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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Impacts of the January 2005 solar particle event on noctilucent clouds and water at the polar summer mesopause" *by* H. Winkler et al.

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Reply to SC C6: 'Comment on nucleation mechanism' by Benjamin Murray

Dear Dr Murray,

thank you very much for your comment on our paper "Impacts of the January 2005 solar particle event on noctilucent clouds and water at the polar summer mesopause". You have addressed some important points, and we think that they will

help us to improve the final version of the article.

I have to admit that I was not aware of these recent findings concerning homogeneous nucleation of ice. Thank you for the information on that. Therefore our *It is generally believed...* seems to be obsolete, and this part of the introduction will be re-written. As you have already mentioned, the findings of our paper will not be affected as we use a constant number density of nucleated material to avoid the nucleation uncertainties.

1) Concerning the saturation pressure:
Equation 3 is indeed an expression for hexagonal ice. As far as the authors know, there are no direct measurements of cubic ice in the temperature range of interest. Eq 3 is used by Bardeen et al. (2010), and the equation $ln(p) = 28.548 - 6077.4/T$ which gives very similar values ($\pm 5\%$ difference with respect to Eq 3 for T=110–150 K) has frequently been used in NLC models, e.g. Jensen and Thomas (1988); Berger and von Zahn (2002); Chu et al (2003). We have decided to follow these studies in using a saturation pressure corresponding to hexagonal ice. But the sentence *There are no direct measurements of the water saturation pressure over ice of cubic structure in the range of the polar summer mesopause temperatures, but there is a useful fit ...* might be missleading, and will be re-written.

2) Concerning the surface tension:
The equation $\sigma = \frac{0.0141 - 1.5 \times 10^{-4}\ T}{1 + 0.3/r}$ is adopted from Berger and von Zahn (2002), and was also used by Turco et al. (1982). It is a combination of the temperature dependent ice-vapour surface tension $0.0141 - 1.5 \times 10^{-4}\ T$ [N m^{-1}] (Hale and Plummer, 1974) and a factor accounting for the decrease of surface tension with radius $(1 + 2\delta/r)^{-1}$ (Tolman, 1949). δ is an emperical factor for very small water or ice particles for which the value $\delta = 1.5 \times 10^{-10} m$ of Turco et al. (1982) is used.

ACPD
12, C16–C18, 2012

3) Concerning the water redistribution:
Currently the abstract states *The sublimation of noctilucent clouds leads to significant changes of the water distribution in the mesopause region.* This can be speciefied by adding *After the SPE there is a pronounced increase of the water mixing ratio by more than one magnitude at 86 km, and a decrease of the water abundance by a factor ∼0.5 between 80–82 km.*

The references can be found in the article, except for:

Bardeen, C. G., O. B. Toon, E. J. Jensen, M. E. Hervig, C. E. Randall, S. Benze, D. R. Marsh, and A. Merkel (2010), Numerical simulations of the three-dimensional distribution of polar mesospheric clouds and comparisons with Cloud Imaging and Particle Size (CIPS) experiment and the Solar Occultation For Ice Experiment (SOFIE) observations, J. Geophys. Res., 115, D10204, doi:10.1029/2009JD012451.

Hale, B. N., and Plummer, P. L. M. (1974), Molecular model of ice clusters in a supersaturated vapour, J. Chem. Phys, 61, 4012–4019.

Tolman, R. C. (1949), The Effect of Droplet Size on Surface Tension, J. Chem. Phys, 17, 333–337.

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