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Comment on acp-2021-837

Anonymous Referee #2

Referee comment on "In situ observations of CH_2Cl_2 and $CHCl_3$ show efficient transport pathways for very short-lived species into the lower stratosphere via the Asian and the North American summer monsoon" by Valentin Lauther et al., Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2021-837-RC2, 2021

I found this an interesting and generally thoroughly prepared paper. The interpretation of in-situ measurements of CL-VSLS using transport calculations and general knowledge of the geographical and seasonal characteristics of source regions seemed sensible and plausible to me.

I have given some suggestions below for how the paper might be improved before appearing in a final version.

General Comments:

Introduction p2-3: To me there seemed to be a lot of detail here about the overall significance of the CL-VSLS, and about sources. This is important, of course, but it does not all seem to be essential to this paper. The key points, for this paper, are the general geographical characterisation for the source regions of the different species being considered. The reader would be able to focus more effectively on the major points of this paper if some of the detail was removed.

p10-11: I think that it is a bit confusing to refer to the 'lower branch of the correlation' for the CH2Cl2-N2O relationship. It looks as though there are large number of parcels for which the N2O values are around 330ppb but the CH2Cl2 values are distributed across the range 30-45ppt. I think that in some ways it weakens your case if you call something a correlation when by conventional measures the correlation is rather weak. I am not disputing the fact that there are two 'families' in the plot at high N2O values -- but can you find a more neutral term to describe them?

p12: A similar comment applies to this approach of fitting a 'mean correlation curve' and

using that as a basis for separating the upper and lower branches. The quadratic fit might be intended to seem quantitative -- but there is really no reason to believe that the extrapolated values have any concrete relevance to the concentrations of CH2Cl2 measured in high N2O concentration parcels -- the split between the two categories is essentially being made on the basis of the appearance of the plot. It seems very reasonable to make the split -- but if the authors (or the readers) felt that it was more justifiable on the basis of a quadratic fit and an extrapolation then I would say that they were confused.

p21: At this stage in the paper you use the term 'convective transport' quite frequently and in association with trajectories/CLaMS. I think that you should be a bit clearer about what transport is included in trajectories/CLaMS -- which I believe is simply that in the ERA-I velocity fields, i.e. there is no inclusion of convective transport by parametrisation. I suspect that ERA-I velocities tend to be rapidly upward in regions of large-scale convection -- and that serves as some kind of representation of convective transport, but it is unlikely that upward velocities are quantitatively correct. Certainly this sort of interpretation has been made by many authors who have used trajectory-based approaches, including myself, and I would not quarrel with it -- but I do think that it needs to be clearly stated. The uncertainty perhaps becomes a bit more serious when considering tropical cyclones. How well is vertical transport in tropical cyclones represented by something like ERA-I? One imagines that maximum vertical velocities are significantly underestimated -- but it could be, for example, that vertical transport is distributed over too large a region. You may not be able to resolve this uncertainty, but I think that you should at least say that it exists.

Detailed comments:

l126: 'last accessed' info not needed in citation?

l164: 'essential' would be better than 'mandatory'. ('Mandatory' means 'required by some rule or regulation'.)

l210-215: I found these sentences confusing. What is the distinction between 'pure CLaMS back trajectories', 'pure CLaMS trajectories' and 'back trajectories'? There seem to be two separate issues here -- 'forward vs backward' and 'with CLaMS mixing vs without CLaMS mixing'.

l221: 'lapsrate' should be 'lapse rate'.

l239-240: This seems to repeat some information on back trajectories what has been given early (which potentially causes more confusion -- 'is this intended to be subtly different to what has been said previously').

l241: 'The spatial uncertainty of calculated back-trajectories increases with time because mixing processes occurring during transport are neglected' -- the uncertainty doesn't just result from neglect mixing processes -- the nature of chaotic advection is such that e.g. small errors in velocity fields convert into increasingly large errors in particle position. The idea that one could accurately calculate a trajectory for, e.g. 50 days, simply doesn't make sense (whether or not one accounts for mixing). The key point for back-trajectory calculations on this sort of time scale is that ensembles of particles are used -- so one is essentially calculation probabilities of location of origin rather than 'the' location of origin'.

l250: 'Thereby mainly air parcels of ... branch are from below the thermal TP' -- do you mean this -- i.e. that most of the parcels from below the thermal tropopause are from the lower branch, or do you mean something slightly different, that most of the parcels from the lower branch are from below the thermal tropopause -- in which case the 'mainly' should before 'from below'.

Figure 15: You use the term 'convective updraft' in this Figure. There seems to be potentially an unfortunate confusion with the use of 'updrafts' and 'downdrafts' as description of rather small-scale features (perhaps ~1km) of convective clouds. 'Convective transport' might be a better term (and a better fit to the fact that, as noted above, your model calculations are incorporating some kind of global re-analysis scale representation of large-scale transport by convective systems.