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Interactive comment on “Unexpectedly high ultrafine aerosol concentrations above East Antarctic sea-ice” by R. S. Humphries et al.

Anonymous Referee #1

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General comments:

This article presents unique and original data regarding natural aerosol cycling in the East Antarctic sea ice region. As identified in numerous publications relating to climate, there exists a serious lack of aerosol data from the Southern Ocean in general, and in particular from the sea ice zone around Antarctica. The manuscript at hand is a significant contribution to remedy this deficiency. The conclusions drawn are based on 32 days of ship-borne aerosol measurements during springtime in the East Antarctic sea ice region. The authors found strikingly high natural ultrafine particle concentrations south of the polar front, hitherto not detected in the atmospheric boundary layer of the Southern Ocean. A subsequent evaluation, mainly supported by meteorological data and trajectory analyses, demonstrated that high particle concentrations frequently

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found during the expedition were unexpectedly not provoked by local nucleation, but obviously caused by down-mixing of free tropospheric air masses. Finally the authors speculate about a potential impact of their finding on cloud formation in the troposphere of the Southern Ocean. The latter consideration, though being debatable, could be of conceivable relevance for the climate modelling community. The paper is written and organized in a clear and concise way, the methodology is sound and assumptions are clearly and conscientiously identified, and all parts, including figures, are essential. The manuscript certainly addresses the scientific scope of ACP and I recommend a final publication after some (minor) revisions I specified below.

Specific comments:

Abstract (page 29126, lines 1-9): Consider shifting of the first three sentences to the Introduction chapter, because they appear somewhat out of place here.

Methods (page 29129, lines 22-27): As stated by the authors, inlet efficiency is an important issue regarding the very long sampling tube. Unfortunately I could not find a more informative and comprehensible description of the corresponding experiments relating to Figure A1, neither in the present manuscript, nor in the cited previous paper (Humphries et al., 2015). I recommend a detailed and complete description of these experiments preferentially presented as Supplementary Material.

Chapter 3.4, page 29140, lines 6-18: Maybe I misinterpret your Fig. 7, but to me it seems that most of the five day forward trajectories remained within the boundary layer (0-500 m, Fig.7a)? Apart from this, please explain the method used to assess the height of the boundary layer.

Discussion (page 29143/44, lines 12-29/1-17): In the second part of the Discussion chapter the authors tried to assess the impact of high (ultrafine) aerosol concentrations on Southern Ocean climate. As already stated by the authors, this estimate remains somewhat speculative requiring further substantiation. Notwithstanding, I miss here a discussion considering long-term continuous condensation particle (CP) measure-

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ments at coastal stations (Syowa, Neumayer, and also Aboa), which usually did not show comparable high particle concentrations throughout the year and especially not during spring (see also hint in Results chapter page 29133, lines 1-15). Given that the high CP concentrations found in the present work are more or less typical and frequent (and hence climate relevant) across the sea-ice zone south of the Polar Front, I would expect a similar appearance at coastal sites which was obviously only observed on rare occasions. Hence I provocatively conclude that elevated CP concentrations as detected in the present study were fortuitous and temporary events but not characteristic for this region.

Minor points:

Page 29142, line 7: Frieß et al., ... (missing space character).

Page 29142, line 12: Neumayer (not Neuymayer).

Figure 2: There are two differently scaled tick marks on right axis. Please clarify!

Figure 3: I must confess that I did not really understand how this figure arised from a mentioned frequency analysis (“number of times a trajectory passes through a grid point”). On how many trajectories this evaluation is finally based? Please also specify “altitude” (height above ground, I guess?) and provide information about the grid box size.

Figure 5: Open circles or smaller dots would be better suited.

Figure A1, legend: Does “nano” refer to CN3-10 data?

Figure A2: The same problem as in Figure 2!

Interactive comment on Atmos. Chem. Phys. Discuss., 15, 29125, 2015.

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