. Brando, CMEMS





From F. Steinmetz, HYGEOS

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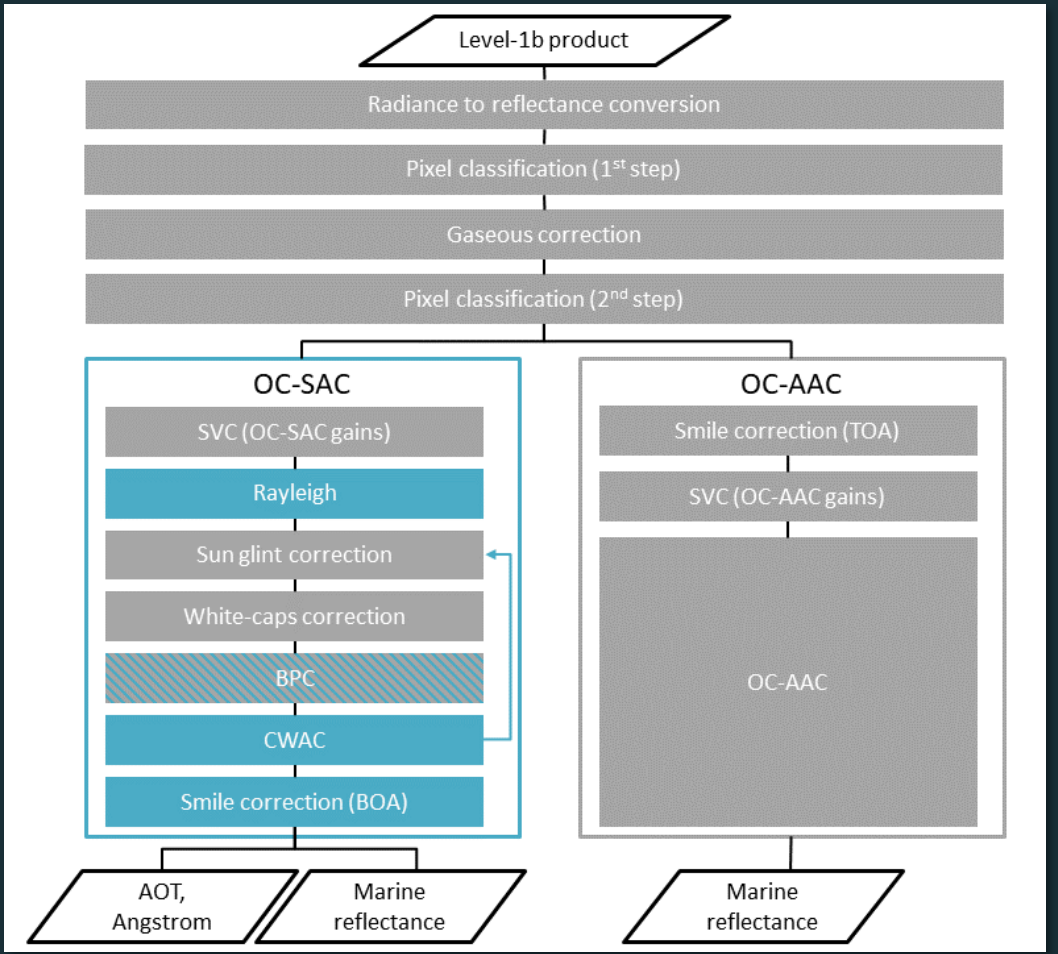

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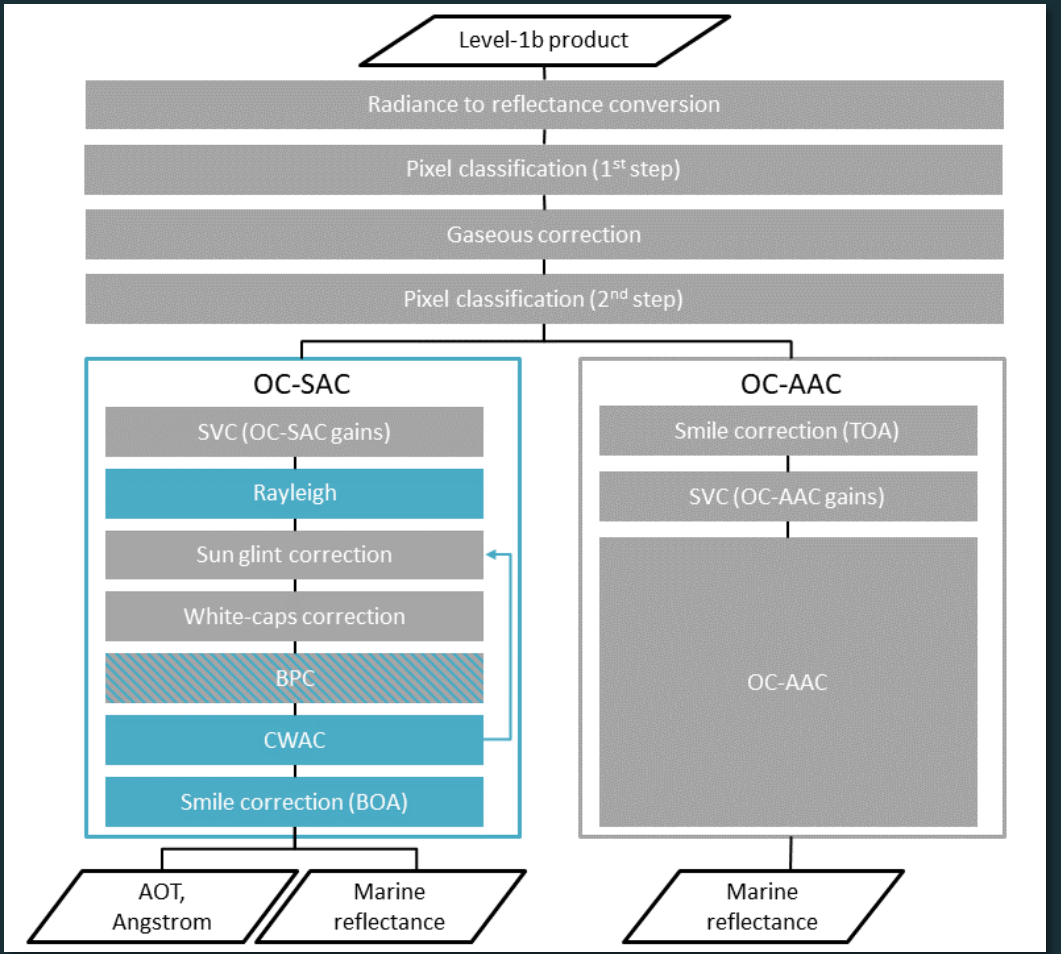

CONTEXT & OBJECTIVES OF EUMETSAT OC-SAC STUDY

Study funded by EUMETSAT contract EUM/CO/21/4600002533/DD

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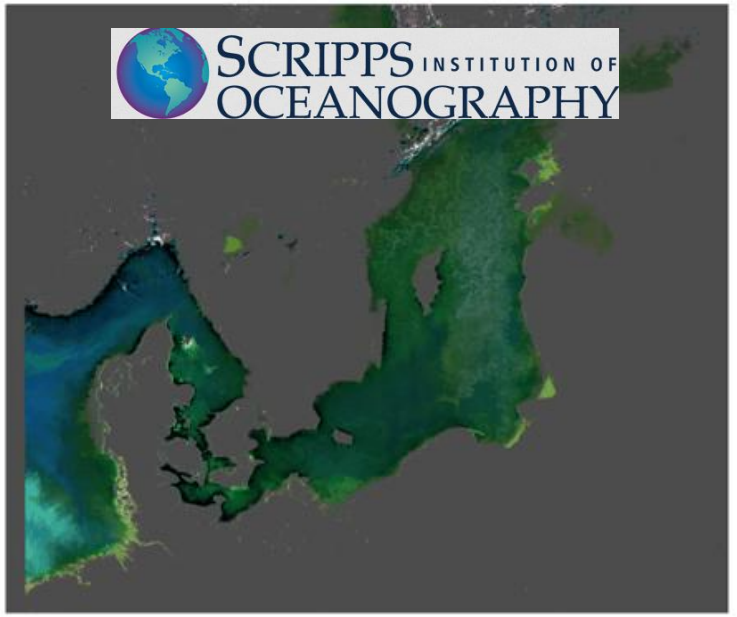

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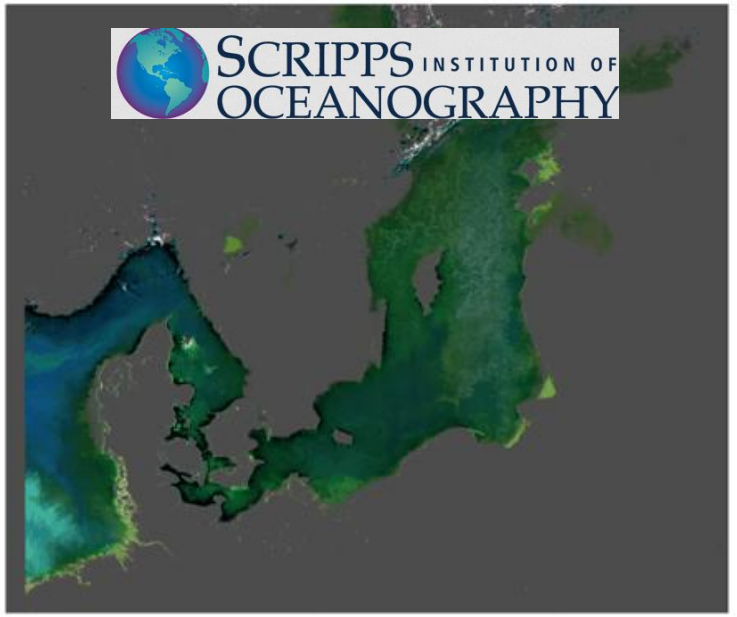
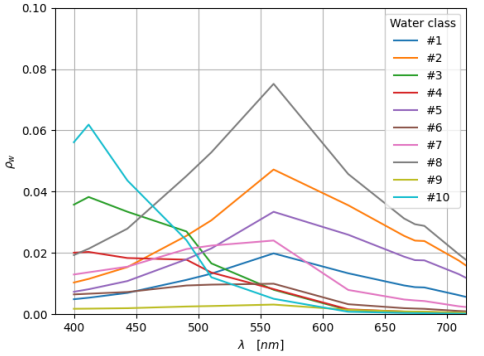


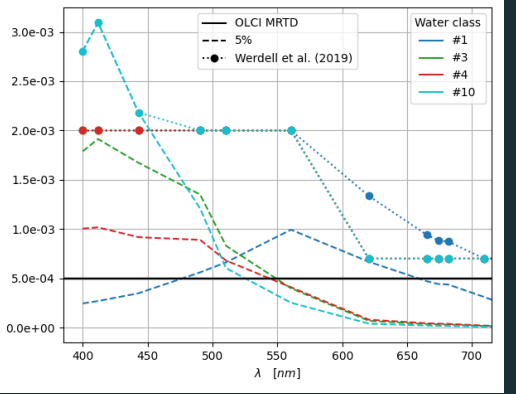
Overall achievements

- Justified requirements for $\rho_a(\lambda)$: 2x10^{-4} (very conservative)

Different water types

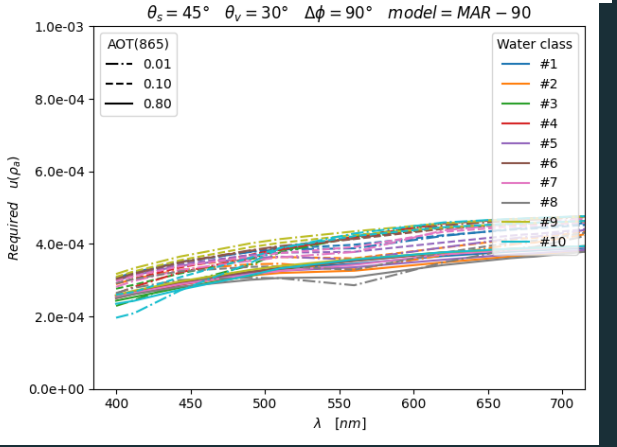


Required uncertainty on ρ_w



$$\left(\frac{u(\rho_w)}{\rho_w}\right)^2 \approx \left(\frac{u(\rho_{gc})}{\rho_{gc}}\right)^2 \left(\frac{\rho_{gc}}{t\rho_w}\right)^2 + \left(\frac{u(\rho_{path})}{\rho_{path}}\right)^2 \left(\frac{\rho_{path}}{t\rho_w}\right)^2 + \left(\frac{u(t)}{t}\right)^2 - 2\frac{u(\rho_{path},t)}{t\rho_{path}}\frac{\rho_{path}}{t\rho_w} + 2\frac{u(\rho_{gc},\rho_{path})}{\rho_{gc}\rho_{path}}\frac{\rho_{gc}}{t\rho_w}\frac{\rho_{path}}{t\rho_w} - 2\frac{u(\rho_{gc},t)}{t\rho_{gc}}\frac{\rho_{gc}}{t\rho_w}$$

Required absolute uncertainty on ρ_a to get an uncertainty of 5.10^{-4} on ρ_w.



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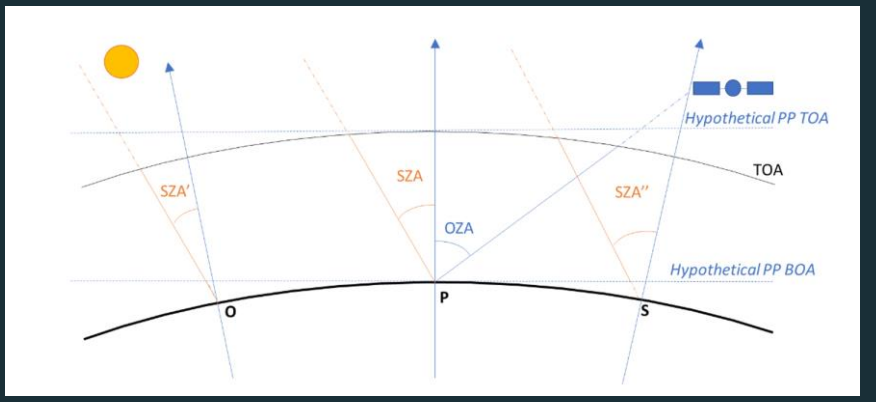
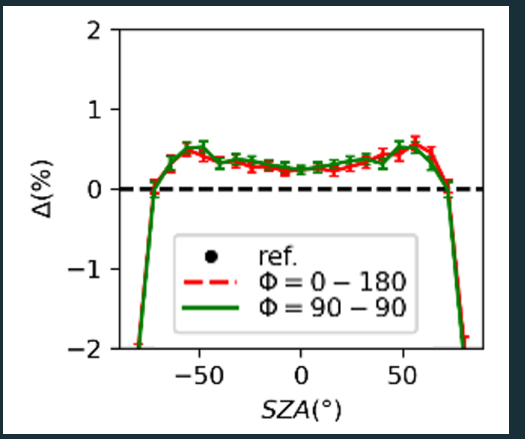


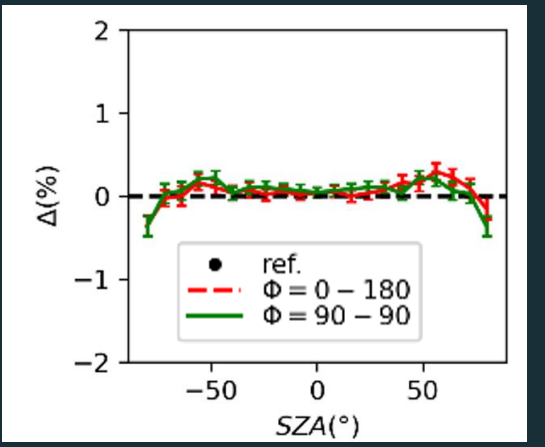
$\Delta\rho_{path}(412)$

PPA assumption



Hybrid approach

$\rho_{path}^{SSA} \approx \rho_r^{SSA} + \rho_{path}^{PPA} - \rho_r^{PPA}$



maritime polluted aerosols, *AOT(550)=0.2, VZA=0°*

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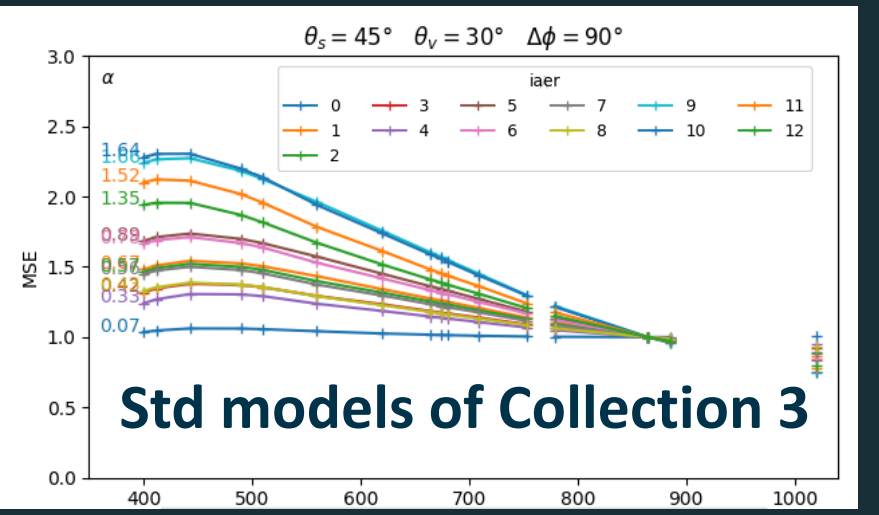

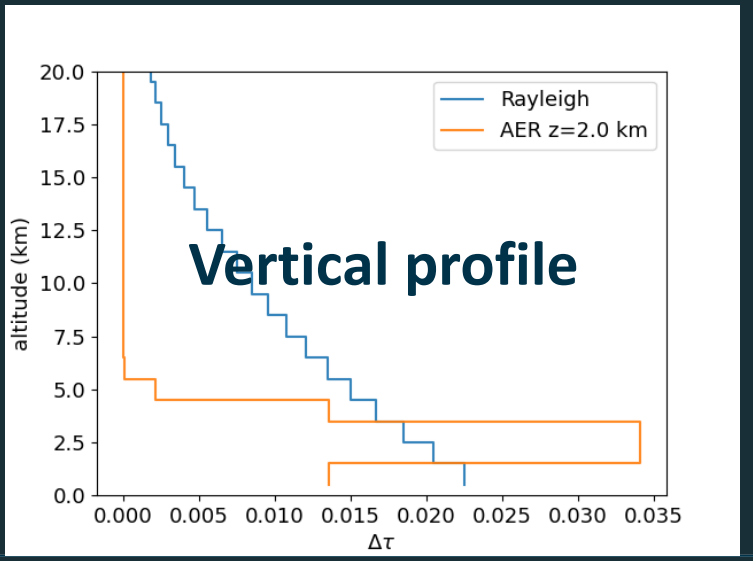

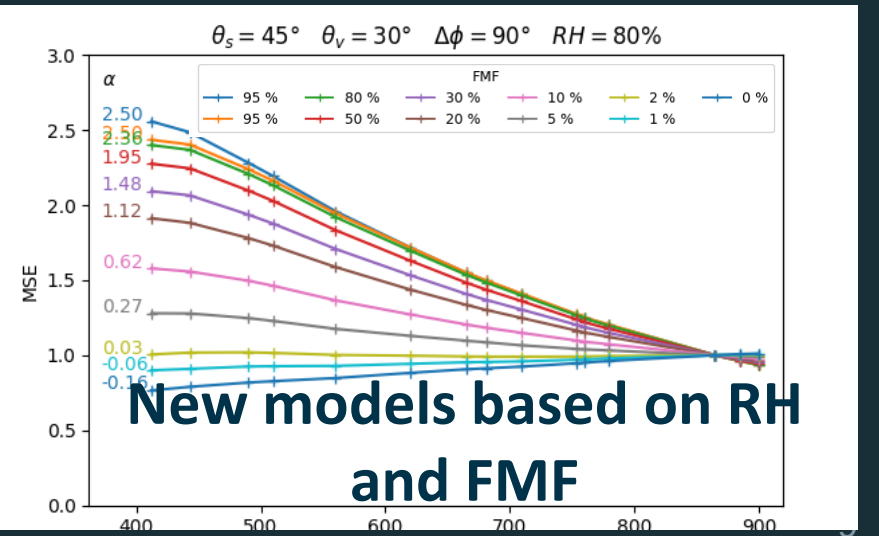

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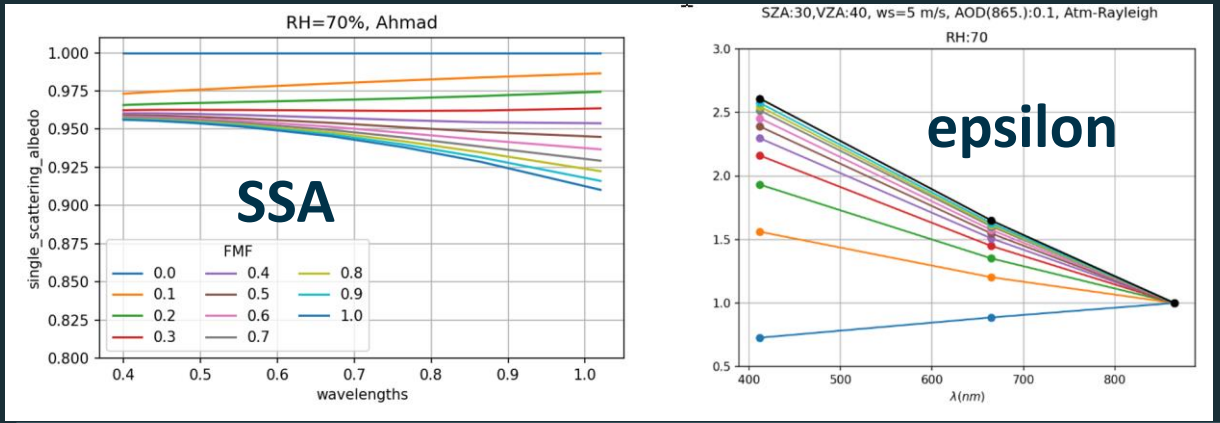
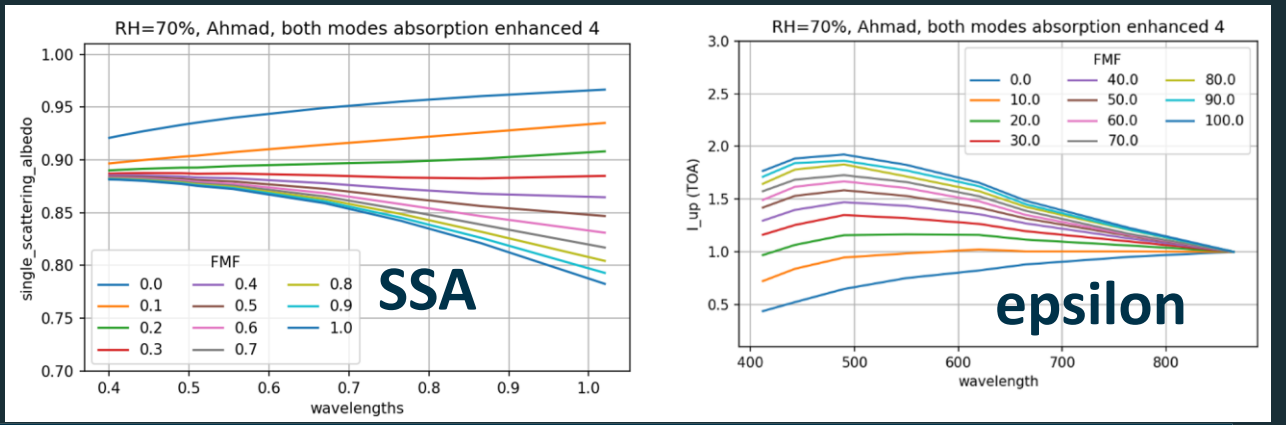
Family	Mode	Component #1	Component #2
Standard Ahmad et al. (2010)	Fine mode	99.5% dust like	0.5% soot
	Coarse mode	100% sea salt	
OC-SAC strongly absorbing models	**Fine mode**	**95% dust like**	**5% soot**
	Coarse mode	**60% sea salt**	**40% dust like**

Std Ahmad et al.



OC-SAC strongly absorbing *(to be further tuned)*



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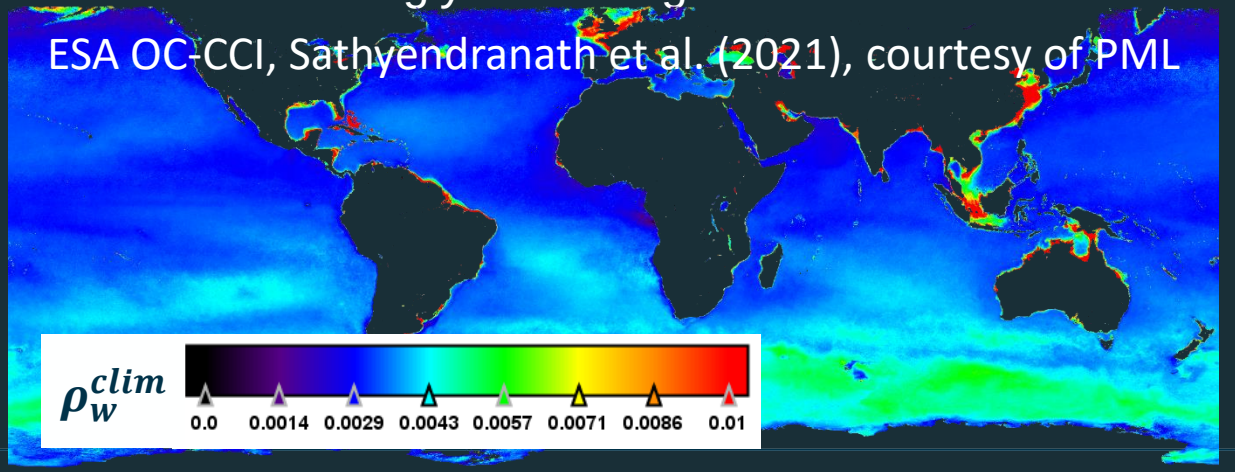
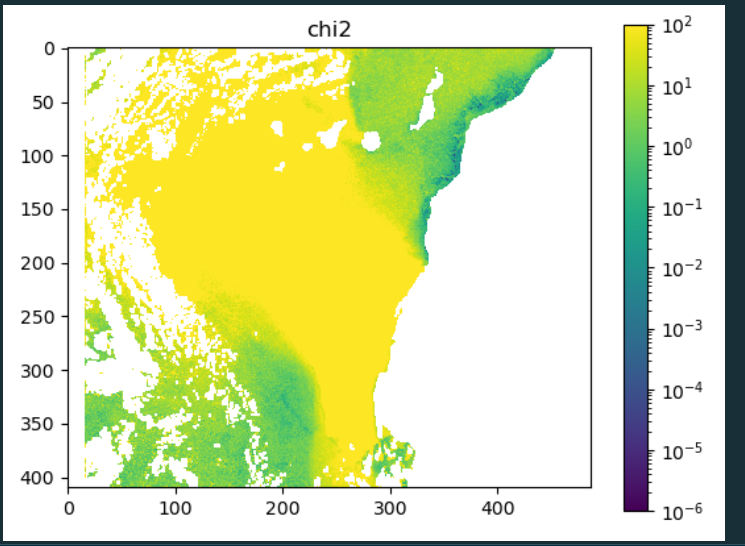
- New detection of strongly absorbing aerosols

Extension of Nobileau & Antoine (2005) at 510 nm:

- More bands
- Updated climatology

$$\chi^2_{clim} = \frac{1}{N_{clim}} \sum_{\lambda} \left(\frac{\rho_w(\lambda) - \rho_w^{clim}(\lambda)}{3 * \sigma^{clim}} \right)^2 > \chi^2_{clim\_thresh}$$





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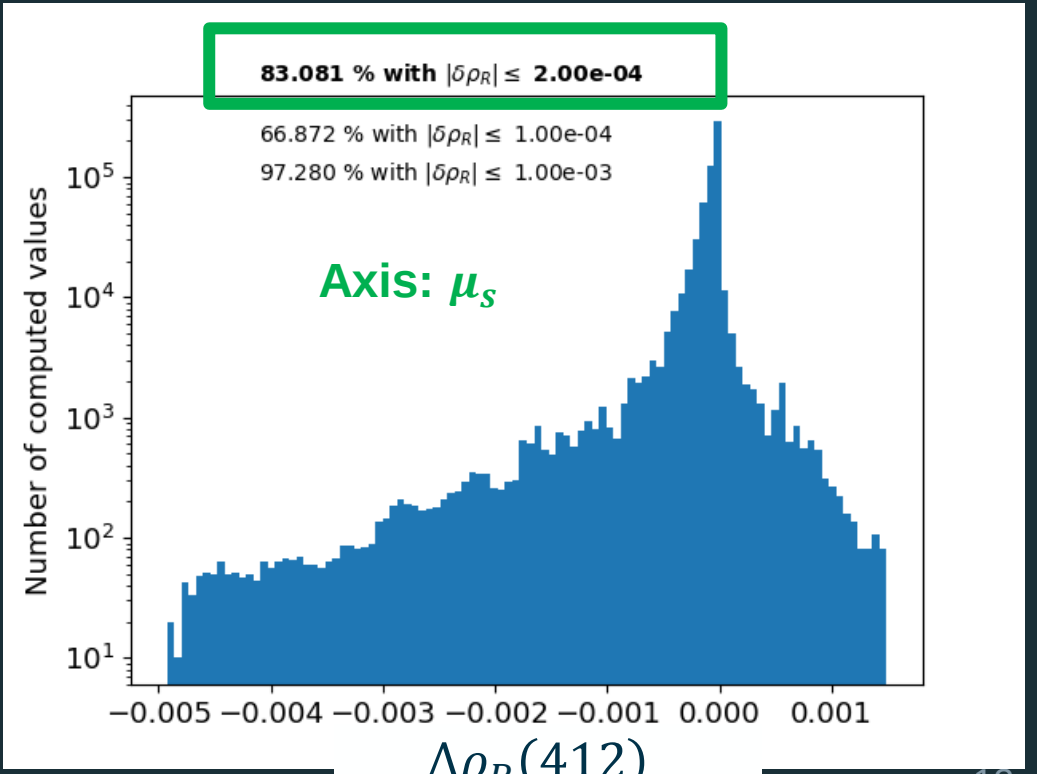
- Innovative optimization of LUT grid based on uncertainty target

Optimized grid and functional fitting thanks to very high resolution simulations, for each LUT axis successively



solvo HYGEOS

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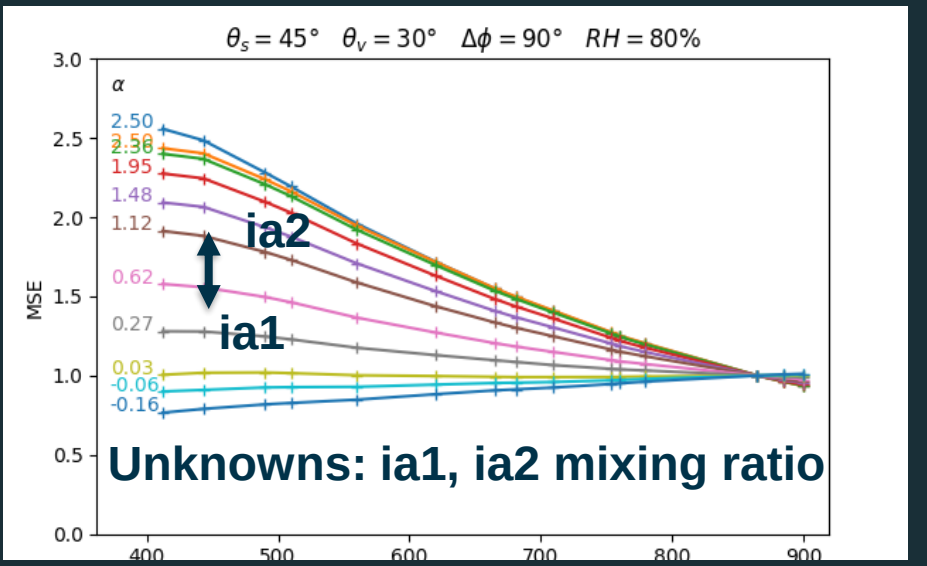

Use 5 NIR bands (possibly 6) with spectral fitting instead of the 779-865 nm standard detection

Loop over all $iaer$ (FMF) to compute optimal τ_{a0}, mix :

$$\chi^2_{iaer}(\tau_{a0}, mix) = \sum_{\lambda} \frac{\left(\rho^{mod}_{path}(\lambda, iaer, \tau_{a0}, mix) - \rho^{obs}_{path}(\lambda)\right)^2}{\sigma^2(\lambda)}$$

Select best $iaer$ with lowest χ^2_{iaer}

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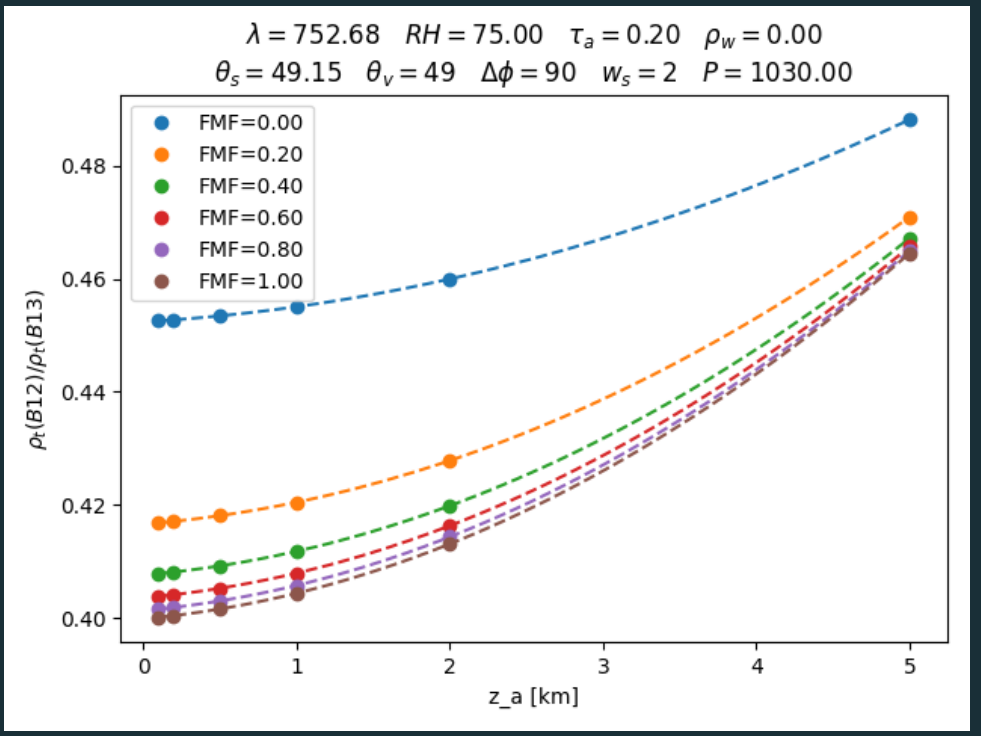
Follows the principle of Dubuisson et al. (2009)



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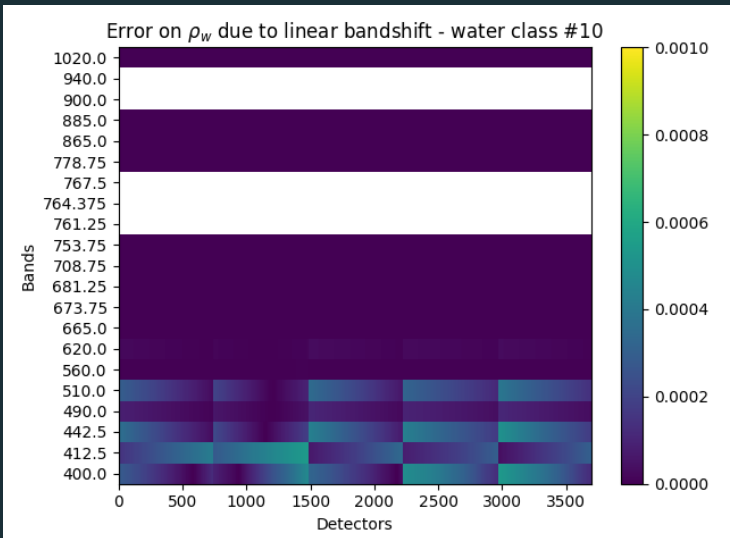
- New Aerosol Layer Height Assessment (ALH) module
- AC handled at exact detector wavelength→ BOA smile corr.

Error on ρ_w with current TOA smile corr.

Error on ρ_w with simple BOA smile corr. *(ideally requires band-shift)*



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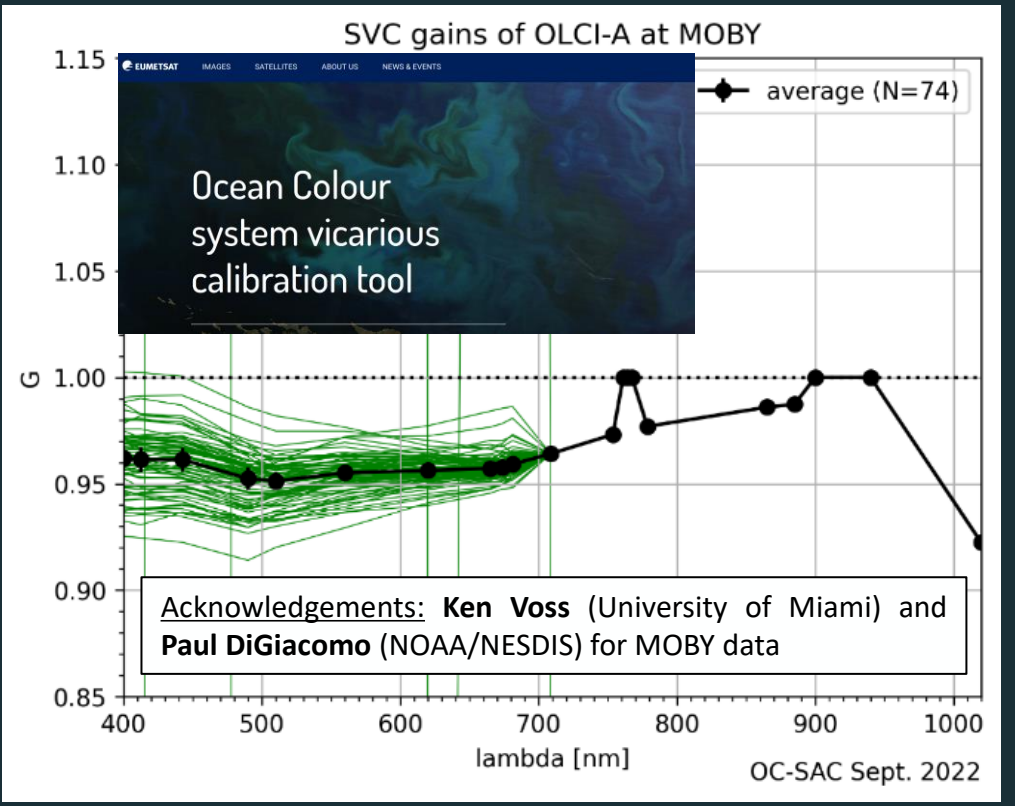
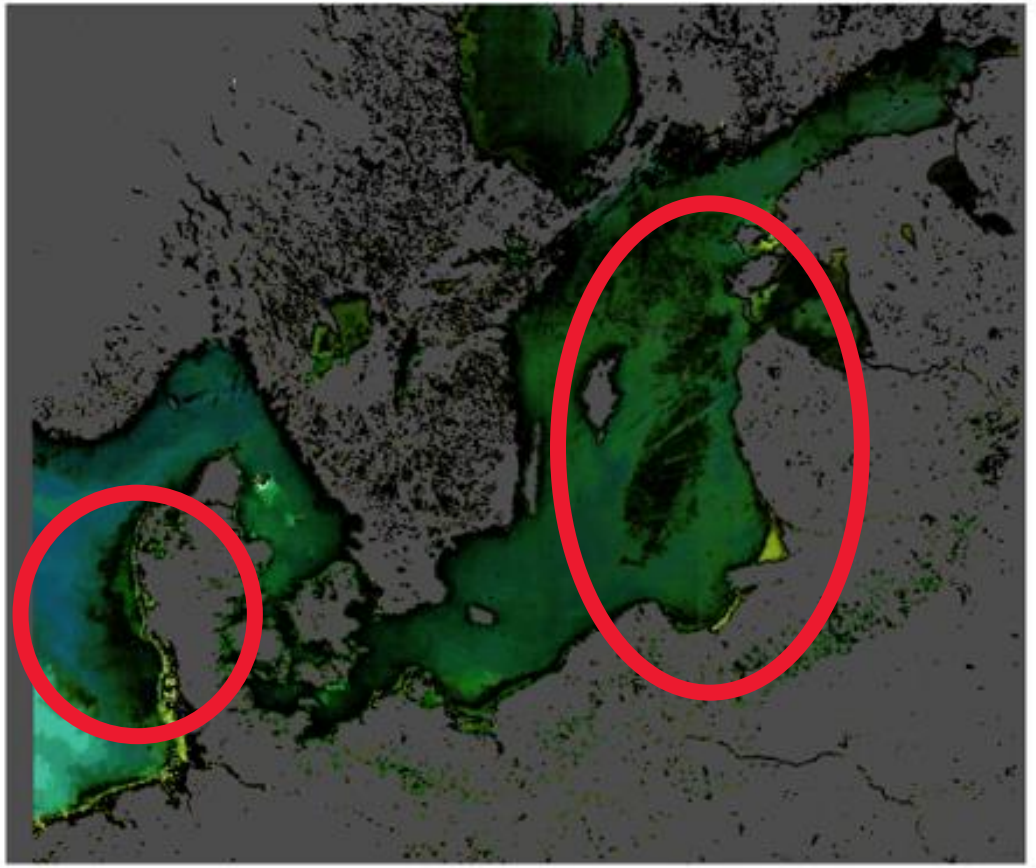
- AC handled at exact detector wavelength→ BOA smile corr.
- Dedicated SVC gains



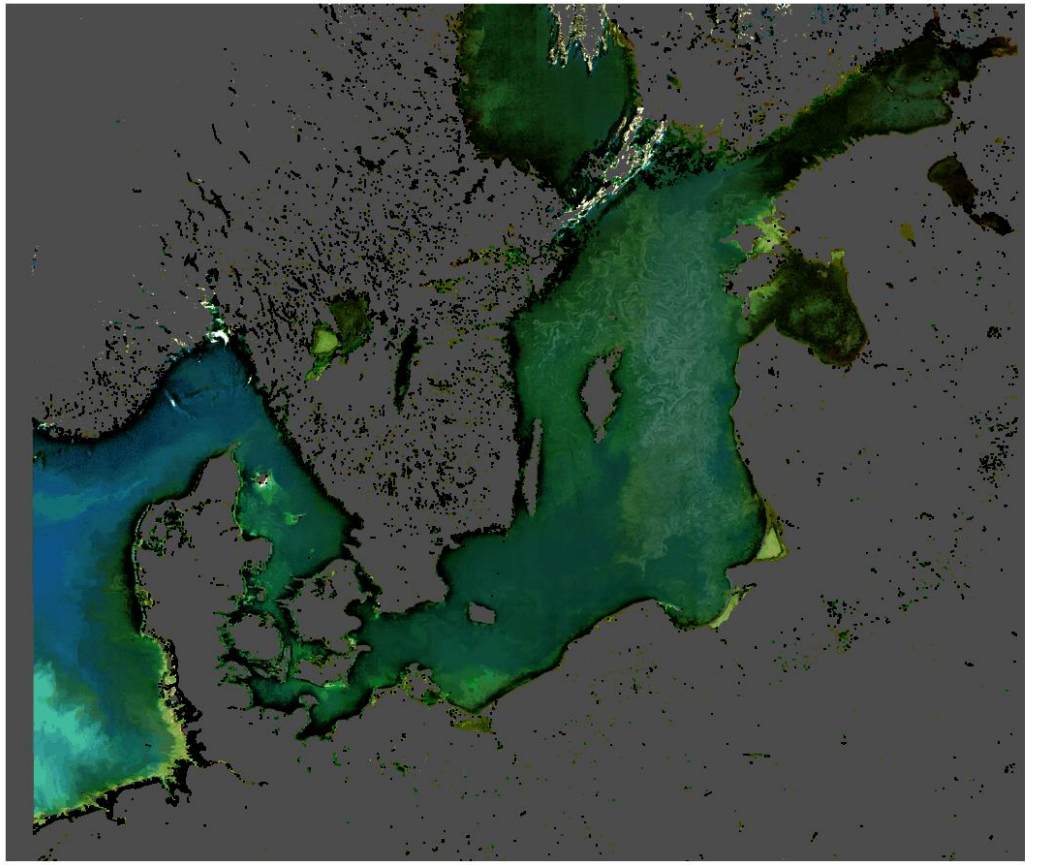
- Standard NIR SVC methodology applied at SPG with a new model best matching MAR-90 (FMF=0.1)
- To be revised following Ahmad et al. at Tahiti AERONET station?

QUALITATIVE ASSESSMENT ON SCENES (BOA RGB) – BALTIC SEA

IPF Collection 3

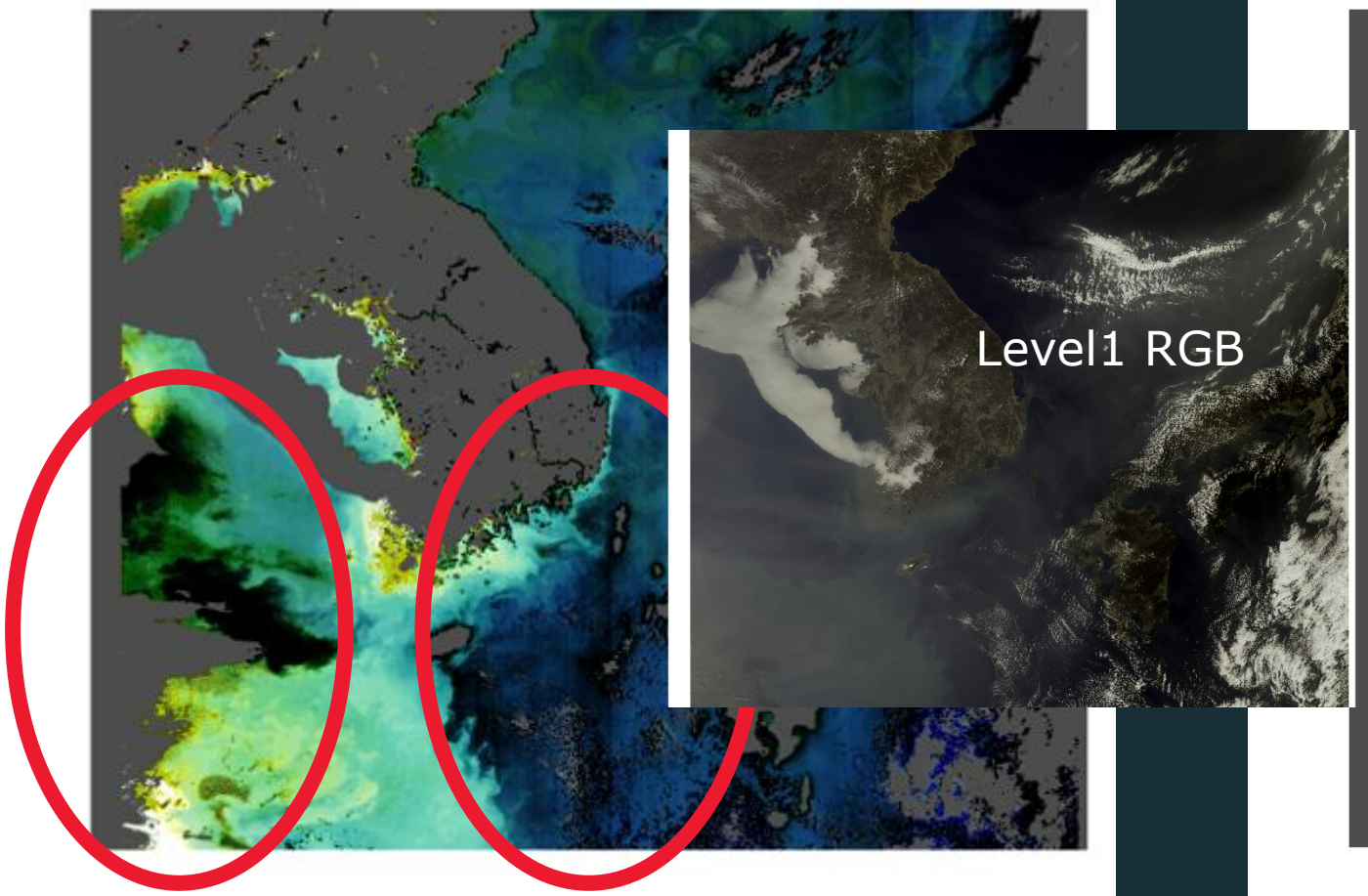


OC-SAC



QUALITATIVE ASSESSMENT ON SCENES (BOA RGB) – YELLOW SEA

IPF Collection 3



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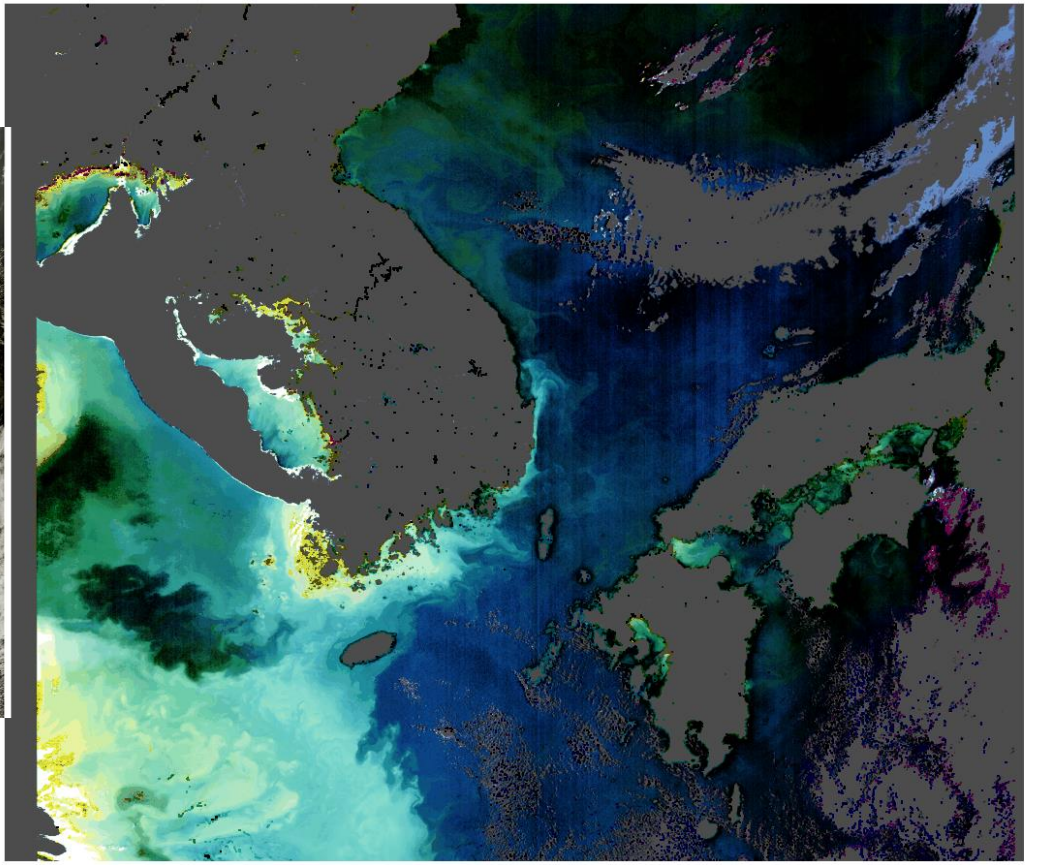
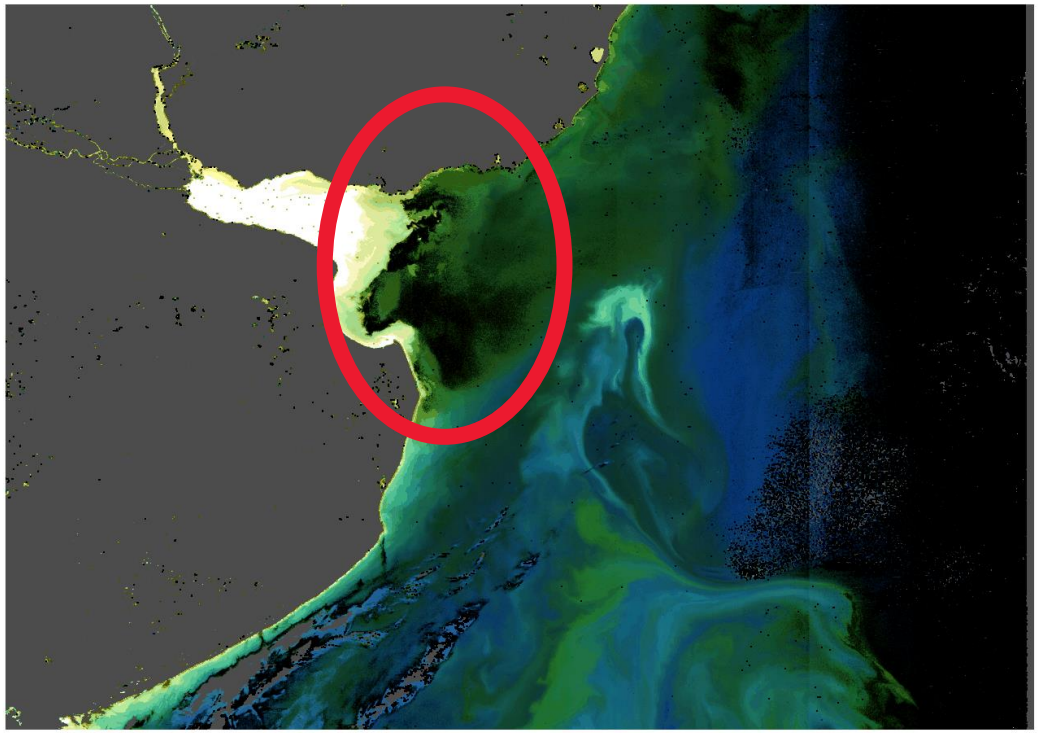
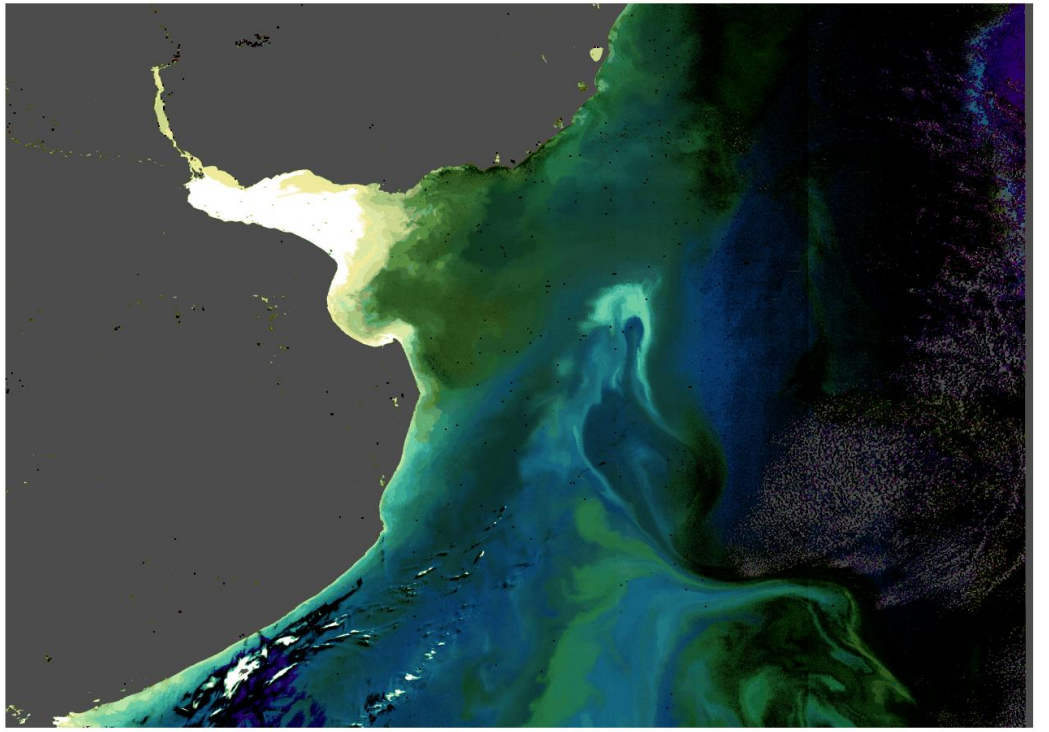


QUALITATIVE ASSESSMENT ON SCENES (BOA RGB) – RIO DE LA PLATA

IPF Collection 3



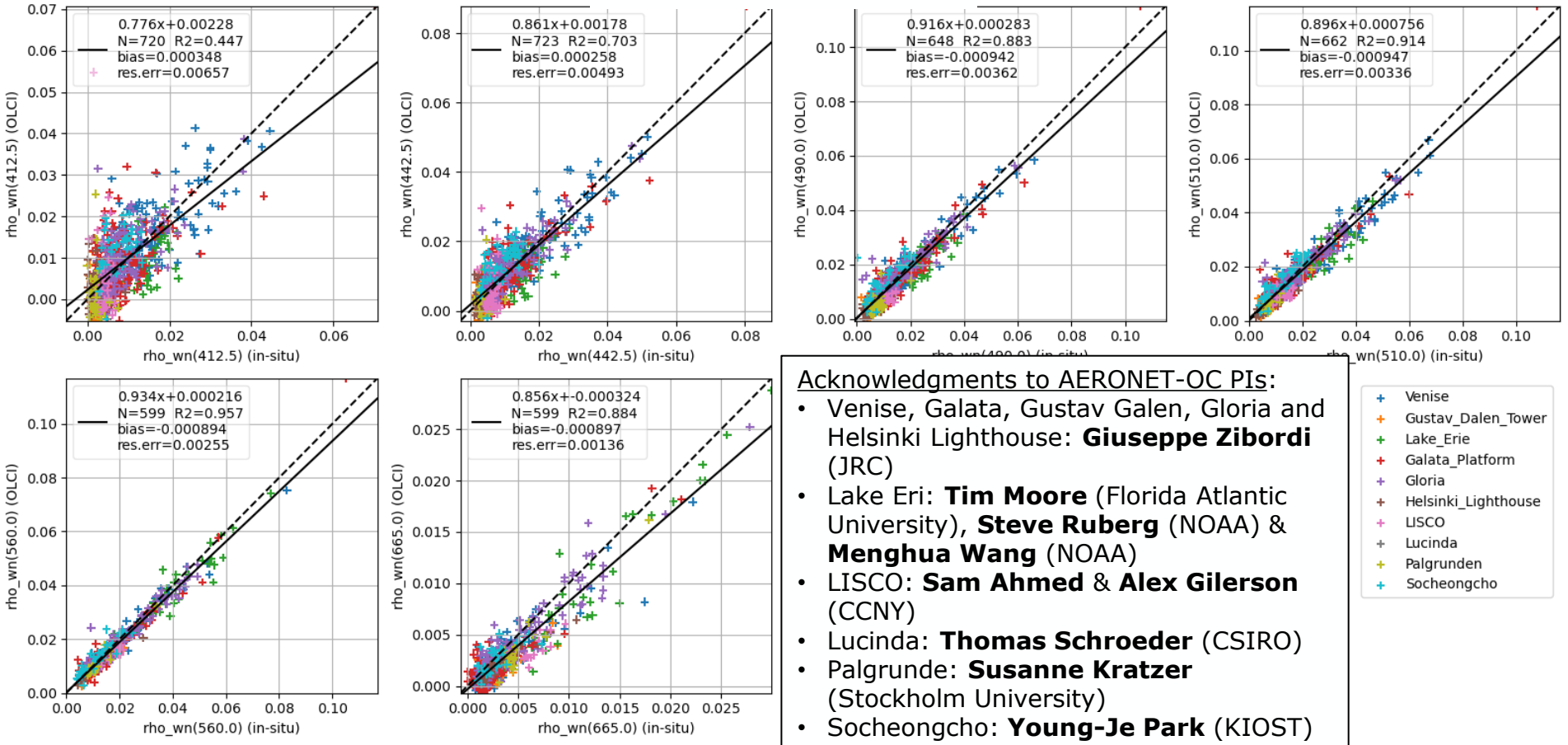
OC-SAC



VALIDATION ON MATCH-UPS – MARINE REFLECTANCE

- Use of EUMETSAT "MDB"
- "Common Best Flag" comparison
- Protocols not totally consolidated

IPF Collection 3



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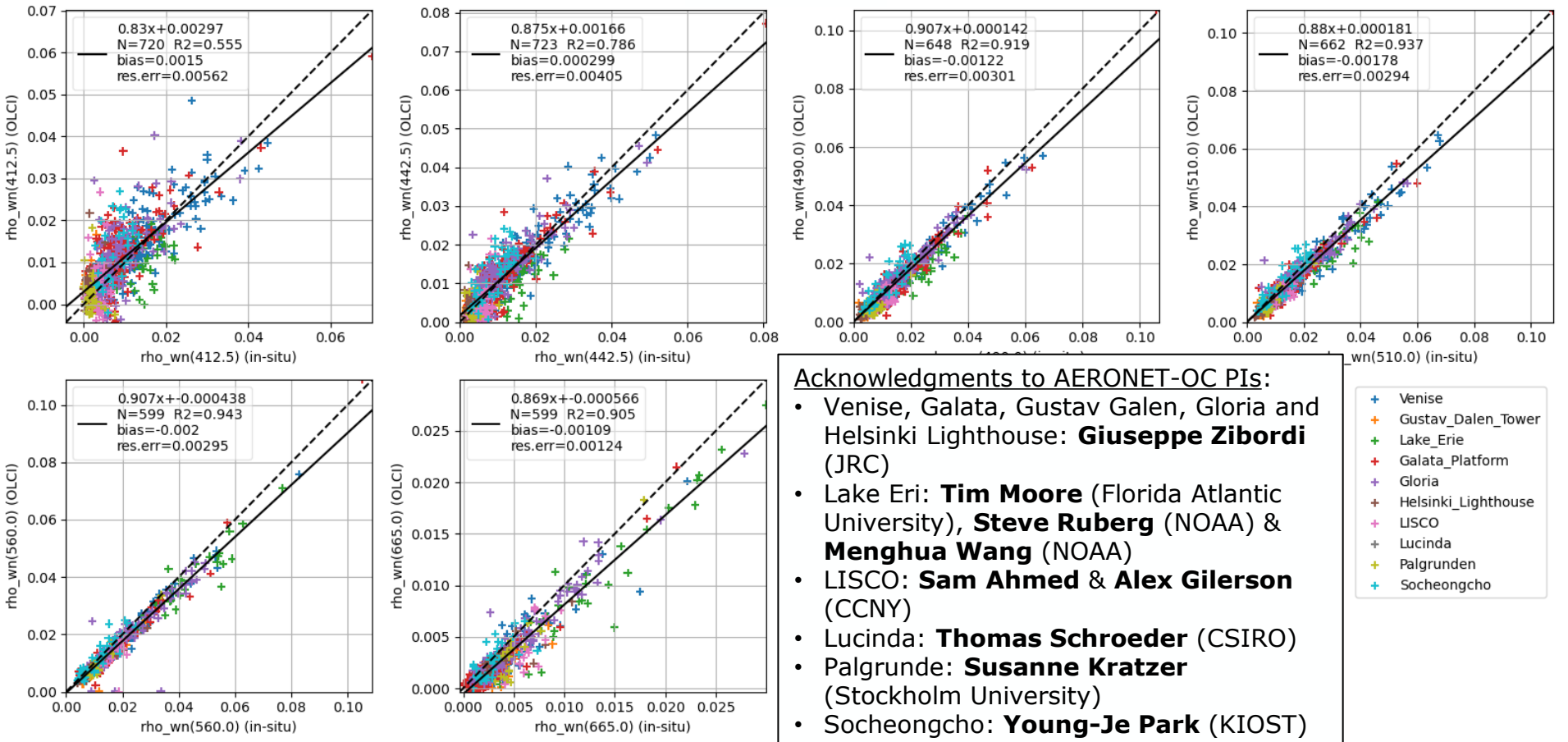

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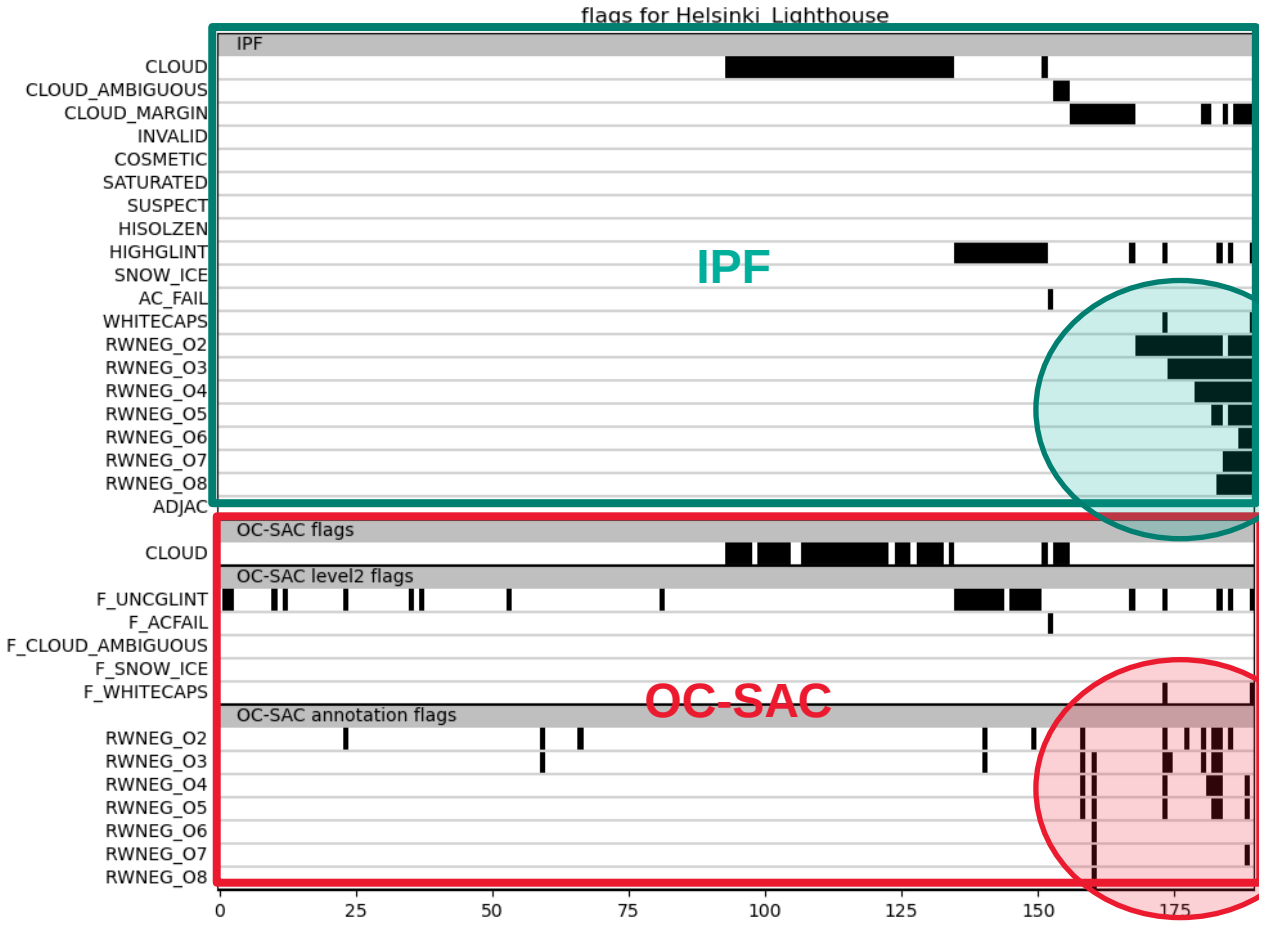
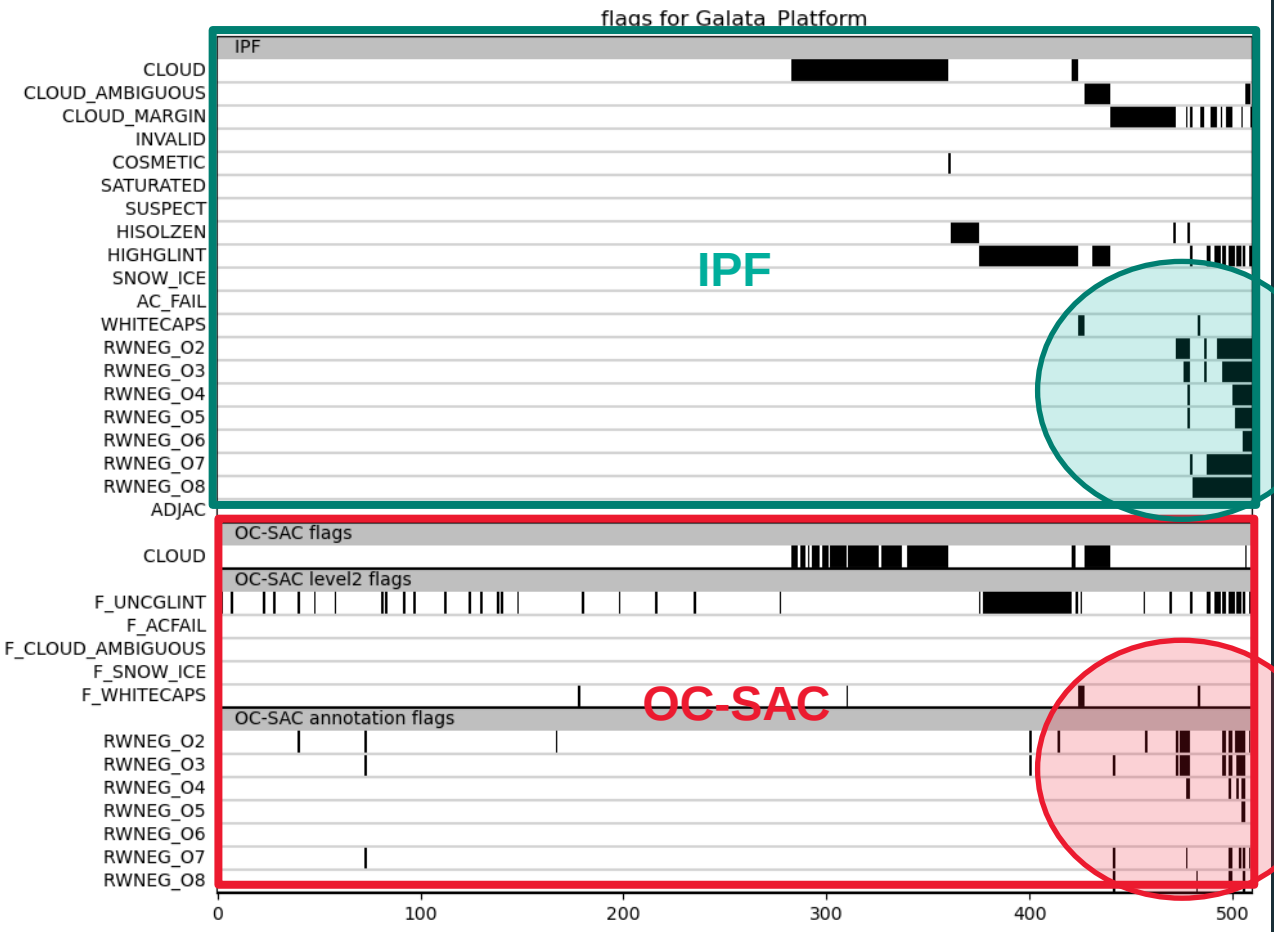
- Socheongcho: **Young-Je Park** (KIOST)

VALIDATION ON MATCH-UPS – OCCURRENCE OF FLAGS

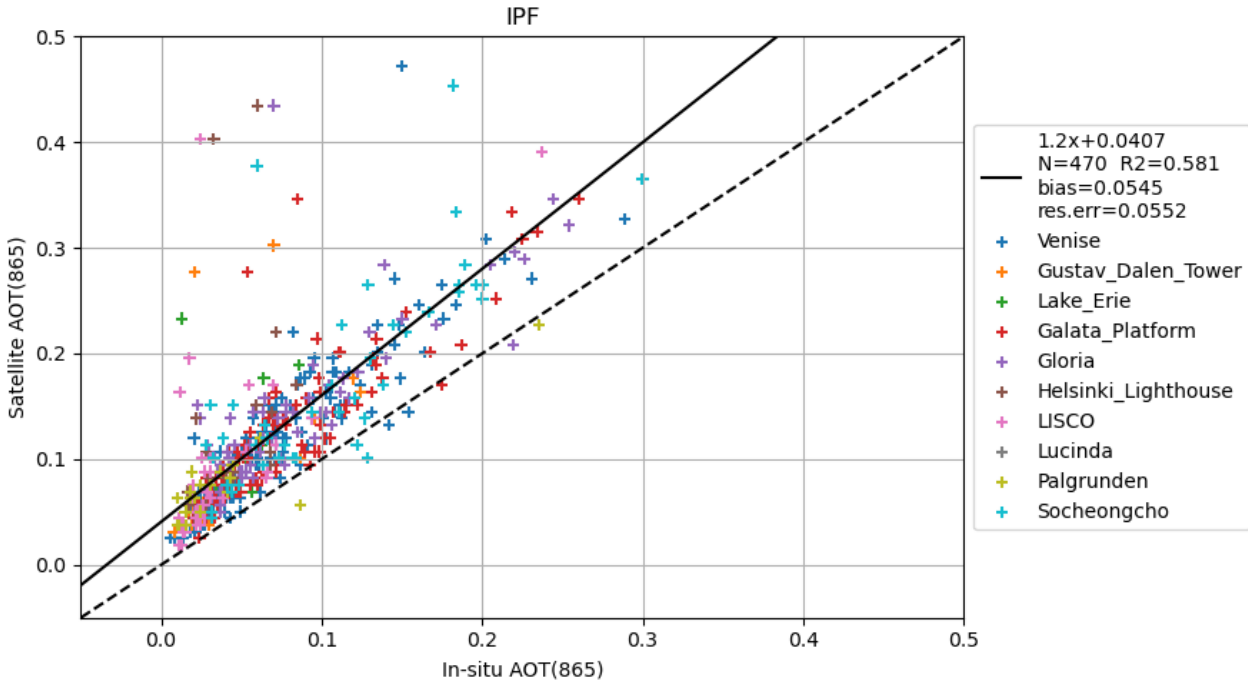


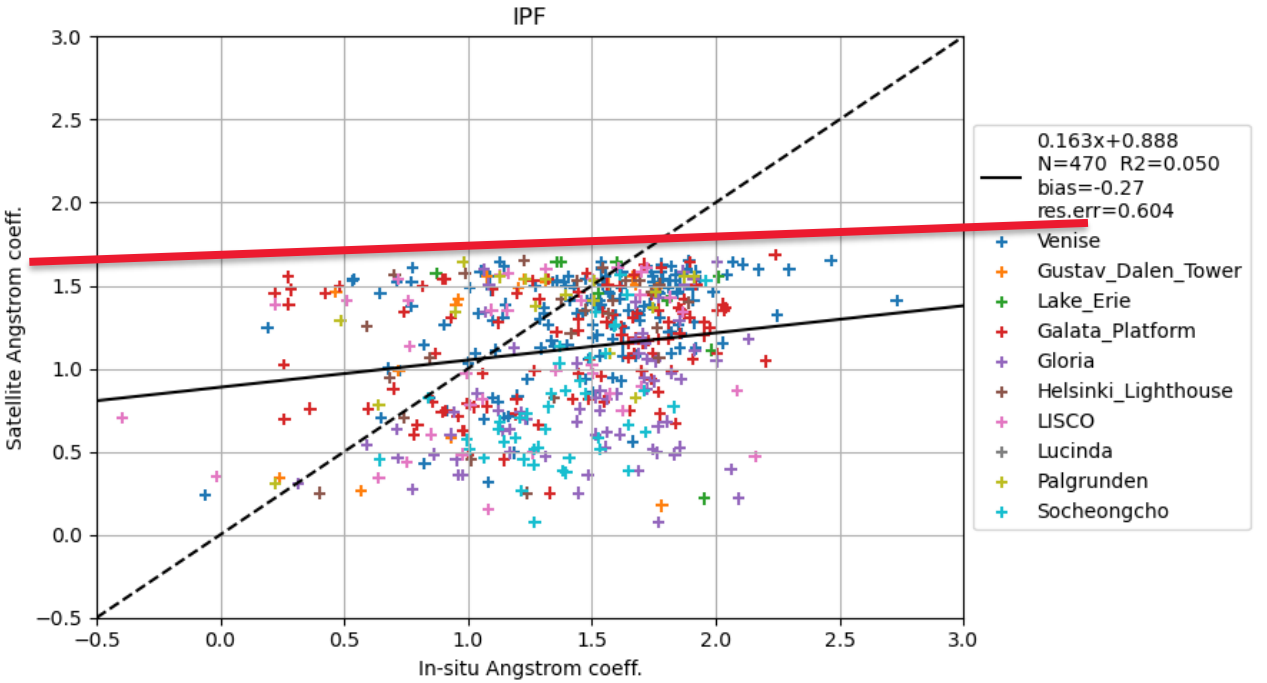


VALIDATION ON MATCH-UPS – AEROSOL PRODUCTS

- "Common Best Flag" comparison
- Protocols not totally consolidated

IPF Collection 3 – similar to Zibordi et al. 2022

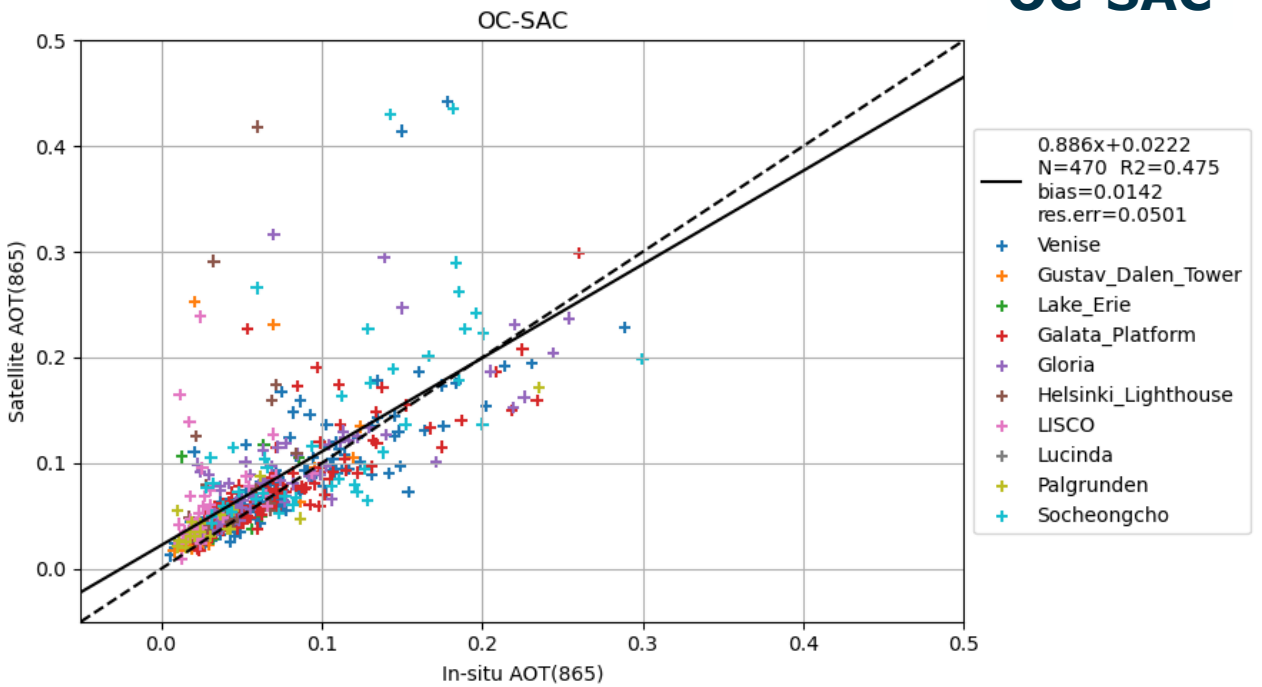


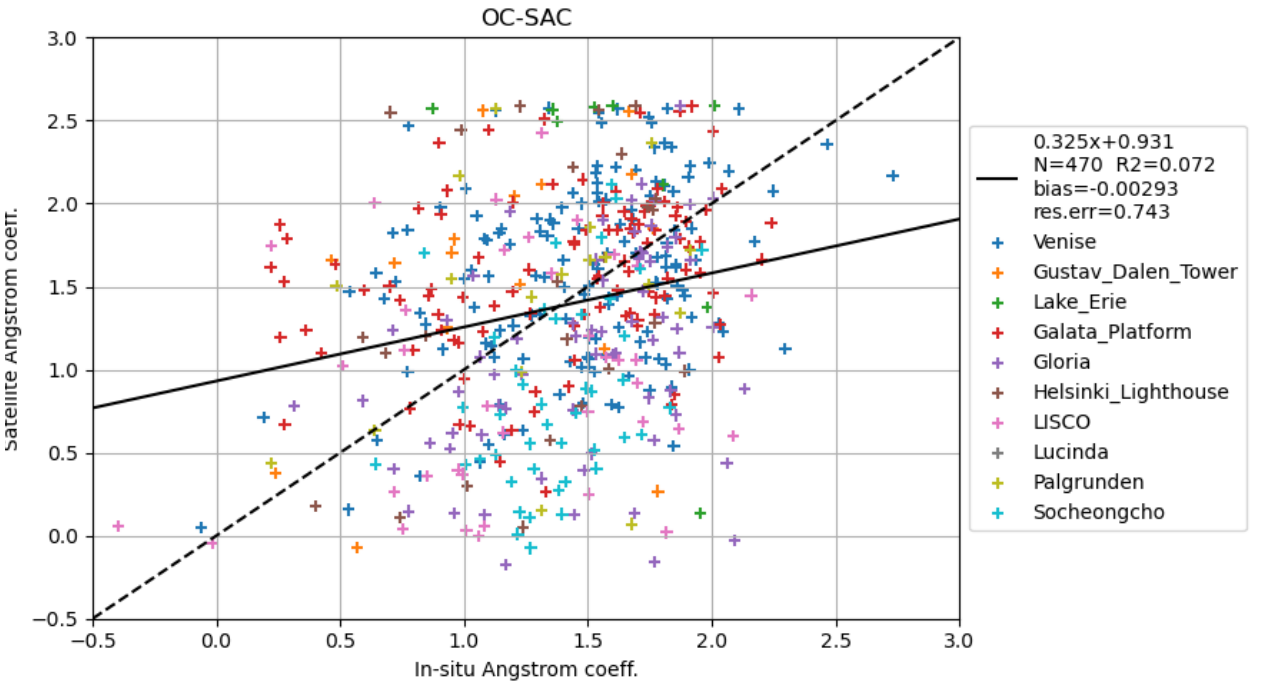


VALIDATION ON MATCH-UPS – AEROSOL PRODUCTS

- "Common Best Flag" comparison
- Protocols not totally consolidated

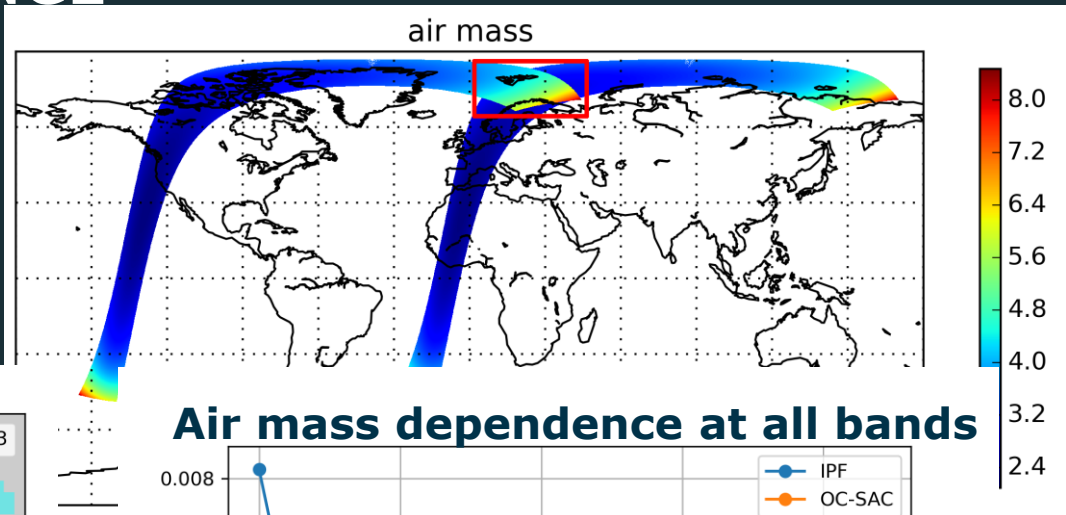
OC-SAC





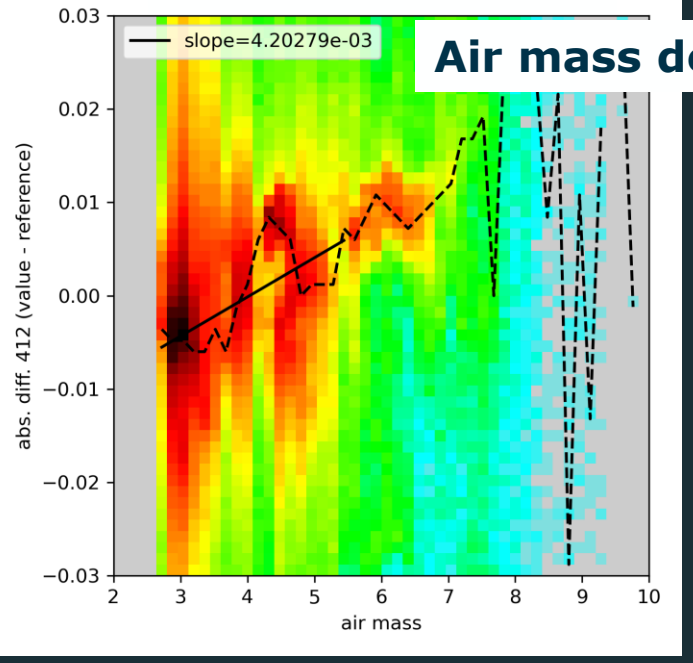
GLOBAL ASSESSMENT: AIR-MASS DEPENDENCE

- Self-consistency analysis of rhowN: overlaps at high latitudes
- Cf. HYGEOS: https://www.eposters.net/poster/consistency-analysis-of-ocean-color-products-at-high-latitudes
- Applied to 4 days of RR products: June 01-04, 2019

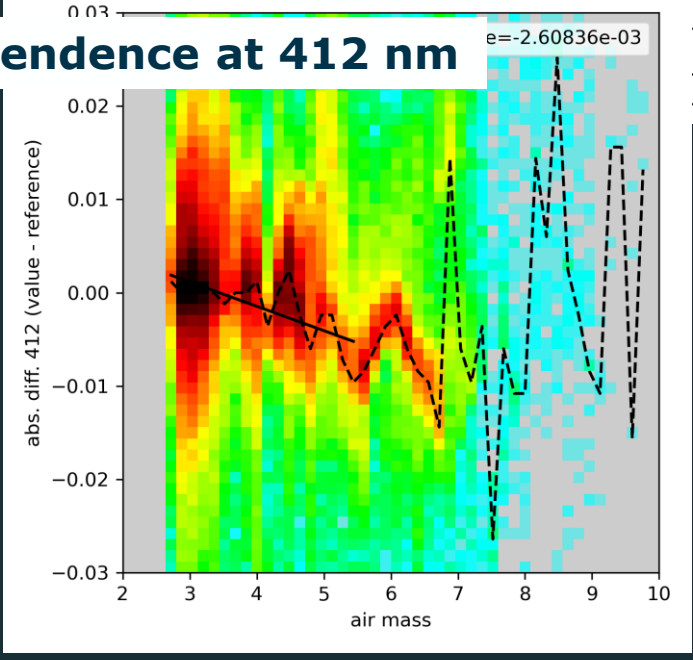


Air mass dependence at 412 nm

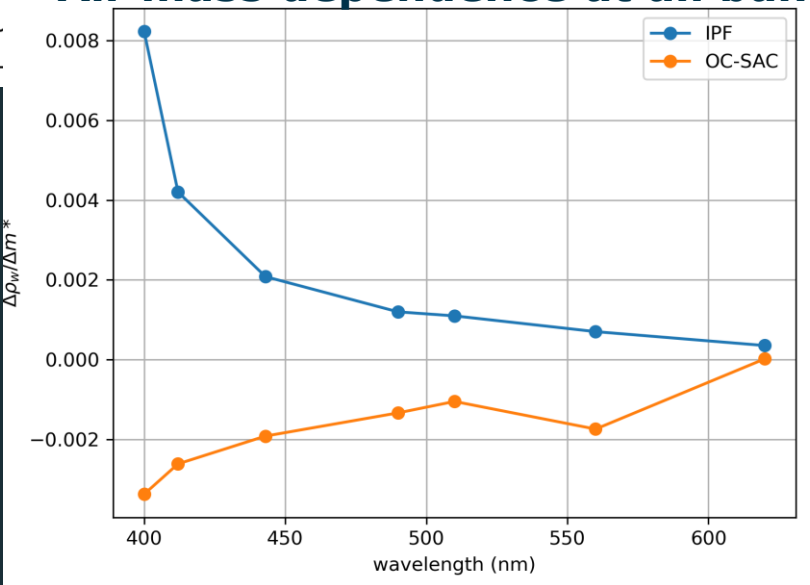
IPF Collection 3



OC-SAC



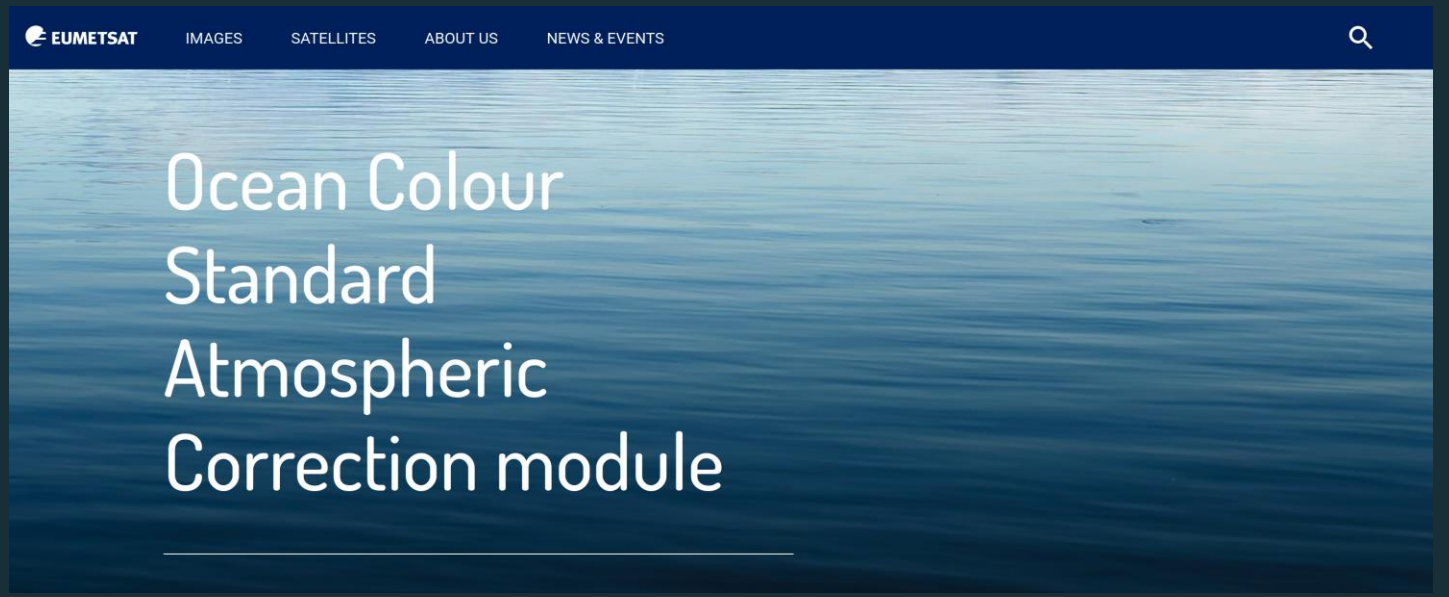
Air mass dependence at all bands



solVo HYGEOS

CONCLUSION – OC-SAC INITIAL PHASE

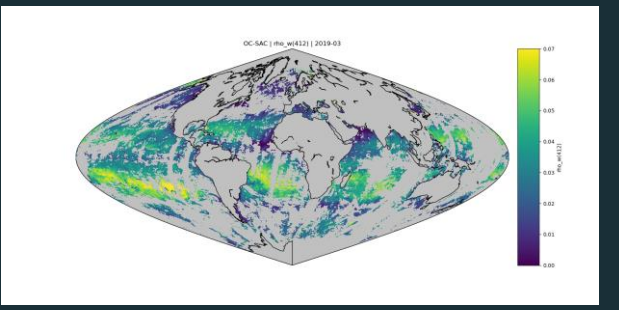
- Full review of OLCI OC-SAC algorithm, dated from the 90s' (MERIS heritage)
  - Aerosol models, RTM, LUT optimization, multi-band aerosol detection …
- Wide range of validation: match-ups, scenes, atmospheric products, global scale, time-series
- New OC-SAC module plugged-in the OLCI operational Level 2 processor (+ external "SACSO" prototype)



- https://www.eumetsat.int/oc-sac
- Soon available:
  - Requirement Baseline
  - ATBD
  - Product Validation Report

CONCLUSION - ON-GOING WORK

- New OC-SAC is a candidate for OLCI Collection 4 reprocessing
- On-going 9-month activity:
  - Improve performance for operational processing at EUMETSAT (RAM, CPU, speed)
  - Consolidate NIR+VIS SVC gains for new aerosol models
  - Extend validation, including ALH, absorbing aerosol models, OLCI-B…
  - Optimize algorithm as necessary



- Any independent validation of new OC-SAC from S3VT member is welcome!
- Care about “coastal biased” validation, we need FRM in open waters too: BOUSSOLE (LOV), AMT cruises (PML) …

THANK YOU