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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Airborne observations of a subvisible midlevel Arctic ice cloud: microphysical and radiative characterization" *by* A. Lampert et al.

Anonymous Referee #4

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General comments This paper presents a cloud case study during the campaign AS-TAR in spring 2007 in Arctic. Several airborne instruments have been used to infer microphysical and radiative properties of a targeted midlevel cloud observed. Not much is known about arctic clouds, and all new piece of information is important.

The closure concept applied to this case study brings interesting points which are discussed in the paper. Complementarity between observations is fairly well exploited but the lack of information on the small particles and the occurrence of a perturbing upper cirrus introduces difficulties in the analysis. This leads to a presentation of results not as convincing as expected. The retrieval of the lidar ratio, which is one of the main

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parameter used to retrieve optical depth, should be better addressed. Questions still remains, especially due to the possible error sources, leading to significant discrepancies, and the non uniqueness of the solution in terms of microphysics, which would merit some more discussion.

The paper is well written and results are interesting. The structure is fine but part of sections should be moved to more clearly separate presentation of data and analysis. Section 4 should be re-organized. A dedicated sub-section on the microphysical model fitting should be added. The paper deserves publication, however I would recommend it is revised in adding more information and discussion on the points identified more in detail here after.

Specific comments Abstract : to be modified to introduce the microphysical representation and new information.

p600 : the temperature of mid-level cloud is not very cold. In a stable environment, it may be possible to find areas with super-cooled water droplets and others with ice crystals. Could this hypothesis (and its impact) be examined ?

p 602, section 3.1, p602 in general : this section should introduce more explicitly the possibility of a direct determination of optical depths and lidar ratios from the signal attenuation as further discussed in section 4.2.

p602, line 3 :after 12:00 UTC a cirrus cloud … : the cirrus cloud is indeed observed in Fig. 9 after 12:02. It is not shown in figure 5a, which should present the overview. Vertical scale in Fig 5a should thus be extended up to 7 km.

p 602 : describe Fig 5b. Give limits observed for depolarization ratio. Large values with an extension in vertical bands are artifacts.

p603, line 3 : presentation of LR value comes too early, as it is discussed in the following paragraph. Values given here should be referred to as a preliminary first guess. Indeed references are corresponding to mid-latitude observations. Although the tem-

ACPD

9, S472–S475, 2009

perature is similar, formation processes may be different and it would be worth finding additional references and discuss this point.

p603, line 24 : multiple scattering can be excluded but not diffraction. This leads to apparent smaller optical depth and lidar ratio (Nicolas et al, Lidar effective multiple-scattering coefficients in cirrus clouds, Appl. Opt., Vol. 36 Issue 15, pp.3458-3468, 1997), when determined directly from lidar observations (as in section 4).

p606, line 25 : this discussion on the extinction measured by the nephelometer and determined from lidar should be placed in the discussion section 4. errors due to the contribution of small particles not detected by the PN need more discussion as small particles are essential to the analysis.

p608, line 26 : …”in agreement …”, to be rephrased as no evidence has been provided of the detection of small ice spheres except a better fitting of PN data at large scattering angles. Needs more evidence.

p608, line 29, same remark on lidar ratio as before

p609, section 3.3 Multiple wavelength spectrometers have been flown, and radiances are used as a closure for comparison to radiative transfer calculations using lidar optical depth. Can near infrared measurements be used to check cloud phase ?

p607-613, Section 3 and 4 : in general separate more clearly instrument and data presentation in section 3 from the analysis (section 4). A specific section on the microphysical model adjustment would be worth adding in section 4. Discuss in this sub-section depolarization as a function of particle mixture.

p609, section 4 : this section would be more adequately present and discuss microphysical parameters from in situ measurements first, then the optical depth retrieval from lidar, and finally from radiative transfer and radiometry.

P613, line 5: the LR value of 15 given here is an apparent (or effective) value. This needs more discussion. What horizontal resolution can be used to retrieve LR accu-

ACPD

9, S472–S475, 2009

Interactive Comment

rately enough ? Due to SNR it should be possible to get a few samples in the cloud. It should be also possible to determine related optical depths, so to infer OD variation and compare to radiometry results (Figs 9 and 11) and to better achieve closure.

P 628, fig 5 : what is the unit on both figures ?

p633, Fig. 10 : What is the relative difference between measured and simulated radiances (outside absorption lines) and why ?

Lines 22 and 23 in the conclusion p 614 : the sentence … “ the cloud optical depth is accurate for a lidar ratio of 21sr ” is presently not a conclusion.

Interactive comment on Atmos. Chem. Phys. Discuss., 9, 595, 2009.