

## ***Interactive comment on “Black carbon concentration and deposition estimations in Finland by the regional aerosol-climate model REMO-HAM” by A. I. Hienola et al.***

**A. I. Hienola et al.**

anca.hienola@fmi.fi

Received and published: 19 December 2012

Answer to Anonymous Referee #1 comments concerning our manuscript “Black carbon concentration and deposition estimations in Finland by the regional aerosol-climate model REMO-HAM” by A. I. Hienola et al., ACPD 12, C8471–C8472, 2012

We thank the referee for relevant and useful comments. In this document, we numbered the statements from the report. Our replies follow bellow each statement.

1. This paper compares modeled BC in Finland against measurements, and concludes that there are problems with the inventory. On reading the paper I suspect that there are major problems with the model setup, and a lack of knowledge (or at least discus-  
C10753

sion) of other studies of BC in Europe, including those from Finland. The main model problem seems to be its small domain. Actually, the model description is rather unusual in not giving any information on the model domain and its vertical resolution at all. All maps show Finland only, so early on in the manuscript one starts to suspect that the domain covers only this one country, with the domain being that shown in Fig.1. This impression is strengthened when reading the text concerning wind-direction and attempting to ascertain sources. Notably, the possible source area to the south-west of Hyytiälä is said to be Tampere. I would have suspected Germany, Poland, the Benelux or other countries.

The model domain covers the entire Europe and is presented in Figure 1 in the new version of the manuscript. The text accompanying the figure is at the end of the first paragraph in page 7. Regarding the source areas of BC measured in Hyytiälä, see below.

2. The possibility of transport from outside Finland is not even mentioned, something which is unacceptable in my opinion. It has been known for decades that air pollution over the Nordic countries can be strongly affected by neighboring countries. BC particles have a low dry-deposition rate, and the potential to travel 100s or even 1000s of km is well known. The Finnish Meteorological Institute has in fact published many very good papers (e.g. Saarikoski et al., Atmos. Env. 2007, Saarnio et al., Sci. Tot. Env., 2010, Aurela et al., Atmos. Env., 2011), on long-range transport of pollutants to Finland - why do the authors ignore such evidence? The use of wind-direction as an indicator of sources areas is also not acceptable, trajectory methods are needed for anything other than very local transport.

We have introduced the discussion on long range transported black carbon in the subchapter 3.2.3 in the revised version of the manuscript (pages 16-18). Back trajectories are presented in Figs.12-14. In order to asses the contribution of the over border transported BC, we conducted an analysis where the BC emissions in Finland were switch off, presented in the same subchapter. Figs. 15 and 16 are relevant to this discussion.

In short, we demonstrated that the lack of local emission sources (residential wood burning) is the dominant source of model underestimation, although cases of very high measured BC concentrations not captured by the model appear to be long-range transport dominated. The references suggested by the referee were included.

3. The paper claims that no other regional model studies regarding black carbon have been conducted in recent years. This is clearly wrong. Schaap et al (JGR, 2004) studied EC over all of Europe, including results for Hyytiälä. Simpson et al. (JGR, 2007) and Tysro et al. (JGR, 2007) presented results for Finland also.

We originally had in mind to refer only to regional climate models that analyzed black carbon. However, we included the chemistry transport models the referee suggested in the introduction chapter, page 3, last paragraph.

4. The issues surrounding BC deposition to snow are again addressed lightly, with no comparison to other relevant studies (e.g. Skeie et al., ACP, 2011).

The last paragraph of subchapter 3.3 includes a more detailed discussion on BC deposition on snow, including the reference given by the referee. Our results can not be quantitatively compared to the results reported in literature, as they are from different years. A qualitative comparison is given.

5. The possibility of uncertainty in the emissions is of course real (though not demonstrated here), which makes it also worrying that the authors do not discuss the more recent BC inventories for Finland produced by Kupianen and Klimont (Atmos. Env., 2007) and the EUCAARI project.

We have added discussion of different emission inventories in subsection 2.1. We do believe that we succeeded to demonstrate convincingly in subsection 3.2.3 that the lack of local BC emissions is the dominant cause for the systematic model underestimation.

6. There is no demonstration, or discussion of, this model's ability with any pollutant, so we are left with the possibility that the lack of model agreement might be emissions,

C10755

or domain size, or vertical dispersion or a combination of these and many other factors.

We now discuss the validation of REMO-HAM in terms of aerosol number concentration, size distribution and gas phase sulfur dioxide at the end of subchapter 2.1 – last paragraph.

---

Interactive comment on Atmos. Chem. Phys. Discuss., 12, 24395, 2012.

C10756