The ASTAR 2007 April 14 Haze Layer: The Radiative Effect of an Aged and Internally Mixed Aerosol in the Arctic

Ann-Christine Engvall[1], Johan Ström[2,3], Peter Tunved[3], Radovan Krejci[4], Hans Schlager[5], Andreas Minikin[5]

[1] Norwegian Institute for Air Research (NILU), [2]Norwegian Polar Institute, [3]Department of Applied Environmental Science – Atmospheric Science Unit, Stockholm University, [4]Department of Meteorology, Stockholm University, [5]Deutsches Zentrum für Luft- und Raumfahrt (DLR), Institut für Physik der Atmosphäre

Background

The ASTAR project (Arctic Study of Tropospheric Aerosol and Radiation) is aimed at investigating the physico-chemical properties of the Arctic tropospheric aerosol by means of aircraft measurements. The goal of the program is to provide an observational data set for improving not only the assessment of the direct and indirect effects of aerosols on the Arctic radiative balance, but also the aerosol parameterisation in the regional climate model HIRHAM [*Rinke, et al., 1999; Treffeisen, et al., 2005*].

Figure 1. The plume visualized from the aircraft. (Photo by A.-C. Engvall).

Results

The layer was located at altitudes between 3000 and 3500 m, cf. Figs 1 and 2. These aerosol characteristics are very similar to those expected to arise from biomass burning; the observed size distribution furthermore shows many similarities with that of a forest-fire plume, cf. Fig 3, (*Fiebig et al., 2003*) which originated in Canada and was detected over continental Europe.

Radiation Modell

To investigate the radiative effects of the enhanced aerosol layer a one-dimensional radiation model was used to simulate the amplified heating rate (K day^{-1}). The calculations were based on in-situ measurements of the input variables, *viz.* relative humidity (RH), temperature (T), pressure (p), aerosol size distribution, and the scattering and absorption properties of the aerosols. Results shows that the aerosol layer may give rise to a heating rate within the plume of up to 1.3 K day^{-1}, dependent on the properties of the plume and the surface albedo. The surface properties, in this study ice/snow covered or ice-free ocean, are of importance since the latter case with a low albedo shows a 25-30% decrease of the heating rate compared to the snow/ice case. These results can be compared to those obtained by [*Treffeisen, et al., 2007*], who estimated a heating rate of 1.7 K day^{-1} at an altitude of 0.5 km based on the observed concentrations of particles, soot, and aerosol at Svalbard 2006.

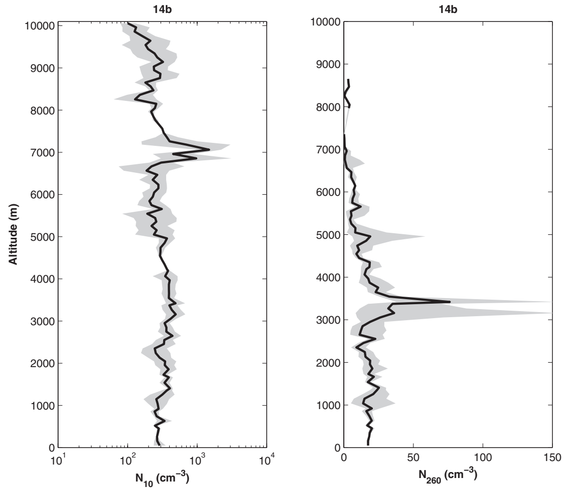

Figure 2. The vertical distribution of N_{10} and N_{260} particle concentrations.

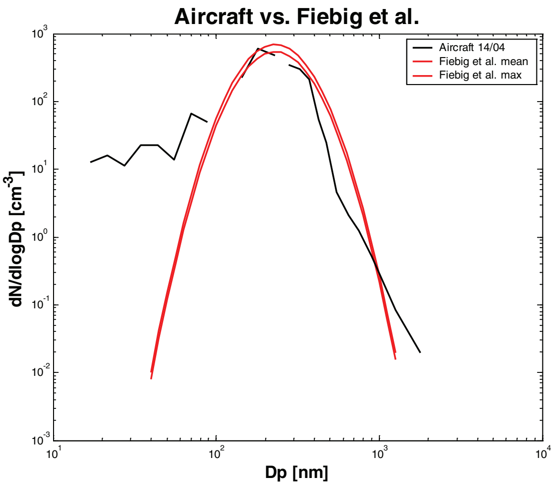

Figure 3. Comparison of the size distirbution measured in the plume with those found from a forest fire plume in Europe (*Fiebig et al. 2003*).

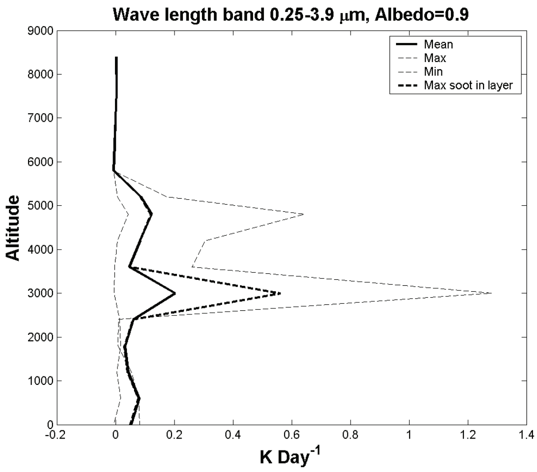

Figure 4. Calculated heating rate with the one-dimesional radiation modell with input of air-craft measurement.

ace@nilu.no

Conclusions

We have shown that upper-layer transport of soot from lower latitudes into the Arctic may be of importance for the radiative budget in the Arctic troposphere. The overall impact of these events is however, difficult to quantify due to the high altitudes at which the transport take place.

References

Rinke, A., et al. (1999), *Polar Research*, ***18***, 143-150.

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