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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Regional aerosol optical properties and radiative impact of the extreme smoke event in the European Arctic in spring 2006" *by* C. Lund Myhre et al.

Anonymous Referee #1

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Using a wide-range of ground-based measurements, this paper studies a biomass-burning aerosol plume transported from Eastern Europe to Scandinavia and the Arctic. Having derived aerosol optical depths, single-scattering albedos, chemical composition and vertical profiles, the authors are able to provide an estimate of the regional aerosol direct forcing. This is a good and interesting paper. The first part describing instruments and observational datasets is complete and accurate. Unfortunately, the last section 4 where the regional aerosol forcing is estimated is less clear. Therefore, some corrections and clarifications are needed before publication.

General comment.

1. Radiative forcing estimates.

The section dedicated to the calculation of the aerosol radiative forcing is quite short, and none of its results are summarised in the abstract. For example, the abstract could state that the direct forcing in the European Arctic, which is normally around -5 Wm^{-2}, reached up to -35 Wm^{-2} during this specific event.

Some details are unclear:

- Is section 4 still estimating the direct forcing? It is said so in the introduction, but not repeated here.

- Is the forcing computed in the shortwave spectrum only?

- Which exact sites provided the aerosol properties? Site names for each of the needed properties should be repeated here.

- It is said that the expected forcing during the season is -5 Wm^{-2}. This value is computed by using "*AOD values typical for the season and the same optical properties*". But the paper just demonstrated that the optical properties are those of a transported biomass-burning aerosol. Surely they don't apply to the typical Arctic haze aerosol.

- What is the use of ECMWF cloud fields in the calculation? Is it an all-sky forcing? How often are aerosols overlying clouds?

- What is the surface albedo dataset used in the calculations? Is it representative of spring conditions?

Minor comments.

Abstract:

- "*Importantly, at Svalbard it is consistency between the AERONET measurements and calculations of single scattering albedo based on aerosol chemical composition.*" is not properly written. I guess the authors want to stress the fact that retrieved single-

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scattering albedos from sun-photometer measurements match quite well those computed from chemical compositions.

- "*This agreement is crucial for the radiative forcing calculations.*" It is crucial for the confidence in the forcing estimates. RT calculations can be done with erroneous optical depths!

Introduction:

- [Bellouin et al.] "*calculate a clear sky direct radiative forcing of -0.8 Wm^{-2} with a standard deviation of ± 0.1*". According to that paper, that value is the all-sky forcing. The clear-sky forcing is -1.9 $\pm$ 0.3 Wm^{-2}.

- "*whereas water has a low albedo*" should read "liquid water" or, better, "oceans".

- "*critical turnover value*": this expression is new to me. I guess it refers to the critical single-scattering albedo, at which the direct radiative forcing changes sign.

Section 2:

- "*in this study is shown Fig. 1*" should read "in Fig. 1".

- "*Sodankyla Observatory, northern Finland (179m a.s.l.)*" and "*Zeppelin* Mountain (478m a.s.l.)". The altitude is only given for those two sites, and not for the others. Are we to conclude that it is an important feature of those two sites? Yet, it is not discussed later in the study.

- [Different] "*automatic cloud-screening algorithms have been used in this work.*" If different cloud-screening algorithms apply to different instruments, it should be made clear which algorithm is applied to each kind of measurements.

Section 3.1:

- MODIS collection 5 retrievals should be referenced, using Levy *et al.* JGR D13211 (2007).

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- "*We have combined the data from Aqua and Terra*". How is this combination made, especially when both instruments provide retrievals in the same gridbox? A simple average is made?

- "*For [Sodankyla] we can see three peaks; the first elevated AOD peak on 27 April, which is also present in Ny-Alesund, and a second 15 peak on 2 May.*" So written, the reader is under the impression that the second peak is not present in Ny-Alesund. In fact, only the third peak is not present in both sites.

Section 3.2.1:

- "*Note in this case the different scales compared to Figs. 4a and b)*". I fail to see the point of having different scales in Fig. 4. All data points can very well be presented on the same scale.

- "*with less than 0.1 absolute errors in* α *for the nominal AERONET absolute AOD errors, 0.01-0.02*". I don't understand this statement. Are those the uncertainties in both Angstrom exponent and aerosol optical depth retrievals, or is it more complicated?

Section 3.2.2:

- "*high surface albedo (snow)*" in UVSPEC radiative transfer calculations. What specific value (or model) is used?

- "*It might be explained the deposition of the large aerosols during the transport*" should read "explained by".

- "*leading to the high the SSA in this region*" should read "the high SSA".

Section 3.2.3:

- "*Only the peak value observed [on] 8 May at Hornsund is not captured by the satellite measurements. However, this peak is not detected at Ny-Alesund and it could be due to high cirrus.*" Should this peak be due to cirrus clouds, I would have expected satellite retrievals to be affected as well, since cirrus screening of satellite observations is quite

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difficult to achieve properly.

Section 3.3:

- "*Based on NOAA's Hysplit model back trajectories*". It could be more efficient to include those back-trajectories as figures, instead of describing them in the text.

- The analysis of the aerosol vertical profiles seems to focus on the magnitude of the aerosol extinction. It is good to know that the extinction varies accordingly to the column-integrated optical depth measured in another manner, but changes in the altitude of the aerosol layer are not discussed. Are they related to changes in boundary-layer height?

- "*British Isle*" should read Isles.

Figure 5:

- Mention the role of the red curve ("normal conditions").

Figure 7:

- Make clear that the comparison over Sodankyla is made at 3x3-degree resolution.

Figure 8:

- Would have been better to put Minsk at the top and Ny-Alesund at the bottom, since the text describes the evolution from source to remote regions.

References:

Aoki *et al.* (2000), Bond *et al.* (2005) and IPCC (2001) are referenced but not cited in the text. Birch and Cary (1996) is cited but not referenced. Myhre *et al.* (2003a) and (2003b) are both numbered 2003a. Shiobara *et al.* (2003) and (2006) are not listed in alphabetical order: I missed them at first!

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 9519, 2007.