Black carbon and organic carbon in Finland: Measurements vs. model

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Measurements of black carbon (BC) and organic carbon (OC) surface concentrations at four locations in Finland have been analyzed and compared to the results of the global model ECHAM5-HAM2 (Stier *et al.* (2005), Zhang *et al* (2012)).

OC and BC concentrations were measured with 3-h time resolution using semi-continuous thermal-optical OC/EC Field Analyzers (Sunset Laboratory Inc., Portland, OR). BC was determined optically and total carbon concentration thermally. The concentration of OC was obtained by subtracting the BC concentration from the total carbon concentration. The measurements were conducted during various time periods during 2010-2011 at Helsinki (urban site, Sept. 2010-Dec. 2011), Oulanka (remote site, July-Dec. 2011), Virolahti (SE Finland, Russian border 6 km to the east and E18 highway 5 km to the north, Sept. 2010-Dec. 2011) and Utö (a small island about 60 km from the Finnish SW coast, July-Dec. 2011).

Three versions of the global model ECHAM5-HAM2 were used in this study: ECHAM5-HAM2 with emissions from AEROCOM 2000 (henceforth called ECHAM), ECHAM with the secondary organic aerosol scheme of O'Donnell *et al.* (2011) (ECHAM-DOD), and ECHAM5-HAM2 with new anthropogenic emission dataset for BC, OC and sulfur dioxide (SO_2) derived from the GAINS model output (Kupiainen and Klimont (2007)) with updated ship emissions and newly introduced aviation emissions (ECHAM-GAINS). The models have been run for 2010 and 2011.

At all four sites the models underestimated the measurements up to a factor of 3 for both BC and OC – depending on the location.

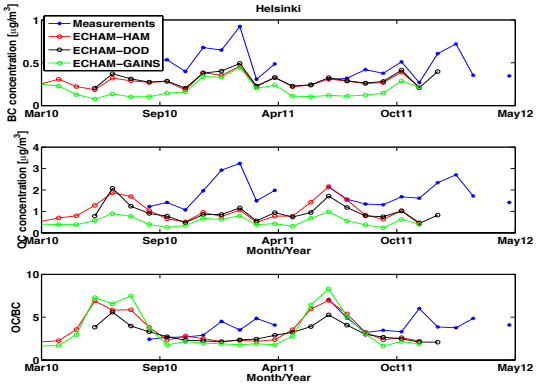

Figure 1. Median BC and OC concentrations and their ratios for Helsinki site.

The best results were obtained by ECHAM-DOD, which was slightly, but not significantly better than ECHAM, while ECHAM-GAINS introduced even a higher difference. Figure 1 presents the BC and OC median concentrations and their ratios for Helsinki, where BC is underestimated by a factor of 2 or less by ECHAM and ECHAM-DOD, and by a factor of 3 by ECHAM-GAINS.

We considered the behaviour of OC to BC ratios, as they can be used as approximate indicator of the potential radiative effects of individual source categories, based on an assumption that OC will reflect light and induce a negative radiative forcing effect in the atmosphere, and that BC will absorb light and induce a positive forcing effect.

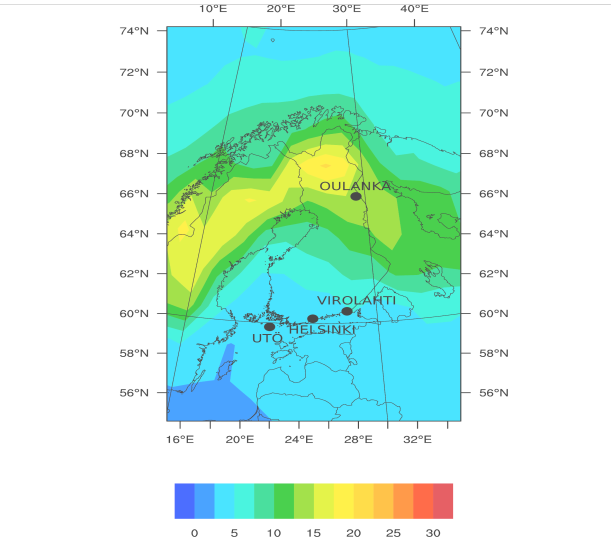

Figure 2. Spatial distribution of the yearly average of OC/BC for 2010. The black dots represent the locations of the measurement stations.

It is known that high OC/BC ratios are due primarily to very small BC concentrations. Figure 2 presents the modeled spatial distribution of yearly averaged OC/BC, showing that Northern Finland is dominated by high concentrations of OC, while in the Southern part the BC is the main driving force.

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