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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Arctic stratospheric dehydration – Part 1: Unprecedented observation of vertical redistribution of water" *by* S. M. Khaykin et al.

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We thank the reviewer for the positive review and constructive suggestions.

We understand that the unavailability of the companion paper at the time of interactive discussion has complicated the evaluation of the present manuscript and therefore readily agreed to postpone the resubmission until the second part is published in ACPD. Now, when both parts are available, one can see a clear link between these articles: the process study in the second part, making use of microphysical modeling, covers all the missing aspects and thereby completes the story of stratospheric

de-/rehydration in January 2010.

Regarding the excessiveness of information provided in the appendices.

Appendix A, showing the details of the selected soundings, provides information that helps understanding of the evolution of dehydration from the balloon soundings perspective. It also contains information that is not available in the manuscript itself, namely the relation between the vertical distribution of temperature, water vapour, backscatter ratio and saturation mixing ratio. Appendix B, reporting the results of the water vapour sensors intercomparison, is important because the study relies first of all on the water vapour observations by different instruments, which need to be fully coherent. The measurement of stratospheric water vapour is known to be technically challenging and sometimes results in considerable discrepancies between the different techniques. Therefore, the results of the intercomparison need to be explicitly described in order to rule out any possible reader's concerns about the data quality. Considering the above, we strongly believe that the information contained in the appendices should be available for a reader. However, following the suggestion of Referee #1, we shifted it into Supplementary material.

Regarding the new knowledge and the scientific questions to be tackled.

Indeed, the paper is first of all a comprehensive documentation of a rare phenomenon. We noted that all the previous papers on dehydration in the polar vortex are generally restricted to a description of the experimental data with an interpretation of the observed features as a consequence of reversible (in most cases) or irreversible dehydration, whose physical nature is relatively well understood. The present study, taking advantage of a larger set of observations, not only provides a more comprehensive documentation of the above phenomenon, but also presents evidence of water redistribution, never previously observed in the Arctic stratosphere. Thus, the essential goal of our study is to show that given the respective background conditions, a synoptic-scale water redistribution, similar to that observed above Antarctica, can also occur

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in the Arctic vortex. Meanwhile, the companion paper focuses on the microphysical processes behind the observed phenomena, thereby tackling a very actual question of ice PSC formation pathways. That said, we modified the introduction to better express the actual scientific concerns: p. 14253, line 7: "Due to lack of in-situ observations in the presence of PSCs there still remain some uncertainties regarding the boundary conditions and the pathways of ice cloud formation. While homogeneous freezing of supercooled ternary solution (STS) particles has been the generally accepted formation pathway of ice PSCs, new results – mainly triggered by space-borne observations using the CALIPSO satellite - suggest that heterogeneous nucleation plays a major role (Pitts et al., 2011; Engel et al., 2013a). " p.14253, line 29: "Recent studies by Hoyle et al. (2013) and Engel et al. (2013a) highlight the importance of this pathway for NAT and ice nucleation. Obviously, the verification and correct parameterization of the heterogeneous ice formation pathway requires accurate in-situ measurements in the presence of ice PSCs, not available until now. The high-quality in-situ observations presented here, including those acquired during the very process of ice PSC formation, provide a reference for representation of ice cloud formation in microphysical models. A microphysical modelling study making use of these observations is presented in the companion paper (Engel et al., 2013b), which relates the question of ice formation pathways and concurrent dehydration to the observations described here."

Minor comments

All the axis labels were corrected to "Physical quantity (unit)"

Fig. 4 (MLS water vapour polar projections) was intended to be a full-page figure, but got shrunk during the typesetting. This will be taken care of for the next submission. The panel in Fig. 5 (Aircraft measurements) is already quite large.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 14249, 2013.