F. Khosrawi

The study presented by Thölix et al. is very interesting, but some of the references given are not correct in the context they are actually cited for. Further, I think the presentation of the results in this study would profit if more results from the the Arctic 2009/2010 winter published in the ACP special issue on "Chemistry, microphysics and dynamics of the polar stratosphere: ozone loss and climate-chemistry interactions" would be taken into account (http://www.atmos-chem-phys.net/special_issue228.html). Additionally, it should be made much clearer in the manuscript for which region the trend analyses is performed: Is it for the polar regions (70-90N) or for Sodankylä?

We thank Dr. F. Khosrawi for the review which we found very useful. We have revised the manuscript to address all the issues. In particular we took into account the results on winter 2009/2010 from the ACP special issue as advised, and corrected the text to make it clearer which area we refer to in the trend analysis.

P22015, l18: The Hanson and Mauersberger paper is not a correct reference for denitrification. An adequate reference would be Fahey et al. (2001) or if one aims on denitrfication in connection with dehydration, the Fahey et al. (1990) paper.
Reference changed to Fahey 1990.

P22015, l20-21: A reference is missing here. An adequate reference would be the paper book by Brasseur and Solomon on Aeronomy of the Middle Atmosphere published by Springer or the review paper by Solomon (1999).
Reference to Solomon (1999) paper is inserted.

P22016, l3: Sedimentation of what? Please be more clear.
Sedimentation of ICE particles

P22016, l26, P22018, l4: Abbreviations of the satellite instruments should be introduced as well as it should be mentioned on which satellites this instruments are operating.
P22018, l9: It should be added what the abbreviation LAPBIAT is standing for and when this campaign was performed?
Thanks for mentioning. The abbreviations of satellite instruments and the campaign and the time of it have been introduced.

P22020, 7-8: "LAUTLOS": the abbreviation for this campaign has not been introduced. When was this campaign performed?
LAPBIAT Upper Tropospheric Lower Stratospheric Water Vapour Validation Project (LAUTLOS-WAVVAP) measurement campaign in early 2004 was performed in the northern Finland (Deuber et al., 2005; Vömel et al., 2007a, Vömel et al., 2007b, Suortti et al., 2008)

P22025, l14-15: I would suggest to add here at which altitude/pressure level the postive long-term trend in water vapour is observed. Does this concern only certain altitude/pressure levels or the entire stratosphere?
P22025, l16: At which altitude do you derive a positive trend? At a certain altitude or ine the entire stratosphere?
Yes, this concerns the whole stratosphere as we specify in the revised version.

P22026, l26: Although may derive this relationship from the formula given by Hanson and

Mauersberger (1993), there are other papers actually stating this and would be thus a more adequate reference.
We believe this comment refers not to P22026, l26, where it makes no sense to us, but to P22027, l26 where we state that water vapour increase '…would have increased the size of ICE PSC areas even if the temperatures have been the same.' To address the comment we add references to Kirk-Davidoff et al. (1999) here, which as we believe, was one of first to point to this mechanism.

P22026, I17: Also here a reference is missing. Observation of dehydration in the Arctic during was shown for e.g. the 2009/2010 winter was reported by Khaykin et al. (2013).
The reference to Khaykin is added.

P22026, L19-21: Does the simulated occurrence of ice PSCs during these 20 winters agree with observations?
We have revised the discussion of ice PSC in this section. The comparison of our simulations with PSC observations from CALIPSO is also improved. Unfortunately there is no other ice PSC observations with reasonable coverage except for CALISPO which is available only since 2007. Therefore we cannot comment on how the simulated occurrence of ice PSC agree with observations over the whole period. We are aware that some observation are available from earlier period as well, based on satellite and ground based platforms (Lidars, backscatter sondes, e.g. Stein et al., 1999; Kivi et al., 2001; Müller et al., 2001). Here we haven't used the other data sets for the comparisons. However, this can be done within the future studies.

P22031, I1-3: Are these long-term changes observed in the entire Arctic or solely at Sondaylä?
Yes, this concerns the whole stratosphere as we specify in the revised version.

P22031, I11ff: Do you see the increase in ice PSCs in both, the FinROSE simulations and the CALIPSO observations or only in the FinROSE simulations? Please clarify.
The increase is seen in both CALIPSO and FinROSE. Text is clarified.

P22041, Fig 4: I do not understand for which region the trend is estimated and shown in the Figure? Are you comparing here Sodankylä data with FinROSE simulations ECMWF data for the polar regions? If yes, is this an adequate approach?
The Sodankylä time series were in the Fig 4 only for comparison. The analysis have done from the anomaly panels. However, the figure 4 have now split into two figures. Figure 4 shows water vapour from Sodankylä and Fig 5 anomalies from 70-90N. The trends have estimated only from the anomalies. Also a lot of new analysis from the anomalies have done.

P22044, Fig 7: Why not doing this comparison for the Arctic? How many CALIPSO observations were actually available for creating such a plot? I guess not that many. I remember that CALIPSO passes through certain Arctic stations locations very infrequently. What does "near Sodankylä" actually mean? What was the allowed maximum distance from Sodankylä?
In the Figure 7 there was total areas of ICE PSCs and NAT PSCs in the northern hemisphere. All the NH CALIPSO observations during winter 2009/2010 were taken into account in the calculation of the areas.
Only the temperature panels in the figure 7 were from Sodankylä gridpoint (6*3 degrees). The Figure was confusing and now the temperature panels have changed to the total areas

of colder than 188K. (Also the NAT areas have totally taken off.)
Now the ICE panels can more easily be compared to the temperature.

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