ILMATIETEEN LAITOS
METEOROLOGISKA INSTITUTET
FINNISH METEOROLOGICAL INSTITUTE

Aerosol optical properties in northern Finland

H. Lihavainen, A.-P. Hyvärinen and N. Kivekäs

Finnish Meteorological Institute, Erik Palménin aukio 1, 00560 Helsinki, Finland

BACKGROUND

It has been estimated that one aerosol component, black carbon, is responsible for 50 % of the total temperature increases in the Arctic from 1890 to 2007 (Shindell and Faluveg, 2009), and this is amplified because of simultaneous reduction of sulfur aerosols. The way that aerosols affect the Arctic climate depends not only on their properties, but also the time of the year they reach the Arctic areas.

Aerosol optical properties have been measured continuously in the Finnish (sub-)Arctic GAW- station Pallas since April 2000.

The scattering and backscattering coefficients:

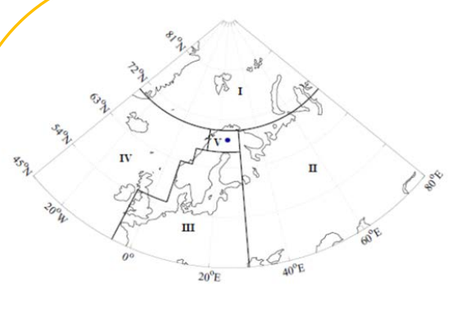
-integrating nephelometer (model 3563, TSI, Inc.)

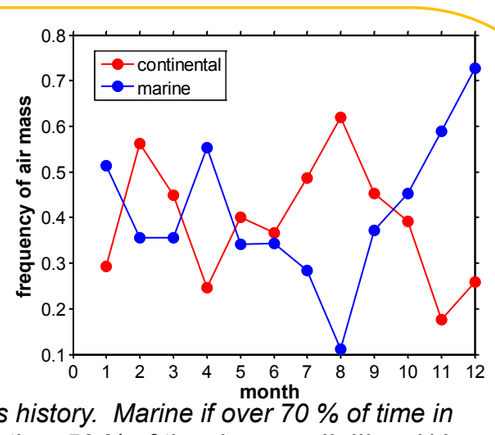
Aerosol absorption coefficient (and BC) :

- Aethalometer (model AE31m Magee Scientific)

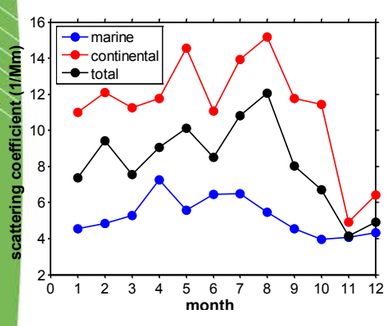
Data reported here is at 550 nm wavelength. Instrumental data coverage was 86 %. The cases when station was inside cloud were left out. This lowered the data coverage to 51 %. Nonidealities due to nonlambertian and truncation errors in nephelometer were corrected with the method by Anderson and Ogren (1998) . The aethalometer filter loading artefact was corrected using approach by Weingartner *et al.* (2003)

RESULTS

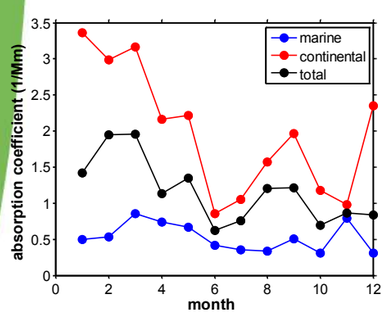




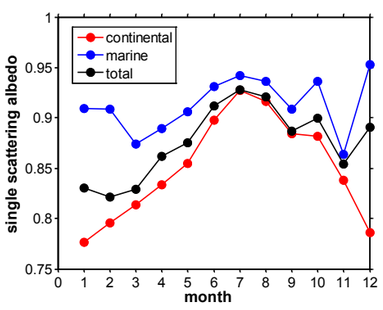
Division data according to air mass history. Marine if over 70 % of time in areas I and IV, continental if more than 50 % of time in areas II, III and V.



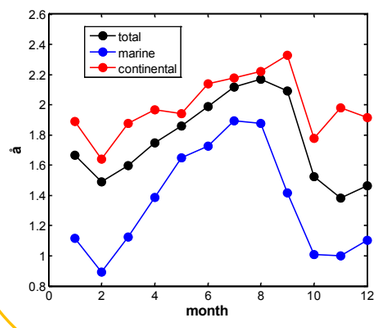
Annual variation of scattering coefficient. *Highest values are oserved in summer with al lair masses . Marine and continental air masses have different locations of maximum values. Minimum in all cases is during late fall –beginning of winter.*



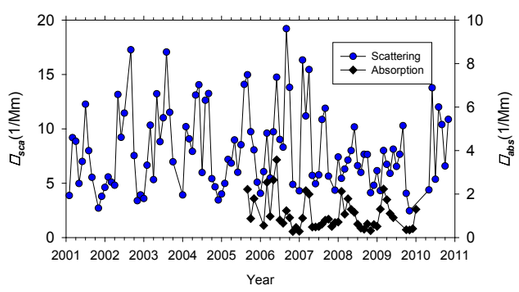
Annual variation of absorption coefficient. *Lowest values are observed during summer and highest during winter, especially in continental air masses. Emissions from domestic wood combustion have very similar trend with continental absorption coefficient. Marine air masses have very little annual variation.*



Annual variation of single scattering albedo. *During winters aerosol is clearly more absorbing than summers. This is because anthropogenic sources dominate . In summers most probably natural sources increase scattering coefficient .*



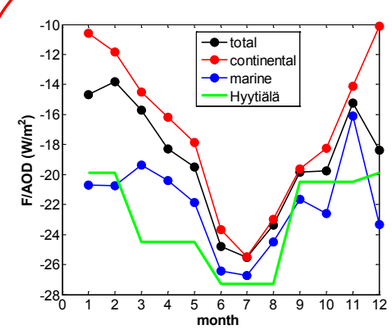
Annual variation of Ångström exponent. *A large Ångström exponent, å, implies an aerosol size distribution with scattering dominated by submicron particles, while a distribution dominated by coarse particles has typically smaller å. Marine air masses are dominated by larger particles, whereas continental air masses are dominated by submicron particles.*



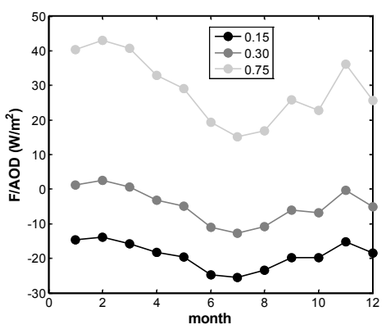
Scattering and absorption coefficients as a function of time. *Clear trend in scattering coefficient is not observed. Summers 2008 and 2010 seems to be lower than the previous years.*

Table I. Long term trend of scattering coefficient in different months. *The trend of scattering coefficient during the measurement period was investigated for each month separately. In all air masses, in summer the trend is decreasing whereas in winter scattering coefficients are increasing during the measurement period.*

Air mass		1	2	3	4	5	6	7	8	9	10	11	12
Total	R^2 slope	0.01	0.01	0.05	0.30 -0.60	0.08	0.80 -0.76	0.14	0.00	0.04	0.07	0.63 0.29	0.39 0.33
Continental	R^2 slope	0.02	0.00	0.03	0.16	0.01	0.42 -0.79	0.34 -0.40	0.03	0.07	0.02	0.00	0.28 0.33
Mari	R^2 slope	0.00	0.02	0.04	0.13	0.13	0.54 -0.53	0.56 -1.02	0.32 0.15	0.36 0.18	0.69 0.29	0.66 0.10	0.56 0.28



Annual cycle of aerosol forcing efficiency. *Direct radiative forcing by aerosols divided by aerosol optical depth (AOD). Values are normalized so that similar values have been used for sun radiation, cloudiness, surface reflectance and atmospheric transmission for both locations. Only aerosol properties are varied. In southern Finland, Hyytiälä (Virkkula et al, 2011) aerosol have higher cooling potential than in Pallas.*



Annual cycle of aerosol forcing efficiency with different surface reflectance values. *Same figure as above for total with different surface reflectance values. Surface reflectance for snow in Antartica is about 0.9 and in boreal forest about 0.3 . The aerosol forcing efficiency is warming during winter time if surface reflectance is above 0.3. However, the winter time warming potential of aerosols interacting with short wave sun radiation can influence only late winter and spring time when sun is actually shining and snow is still on the ground.*

Acknowledgements: This work was supported by the Academy of Finland Center of Excellence Program (project 1118615), Maj and Tor Foundation and MACEB funded by EU LIFE + .

References:

Anderson, T. L. and J. A. Ogren (1998). Determining aerosol radiative properties using the TSI 3563 integrating nephelometer, A*erosol Sci. Technol.*, **29**, 57–69.

Shindell D. and G. Faluveg (2009). Climate response to regional radiative forcing during the twentieth century, *Nature Geoscience* **2**, 294 - 300

Virkkula A. , J. Backman, P. P. Aalto, M. Hulkkonen, L. Riuttanen, T. Nieminen, M. dal Maso, L. Sogacheva, G. de Leeuw, and M. Kulmala, (2011). Atmos. Chem. Phys., 11, 4445–4468,

Weingartner E., Saathoff H., Schnaiter M., Streit N., Bitnar B., and U., Baltensperger (2003). *J. Aerosol Sci.*, **34**, 1445–1463.