Satellite and ground-based retrievals of aerosol optical properties in Arctic (2003-2011)

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Aerosol particles influence the Earth's radiation balance directly by scattering or absorbing incoming solar radiation. Improving our knowledge of Arctic aerosols and their radiative impacts is important, particularly at present day when albedo is decreasing due to reductions in sea ice and snow cover. Realistic simulations of aerosol radiative forcing at the top of the atmosphere and at the surface require knowledge of the aerosol optical thickness (AOT).

In this study 9 years (2003-2011) of MODIS-Aqua aerosol observations have been combined with ground-based long-term sun-photometer and dry nephelometer measurements as well as with climate model simulations to examine the accuracy in estimations of aerosol optical properties in the Svalbard region (82°N-75°N, 10°W-40°E). MODIS 555-nm AOT was compared to ground-based sun-photometer measurements. For the 642 matches that was obtained it was found that MODIS AOT on the whole varies within the expected uncertainty for one standard deviation of the retrieval over ocean ($\Delta AOT = \pm 0.03 \pm 0.05 \cdot AOT$).

Figure 1 shows the annual variation of MODIS median 555-nm AOT, for the period under investigation,

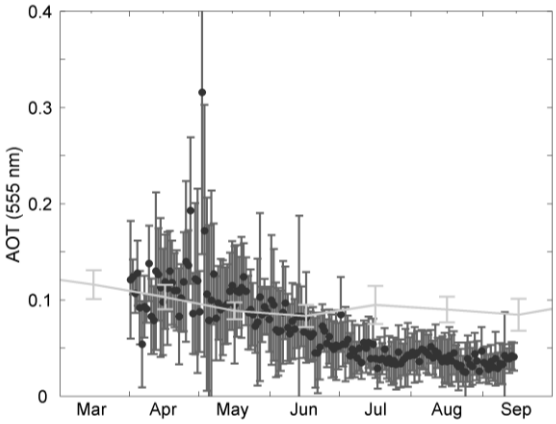

Figure 1. MODIS median AOT at 555 nm (black circle) and one standard deviation (dark gray line) averaged over all pixels that correspond to a day of the year in the 9-years period of observations (2003 – 2011). The light grey solid line denotes CAM3-Oslo model simulation of clear-sky AOT, using boundary conditions representative of the year 2000 and IPCC AR5 aerosol emissions.

compared to clear-sky AOT as simulated with the CAM3-Oslo global climate model. The latter values were obtained at 555 nm wavelength and averaged over the area investigated. Figure 1 shows that reasonable agreement occurs for the spring season while the simulated AOT is approximately a factor of 2 higher than the MODIS observations for the summer season.

Table 1 compares mean tropospheric AOT at 555 nm obtained in the framework of this study with AOT at 533 nm as obtained at Svalbard in the 1990's (Herber et al., 2002). The tropospheric AOT for the time period 2003-2011 was screened for the contribution of volcanic events by subtracting stratospheric AOT from Odin/OSIRIS measurements. In the present study we found June to mark the transition between spring- and summer-time aerosol conditions. Fig. 7 in Herber *et al.* (2002) on the other hand suggests that the transition occurred over a rather short period in late May in the 90's. The difference in AOT between June and July/August for the present period is statistical significant at the 99.9% confidence level (unpaired t-test) for all three platforms. This change in aerosol conditions suggests that Arctic was isolated during a longer period in the 90's compared to the last decade, in in line with weakened zonal winds and increased wave amplitude during 2000-2010, thus, moving the Rossby waves poleward (Francis and Vavrus, 2012).

Table 1. Tropospheric mean AOT at 555 nm (this study) and 532 nm (Herber et al. 2001, 1991 – 1999) resolved according to different times of the year.

Season	AOT (555 nm)			AOT (532 nm)
	2003 - 2011			1991 - 1999
	$MODIS_{c005}$	AERONET	Polar-AOT	Polar-AOT
Apr -May	0.113 ±0.069	0.092 ±0.050	0.070 ±0.036	0.089 ±0.033
Jun	0.071 ±0.045	0.066 ±0.037	0.063 ±0.035	
Jul - Aug	0.040 ±0.026	0.040 ±0.025	0.035 ±0.023	
Jun - Aug				0.046 ±0.024
Sep	0.032 ±0.021	0.036 ±0.020	0.025 ±0.058	0.031 ±0.014

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Francis, J. A. and Vavrus, S. J. (2012) *Gephys. Res. Let.*, **39**, L06801, doi:10.1029/2012GL051000, 2012.
Herber, A. *et al.* (2002) *J. Geophys. Res.*, **107 (D10)**, doi:10.1029/2001JD000536.