Project no. 282688

ECLIPSE

Evaluating the **Cl**imate and Air Quality **Im**p**a**cts of **S**hort-Liv**e**d Pollutants

Collaborative Project

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Deliverable 1.2

Quantifying black carbon from biomass burning by means of levoglucosan –

A one year time series at the Arctic observatory Zeppelin

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Organisation name of lead contractor for this deliverable:
NILU - Norsk institutt for luftforskning
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Revision 1

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Levoglucosan, a highly specific tracer of particulate matter from biomass burning, has been used to study the influence of residential wood burning, agricultural waste burning and boreal forest fire emissions on the Arctic atmosphere black carbon (BC) concentration. A one year time series from March 2008 to March 2009 of levoglucosan has been established at the Zeppelin Observatory in the European Arctic. Elevated concentrations of levoglucosan in winter (Mean: 1.02 ng m^{-3}) compared to summer (Mean: 0.13 ng m^{-3}) were observed, resembling the seasonal variation seen for e.g. sulphate and BC. The mean concentration in the winter period was two to three orders of magnitude lower than typical values reported for European urban areas in winter, and one to two orders of magnitude lower than European rural background concentrations. Episodes of elevated levoglucosan concentration were more frequent in winter than in summer and peak values were higher, exceeding 10 ng m^{-3} at the most.

Concentrations of elemental carbon from biomass burning (EC_{bb}) were obtained by combining measured concentrations of levoglucosan and emission ratios of levoglucosan and EC for wild/agricultural fires and for residential wood burning. Neglecting chemical degradation by OH provides minimum levoglucosan concentrations, corresponding to a mean EC_{bb} concentration of 3.7±1.2 ng m^{-3} in winter (October–April) and 0.8±0.3 ng m^{-3} in summer (May–September) or 8.8±4.5 % of the measured equivalent black carbon (EBC) concentration in winter and 6.1±3.4 % in summer. When accounting for chemical degradation of levoglucosan by OH, an upper estimate of 31-45 % of EBC could be attributed to EC_{bb} (EC_{bb} adjusted for chemical degradation) in winter and < 65% in summer. Hence, fossil fuel sources appear to dominate the European Arctic BC concentrations in winter, whereas the very wide range obtained for summer does not allow us to conclude upon this for the warm season.

Calculations using the Lagrangian particle dispersion model FLEXPART show that the seasonal variation of the modelled EC_{bb} (EC_{bb}, m) concentration compared relatively well with observationally derived ECbb from agricultural/wild fires during summer, and residential wood burning in winter. The model overestimates by a factor of 2.2 in winter and 4.4 in summer when compared to the observationally derived mean EC_{bb} concentration, which provides the minimum estimate, whereas it underestimates by a factor of 2.3-3.3 in winter and a factor of 4.5 in summer when compared to EC_{bb}, which provides the upper estimate. There are indications of too low emissions of residential wood burning in Northern Russia, a region of great importance with respect to observed concentrations of BC in the European Arctic

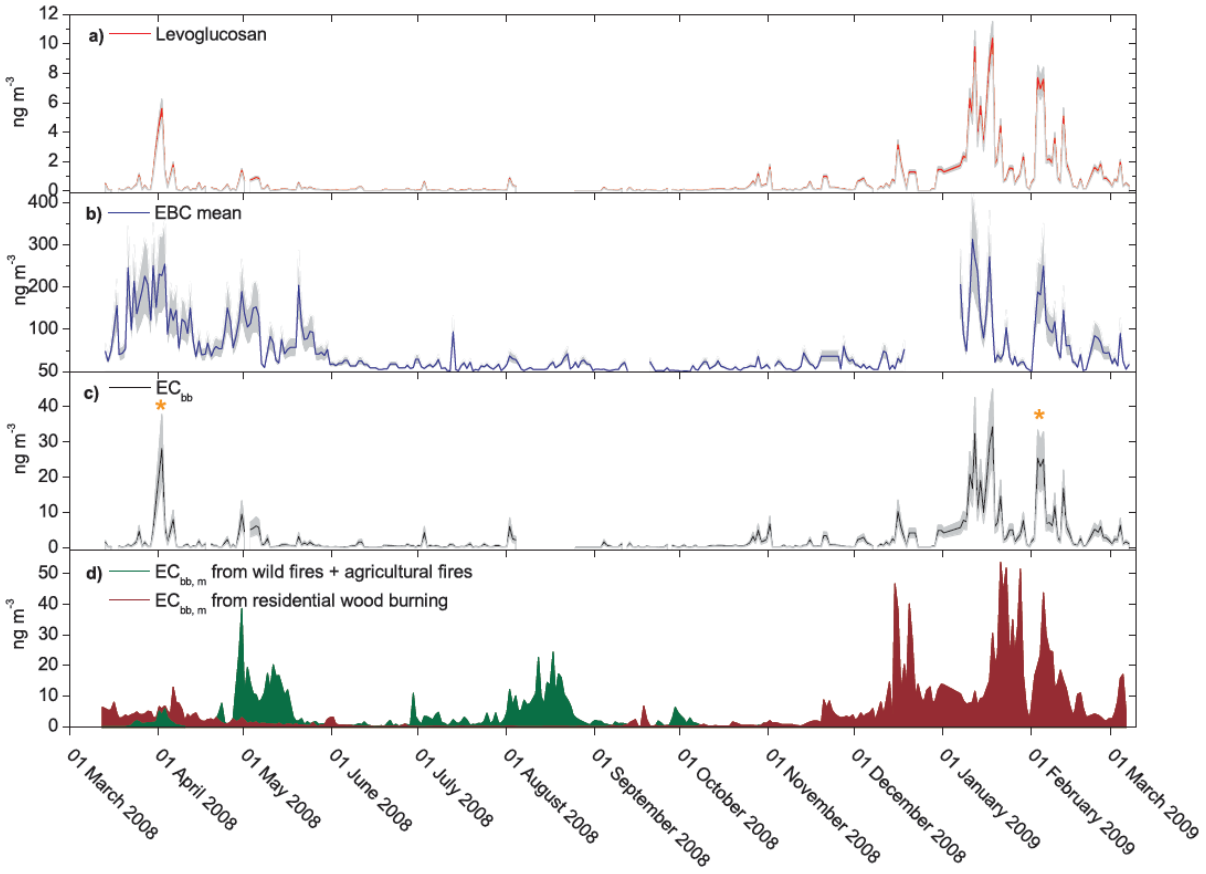

Figure 2: Ambient aerosol concentrations of levoglucosan **(a)**, equivalent black carbon (EBC) **(b)**, and elemental carbon from biomass burning (EC_{bb}) **(c)**, presented as 24 h mean concentrations or the Zeppelin Observatory during the period March 2008-March 2009. **(d)** shows modeled concentrations of EC_{bb} ($EC_{bb, m}$), as obtained by the FLEXPART model. The green curve is the sum of EC from wildfires and agricultural fires, whereas the red curve is EC from residential wood burning. The two orange asterisks in **(c)** indicates episodes with a rapid increase in the EC_{bb} concentration that are not captured well by the model and which are discussed in further detail in Sect. 4.4 of the peer reviewed paper.

The whole study can be found at:

Yttri, K. E., Lund Myhre, C., Eckhardt, S., Fiebig, M., Dye, C., Hirdman, D., Ström, J., Klimont, Z., and Stohl, A.: *Quantifying black carbon from biomass burning by means of levoglucosan – a one year time series at the Arctic observatory Zeppelin*, **Atmos. Chem. Phys. Discuss.**, 13, 31965-32003, doi:10.5194/acpd-13-31965-2013, 2013.