

Review of ACP-2019-370, Marsing et al. "Chlorine partitioning in the lowermost Arctic vortex during the cold winter 2015/2016"

The manuscript by Marsing et al. describing the variation in the partitioning of chlorine in the Arctic polar vortex over the course of the winter 2015/2016 is highly topical for Atmospheric Chemistry and Physics. Overall the paper is clear and well-written. The arguments the authors make in the paper are reasonably well supported by the data they present and that data presentation is generally clear and understandable, in particular I appreciated Figure 7. I recommend the manuscript be accepted for publication, but would request the authors consider and possibly address the points below.

In section 2.2.2, it would be good for the authors to include the correlation value they have used to infer Cl_y from CFC-12, i.e. $Cl_y = \dots CF-12$ so that there is a record of what values/relationship was used.

Throughout the manuscript, I find the use of "recovery" to describe the repartitioning of Cl into reservoir species somewhat odd. I understand the usage, but it carries a viewpoint of what "normal" is, while indeed the whole repartitioning cycle between active and reservoir species is normal given the conditions. It seems like the discussion could be of "partitioning" or "repartitioning" into the reservoir species. A couple suggestions along these lines are included in the specific comments below.

Figure 4 does not seem particularly important to the argument and is only addressed as an example in a single paragraph. I would think that it could be omitted without effect on the paper.

Is there a reason for plotting the data in Figure 5 as stalactites (inverted y-axis) instead of the standard way with bars increasing upward?

The caption for Figure 8 indicates there should be grey areas to indicate the model HCl overestimation period, but the figure in my copy does not have any shaded areas.

Specific minor comments and suggestions for the text:

- P1 L1 "process" seems somewhat generic—maybe use "destroy" or similar
- P1 L6-7 "an altitude dependent shift in the pathway of..." is a little unclear, perhaps something like "an altitude dependence of the pathway for chlorine deactivation with HCl dominating below the 380 K isentropic surface and ClONO₂ becoming significant "
- P1 L20: "abbreviated with" → "abbreviated as"
- P2 L1: "Besides chlorine, bromine compounds are also important contributors to catalytic ozone destruction."
- P3 L32-33 suggest adding "campaign"—"first major campaign phase"

- P5 L3 “the instrument is already taken into account” could be “the instrument is already accounted for”
- P5 L10-11 the use “parts per trillion (pptv) of molar mixing ratio” is awkward. The “v” is used for “by volume” which is typically taken as equivalent to by mole. Options would be to delete “of” or replace with “by mole” or volume.
- P6 L4 “is should be partitioned”—need to use one or the other, “is” or “should be” or perhaps “is expected to be”
- P6 L20 “winder” → “winter”
- P7 L1 “of N₂O ... measurements” → “measurements of N₂O and potential temperature” (although potential temp is calculated, not measured)
- P7 L1 delete “of” from “of PV”, and delete “also”
- P7 L3 “diagram” is not correct—could use “plot” or “figure”. Perhaps “The plot shows data for potential temperatures above 320 K to focus on”
- P7 L18 “include also” → “also include”
- P9 L10 “where the vortex” → “when the vortex”
- P9 L12-13 the HCl is not really “depleted” wrt to December values, but “HCl makes up a smaller fraction of the total Cly”
- P9 L30 the warming “made” higher theta “levels” accessible
- P10 L13-14 delete “first”—“model, the model results”
- P10 L25-26 “on higher isentropes” → “at higher potential temperatures”
- P10 L28 “The modeled vertical shift from HCl to ClONO₂ as the dominant reservoir species during repartitioning in March between 360 – 400 K”
- P11 L1 “The phases”—what phases? “The campaign phases”?
- P11 L19 “this demonstrates” → “which demonstrates”
- P11 L27 comma after HCl “recovery of HCl, as well as”
- P12 L16 “achievable cooling” perhaps would be better “cooling that occurs” or “resultant cooling that occurs”
- P12 L20 “The same instrumental configuration”? Perhaps “The same instruments used in the present study were previously used for measurements in the Antarctic polar vortex”
- P12 L21 “were” → “was”, perhaps “was observed.”
- P12 L 24 “on” → “in”
- P12 L24 “also close to” is awkward and vague—“near”?
- P12 L31 “showe” → “show”
- P13 L2 in standard usage, “supposed to” has a different connotation than the root for “supposition”; here it might be better to say “