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Interactive comment on "Investigation of Arctic middle-atmospheric dynamics using 3 years of H_2O and O_3 measurements from microwave radiometers at Ny-Ålesund" *by* Franziska Schranz et al.

Anonymous Referee #1

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In the present study, Schranz et al. analyse three years of ground-based microwave water vapour and ozone observations in the Arctic stratosphere and compare these data with satellite observations (MLS and ACE-FTS), ERA5 reanalyses and SD-WACCM model simulations. The data are used to study transport and dynamics of the stratosphere and mesosphere, in particular effective mesospheric descent rates, the effects of stratospheric warmings on stratospheric and mesospheric water and ozone and periodic oscillations in the middle atmosphere.

This is a very valuable and important observational data set that can be used to analyse

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Discussion paper

transport and dynamics of the high latitude middle atmosphere. However, the different topics addressed are not well connected and it is not always clear what has been learned from this analysis. I believe the paper can be strengthened by further exploiting the MLS data as well as the ERA5 reanalyses and the SD-WACCM simulations in comparison with the ground-based observations to arrive at more general conclusions. E.g.:

- In Section 6: Is the effective water vapour descent rate in the mesosphere a good proxy for TEM w_bar_star? In principle the SD-WACCM output should help to address this question.

- Section 7 is very short and I am not at all sure what can be learned from it. Could an analysis of the latitudinal gradients of H2O and O3 from MLS (and/or the models) be combined with the ground-based observations to tell us something on the air mass origins that could be contrasted with the Lagranto calculations?

- In Section 9, it didn't become obvious to me what we can learn from the analysed periodicities. Would it make sense to compare these to a corresponding analysis of SD-WACCM to say more directly which of these periodicities are well captured by the model and which are not? Any ideally even why?

Overall I believe that with a few additional analyses of the available data sets and by spelling out more clearly in the text what the conclusions are, the value of these important observations could be further improved. So I recommend publication in Atmos. Chem. Phys. after consideration of the suggested improvements and after addressing my specific comments below.

Specific comments

Abstract, line 1: I have to say, I don't like the expression "dynamic events" too much. This is jargon and not particularly specific. I would suggest to better find a more specific expression, like "dynamics of the polar vortex" or maybe even "factors affecting subsidence inside the polar vortex".

Abstract, l.8: better spell out (again) what kind of profiles: "the MIAWARA-C profiles" -> "the MIAWARA-C water vapour profiles"

l.10: "Stratospheric GROMOS-C profiles" -> "Stratospheric GROMOS-C ozone profiles"

Abstract: Why is the comparison with SD-WACCM only presented for H2O, not for O3?

Abstract: I suggest to mention NDACC already in the abstract.

p.2, l.18/19: (a) NOx ist produced in the mesosphere not only by solar proton events, but also by energetic electrons. (b) ozone loss of 10% is too specific, numbers could be very different for different events

p.3, l.2: "Atlantic streamer": better spell out (e.g. "steamers of enhanced ozone in the middle stratosphere into the Arctic over the Atlantic sector" if this is what you mean) as the expression does not seem to be standard (yet).

p.4,l.25: "dry bias": better spell out which instrument measures less H2O to avoid any possible misunderstanding

p.5, l.10: Would be nice to have also information on precision and resolution of wind profiles.

Caption Fig. 8: "When the polar vortex shifts away from Ny-Ålesund water vapour and ozone increases are measured because airmasses arrive from the midlatitudes". Ozone increases are not evident from the figure.

p.6, section 3.7: Information on the data sources for water and ozone in ERA-5 is missing. Are these assimilated from (satellite) observations? Or purely modelled?

p.8, l.11: "the diurnal variation is seen in mid summer during the period of polar day": Only during polar day, not during spring and autumn day/night periods?

p.8, l.23: “The balloon borne ozone sonde data were not convolved.” Why not? How was this done for the comparison with the OZORAM, which has a similar vertical resolution as the GROMOS?

p.8, l.29: “ERA5 sees“: "seeing“ does not seem to be an appropriate expression for the assimilated data set.

p.9, l.17 “This annual variation persists up to 1 hPa.”: Unclear how this relates to previous sentences.

p.9, l.20: “. . .deviates substantially from the other datasets and is therefore not included in the intercomparison.”: Even if there are substantial differences a comparison would be valuable – in fact how to know that there are differences without a comparison?

p.9, l.28: would be interesting to include also MLS at Ny-Alesund in addition to zonal mean – or investigate the difference between at Ny-Alesund and zonal mean with the models.

p.10, l.25: What does theory tell us about the relation between tracer descent and mean vertical wind? I would have expected that one has to consider a Transformed Eulerian Mean w_bar_star, instead of just the average vertical wind? Could you calculate w_bar_star from SD-WACCM? (see also your own discussion on page 13)

p.10l31/p11,1: “also difficulties with the H2O and CO chemistry”: in order to attribute differences to transport or chemistry it would be useful to investigate the relation between tracer descent and, w_bar_star and average vertical wind in the model(s)

p.11, l.21: I thought the standard definition for a major warming is a reversal of the 10 hPa zonal mean zonal wind at 60N, not poleward of 60N?

p.12, l.22: “The isentropes show that airmasses were rising in the mesosphere and descending in the stratosphere.”: strictly speaking, one should also consider diabatic cooling rates to decide whether air masses are rising together with the isentropes, or descending across the isentropes.

Technical Corrections

p.4, l.30: “a FFT” -> “an FFT”

p.12, l.18: “splitted” -> “split”

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