

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 #2

Received and published: 2 August 2007

Estimates of aerosol radiative forcing are lacking for the Arctic. In addition, reports of measurements of aerosol optical properties within the Arctic are limited and have rarely been used in estimates of radiative forcing. Hence, this paper is a significant contribution as it combines in-situ and ground- and space-based measurements of optical properties and uses them to estimate the radiative forcing of background Arctic aerosol and of an extreme smoke event that recently impacted the Arctic. Because radiative forcing estimates for the Arctic are rare and unique (e.g. due to very high surface albedos), it is important that the description of the calculations are detailed and very thorough. Remarks to this effect are listed below as are other issues that hopefully will be taken into consideration by the authors.

- 1) p. 9520, line 14: provide lat and long information for Andenes.
- 2) p. 9520, lines 15 - 17: Sentence starting with “Importantly, at Svalbard” is incomplete and needs to be fixed.
- 3) The abstract should provide more of a summary of results. The first paragraph does a good job of introducing the topic of the paper but then should go on to report more specifics of what was learned about the evolution of the aerosol optical properties. Also report quantitatively the range of regional radiative forcing values from the smoke periods and compare to background Arctic aerosol.
- 4) p. 9521, lines 1 - 2: Change to “which is a function of their composition, SIZE, shape, and phase.
- 5) p. 9521, line 2: Change to “Calculations of the direct effect of aerosols has a high level of uncertainty despite the huge scientific focus.”
- 6) p. 9512, line 7: Provide a brief explanation for the difference in the DRF estimates based on satellite observations versus model calculations.
- 7) Introduction: For clarity, the introduction needs more paragraph breaks separating the topics that are introduced.
- 8) p. 9522, lines 14 - 17: Explain the connection between highest record temperatures and extensive pollution transport into the region.
- 9) p. 9522, line 15: define PM_{0.7}.
- 10) p. 9523, line 3: Should be “source regions.”
- 11) Table 1 and Figure 1: Naming convention for Andoya-ALOMAR-Andenes should be made consistent between the table and the figure.
- 12) p. 9525, line 8: Should be “based on separate sky radiance.”
- 13) Table 2: Explain the use of a factor of 1.1 to convert from EC to EM. Likewise for

the factor of 1.8 to convert from OC to OM. Provide references for these conversion factors.

14) p. 9527, line 26: What exactly does the percent data coverage refer to? Percent of daylight hours? Percent of geographical regions?

15) Section 3.1. (Or perhaps there is a more appropriate section elsewhere?) Can something be said about the source of the plume, i.e., was it due to agricultural fires or agricultural fires that turned into forest fires? It would be useful to place these results into a broader context and to associate cause of the plume to the impact on the optical properties. This information may be more appropriately placed in the Introduction section of the paper.

16) Section 3.2.1. Define Angstrom exponent and describe how it was calculated.

17) Table 3: Is only the May 2006 AOD at ALOMAR at a wavelength of 320 nm? Each value measured at that wavelength should be indicated. Also, please provide standard deviations with the mean values to give the reader a sense of the variability of the measured AOD.

18) Figure 4: For ease of comparison between sites, make all y-axes cover the same range for AOD and Angstrom exponent.

19) p. 9529, line 21: Describe in more detail what is meant by “the AOD decreased slowly due to the stable conditions.” Is this referring to a stable atmosphere with little deposition or vertical mixing occurring?

20) p. 9531, section 3.2.2. and Table 4: What is meant by “volume fraction”? Is this the fraction of the total aerosol volume that exists in a particular mode? Clarify in the text and table caption.

21) p. 9531, section 3.2.2. and Table 4: Is the accuracy of the retrieved parameters such that 3 and 4 significant figures are warranted? It is stated in the text that “the retrieval of the particle volume size distribution is adequate.” Please quantify the un-

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

certainty of the retrieved parameters. Table 4 should include standard deviations with the mean values to indicate the variability observed.

22) Table 4 caption: Change to “for the inversions for $AOD_{440nm} > 0.5$ and”.

23) p. 9531, line 28: Why are the radii for the fine mode larger near the source than at Hornsund? Is the retrieved median radii accurate to $\pm 0.04 \mu m$, i.e., the difference between values measured at the three locations? The diameter would be expected to increase with time due to processing during transport.

24) p. 9532, lines 15 - 16: “the volume size distribution has values comparable to” Exactly what values are being referred to here? State these explicitly.

25) p. 9532, lines 26 - 28: “could explain the differences in the size distribution” State what differences are being referred to.

26) p. 9533, line 10: SSA calculated using Mie theory and measured composition will be very sensitive to the approach used to account for the dependence of scattering on RH. Exactly how was hygroscopic growth taken into account?

27) Figure 6. It would be useful to put SSA values calculated from the Zeppelin data on this plot for comparison to the AERONET retrieved values.

28) p. 9533 - 9534, discussion of difference in SSA between source and distant regions: Two reasons are given for the higher SSA observed at the Arctic sites relative to the sites closer to the source regions: deposition and RH. Deposition is expected to (and, indeed did according to the earlier discussion) primarily affect larger supermicrometer particles for the transport times in this study. BC emitted from biomass burning is associated with smaller, newly formed particles. Is there evidence for significant BC mass in the larger size range as suggested here? RH is stated to decrease SSA, presumably by increasing light scattering but not affecting light absorption. Please provide more details on your reasoning here. Also, please expand on the statement that “The increase of SSA can also be a result of condensation and/or formation of

[Full Screen / Esc](#)[Printer-friendly Version](#)[Interactive Discussion](#)[Discussion Paper](#)

secondary organic aerosols.” Does this refer to changes in mixing state for the BC? Please provide more details.

29) p. 9534, lines 27 - 28: Instead of simply stating that “the results are in good agreement”, quantify the level of agreement for the MODIS and ground-based AOD values (e.g., provide an r^2 value).

30) p. 9535, lines 2 - 4: Can the statement that “This is expected as the ground-based data from Minsk is for 500 nm” be supported by an analysis of the Angstrom exponent and a conversion of the data so that the wavelengths match up between the two instruments?

31) p. 9536, first paragraph: The comparison of backscatter coefficients measured as a function of altitude at Minsk could be improved by sticking to a comparison of maximum values in the boundary layer OR average values within the boundary layer.

32) p. 9536, last lines: Can values of the maximum ABC along with the height of the maximum value and the height of the aerosol layer be given for the European plume arriving later in the day on May 5th? This would provide an interesting comparison of a plume of European origin and the biomass burning plumes that are the subject of the paper.

33) Section 4: Because there is such a lack of calculations of aerosol radiative forcing for the Arctic, this portion of the paper is perhaps the most interesting and most significant. Therefore, the description of the calculations should provide much more information than is currently given. For example: How is RH taken into account (dependence of scattering on RH)? What is meant by “AOD based on chemical composition \checkmark .. is scaled with AOD from MODIS.” Are these TOA forcings? Diurnally averaged? Clear sky only? (This latter point is confusing because on line 19, the paper refers to “ \checkmark some few cloudy regions.”) How was surface reflectance handled? Was one uniform value chosen for the model region or was it varied? This is of particular importance given the conclusion that “The climate effect of the aerosols in this region is particularly sensitive

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper

to the surface albedo.”

34) p. 9539, lines 9 and 10: Please provide standard deviations with the mean SSA values.

35) p. 9539, line 21: Please quantify “We find high agreement at all sites.”

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

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper