

## ***Interactive comment on “Denitrification and polar stratospheric cloud formation during the Arctic winter 2009/2010” by F. Khosrawi et al.***

**Anonymous Referee #2**

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This paper provides an analysis of ground based and satellite PSC observations, analyzed temperature fields for air parcel back trajectories, and microphysical box model PSC simulations to predict areas of denitrification during winter 2009-2010. The PSC observations and predictions are in agreement with satellite measurements of nitric acid indicating a severe and permanent denitrification in the Arctic which began in early January 2010. The results are presented well and the paper is well written. It should be published after consideration of the following minor corrections. In most but not all cases I use the style Location: . . . manuscript text – with suggested changes – manuscript text . . . to suggest changes to help the presentation.

Some questions on confusing points

11388.25: If dissolution of the PSCs renitrifies the air then the denitrification was not  
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permanent? Clarify this statement.

Fig. 2: The denitrification occurs very rapidly over about a 10 day period in early January. There is then a rapid recovery to hno3 levels about 30% below the mid December levels, but it does not remain at the 50% lower values observed in early January. The authors may wish to consider this point in light of the previous comment.

11391.11-14: Confusing. Suggest, “However, NAT formation has also been observed at temperatures above Tice suggesting heterogeneous formation of NAT on particles other than ice, e.g. meteoric smoke particles (Voigt et al., 2005).”

11393.15: What does it mean that PSCs are simulated? Do you mean the PSC simulations indicate the presence of PSCs in these areas? It would be clearer to state, “The box model simulations predict the presence of PSCs at the trajectory end (time of the lidar measurements) and occasionally at the beginning (5 to 6-days before the lidar measurements), when trajectories passed through the cold pool between Scandinavia, Svalbard and Novaya Zemlya.”

In general the starting and ending points of the trajectory are confusing as used in the manuscript. I expect, as would most English readers, that the trajectory is ordered in time. Thus the ending point of the trajectory is the measurement, or the point where the back trajectory is initiated, whereas the starting point of the trajectory is the first point of the back trajectory, or 140 hours prior to the measurement. Another example occurs at 11395.6. In my view this sentence would be easier to understand if it read, . . . along the trajectories which ended between 22 and 24 January . . . Then the following dates make more sense, since they do not occur before the previous trajectories “started”. Another way to handle this is to be very clear whether it is a trajectory (usually assumed forward) or back trajectory. Thus a back trajectory can be started at Esrange, but not a trajectory.

Fig. 6: These data would be much easier to understand if presented in the conventional form as backscatter and depolarization ratio. Then the layers of cloud containing some

fraction of NAT would be clearly shown. As presented now the figure requires the reader to do the work of forming the ratio in their mind to see the regions containing aspherical particles.

11396.14: The authors have no basis for this statement that ice formed on NAT particles. How do they know that? Why could not the ice form in the very cold STS particles? Some believe that NAT forms only after ice forms, so the authors should be more careful here, stick to the observations, and avoid speculation. The sedimenting ice particles would still cause denitrification, I believe, even without NAT being involved, but this would be a good thing to check. How would denitrification resulting from sedimenting ice particles formed from STS compare to sedimenting ice formed from NAT? If there is a significant difference then this would provide support for the authors' suggestion of ice on NAT.

11397.21: In this paragraph the PSCs are characterized as STS, NAT, ice. Why now slip back into type 1b, and then in the next sentence back to STS?

Problems with begin

11388.21 ... while at the beginning of ...

11393.22: ... at the beginning (or start) and end ...

11394.11: Here and elsewhere "begin" is used incorrectly. I have already noted this a couple of times. This will be my last notice, but the authors should check the rest of the manuscript for the use of both begin. Here the sentence could be, "... by NAT in the beginning of January..." or "... by NAT at the start of January ..." The first option would be chosen by most writers. Oddly, in English, the construction at 11394.13, "... to end of January ..." is okay, because end is both a noun and verb, whereas begin is only a verb, with the noun being start or beginning.

Other minor corrections

11388.10: ... cooled synoptically ...

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11392/16: ...occurred ... 2010 and was ...

11396.10: ... The ice PSCs measured ...

11397.10: Here and elsewhere use the plural of PSC when plural is intended. Thus change this to ... area the PSCs were ... January and then by ... Also check for this construction throughout the manuscript. Up to here I have been ignoring the mistake.

11398.1: ... consistency suggests ...

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