

Interactive comment on “Vertical profiling of aerosol particles and trace gases over the central Arctic Ocean during summer” by P. Kupiszewski et al.

P. Kupiszewski et al.

piotr.kupiszewski@psi.ch

Received and published: 29 September 2013

We are grateful to the reviewer for the critical and valuable comments, which are addressed in detail as follows:

P 10402, L 6 - 7: Modified to “both highly complex and uncertain”

P 10402, L 26: Replaced.

P 10411, L 20 - 23, Figure 3b: We have included the cloud radar reflectivity unit in the text and figure caption and added a color-bar to the figure.

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P 10412, L 13-16: One cannot estimate the differences in magnitude of the cloud radiative forcing from Figure 3a; this requires a much more careful analysis (see e.g. Sedlar et al. 2011) and better temporal/vertical resolution of the radar data. And even if the change in clouds were the same, one can still not expect the same change in cloud radiative forcing since the cloud forcing by definition is relative to the radiation conditions for the same conditions but without the clouds. The net effect on temperature at a given time is also a combination of several other factors that may also have changed between these times. Whereas the change in cloud forcing may be dominant at both times, other factors contribute to the surface temperature, such as changes in the general meteorological conditions, surface albedo, solar zenith angle and last but not least, the time history - the conditions before the temperature drops - also play a role.

P 10413, Fig. 5: Figures 5a and 5b have been updated using semi-transparent colors.

P 10413 - 10414, L 1 - 3: The temperature unit [°C] is now specified in the figure caption and text.

P 10416, L 6 - 10, Fig. 7. (middle panel): Yes, the two flights with strong particle concentration increases aloft in the D14-300 range are treated in the manuscript (i.e. flights on 21st and 22nd of August, during period 2, shown in plot 9b). It is hypothesized in the manuscript (section 4.5) that the high concentration is due to long range transport of plumes from the Canadian Arctic Archipelago, as seen in the 10 day backward HYSPLIT trajectories shown in Fig. 11.

P 10416, L 11: Yes, this refers to the median concentrations.

P 10416, L. 21-end: The meaning of “coincide” here is “to correspond” or “to occupy corresponding or equivalent positions on a scale”. By “coincide” we mean here that vertical variations in concentrations closely follow changes in the altitude of the lower troposphere cloud level. We have made it clearer by changing the sentence to “Additionally, strong gradients in D>300 concentrations tend to coincide (...)”.

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P 10417, section 4.3: The mean background concentration measured onboard Oden during the ASCOS campaign was 44 ppt(v), with a standard deviation of 20 ppt(v). Therefore, the acetonitrile concentrations measured during the helicopter flights were fairly high relative to the background concentrations; as stated in the paper on p 10417, L13 – 15, in-flight mean concentrations were 68 ppt(v) below 200 m, 81 ppt(v) between 200 and 1000 m and 105 ppt(v) above 1000 m.

P 10421, L 3 - 9: This was an error on our part – figure 9a has been re-plotted to include the entire flight profile. Please note however, that measurements for the D3-14 size range were not available for altitudes over approx. 250 m, due to issues with the UCPC instrument.

P 10422, L 9 - 10, Fig. 10b: The period shown as blank has been flagged as contaminated.

The broadening and concentration increase of the Aitken mode is most likely due to a shift in the wind direction, which was also the cause of the contamination marked by the aforementioned blank period. This results in a different air mass reaching the ship. Previous high Arctic studies (Bigg et al., 1996; Bigg et al., 2001) have shown that such swings in air trajectories can have significant effects on the measured aerosol properties.

P 10422, section 4.5, Fig. 9b: While DMS concentrations are typically highest near the surface, maxima are also occasionally found above the boundary layer (in 3% of the profiles found over the pack-ice, according to a modeling study conducted by Lundeñ et al., 2010). The DMS maxima are typically associated with frontal zones, with lifting of the warm air mass resulting in transport of DMS aloft. In this case however, there is little to confirm such an occurrence and we do not know how the DMS peak aloft came to be.

We have also looked at back trajectories, however these suggest that the air mass has not been in contact with the near-surface and has been transported over ice-covered

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areas for at least five days. Therefore, they also fail to explain the origin of the DMS peak. However, as described in section 2.3, results of back trajectory analysis have to be treated with great care and, in some cases, they can be highly uncertain.

A comment on acetonitrile has been added on page 10422, L 3 - 5: “Profiles from both flights conducted during the cold spell show strong increases in the D14–300 mode concentrations at ca. 1000–1500 ma.g.l., with raised DMS concentrations and a local acetonitrile minimum measured during the flight on 22 August (Fig. 9b).”

P 10425, section 4.6: Analysis of Fig. 10c has been included to support the helicopter measurements, with the following references to Fig. 10c added on page 10425, L 23 and L 27 respectively:

“At this time, an increase in particle concentrations within the size range of approx. 3-30 nm was detected by the TDMPS onboard Oden (Fig. 10c).”

“An increase in accumulation mode particle concentrations is also detected by the TDMPS onboard Oden (Fig. 10c), confirming the helicopter measurements.”

Regarding, extra figures from the TDMPS, Shupe et al., 2013 presents a very detailed case-study, which includes also figures showing the TDMPS-measured aerosol particle concentrations for size ranges of $D > 100$ nm and $D > 300$ nm for the 28th and 29th of August. Consequently, in place of duplicating the figures, we have now included the below reference to Shupe et al., 2013 on L 29:

“For a further in-depth case-based analysis of the interactions between the boundary layer, surface fluxes, aerosol concentrations and stratiform clouds during this period, the reader is referred to Shupe et al., 2013.”

P 10430-10431, section 5: In order to highlight the possibility that other sources for the pollution plumes are possible, on p 10431, L 9, we have added a short explanation with a reference to Stohl et al., 2013:

“It should also be noted that other sources, such as emissions from gas flaring by the

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oil industry, have recently been suggested to be an important contribution to pollution plumes in the Arctic (Stohl et al., 2013).”

Unfortunately a flight profile with aerosol pollution layers and acetonitrile measurements is not available.

P 10431, L 7: We mean instrumental, as e.g. in the definition given by the Merriam-Webster dictionary (<http://www.merriam-webster.com/dictionary/instrumental>): “serving as a crucial means”.

P 10433, L 21 - 25: The removal processes have been added to Fig. 15.

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