Aerosol and underlying surface characteristics retrieval at high spatial resolution

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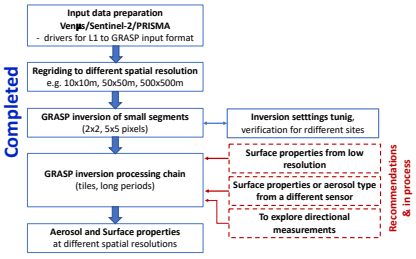
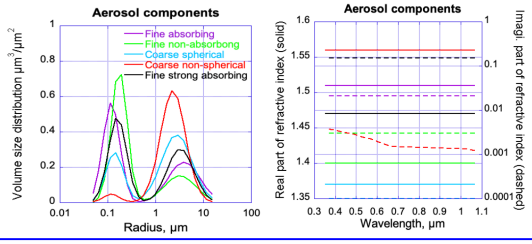
Summary: The study presents inversion of a series of synthetic and real measurements aiming evaluation of atmospheric aerosol retrieval from high spatial resolution and hyperspectral space instruments. It has been illustrated by application of the algorithm GRASP (Generalized Retrieval of Aerosol and Surface Properties) (Dubovik et al. 2021) to Venus, Sentinel-2 and PRISMA space sensors. Based on the experience of previous high spatial and hyperspectral measurements treatment, several tests were thus configurated and conduced to get an idea about aerosol retrieval capability. The tests showed that aerosol can be represented by two to four aerosol models with precomputed lookup tables of optical characteristics. To note however that in contrast to more often used lookup tables approach, the satellite level radiances in GRASP are calculated online, enabling more flexible fitting of the measurements. The derived aerosol property is thus a mixture of several aerosol components fractions having different size distribution, composition and shape. The surface reflectance is calculated through a BRDF taken at the relevant viewing and solar angles. The algorithm fully accounts for multiple interactions of scattered solar light with aerosol, surface and gas by means of solving the radiative transfer equation. In addition, the aerosol and surface properties are retrieved simultaneously, which is one of specific characteristics of the GRASP algorithm that reduces assumption and improves the retrieval consistency. If monodirectional measurements are used, then only the first parameter of the BRDF is retrieved and the second and third parameters are assumed. The inversion procedure of GRASP is based on a statistically optimized fitting following the multi-term Least Square Method and unites the advantages of a variety of approaches (Dubovik, 2004).

Methodology

Data processing approach



Aerosol model employed in the inversion

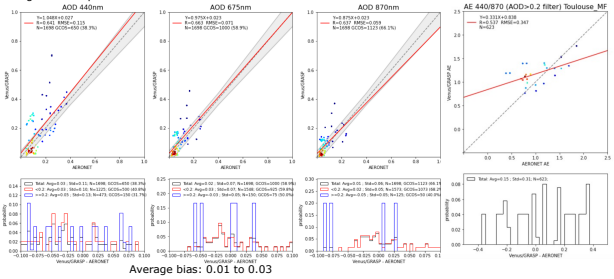


Results

AOD VENµS/GRASP vs. AERONET

Feb 2019 – Sep 2020
Toulouse site

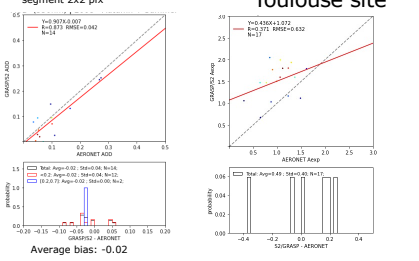
Resolution degraded to **50 m x 50m**
segment 2x2 pix



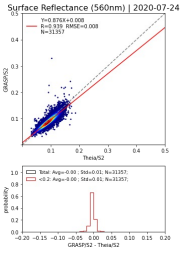
AOD Sentinel-2/GRASP vs. AERONET

Jun 2020 – Nov 2020
Toulouse site

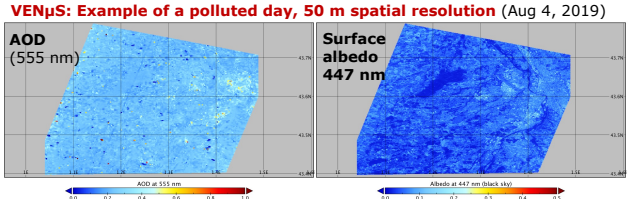
Resolution degraded to **500 m x 500m**
segment 2x2 pix



Surface reflectance Sentinel-2/GRASP vs. Theia



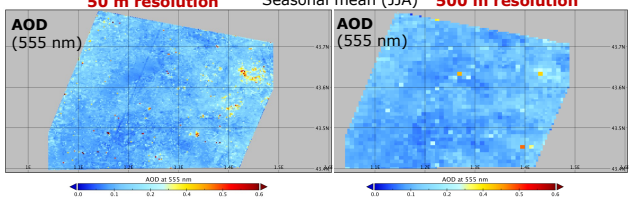
VENµS: Example of a polluted day, 50 m spatial resolution (Aug 4, 2019)



AOD can be correlated with surface, more work is needed

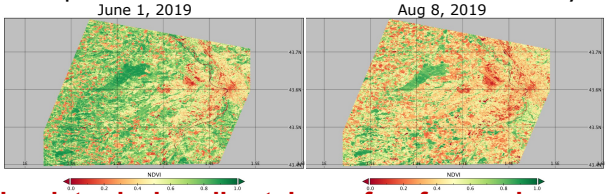
VENµS, AOD at 50m vs 500m resolution

Seasonal mean (JJA)



50m -> finer structure, more informative

Example of derived NDVI at 50 m resolution that shows seasonal variability



PRISMA images were processed using three different approaches introducing climatology of surface and aerosol.

1. **wo_clim**: one climatological aerosol type, as obtained by S5p TROPOMI/GRASP, is used universally for all PRISMA scenes, the surface is treated as isotropic;
2. **V2_w_clim**: monthly 2 degree resolution S5p TROPOMI/GRASP climatology of aerosol type is used, the surface is treated as isotropic;
3. **V3_w_clim**: monthly 2 degree resolution S5p TROPOMI/GRASP climatology of aerosol type is used, the climatology for the volumetric and geometric surface "BRDF2" and "BRDF3" parameters from TROPOMI/GRASP is used.