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Atmospheric Chemistry and Physics Discussions

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

Anonymous Referee #2

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General

The authors present a nice and unique dataset collected during an Arctic expedition. In contrast to ground- or ship-based measurements, these data give the opportunity to understand processes in the boundary layer which are usually connected to the vertical stratification.

However, also these measurements are limited to parameters like number concentration in three size classes and do not contain any number size distributions or even cloud microphysical parameters. Thus, the authors should be careful and not promise

too much. Direct conclusions on the formation and evolution of low-level clouds as promised in the abstract are difficult because the number of CCN cannot be calculated from the profile: size distributions are not available and the activation diameter is not known here. Thus, such parts have to be revised. Other questions and remarks will be given below. However, I think this revision can be done by the authors and after that I think the paper is ready to be published in ACP.

Comments in detail

Introduction:

A very detailed overview mainly over expeditions performed by the Oden is given here. However, there have been more expeditions in the past. There should be publications available too. And I would like to read more about vertical aerosol measurements and results, e.g. by helicopter or balloon/kite. Is there nothing published yet?

Instrumentation:

In general this type of instrumentation is perfect if a limited capacity of weight and power is available. However, one has to accept that potential conclusion from these instruments are limited too. Some more technical details should be given here. One problem is the sampling line: how long is it? Since the number concentrations are not really size resolved a correction for losses due to diffusion and so on is not possible. Nevertheless I would like to get an idea about these losses, thus the authors could give examples like the losses are e.g. 30% for 10nm-particles. This is easy to calculate and gives us an idea.

The next point I do not like is the temperature difference between outside air and the sampling system. How much is the temperature difference? Do you have any idea what will evaporate in that system? This question is even more important for the chemical analysis. The samples are probably also taken under warmer conditions and probably also organic compounds may evaporate. Can you comment on this?

Concerning the aerosol-inlet: is there any influence from the helicopter boundary on the inlet? This could be checked by a model. Did you do that?

Results (Section 4)

At first I would like to get some more information about the measurement procedure, e.g., flight pattern of the helicopter. Was it possible to fly through clouds? If not how much was the minimum distance between helicopter and cloud.

Why these 5 cases? Are they representative for typical situations in the Arctic? In order to understand the cloud formation it would be necessary to combine aerosol and cloud measurements at this stage. Are measurements of cloud droplet size distribution available? What can be calculated from the radar? If this is impossible to combine, the paper has to be considered as focused on aerosols but direct conclusion on cloud properties are not possible.

Figs. 9a-e: The relative humidity is discussed in detail but not shown. Is it possible to show it here? Why are the two chemical species shown only for two cases? I would like to see the height of clouds added in the figure, since this is discussed in detail.

Page 10420, line 1 ff: Do you mean the open water as a source for primary particles? If yes, how fast do they grow? Are there enough condensable vapors to ensure a fast particle growth? Or is the open water a source for gaseous species? This is not clear to me.

Page 10420, line14ff: the cloud processes are described in very detail here, but I think none of them are measured, right? Or did you fly through clouds?

Page 10420, line 21-24: The sentence needs to be rewritten, I did not get it.

Page 10420, line 26 ff: How do you know which particles are activated? In the very clean conditions in the Arctic I would assume that particles at least down to 40 nm can be activated which is definitely within the Aitken mode. I think you did not measure this and it is just speculation. If you have any proof for this please give it here, if not, leave

it out.

Did you perform measurements right above cloud top? What was the minimum distance there? Did you see any evidence for new particle formation above clouds? In some cases at other locations, new particles have been observed above St/Sc clouds. Thus I would like to know if it may happen in the Arctic too.

Page 10423, Line 5ff: The capping inversion is only visible between 400 and 500 m, in the text is written from 600 m to 1200 m. Th is is generally difficult because measurements are shown only up to 700 m height. Maybe the height of the low level jet can be marked in the figure as well as the cloud height?

Page 10428, line 3 ff: Why not? Particle growth rates can be very high in the turbulent environment. Thus, if you show increased turbulence there, I would really expect new particles there!

Page 10428, line 9 ff: I would be careful with such statements. Nobody knows exactly which substances are involved in particle formation and growth. This varied probably between different environments. There are several experiments done in the laboratory showing which substances are able to make but I would not exclude everything else. The Arctic has the advantage of a low condensational sink. Thus, I would really expect new particle formation there!

The description of the 5 cases is a bit long, it should be shortened!

Summary and conclusion

Page 10433, line 10433: I cannot believe that the absence of particles > 300 nm leads to the absence of clouds. There are high number concentrations of smaller particles, which can be also activated if the supersaturation is high enough. Otherwise you get unrealistically high supersaturation?!

The results should be placed in the scope of former results. Do they fit or is everything completely new?

What is still missing and should be done in future measurements? I think measurements within the clouds would be desirable, i.e. aerosols, clouds, and turbulence! Maybe this should be stated create maybe new ideas and campaigns!

Technical points:

The double f: 'ff' appears a bit strange in the printed version. This should be corrected technically.

Page 10409, line it should be 5 l min-1, with a small 'l'

Figure 4: the trajectories are too small to see any details.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 10395, 2013.