Aerosol Properties in the European Arctic Region

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Anthropogenic aerosol sources are almost absent in the Arctic. Arctic haze, commonly present in Arctic springtime, is a result of long-range transport from sources in Russia, Europe and North America. Recent studies indicate that boreal forest fires might be an important source of light absorbing aerosols in the Arctic (Stohl *et al*, 2006). This study focuses on optical properties of aerosols in the European Arctic discussed in relation to observations of chemical constituents and transport into the Arctic.

ALOMAR: The observatory managed by Andøya Rocket Range (http://alomar.rocketrange.no/) is located at the Atlantic coast of Norway at 69.2°N, 16.0° E, 380 m asl. The instrument used is a Cimel Electronique CE-318 sun photometer with spectral interference filters centred at 340, 380, 440, 501, 675, 870 and 1020nm for aerosol measurements (Toledano et al, 2006).

Ny-Ålesund: The precision-filter-radiometer (PFR) is located at the Sverdrup station in Ny-Ålesund (50 m asl) whereas the chemical measurements is from the Zeppelin observatory at a mountain 474 m asl. The PFR has been operated for four years, (Hermansen, et al. 2005) with direct sun radiation measured in four narrow spectral bands at 862, 500, 412, and 368 nm.

Ny-Ålesund ALOMAR

Ny-Ålesund 2005

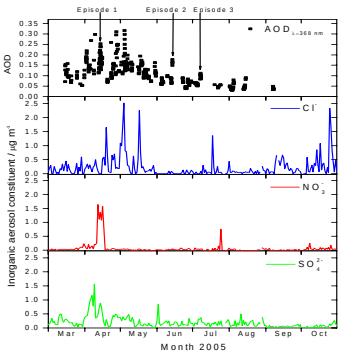


Figure 1: *AOD measurements from Ny-Ålesund in 2005 together with inorganic aerosols constituents from the Zeppelin observatory.*

Figure 1 shows hourly AOD measured at Ny-Ålesund in 2005 together with daily filter analysis of SO_4^{2-}, NO_3^- and Cl^-. The observations show increased aerosol levels during the Arctic haze period in spring. However, there are also episodes later in the year with elevated AOD levels. Noteworthy the episodes does not necessarily coincides with increased levels of inorganic aerosol constituents at the Zeppelin station. During summertime the number of days where measurements can be performed is reduced due to foggy weather conditions. Therefore we plan to move the instrument during 2006 to the Zeppelin observatory to increase the number of observations.

Comparison with ALOMAR

A comparison of AOD measurements from summer 2005 at ALOMAR and Ny-Ålesund show, as expected, much higher aerosol load at the Sub-Arctic site ALOMAR. Few periods with high AOD at ALOMAR agree with high AOD at Ny-Ålesund. More measurements and transport modelling are necessary to explore this further.

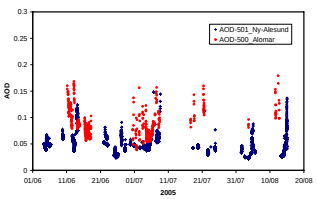
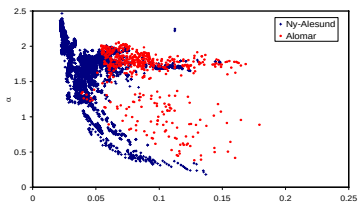


Figure 2: *AOD measurements from Ny-Ålesund and ALOMAR during summer 2005.*



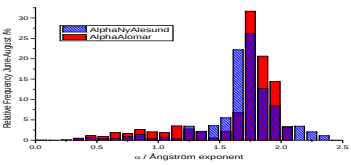


Figure 3: *A comparison of a based on data from ALOMAR and Ny-Ålesund.*

The Ångstrom exponent, a, provides information about the size of the aerosols. Larger values of a imply a relatively high ratio of small particles to large particles. The results in Figure 3 indicate that for both sites there is a predominance of large Angstrom exponents, indicating samall aerosol particles. According to Toledano et al. (2006) in summer 2006 a was larger than 1 in 97 % of the time at ALOMAR. These results need further evaluation.

Selected episodes at Ny-Ålesund 2005

	Date	Max. $AOD_{\lambda=501\,nm}$	Ångstrom exponent, α mean values	Inorganic constituents
Arctic haze	March-April	0.25 (0.12 mean)	1.18, σ = 0.27	Medium
Episode 1	13. -14. April	0.16	1.73 σ = 0.08	High
Episode 2	12 -14. June	0.11	1.77 σ = 0.06	Low
Episode 3	7. - 8. July	0.08	1.88 σ = 0.06	Low

Interpretation supported by the FLEXPART model and lidar* observations

We have used FLEXPART and *The NILU Atmospheric Backward Transport Analysis Products* to interpret transport processes and how they influence measurements taken at the Zeppelin observatory. See: http://zardoz.nilu.no/~andreas/STATIONS/ZEPPELIN/index.html

The analysis support the suggestion that anthropogenic CO sources in Europe and North America contributed to elevated AOD at Ny-Ålesund in mid June 2005, and there were no anthropogenic sources of inorganic constituents at the same time. Interpretation of the episodes are supported by lidar measurements performed by NASA (MPLNET*).

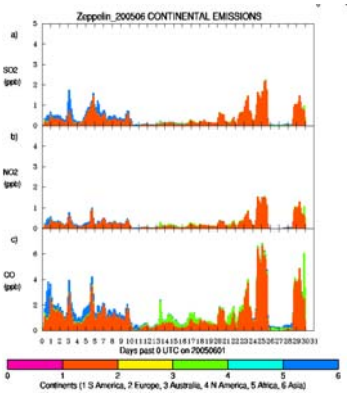


Figure 4: *The continental emissions influencing the air masses arriving daily at Zeppelin in June 2005 (Episode 2).*

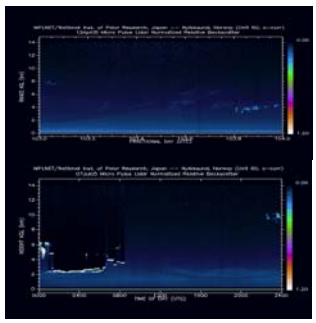


Figure 5 (left): *Lidar results for episode 1 and 3.*

In the upper panel we see increased backscatter in the boundary layer, while 7. July, afternoon, an aerosol layer around 2-3 km is evident.

Conclusions

- AOD data from Ny-Ålesund clearly show the presence of Arctic haze in the spring months.
- The episodes in June and July seem to be a result of long range transport.
- Anthropogenic CO sources in Europe and North America contributed to the aerosol load at Ny-Ålesund in mid June 2005.
- Comparison of AOD data from Ny-Ålesund and ALOMAR is difficult due to few data for overlapping dates, however there might be situations where the aerosol sources at the two sites are the same.
- High Ångstrøm coefficients indicate that small aerosols dominate both at Ny-Ålesund and ALOMAR.

Further studies…

- Complement the analysis with observed CO, BC, extinction measurements and analyse filters for tracers like levoglucosan.
- Use Flexpart to analyse episodes with elevated AOD.

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References

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Acknowledgments

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