Masterproject: ”Tracking black carbon sources in Europe”

Supervisors: Dr. Peter Tunved, Dr. Paul Zieger, Prof. Johan Ström (ACES luftlab)

Credit: 45 or 60 credits

Start: January 2016 or later.

Atmospheric aerosols, which are defined as solid or liquid particles suspended in the air, are tiny and mostly not visible to our eyes. Nevertheless, they have an immense impact on our health and on our global climate as well. Aerosols scatter and absorb solar radiation and by doing so they directly influence the Earth’s radiation budget. In addition, anthropogenic aerosol particles also modify cloud properties, causing e.g. brighter clouds with longer lifetimes and changed precipitation behavior.

Black carbon (BC) is emitted from different natural and anthropogenic combustion processes like wild fires and fossil fuel burning in industrial processes or transport. The atmospheric lifetime of BC ranging from a few days to weeks is small compared to green-house gases and thus explains the very inhomogeneous spatial distribution. In addition, the long-range transport and processes affecting the lifetime of BC are poorly understood.

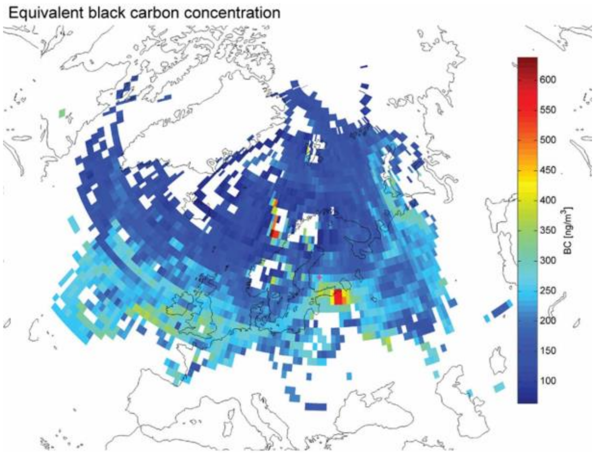

Figure 1 *An example black carbon sources deteremined for Hyytiälä (Finland, see magenta cross). The color scales gives black carbon concentration and hot spots can e.g. be identified around St. Petersburg. This calculation is done for May-August 2013 (see Zieger et al., 2015).*

Within this master work, the candidate will use and improve inverse model approaches to map the BC source regions in Europe using measurements of BC from different European monitoring stations together with air-mass trajectories describing source history in terms of geographical coordinates as well as meteorological parameters such as precipitation (HYSPLIT; Draxler and Hess, 1998) to identify the sources, their strength and seasonality. BC is usually measured using optical methods (like aethalome-ter, multi-angle absorption photometers or particle soot absorption photometers). This data is already available and can be ob-tained from open databases (e.g., EBAS).

The method has been tested for several other sites, e.g. Hyytiälä, Finland (see Fig. 1) with promising results. However only for a limited time of and using single receptors. Taking several stations for a common time period throughout Europe will substantially enhance the source identification potential by reducing shadowing effects due to non-stochastic air mass transport patterns and will enable to map the BC sources for the entire European continent.

Methods:

- Literature study to become familiar with the used measurement techniques for BC and the trajectory modeling
- Time series analysis for the different measurement sites, site evaluation, HYSPLIT trajectory analysis, cluster analysis
- MATLAB (basic analysis software will be provided, the student is encouraged to improve upon these programs)

Literature:

- Bond, Tami C., et al. "Bounding the role of black carbon in the climate system: A scientific assessment." Journal of Geo-physical Research: Atmospheres 118.11 (2013): 5380-5552.
- Draxler, R. R. and Hess, G.: An overview of the HYSPLIT_4 modelling system for trajectories, Aust. Met. Mag., 47, 295–308, 1998.
- Zieger, P. et al.: Low hygroscopic scattering enhancement of boreal aerosol and the implications for a columnar optical closure study, Atmos. Chem. Phys., 15, 7247-7267, doi:10.5194/acp-15-7247-2015, 2015.

Interested or questions? Please contact Paul Zieger (paul.zieger@aces.su.se).