

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 #2

Received and published: 15 June 2020

Summary: This paper presents new data of HCl vertical profiles obtained by the SMILES instrument operational between October 2009 and April 2010 on the International Space Station. The HCl vertical profiles cover an extended range from the upper troposphere/lower stratosphere up to the upper mesosphere/lower thermosphere region. The retrieval technique is discussed and results are presented and compared to output from the WACCM model. The main part of the paper consists of a validation study that features comparisons of the SMILES HCl with measurements from the MLS instrument on the Aura Satellite, the ACE-FTS on the Scisat-1 satellite, and the TELIS balloon-borne instrument. Overall agreement is good although significant differences are found that are most pronounced in the upper stratosphere/lower mesosphere re-

C1

gion. The paper suggests that differences in the temperature profile used for trace gas retrieval from the thermal emission measurements are responsible for a significant part of the differences between SMILES and the other satellite measurements.

Review: This is an interesting paper that fits well into the scope of Atmospheric Measurement Techniques. The most interesting part of the presented material is the vertical range over which HCl profiles can be retrieved due to the high spectral resolution and signal-to-noise ratio achieved by the measurement technique. The coverage in the mesosphere and in the transition zone to the lower thermosphere makes this dataset unique and I can envision significant interest in it for example for studies of the dynamics in this atmospheric region, which is otherwise difficult to access. My main point of criticism of this paper is the lack of a description of the temperature retrieval that underlies the trace gas retrieval. This is particularly important as the authors identify differences in the underlying temperature profile as the main reason for differences in HCl in the upper stratosphere/lower mesosphere region. A description of the temperature data, including the method of the temperature retrieval, its vertical range and its accuracy in the various altitude regions is essential for understanding possible caveats of the HCl data, especially for use in studies of the mesosphere and lower thermosphere, where other data is sparsely available. With the addition of this information, as well as responses to my more detailed comments below, I would recommend this paper for publication.

Detailed comments:

Abstract, last sentence: The last sentence of the abstract should be moved further up, somewhere in the first third of the abstract. Acronyms should be introduced also in the abstract.

Line 86: This is the location where a description of the temperature retrieval should be provided. It will set the stage for a lot of the discussion further below. It should answer questions such as: How is the temperature retrieved? What is the vertical range of the

C2

temperature retrieval? How accurate is it, especially in the mesosphere?

Line 110: “an increasing with the altitude increased” should be “an increase with altitude”

Line 111: “decreased with the altitude increasing” should be “decreased with altitude”

Line 116 concerning differences between SMILES and WACCM in the mesosphere: Is there an explanation for these differences? How does the high HCl near the mesopause compare with Cly at lower altitudes? Is this realistic? A depiction of the HCl/Cly ratio based SMILES HCl and Cly estimates from lower altitudes in comparison to the WACCM HCl/Cly ratio may be interesting.

Lines 138-139: How can the accuracy be smaller than the precision? In my understanding the precision is largely due to statistical errors, while the accuracy also includes systematic errors and hence should be larger than the precision. This should be corrected or explained.

Lines 155-156: The discussion of water vapor as a source for differences is not convincing. There is very little water vapor in the stratosphere around 30 km.

Line 166: What is “MAD”? Abbreviations should be introduced.

Figure 5: For the right panel an x-axis range at which relative difference does not go off scale should be used.

Line 176: “overlapped” -> “overlap”

Line 177: “conformed” -> “confirmed”

Line 199: The reference to Webster is ok for the mechanism but is there also a reference to the development of chlorine activation for that particular winter. That would be more relevant.

Line 201-202: Is there a reference that supports this statement about calibration un-

C3

certainties and their impact on the TELIS retrieval?

Figure 10: Same comment as for figure 5 - for the right panel an x-axis range at which relative difference does not go off scale should be used.

Table 4: I don't understand the statement in the footnote. The comparison didn't actually look that bad at these altitudes.

Line 242: The paper states that “The temperature profile used for the retrieval procedure of SMILES was smaller than those of MLS and ACE-FTS particularly in the upper stratosphere, mesosphere, and lower thermosphere”, however, no temperatures for upper mesosphere, lower thermosphere are shown. This should be added, probably in figure 12. It should be stated how the temperatures for the other satellite measurements were derived. Instead of the word “smaller”, I'd maybe suggest “lower” or “colder”.

Line 253: “at the altitude (of) 50–70km.” – Again, no data is shown for 70 km altitude.

Figure 12: The altitude scale is different in panel a compared to panels b, c, d. These panels should be plotted over the same vertical range avoid confusion. Also, the figure quality is inferior, with the lines and text kind of blurry even when zoomed in, so the figure should be redone.

Lines 260-265, discussion of bias at 55 km: What about other altitudes? Figs. 5 and 8 suggest that differences start around 40 km and increase gradually with altitude. However, Fig. 12 suggests that the temperatures around 40 km are very consistent. This behavior should be included in the discussion.

Line 292: “Totally,” – I suggest maybe “In Summary,”

Line 295: “above stratosphere” – I suggest “above the stratopause”

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-105, 2020.

C4