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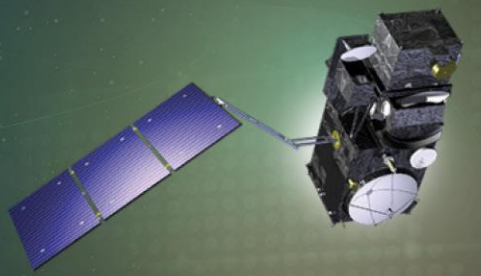

7th Sentinel-3 Validation Team Meeting 2022

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

Sentinel-3A/OLCI aerosol and surface retrieval based on the GRASP algorithm:

retrieval development and preliminary validation

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[1]GRASP-SAS, France; [2]LOA, CNRS, Univ. Lille, France; [3]CloudFlight, High Performance Computing , Austria; [4]EUMETSAT, Darmstadt, Germany

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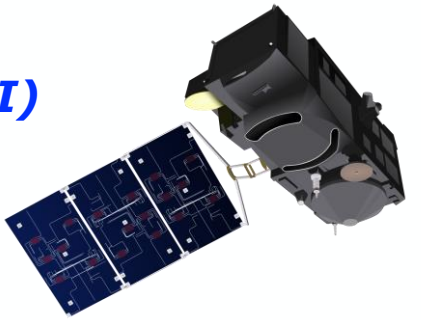
Sentinel-3A/OLCI instrument

OLCI-A Band	Central Wavelength (nm)	Band Width (nm)	Radiance Bias Correction
Oa02	412.5	10	-2%
Oa03	442.5	10	-2%
Oa04	490	10	-2%
Oa05	510	10	-2%
Oa06	560	10	-2%
Oa08	665	10	-2%
Oa12	753	7.5	-2%
Oa17	865	20	-2%
Oa21	1020	40	-6%

Radiometric bias correction
(informal communcation with EUMETSAT)

Ocean and Land Color Instrument (OLCI)

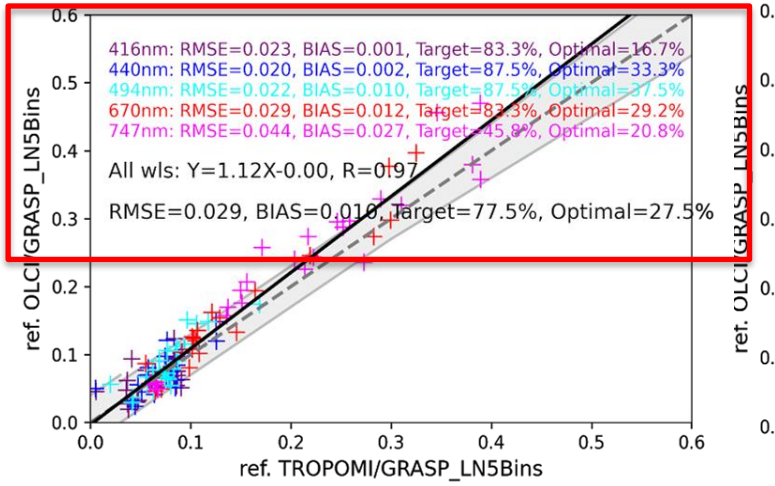
Onboard Sentinel-3A ~~and -3B~~
Single-viewing
Overpass: ~10 a.m. L.T. (descending node)
Bands: 412 – 1020 nm



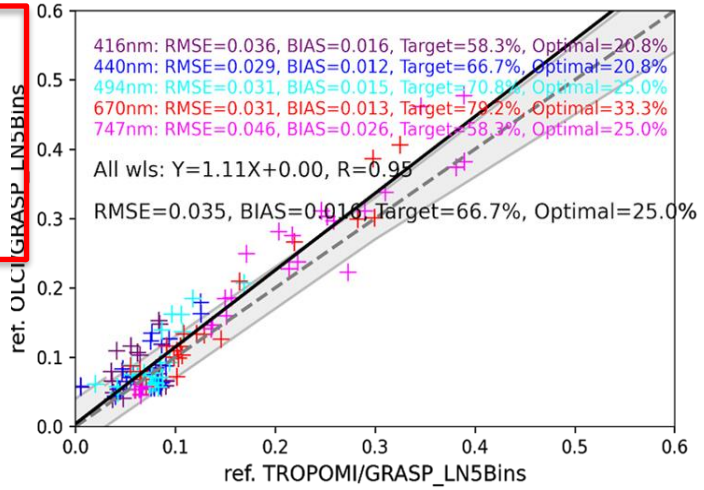
L1B RR -> Target 10km pixel aerosol and surface retrieval

OLCI vs. TROPOMI

With EUM correction (-2%.., -6%)



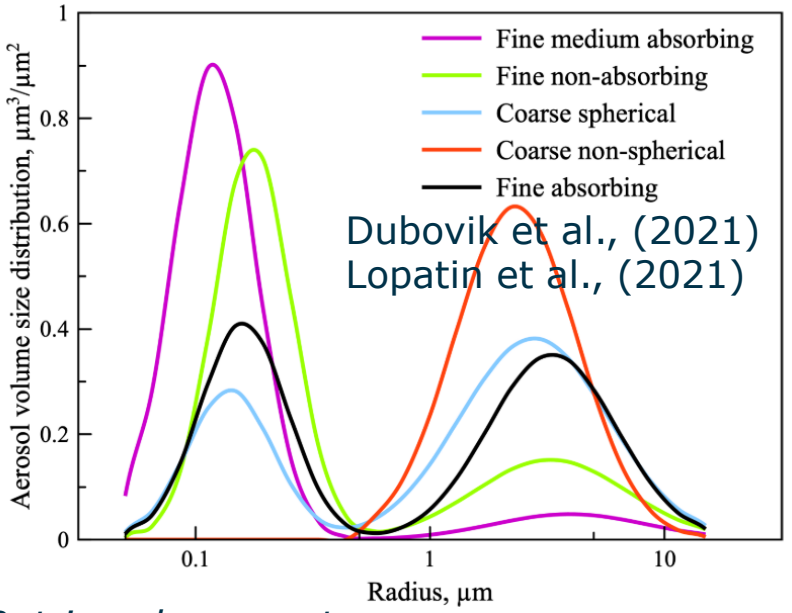
Without correction



More details about synergetic retrieval (P. Litvinov 14:00 this afternoon)

GRASP/Models on POLDER and OLCI

Simplified external mix of aerosol models



Retrieved parameters:

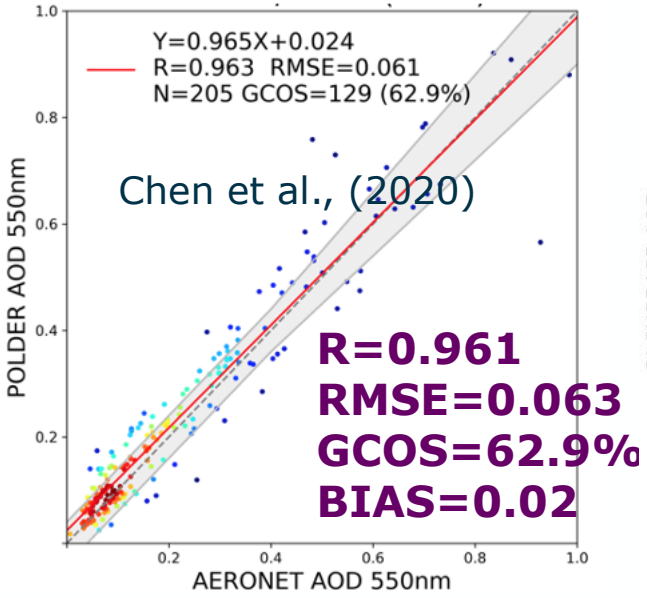
Ratio of 4/5 aerosol model
1 total aerosol concentration
1 layer height

Spectral BRDF isotropic, volumetric, geometric terms

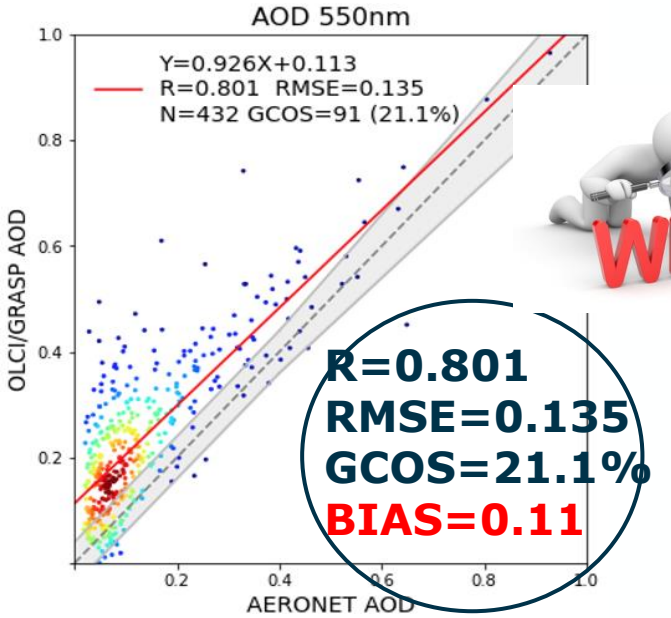
5 unknow parameters to represent aerosol

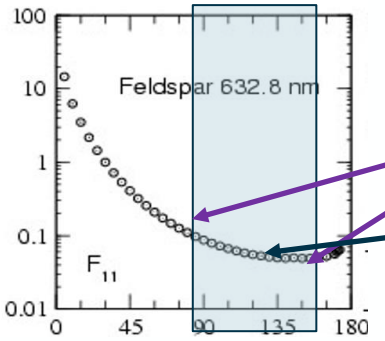
<0.5 sec/pixel/core

PARASOL/GRASP-Models



OLCI/GRASP-Models





Same inversion model, different performance due to ***information content***.

PARASOL: multi-angular + polarization

OLCI: single-viewing radiometer

✓ Optimization of AOD retrieval over ocean

1. Constrain angular properties of ocean surface BRDF using windspeed

$$\mathbf{R} = a_0(\lambda) + \delta_{Fr}\mathbf{R}_{CoxM}(\sigma^2)$$

$$\delta_{Fr} = 1.0 - (2.95 \times 10^{-6} \times w^{3.52})$$

$$2\sigma^2 = 0.003 + 0.00512 \times w$$

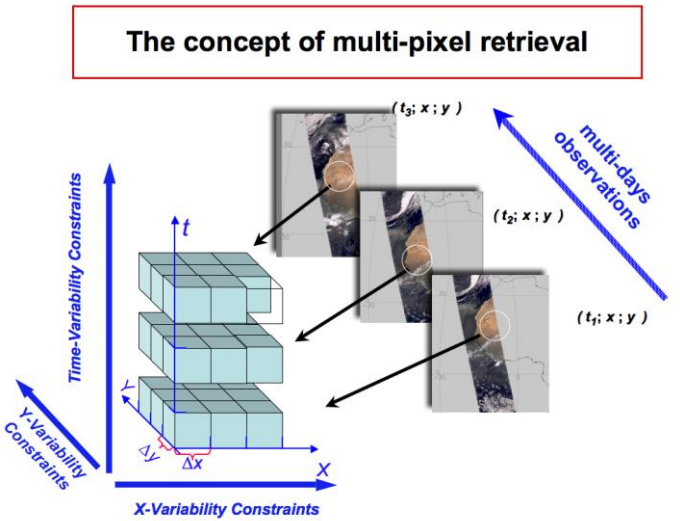
$a_0(\lambda)$ → Only isotropic term is retrieved

Dubovik et al. (2011; 2021)

2. Optimized use of OLCI spectral TOA radiances over ocean

- Including 1020 nm measurement
- Assuming higher noise for wls < 500 nm

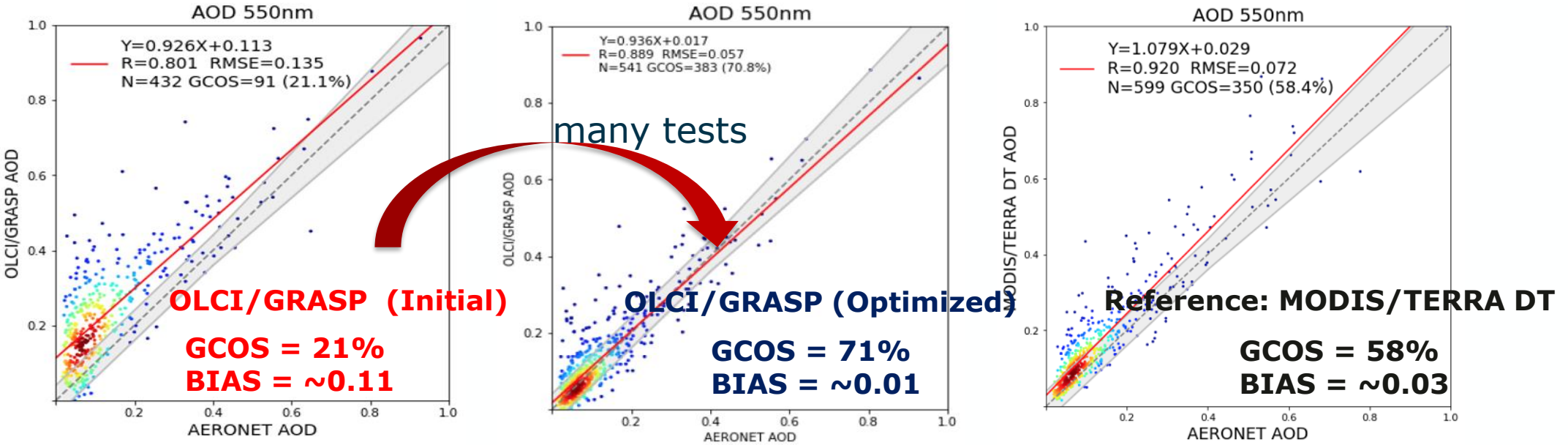
3. Multi-pixel constraints on aerosol type variability in neighboring pixels (stronger constrain on aerosol model variability in X, Y and T dimensions)



Evolution of OLCI/GRASP retrieval over ocean surface

✓ ***OLCI/GRASP AOD retrieval over ocean***

1 yr validation with AERONET



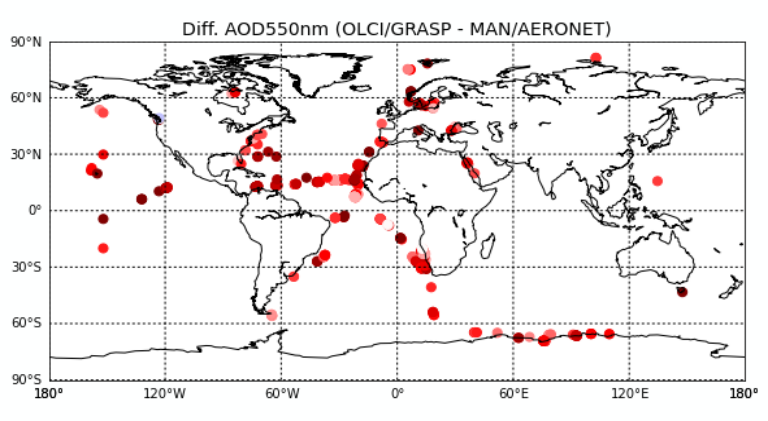
The retrieval was notably improved by including several optimizations.

GCOS AOD requirement: max (0.04 or 10%AOD)

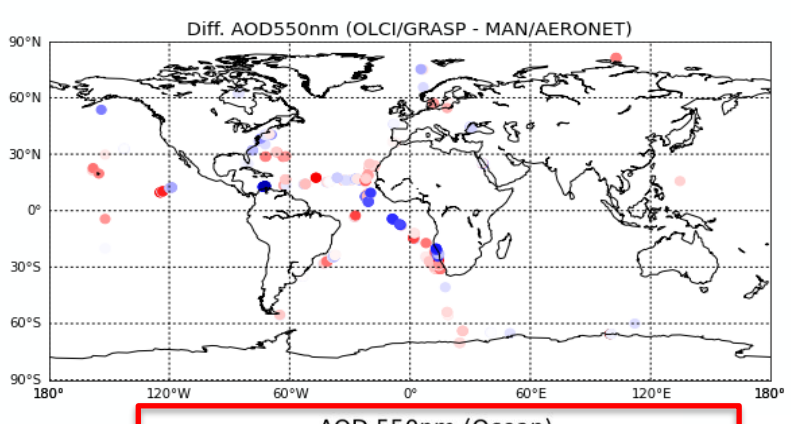
✓ *AOD retrieval over ocean*

1 yr validation with **MAN**/AERONET

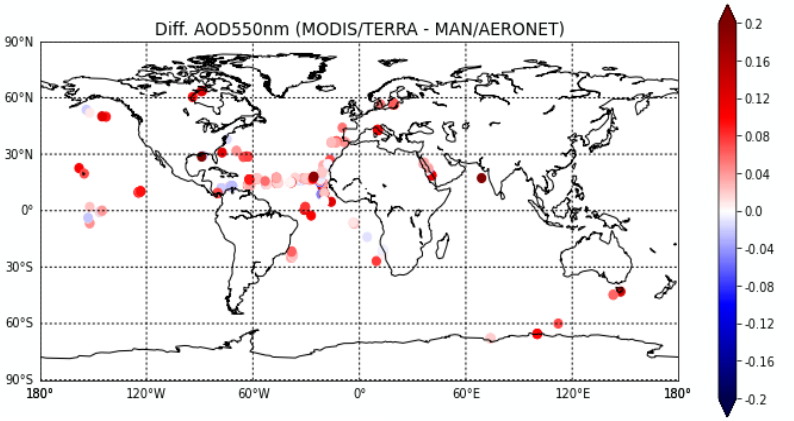
OLCI/GRASP (Initial) - MAN



OLCI/GRASP (Optimized) - MAN



MODIS/TERRA - MAN

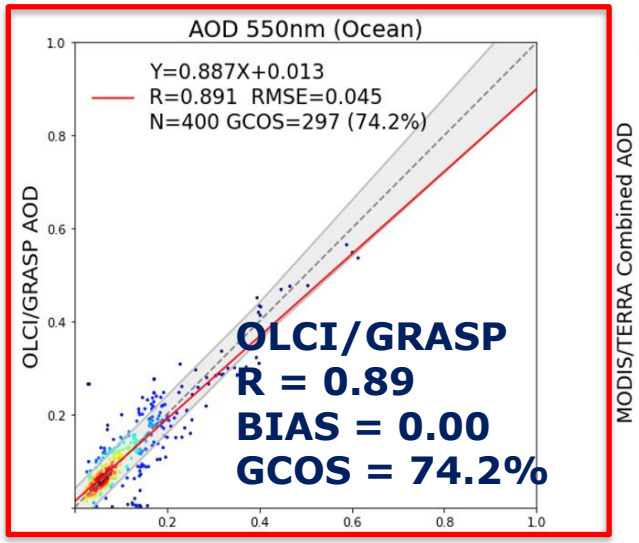


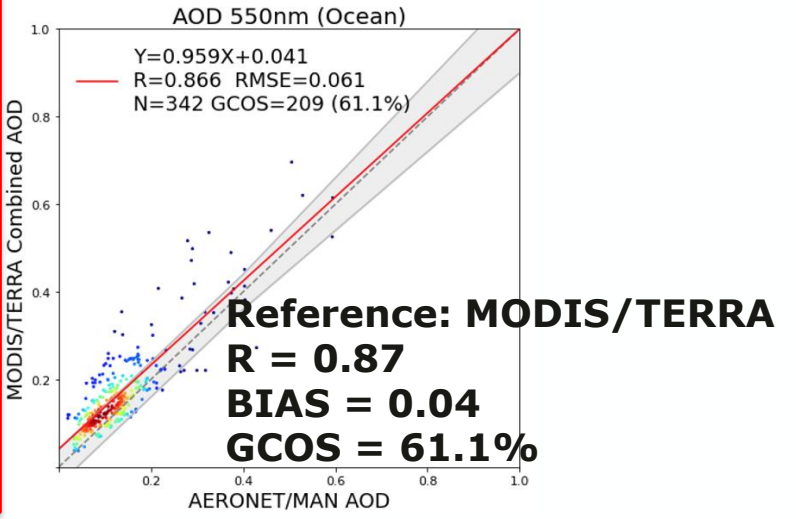
Observed improvements:

a. Clear evolution from Initial to Optimized OLCI/GRASP retrieval over ocean

b. The AOD BIAS decrease from +0.11 to +0.01 with AERONET coastal sites and ~0.00 with MAN deep ocean measurements.

c. Comparable quality of AOD product with MODIS/TERRA. The OLCI/GRASP bias is even smaller than MODIS/TERRA over ocean.

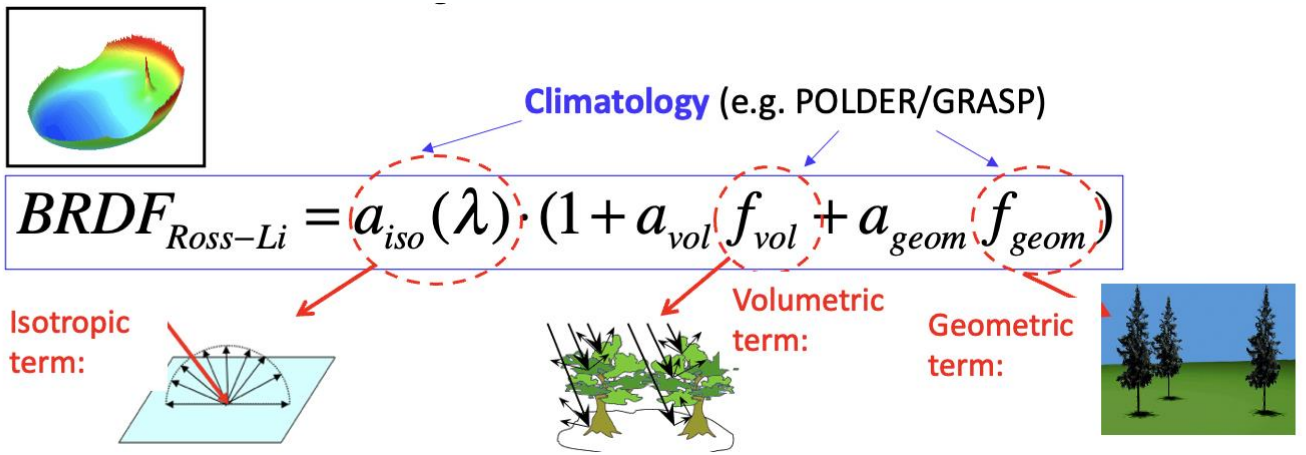




✓ Optimization of AOD retrieval over land

1. to use values from POLDER/GRASP climatology as an initial guess for $a\ iso\ (\lambda)$

2. to use values from POLDER /GRASP climatology as a priori estimates for $a\ vol$ and $a\ geom$ with significantly high corresponding Lagrange multipliers



3. to adopt vector radiative transfer in forward model calculation

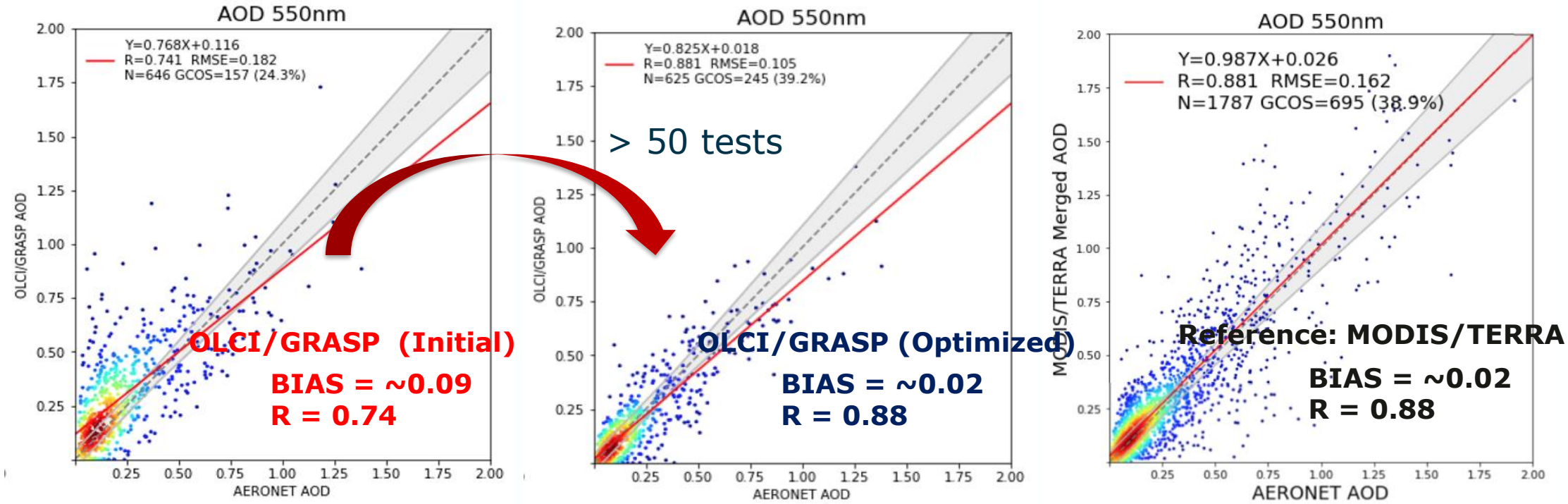
4. to include 1020 nm measurements

5. Multi-pixel constrain on aerosol type variability in neighboring pixels (stronger constraints on aerosol model variability in X, Y and T dimensions)

Evolution of OLCI/GRASP retrieval over land surface

✓ *AOD retrieval over land*

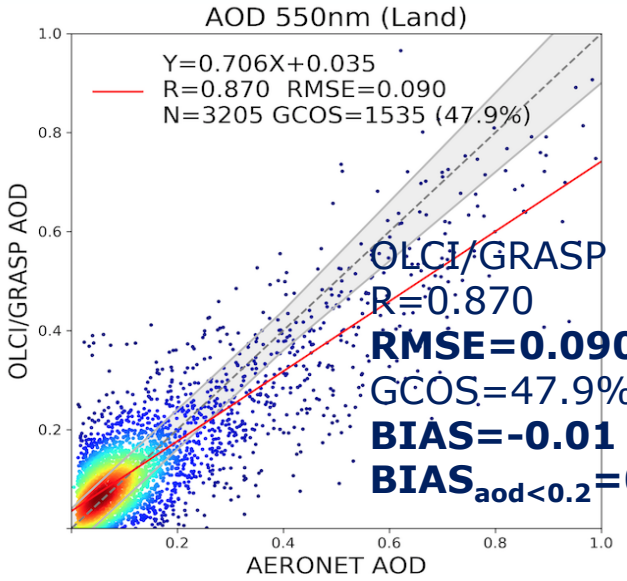
1 yr validation with AERONET



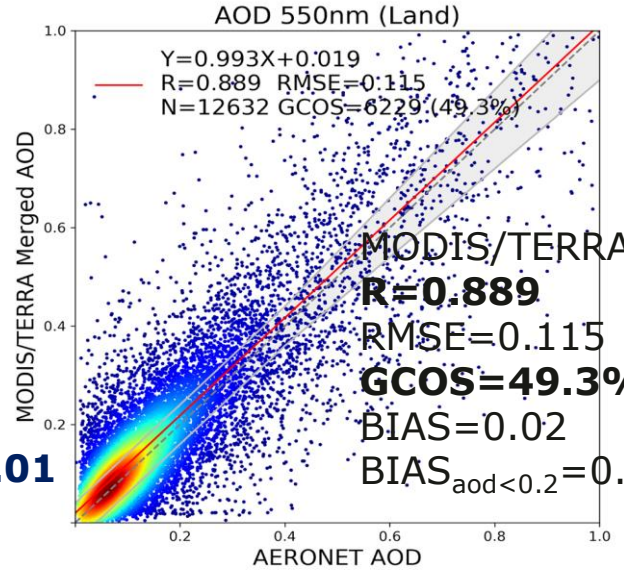
The retrieval was notably improved by including several optimizations.

✓ *AOD retrieval over land*

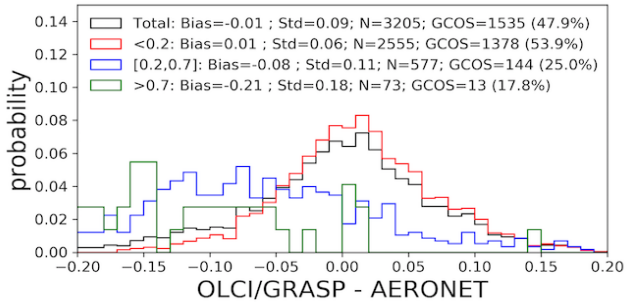
Comparing with MODIS/TERRA

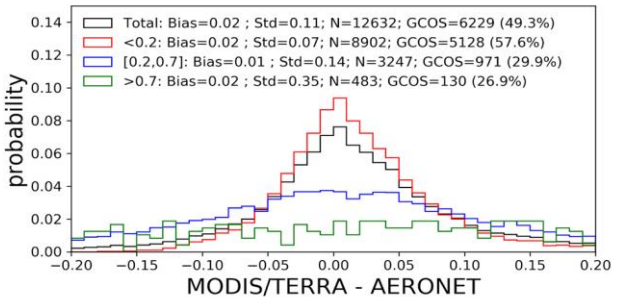


OLCI/GRASP
R=0.870
RMSE=0.090
GCOS=47.9%
BIAS=-0.01
$BIAS_{aod<0.2}$=0.01



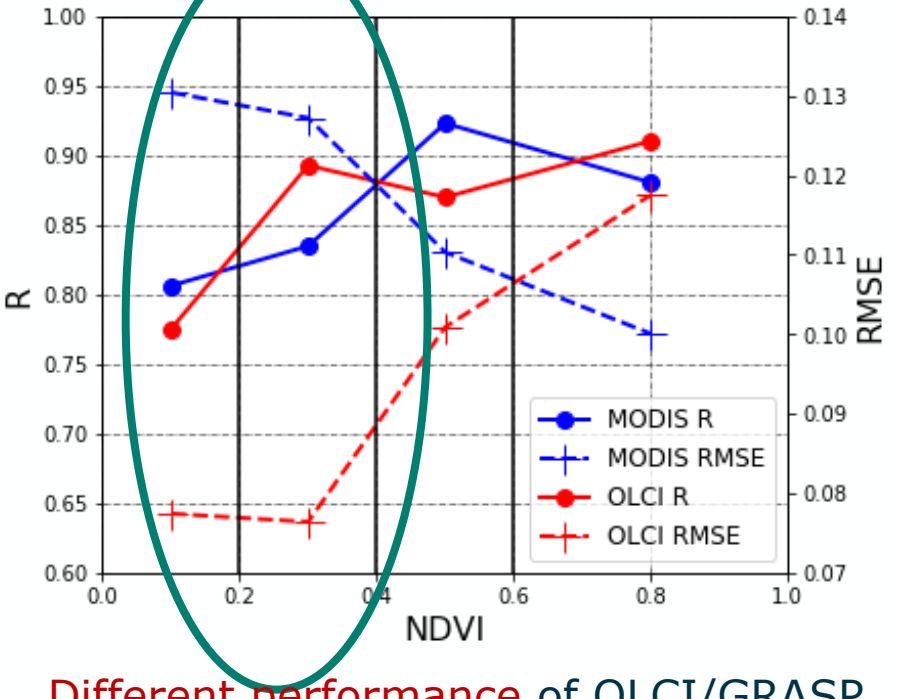
MODIS/TERRA DT+DB
R=0.889
RMSE=0.115
GCOS=49.3%
BIAS=0.02
$BIAS_{aod<0.2}$=0.02





1 yr global processing with AERONET

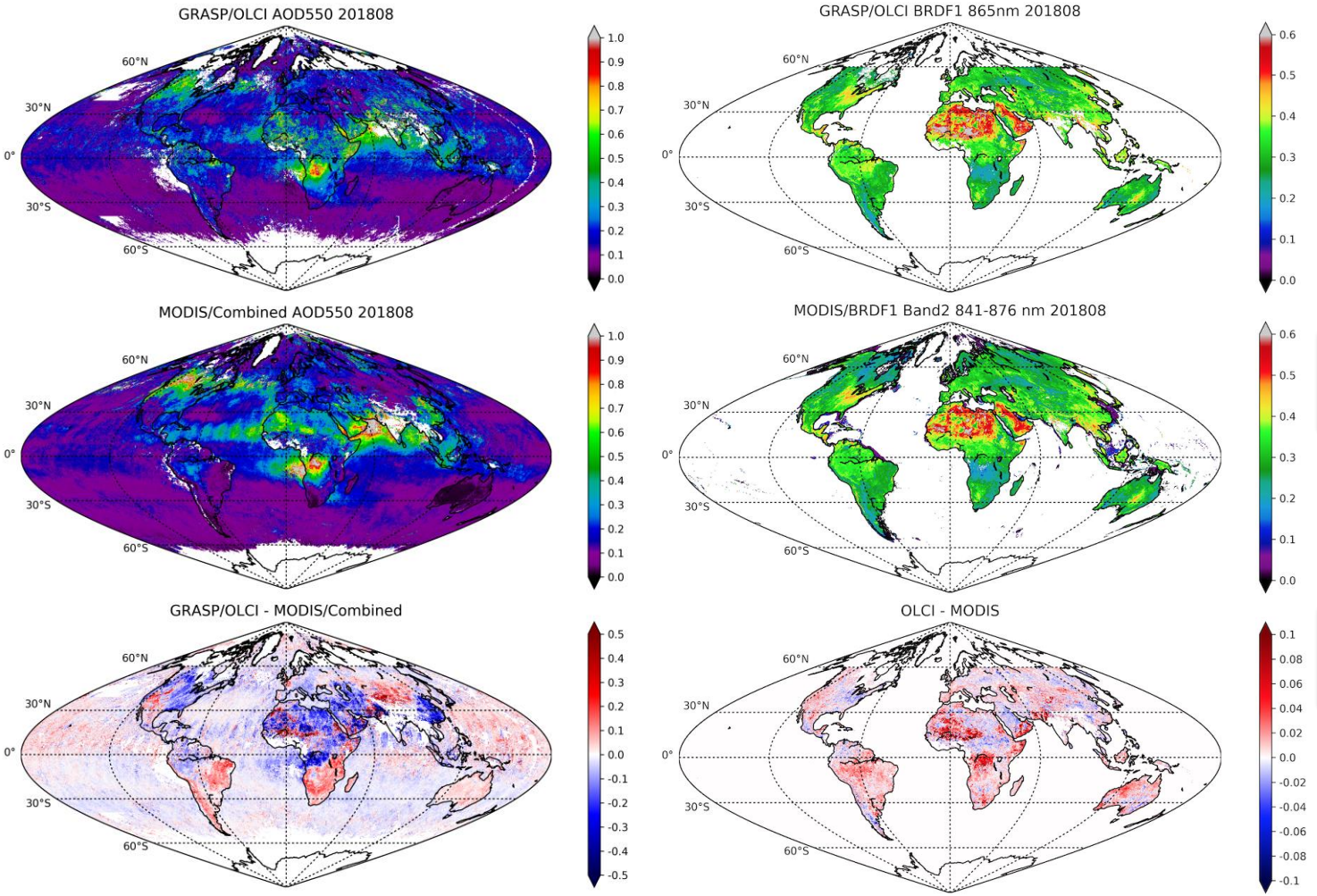
Split statistics by NDVI



Different performance of OLCI/GRASP and MODIS/TERRA over NDVI<0.4.

NDVI>0.4 -> good ✔

Pixel-to-pixel intercomparison OLCI and MODIS products



AOD 550	R	RMSE	GCOS (%)	Diff. (OLCI-MODIS)
Land	0.717	0.141	33.7	-0.02
Ocean	0.877	0.054	66.6	-0.02

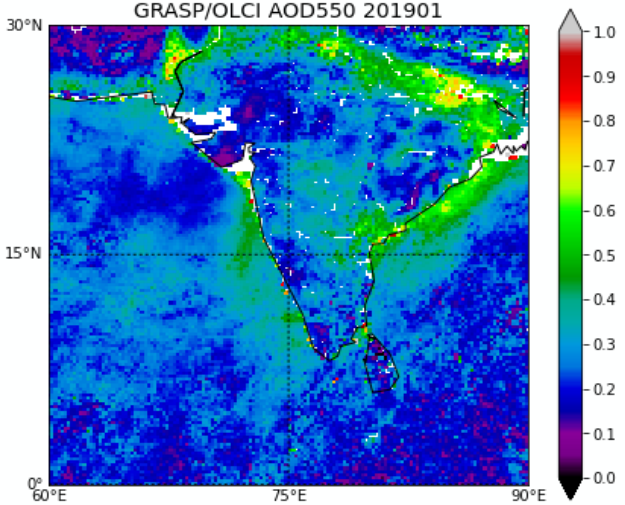
Isotropic BRDF	R	RMSE	Diff. (OLCI-MODIS)
Land	0.945	0.03	<0.01

Illustration of remaining issues in OLCI/GRASP retrievals

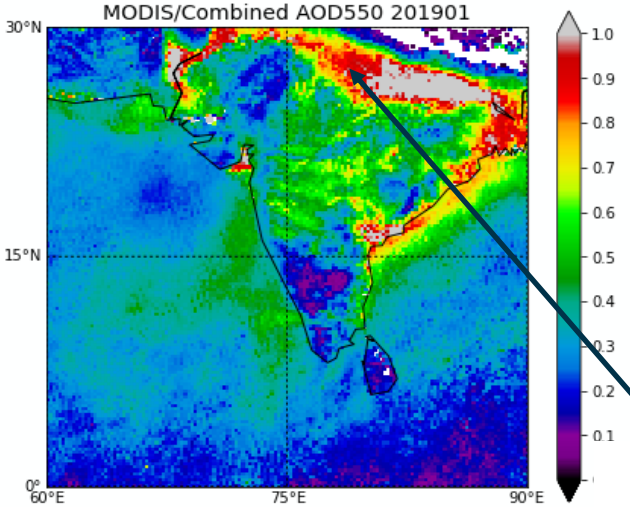
✓ ***AOD retrieval over land***

An example over India region with large differences

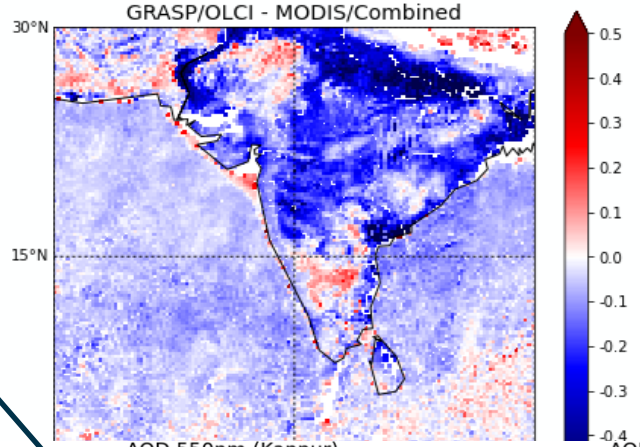
OLCI/GRASP

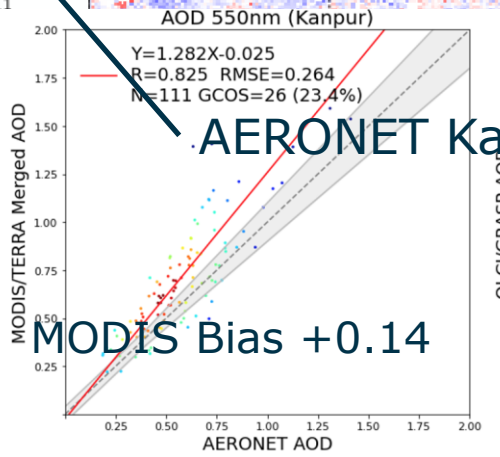


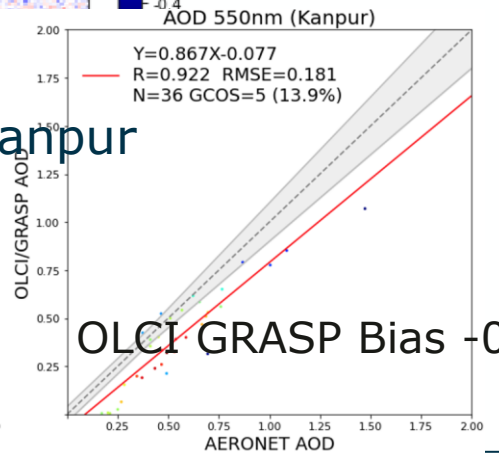
MODIS/TERRA



OLCI-MODIS







AERONET Kanpur

MODIS Bias +0.14

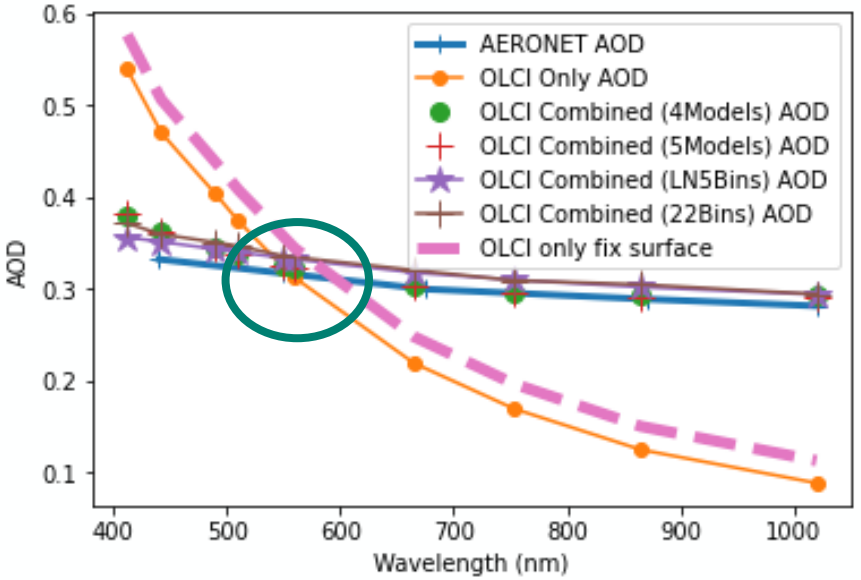
OLCI GRASP Bias -0.15

Observed tendencies:

- over screening high AOD aerosol events;
- orbit differences;
- complex surface/aerosol types;
- *opposite biases in retrieved AOD;*

✓ *An example – lack of sensitivity to particle size over bright surface*

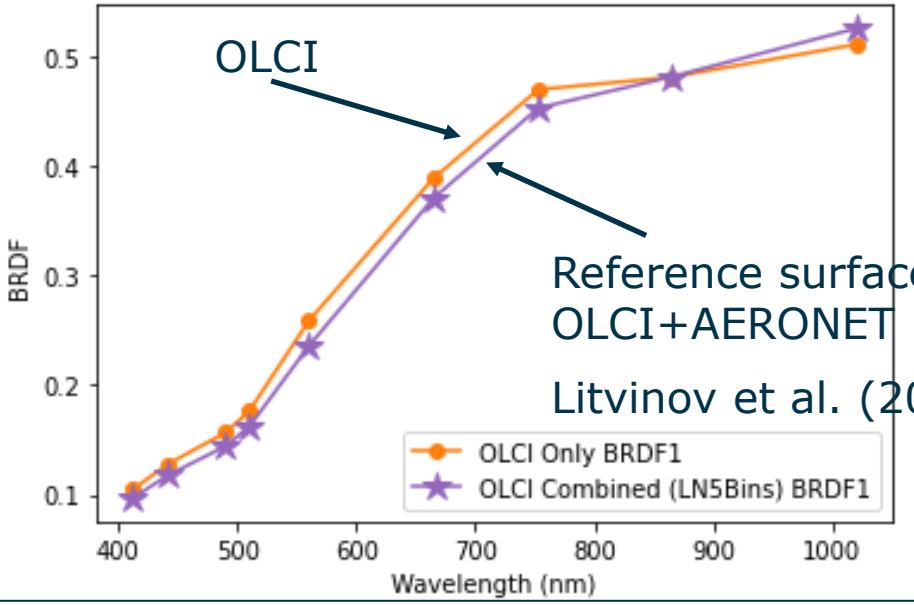
Spectral AOD



Case: Banizoumbou 2019-06-20 09:35:22

	AOD (550 nm)	AE
AERONET:	0.32	0.21 (dust)
OLCI only:	0.32	**1.98**

Spectral BRDF isotropic term



Reference surface: Syenergy OLCI+AERONET

Litvinov et al. (2020, AGU)

- ✓ AOD at 550 nm is unbiased, good surface retrieval +/- 0.01 spectrally and good data fit.
- ✓ AE is overestimated. OLCI only fit dust with urban model. Over/under-estimate AOD at other channels.
- ✓ It may imply the lack of sensitivity to particle size over bright surface especially the AOD is low.

Outcome & Lessons from OLCI/GRASP development

- The use essential a priori constraints for angular properties of land and ocean BRDF is desired for single-viewing instrument, such as OLCI.
- Using the GRASP multi-pixel concept is beneficial and helps for retrieval of the isotropic surface reflectance properties together with aerosol.
- The AOD product outcome from OLCI/GRASP global processing show overall quite comparable quality with the community-reference MODIS/TERRA.

V1 is released on GRASP-OPEN web pages:
https://www.grasp-open.com/products/olci-data-release/

Main products:
AOD: 412 – 1020 nm
BRDF, BHR_ISO
Diagnoised parameters:
SSA, AAOD, etc.

Paper published in RSE for more details:

Chen, C., Dubovik, O., Litvinov, P., Fuertes, D., Lopatin, A., Lapyonok, T., Matar, C., Karol, Y., Fischer, J., Preusker, R., Hangler, A., Aspetsberger, M., Bindreiter, L., Marth, D., Chimot, J., Fougnie, B., Marbach, T., Bojkov, B., 2022. Remote Sensing of Environment Properties of aerosol and surface derived from OLCI / Sentinel-3A using GRASP approach : Retrieval development and preliminary validation. ***Remote Sensing of Environment*** 280, 113142. https://doi.org/10.1016/j.rse.2022.113142

Thanks for your attention

GRASP
In principle, yes!

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cloudflight

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