3. weekly report SO 259-2

During the second week on its voyage way from Capetown (RSA) to Emden (GER) the R.V. Sonne passed the western rim of northern Africa and experienced enhanced atmospheric aerosol loads, as Saharan mineral dust plumes were transported onto the Atlantic. Thus, these dust events are topics of this report.

Even just by observing changes to the color and shape of the sun-disk, extra aerosol loads by mineral dust in the atmosphere were apparent, as those colors are quite different compared to low aerosol background conditions. At lower atmospheric aerosol loads, the sun sets at the horizon and the sun disc color is yellowish, because some of the blue color component of the sun's direct irradiance is removed by sun light scattering on air molecules (which also causes the blue color of the sky). With larger aerosol loads, especially when the sun-disc disappears before even reaching the horizon, now scattering features of aerosols start to control the colors of sky and sun-disc. However, color changes are different for smaller and larger particles. Smaller aerosol particles (e.g. originating from urban pollution, wildfires or volcanic eruptions) give the sun disc a red color, because smaller particles scatter (similar to air-molecules but at a weaker rate) preferentially at shorter solar wavelengths (blue) and can at larger aerosol loading not scatter away the blue but also the green light of the sun. In contrast, larger aerosol particles (e.g. mineral dust) do not preferentially scatter a particular color and tend to take color out of the (formerly blue) sky and the (formerly yellow) sun disc. Moreover, with the larger particles the shape of the sun-disk blurs, as larger particles have a stronger diffraction. The result is a white poorly contoured sun-disc over a white-to-greyish background. This makes for ghostly scenes which were observed during these dust events. The initial smaller mineral dust-event occurred off Senegal and the colors of its sunset is compared to the colors of other sunsets in Figure 1.

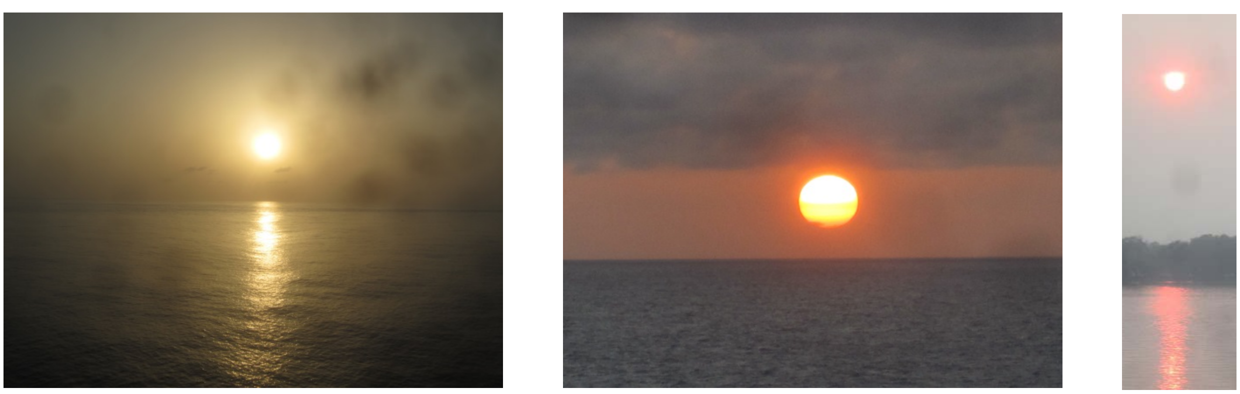

Figure 1. A sunset on a day with moderate mineral dust loads off Senegal on October 24 (left) compared a sunsets at a low aerosol loads day on October 21 near the equator (left) and of a with major pollution over Beijing in October 2016 (the color difference are even moderated by the camera)

Looking at the MICROTOPS sun-photometer measurement summary of Figure2 - as the R.V. Sonne traveled from the equator to Las Palmas - two distinct AOD maxima occurred at latitudes of about 10 and 23 deg north (there are data gaps - as sampling is possible only during the day). The low Angstrom parameter (<0.5) especially for the larger second event clearly suggest mineral dust.

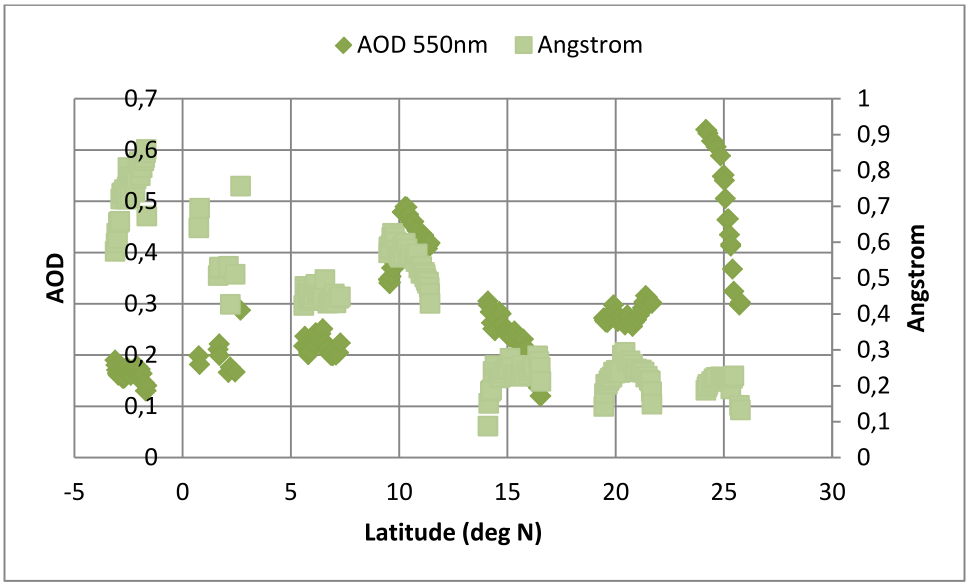

Figure 2 AOD (at 550nm) and Angstrom parameter based on sun-photometer sampling at R.V. Sonne. Data are presented for the 10/21 to 10/27 period. The AOD (dark) captures the total aerosol amount, while a relatively low (<0.5) Angstrom parameter (light) at higher AOD indicates mineral dust presence.

These measurements, in particular the strong changes in AOD, establish a useful reference data test the skill of forecast models or just the capabilities of satellite retrievals. For an initial test, five day AOD forecasts with the NRL's NAAPS model (https://www.nrlmry.navy.mil/aerosol/) are examined. This model considers MODIS satellite data and interprets them into the future (via data assimilation). This also is affected by the accuracy of the MODIS satellite data which is also examined. Hereby satellite data are spatially limited since only in cloud-free regions and over darker regions AOD data are offered. NAAPS data are presented in Figure 3 and MODIS sensor retrievals for AOD are presented in Figure 4.

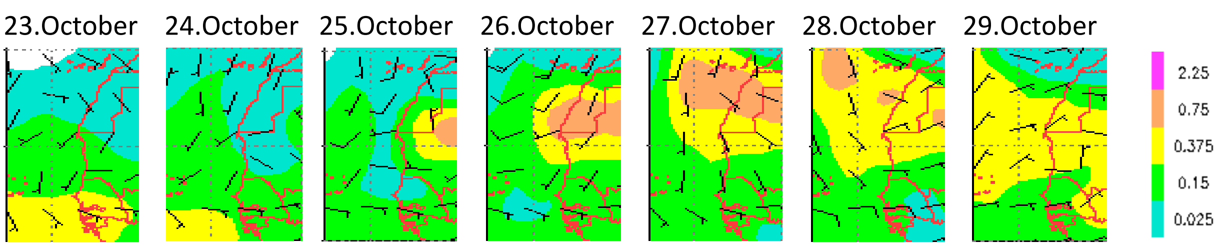

Figure 3 5 day forecasts for the dust AOD and 700mb winds for 25-10W/10-30N regions at 12UTC from 10/23 to 10/29 with the NAAPS model of the Navy Research Lab https://www.nrlmry.navy.mil/aerosol/

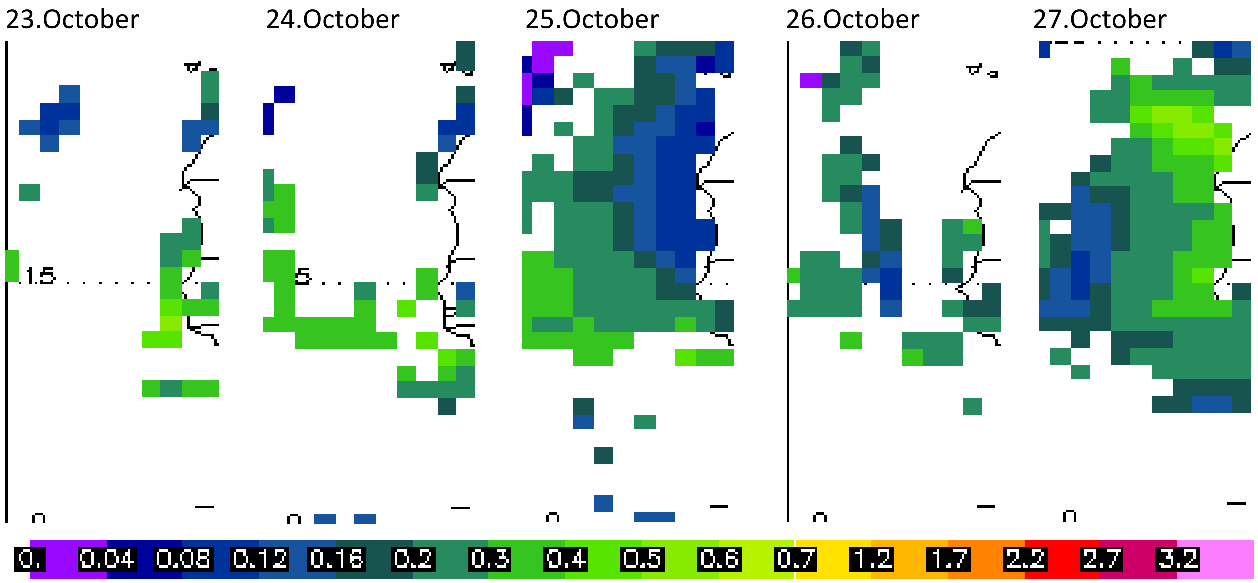

Figure 4 MODIS satellite sensor late morning and early afternoon retrieved AOD (at 550nm) maps from 10/23 to 10/28 for the 25-15W/00-30 N region. White areas did not allow retrievals due to cloud cover

The temporal AOD variability is nicely reproduced by the forecast, although the first event was predicted a day earlier, while the second maximum is too strong and placed too far to the north. Also remote sensing has reasonable skill considering difficulties to distinguish between dust and clouds, though some of the dust could not be reported, in case of co-locations with clouds (dust is frequently accompanied by high altitude cirrus clouds). Based on Figure 3 and 6 comparisons for AOD (at 550nm) at about 12 UTC are summarized in Table 1.

Table 1 comparisons of AOD (at 550nm) at the ship vs (NAAPS) predictions and (MODIS) retrievals

date *time*	*ship* **lat**	*ship* **lon**	**Angstrom**	**AOD** *ship*	**AOD** *NAAPS*	**AOD** *MODIS*
Oct 21 *12UTC*	-2.8	-7.1	.74	**0.15**		
Oct 22 *12UTC*	1.6	-10.5	.51	**0.21**		
Oct 23 *12UTC*	6.3	-14.1	.45	**0.24**	0.05-0.25	no data
Oct 24 *12UTC*	10.2	-17.2	.60	**0.49**	0.25-0.50	0.40-0.50
Oct 25 *12UTC*	15.1	-18.1	.27	**0.23**	0.00-0.05	0.16-0.20
Oct 26 *12UTC*	20.4	-18.5	.25	**0.26**	0.25-0.50	0.20-0.30
Oct 27 *12UTC*	24.8	-16.9	.22	**0.59**	0.50-1.00	0.40-0.60

The first impression is that the locally tested AOD skill by both the NAAPS model and the MODIS satellite retrieval is encouraging. And confidence in their skill needs to be demonstrated, because we rely on their capabilities to provide information on spatial context and useful aerosol forecasts.

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