

Interactive comment on “Validation of the vertical profiles of HCl over the wide range of the stratosphere to the lower thermosphere measured by SMILES” by Seidai Nara et al.

Anonymous Referee #1

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This paper presents a new hydrogen chloride (HCl) data set, derived from SMILES measurements performed from October 2009 to April 2010. HCl plays a key role in the stratospheric ozone destruction mechanisms and observations of this species are essential to quantify the total budget of stratospheric chlorine. The vertically resolved data presented in this paper covers the altitude range 16–100 km, from the lower stratosphere to the lower thermosphere. This is the first time that HCl is observed in such a broad vertical range, making this new data set particularly valuable. The SMILES HCl retrieval procedure is described, and the resulting profiles are compared to independent observational data sets as well as to model simulations. Those comparisons are discussed, in light of the error analysis included in the study. I recommend the

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publication of this paper in AMT, after consideration of the minor revisions suggested below.

(For your information, I have not read Referee #2's report before writing mine, for the sake of integrity. There might therefore be some redundant comments.)

General comments

The paper presents an important new data set for middle atmospheric studies. The retrieval process is presented clearly, and the validation method is valid. The overall presentation is well structured. However, some important explanation is missing. For example, you say that the water vapour effect is a possible cause for the observed latitudinal differences, but you do not explain anything about this effect, or you describe the HCl vertical and geographical distribution, without discussing the chemical and dynamical mechanisms controlling it. Last but not least, you conclude that the temperature data used to retrieve HCl is responsible for up to 30 to 40% of the observed differences between SMILES and the other instruments, but you do not give any information about the source and quality of these data sets. Please see my specific comments below for more detailed questions and suggestions. Moreover, the language should be improved. See my suggestions for technical corrections below.

Specific comments

p.1 l.12-14: Please specify also the relative values corresponding to the given absolute differences.

p.2 l.43-46: Could you please explicitly comment the differences between the results of the comparisons mentioned here (between SMILES v2 and MLS / ACE-FTS, by Sugita et al., 2013) and the results of your validation study? It would be interesting to add such a comment in the conclusion section, where you discuss your results.

p.4. l.76: Do not forget to specify in the text that you are talking about the daily number of observations.

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p.4 I.92: Could you give some information about the a priori data used in the retrieval process: what is the source of this data set? Does it depend on latitude and time? Etc.

p.6 I.102: “We assumed that the natural isotopic abundance of H₃₅Cl/HCl was 0.7576...”: Please explain where this value comes from. A citation should be added here.

p.6-7 Sect.3: Please discuss the differences and/or similarities between the three sub-periods under consideration or change Fig. 4 to show only the results averaged over the whole SMILES operational period. I do not understand the point in dividing the comparisons between SMILES and SD-WACCM into three different time periods if this is not discussed.

p.6 I.110-112: An explanation about the HCl vertical and latitudinal distribution is missing. Please describe the chemical and physical mechanisms controlling it, or at least comment on the current state of knowledge about that. (This could be added either here or in the introductory section.)

p.9 Eq.3: Even if it is obvious for most readers, N should be explicitly defined.

p.9 Tab.3: That could be helpful to include the vertical resolution and the altitude range covered by each of these instruments.

p.9 I.140: Regarding the MLS vertical resolution, you should explicitly say that it is of the same order as that of SMILES, in order to highlight the fact that the observed differences in the profiles are not due to differences in vertical resolution. (Same comment about the comparison with ACE in Sect. 4.2.)

p.10 I.148-149: There are however changes with latitude observed below 35 km. Please describe them.

p.10 I.155-156: The water vapor effect should be explained (maybe not here, but earlier in the paper, when explaining the retrieval process).

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p.10 l.166: “MAD” has not been defined.

p.12 l.192: Please specify the geographic coordinates of the Kiruna station.

p.13 Fig.7: It is good that information about the variability of the differences is given in panels (B), by the representation of $\pm 1 \sigma$. However, I wonder why this information is not given for difference profiles shown in panels (A), as well as in Fig. 9 (A).

p.18 Eq.10: I guess that Δb_0 is the uncertainty on model parameters. Please define it explicitly.

p.18 l.234: “about 0.9 ppbv at 50 km” This value is inconsistent with what is shown in Fig. 11. Please correct.

p.18-20, Sect. 5.2: Please give more information about the temperature data used in the retrieval process, for the three instruments under consideration. Has the temperature been retrieved from measurements performed by the instrument itself or has, in some cases, external data been used? Discuss the quality of these T data sets, comment on their accuracy. Are there some validation studies that could give an indication as to which ones of the SMILES, MLS and ACE-FTS temperature profiles are closer to the true atmospheric temperature? Such additional information would be helpful for future users to know which of these three HCI data sets is likely the most realistic in the upper stratosphere / lower mesosphere. Knowing more about the temperature data used in the SMILES retrieval procedure would also be useful to better estimate the quality of the SMILES HCI data set in higher altitude regions, where measurements from other instruments are not available.

p.21, Fig.12: The quality of this figure needs to be improved. The legends are barely readable. It is confusing that panel (A) does not have the same vertical scale as the other ones. Also, it would be clearer to use the same colour code or line styles in both panels (C) and (D).

Technical corrections

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p.1 l.2: Change “has been” to “is”.

p.1 l.12: Change “well agreed” to “agreed well”.

p.1 l.18: “concentration” add an “s”.

p.2 l.30: “HALOE HCl” remove “HCl”.

p.2 l.48-49: Incomplete sentence (no verb).

p.3 l.58: “observation” add an “s”.

p.3 l.60: Reword (suggestion “SMILES operational period started on October 12, 2009 and ended on April 21, 2010.”)

p.3 l.4: “observation” add an “s”. “Kasai et al. (2013)” add “by Kaisai et al. . . .”

p.4 l. 68: Change “and” to “or”.

p.4 l.92: “y is THE observed spectrum”.

p.6 Fig.2, caption: Change “spectrum” to “spectra” (three times). (Same comment about the caption of Fig. 3.)

p.6 l.105: “the altitudeS 50 km-90 km” or “the altitude range 50 km-90 km”.

p.6 l.110-112: Reword (suggestion “The HCl vertical distribution shows an increase with altitude with a maximum below the stratopause, approximately constant values between [. . .], and a decrease with altitude from the mesopause to . . .”)

p.6 l.114: “panelS (B)”

p.7 l.122: “observationS”

p.8 Fig.4, caption: “. . . within latitude bins of 10°.”

p.9 l.132: “previous work ON MLS observations”.

p.10 l.147: “increases” remove the “s”.

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- p.10 l.154: “at below 30 km” remove “below”.
- p.10 l.156: Change “was” to “is”.
- p.10 l.156: “one of the possible results” Do you mean “one of the possible causes”?
- p.10 l.157&170: Change “less” or “lower”.
- p.10 l.169: “945” There is a mistake. This value is different from the one given in Table 3.
- p.10 l.172: Change “tropic region” to “tropical region”.
- p.10 l.173: “altitude” written twice in a row.
- p.11 l.177: “conformed” Do you mean “confirmed”?
- p.12 Fig.6: Adding “SMILES” and “MLS” as a title for the left and middle panels would make the figure clearer.
- p.13 Fig.7, caption: Change “Eq (4)” to “Eq (3)”.
- p.18 l.226: “valueS”
- p.18 l.234: Change “between the altitude region of 30 and 60 km” to “between 30 and 60 km”.
- p.19 l.249: “synthesizes” reword. “lower smaller” remove smaller.
- p.20 l.269: Change “a had” to “had a”.
- p.20 l.270: Change “were” to “was”.
- p.20 l.273-275: Reword (see previous comment about l.110-112).
- p.20 l.281: “coincidenceS”
- p.21 Fig.12, caption: Change “dash” to “dashed”

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p.21 l.284: Change “The negative bias” to “A negative bias”.

p.21 l.295: “improvement of THE retrieval algorithm”.

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