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Review of Ziereis et al., 2021

Anonymous Referee #1

Referee comment on "Redistribution of total reactive nitrogen in the lowermost Arctic stratosphere during the cold winter 2015/2016" by Helmut Ziereis et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-707-RC1, 2021

Ziereis et al. use airborne in-situ observations of total reactive nitrogen (NOy), nitric acid (HNO3), nitrous oxide (N2O) and ozone (O3) below the Arctic polar vortex to study the vertical redistribution of reactive nitrogen via PSC particle sedimentation. The measurements on the research aircraft HALO cover the polar winter 2015/2016 from the early phases of vortex formation in December 2015 to the late phase in mid-March 2016. Using tracer-tracer correlations, the authors identify deviations in the vertical distribution of NOy in the lower stratosphere. They demonstrate that the sedimentation of PSC particles leads to a re-nitrification of the lower stratosphere in mid-winter, while later measurements connect the NOy enhancements to denitrification that occurred at higher potential temperatures. This hypothesis is further explored with the help of the CLAMS model, simulating the formation, sedimentation and evaporation of PSC particles.

The manuscript fits well with the scope of ACP, the data set is of highest quality and the data analysis is sound. I recommend publication after some minor modifications.

General comments:

The discussion of tracer-tracer correlations (N2O – NOy) and in particular the comparison between NOy and NOy* during the early phase of the campaign - before renitrification occurred - could be more quantitative. The results of a York-Fit (R2; slope (+- STD)) for the data in Figure 6a and Fig 7a could give a better understanding how accurate the relation between NOy and N2O is. In a similar way, a quantitative study on the deviations between NOy and NOy* in Figure 1b would give an indication on the smallest amount of NOy change that can be derived from the data.

As mentioned in the manuscript, the individual flights covered a large area from the mid-latitudes to the northern sub-vortex region, with the majority of the observation made at high latitudes. It would interesting to see, whether signatures of re- and denitrification occur exclusively below the polar vortex, or whether vortex processed air-masses are transported to the mid-latitudes. This could be done e.g. by classifying air masses with deviations in NOy relative to the vortex edge (e.g. using equivalent latitude).

Typo:

Line 602 should read, “winter 2002/2003”.