Aerosol optical properties obtained from troposheric lidar and s photometer measurements in 2005 and 2006 at ALOMAR (69°N,

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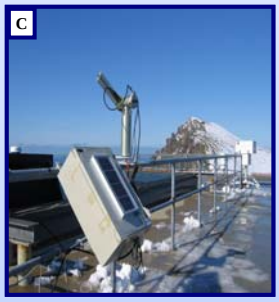
At the northernmost, and only sub-Arctic/Arctic site in the EARLINET, at ALOMAR (69°16'N, 16°00'E), a tropospheric Raman lidar is in operation since July 2005. It is co-located to a sun photometer, a Cimel Electronique instrument, type CE-318. After a few years of campaign operation, the photometer has been deployed to ALOMAR on a permanent base in spring 2006. It is regularly calibrated within the Spanish Network for Aerosol Measurements (RIMA), in close collaboration with AERONET-PHOTONS and according to the AERONET protocols. Synergy with further co-located instrumentation, like a Brewer and a VHF radar (from IAP, Kühlungsborn, Germany) is beneficial for finding answers to scientific questions as well as when using the measurements from the site as ground-truth for satellite and model validation.

A

B

Map ***A*** shows the location of all EARLINET sites in 2007. The above photo shows the ALOMAR observatory (Fig. **B**). The sun-photometer is located on the roof of the building (Figure **C**), the tropospheric lidar (Figure **D** shows the telescope), is co-located with a stratospheric ozone lidar, the stratospheric / mesospheric RMR lidar and a Na-lidar. An overview of the technical specification of the topospheric lidar is given in Table **E**. For further information about the lidar and the sun-photometer see [1],[2] and [4],[5], respectively.

C



D

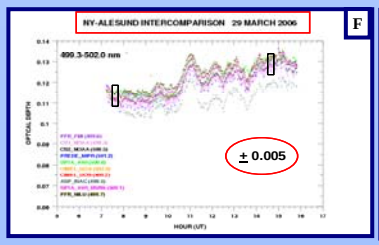
System name	ALOMAR Troposphere Lidar				
Home Location Coordinates	69.270 N	16.000 E	380 m asl		
Home Location Environment	coastal / remote continental				
Emitter	**Laser 1**				
Laser type	Nd:YAG				
Laser manufacturer	Spectra-Physics				
Laser model	GCR 6-30				
Pulse energy total (typ.)	1.0 J				
Repetition rate	30 Hz				
Wavelength	1064 nm	532 nm	355 nm		
Pulse energy (typ.)	0.60 J	0.29 J	0.11 J		
Polarization and purity (nominal)	unpoarised	linear	linear		
Polarisation orientation		vertical	horizontal		
Laser beam diameter (mm)	10				
Beam expansion factor	5				
Beam divergence	80-140				
Receiver Optics	**Telescope 1**				
Telescope type	Newtonian, primary parabolic				
Telescope manufacturer / model	Unknown				
Telescope obscuration diamete	0.050 m				
Focal length	1.25 m				
Detection channels					
Centre wavelength [nm]	355	387	532	532	1064
Scattering mechanism	Elastic	Vibr.Raman N2	Elastic parallel	Elastic cross	Elastic
Operational	Yes	Yes	Yes	Yes	Yes
Raw data dange resolution			7.5 m		
Raw data time resolution			70 s		
Raw data altitude range			64 km		
Upgrade					
Centre wavelength [nm]	408	608	660		
Scattering mechanism	Vibr.Raman H2O	Vibr.Raman N2	Vibr.Raman		
Operational	No	No	No		

E

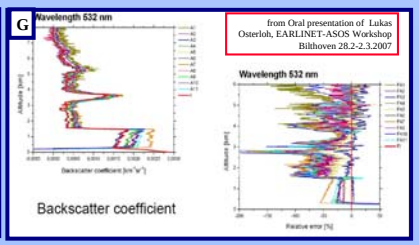
Data quality:

To ensure good data quality, instrumental and algorithm intercomparisons are important. Figure ***F*** shows an expample outcome from the POLAR-AOD network intercomparison campaign, which has been held in March / April 2006 in Ny-Ålesund. Recently, an algorithm intercomparison has been performed within the EU project EARLINET-ASOS. In Figure **G** we show results from Stage 1, where synthetic elastic data without further information, except for ground temperature and pressure, have been distributed (the results from ALOMAR are labelled as A2). The performance of the Cimel-sunphotometer seen during the POLAR-AOD intercomparison campaigns as well as the results from the EARLINET algorithm intercomparison have been good, which gives confidence in the quality of the results obtained at that site.

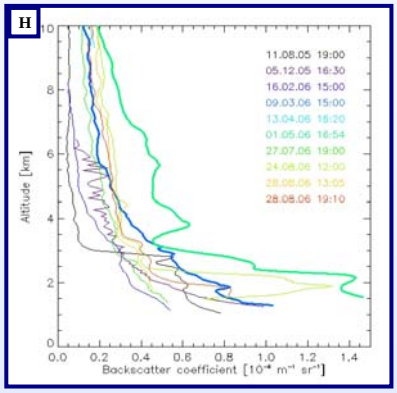
F



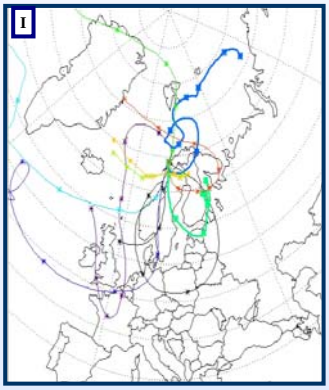
G



H

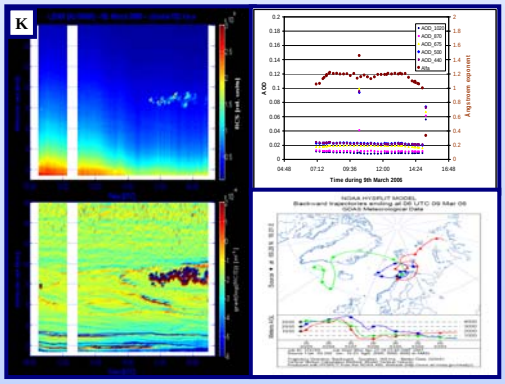


I

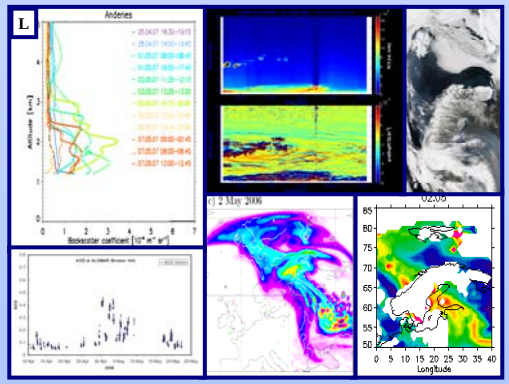


J	Site	Yearly mean			Typical Arctic haze level	
		Period	AOD	α	AOD	α
	ALOMAR	2002-2006	0.086	1.54	0.13	1.65

K



L



In Figure **H** examples of lidar measurements from ALOMAR (profiles of aerosol backscatter coefficients), which have been submitted to Earlinet, from the end of 2005 and 2006, are shown. Depending on the synoptic weather situation, air masses characterized by strong marine or continental influenced aerosol content can be observed. For trajectories from the north and north-west ALOMAR experiences relative unpolluted, clear air (see Figure **I**). Two cases are highlighted, showing a. a background aerosol layer (see Figure **K**) and b. results from the record high pollution level seen in the European Arctic due to agricultural / forest fires in Eastern Europe in spring 2006 (Figure **L**). The latter case is discussed in detail in [5]. For comparison average yearly mean AOD and typical Arctic haze values are given in Table **J.**

In Figure **I** the range-corrected backscatter signal (RSC), the gradient of the log RCS - showing the layering, the AOD and Ångström coefficient and back-trajectories during a background situation are shown.

Figure **L** illustrates the situation during an extreme pollution event seen in spring 2006. Profiles of aerosol backscatter coefficients, RCS, grad(log RSC) back-trajectories are shown. Below, Brewer AOD from ALOMAR are given. The plume is as well clearly seen in the MODIS pictures of northeast Europe and Northern Scandinavia. The red dots in Eastern Europe indicate fires. Aerosol optical depth at 550 nm for the period 2 May 2006 from the MODIS Collection Version 5. Data from Aqua and Terra are combined in the plots. The event is well captured by the total columns of the FLEXPART BB CO tracer (for more details see [5]).

Outlook:

To estimate a climatology of aerosol properties and to study air pollution/haze events at the Sub-Arctic site.
To further exploit the synergy between the tropospheric lidar and the co-located VHF MST radar (from IAP Kühlungsborn, Germany) to study aerosol layer dynamics.
Validation and use of data from CALIPSO, **ADM-Aeolus** (use lidar for aerosol profiles + radar for winds), and **EarthCare**

Publications:

1.Frioud et al., New Tropospheic Lidar System in operation at ALOMAR (69N, 16E), 23rd ILRC, July 24-28, 2006, Nara.
2. Frioud et al., Observation and characterization of aerosols above ALOMAR (69°N) by tropospheric Lidar, sun-photometer and VHF Radar, Remote Sensing SPIE, Sept 11-14, 2006, Stockholm.
3. Myhre, C.L. et al.,Aerosol optical properties and regional radiative impact of the extreme Arctic haze event in spring 2006, to be submitted to Atm.Chem.Disc., 2007.
4. Toledano, C.: Climatología de los aerosols mediante la caracterización de propiedades ópticas y masas de aire en la estación "El Arenosillo" de la red AERONET, Tesis doctoral, Universidad de Valladolid, 2005.
5. Toledano, et al.: Aerosol optical depth at ALOMAR Observatory (Andøya, Norway) in summer 2002 and 2003, Tellus, 58B, 218--228, 2006.

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