SEAWIFS4OLCI

Adaptation of the SEAWIFS4MERIS Algorithm to OLCI

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The aerosol retrieval algorithm for SeaWiFs (Sea-Viewing Wide Field-of-View Sensor onboard of GeoEye's OrbView-2, Sayer et al.,2012; Hsu et al., 2013) had been adopted to the similar MERIS instrument on ENVISAT (Kosmale, ATBD, 2018). Generally, the algorithm approximates aerosol optical depth (AOD) by minimizing a cost function for differences between measured and simulated top-of-atmosphere reflectances in several channels for a set of 36 different aerosol types. The AOD of the best fitting aerosol type is then selected as retrieval result. Although the fractions of dust, sea salt and absorbing aerosol are also estimated with the algorithm, they should be used with care due to the limited number of degrees of freedom in particular for weaker aerosol loadings. The algorithm works over land and ocean.

OLCI on Sentinel-3A and -3B is the successor of MERIS, so that a direct adaptation is possible using the same set of almost identical channels. OLCI has several additional channels some of which are especially designated for aerosol and atmospheric correction.

After the technical transfer from MERIS to OLCI, we present here the first results of OLCI AOD data processed with this algorithm "SeaWIFS4OLCI (S4O)" covering all 2019. Results are provided as netCDF files in orbit projection (level2) and as gridded daily and monthly averages with a horizontal resolution of one degree (level3). The level3 data is freely available (after registration) at the Copernicus Climate Change Service website(https://cds.climate.copernicus.eu/cdsapp#!/dataset/satellite-aerosol-properties?tab=overview9. It is extended every 6 months with a full mission reprocessing every 2-3 year (next at the end of 2020).

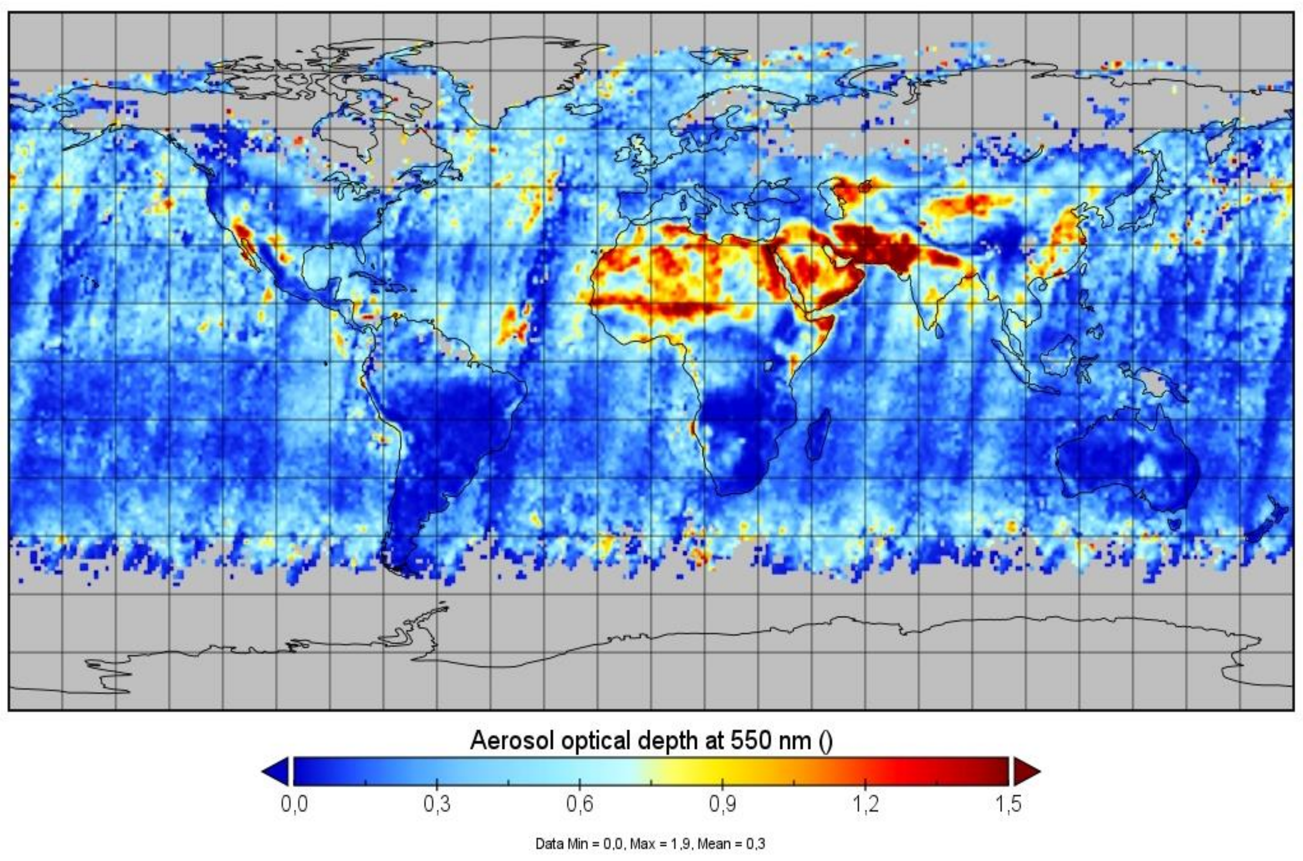

Figure 1: Monthly gridded AOD at 550 nm for May 2019 from OLCI data

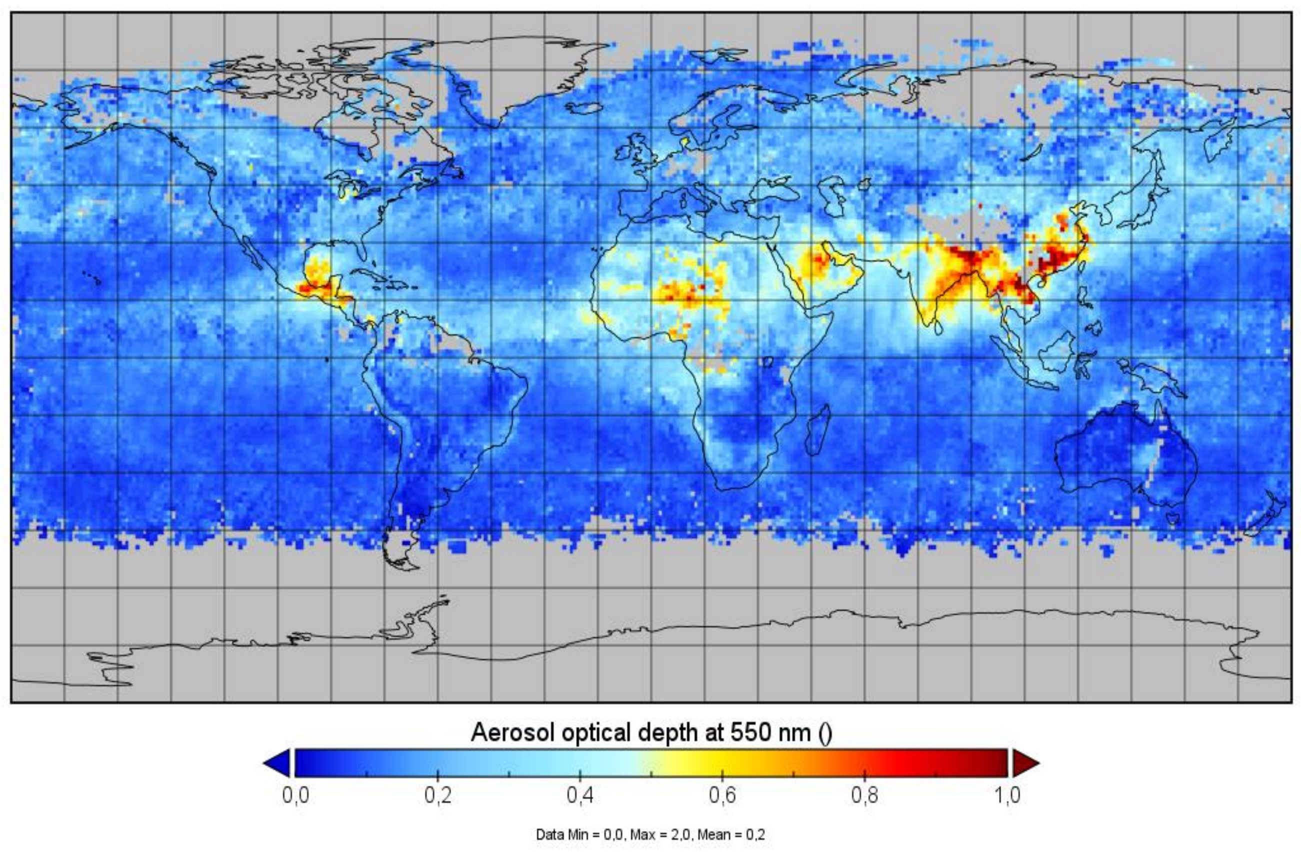

Figure 2: Monthly gridded AOD at 550 nm for May 2019 from SLSTR data

We compare the AOD results of OLCI (figure 1) to results from an ensemble of 3 algorithms (figure 2) providing AOD from the SLSTR instrument (Sea and Land Surface Temperature Radiometer). The ensemble is described in Popp et al 2019. Please note the different scales in figure 1 and figure 2. Over ocean values from the OLCI retrieval reach up to 1.2 for AOD in the Northern hemisphere and in the "Roaring Fourties" in Southern mid-latitudes. Over land the dust belt sticks out in particular in the retrieved monthly product in figure 1. There values of 1.5 or higher are widely present, particularly in the Sahara, Arabian Peninsula and stretching from Iran to the Indo-Gangetic plane. The pollution in Eastern China is visible as well. In both figures (1 and 2), AOD in the Southern hemisphere stays mostly below the value 0.5. The S4O algorithm seems to catch major patterns in the dust belt and even over Namibia, Congo and Australia. In the Middle East and California S4O shows different patterns. Those coincide with bright surfaces (see figure 3). Overall the values in figure 1 are significantly higher both over land and ocean compared to figure 2. Over land surfaces, the algorithm requires estimates of the surface albedo as input to simulate top-of-atmosphere reflectances. Those are calculated as a minimum of 10-day periods of the observed data. The current version of the albedo database was calculated from MERIS data of 2008 and therefore cannot yet treat the additional bands of OLCI.

We are working on recalculating the albedo with OLCI data to enable the use of all OLCI channels and to better characterize albedo variations between the years. Also we aim to reduce areas without albedo estimate as can be seen in high Northern latitudes in figure 4 where no AOD retrieval can be conducted.

Figure 4 shows a ten day albedo map with highest values in deserts such as the Sahara, Gobi and the Arabian Peninsula, Ayers rock and east of the Caspian sea. The lowest values can be found in mountains such as the Himalayas, the Andes and Central America. There are no values for the majority of New Guinea, Russia, Scandinavia, Canada and the polar regions. A retrieval of AOD is currently not possible in these areas. Furthermore, the albedo database needs improvement of its minimum approach and the consideration of bi-directional effects, as currently it appears that the ground albedo signatures remain visible in the AOD patterns (indicating to an incomplete correction of the albedo in the AOD retrievals). In particular, we will assess the suitability of the minimum approach in areas of brighter surfaces such as California or the Middle-East, where obviously too large AOD values are retrieved.

Another remaining deficit of the algorithm is noticeable over oceans in the monthly product (figure 1): one can see stripe-like structures which are due to an incomplete detection of glint (direct sun reflection from water). So far, glint is detected by two methods: Firstly geometrically, and then additionally with a cut off value for bright water (so far experimentally set to a retrieval value of 1.5 for AOD). When looking at an example daily image (figure 3) a regular pattern with narrow stripes of significantly larger AODs at the Eastern side of some orbits over ocean can be seen. Seasonally these stripes move further South or North leading to the conclusion, that it might be sun glint. OLCI differs from MERIS with a tilted view, which is meant to reduce glint-affected areas, but obviously needs adjustment of the glint filtering criteria.

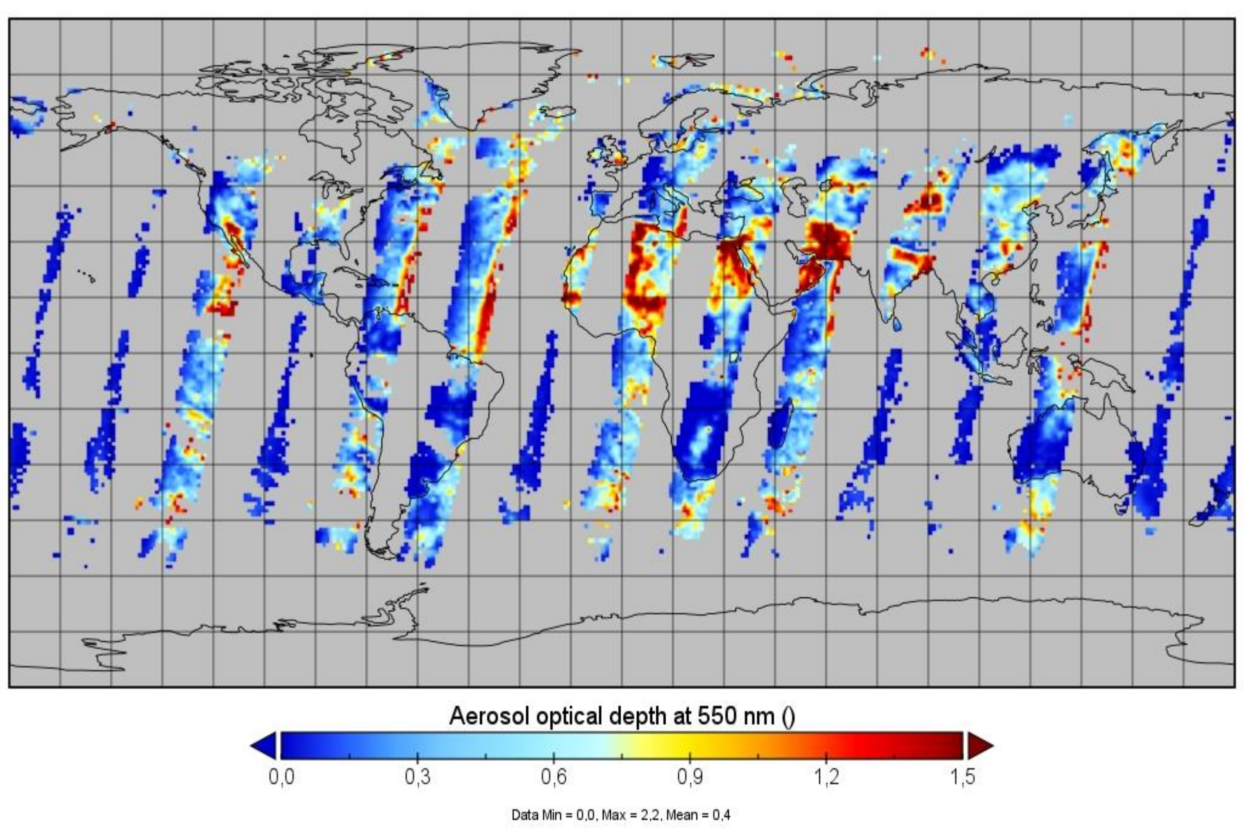

Figure 3: Daily gridded AOD at 550 nm for 01.05.2019

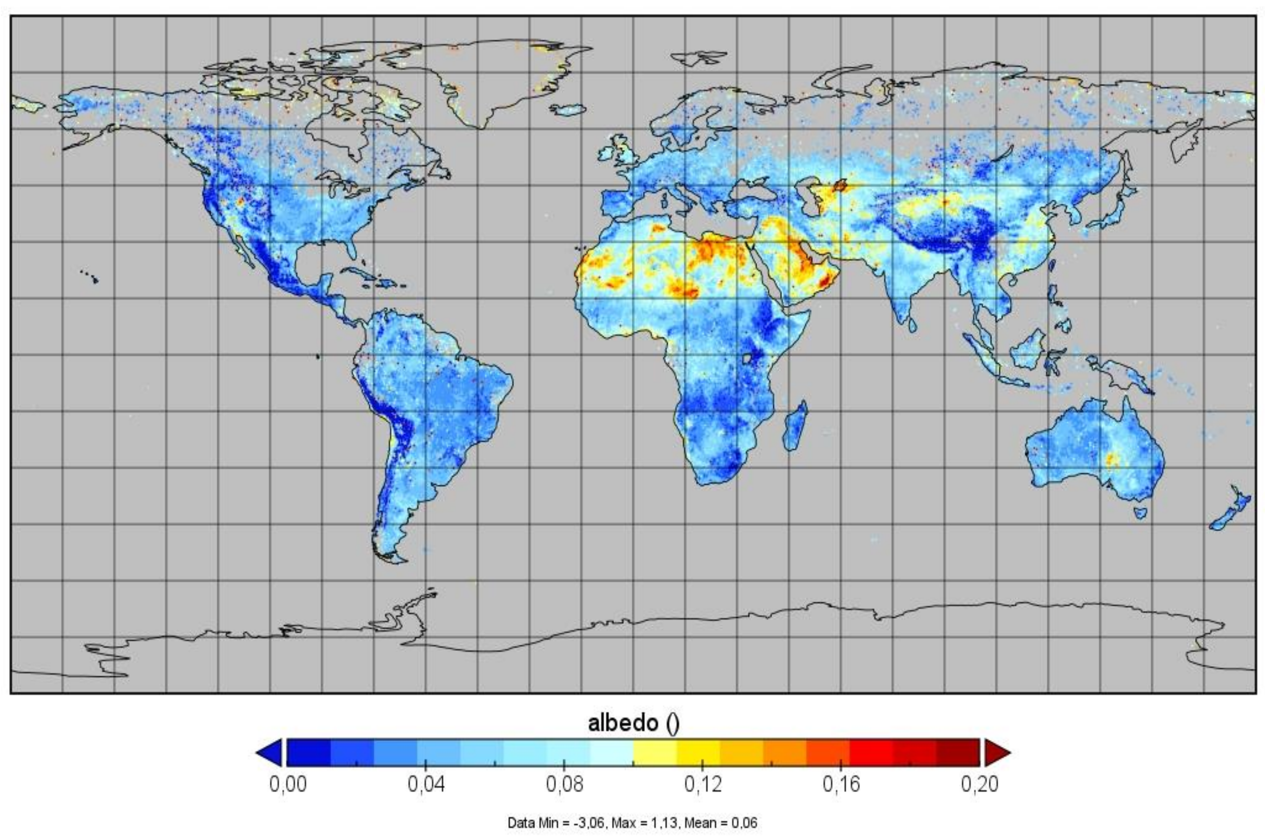

Figure 4: Surface albedo at 550 nm for the first 10 days of May calculated from MERIS data of 2008

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