

Interactive comment on “Strato-mesospheric ClO observations by SMILES: error analysis and diurnal variation” by T. O. Sato et al.

Anonymous Referee #1

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The paper “Strato-mesospheric ClO observations by SMILES” by T.O. Sato and co-workers describes the ClO measurements from the ISS SMILES instrument for the first time. ClO is measured by SMILES in the submm wavelength range using a very advanced mixer technology, providing ClO observations with a never-before obtained precision from space. Due to the non-sun-synchronous orbit of the ISS, a full diurnal cycle is obtained within two months of data by SMILES. The ClO observations and retrieval procedure is described, and a very thorough error analysis is given. In the end, the observed diurnal variation of ClO is described both in the stratosphere and in the mesosphere. In the stratosphere, the observation of the diurnal variation confirms previous observations from MLS/UARS; SMILES provides the first observations of the mesospheric diurnal cycle from space. This paper describes a very interesting

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data-set; the diurnal variations observed by SMILES should provide a nice test-case for photochemical models of the middle atmosphere. The paper is well structured and generally well written, and on the whole, I quite enjoyed reading it. However, I have three comments/concerns that should be taken into account before publishing. (a) I think the discussion of the diurnal cycle of ClO can be better presented. Especially the discussion of the mesospheric diurnal cycle seems incomplete – why is it reversed? Where does the maximum at ~70 km come from? (b) For the observed ClO enhancements, a test of significance should be carried out, and stated precisely. (c) I also found quite a large number of typos and/or language errors. All three points are discussed in more detail in the list attached below, which also includes a couple of minor comments.

Comments on context

Page 4670, Line 24: has the diurnal variation of mesospheric ClO been observed by ground-based or airborne instruments yet?

Page 4676, Line 19 – 22, I don’t understand what is calibrated (or not) with what in this sentence. Maybe you could re-formulate it somehow to make the meaning more clear.

Page 4680, discussion of m in Figure 3: can you discuss what it means that m (the sum of the averaging kernel elements at one altitude) is larger than one over nearly the whole altitude range?

Page 4687, Line 20: As far as I see, the vertical resolution of SMILES is comparable to MLS and Odin at 10 hPa, better than MLS and Odin at 2 hPa.

Page 4688, Line 17 ff, line 22: “qualitatively reliable” is a term that does not appear to have a clearly defined meaning. What you do show is that the observation of strato-spheric diurnal variation is consistent with the observations of MLS / UARS within error bars; what you also should show is whether the observation is significant at a given confidence limit. Same goes for the mesospheric diurnal variation.

Page 4689, Line 1: To show whether the variation is realistic, you should show whether

it is significant (at the 90%, 95%, 99%? confidence limit at least).

Page 4689, Line 20, 21: what about photolysis of ClO? Does that play a role?

Page 4689, Line 24, 25: What is the reason of the reversed diurnal cycle in the mesosphere? If it was predicted by models, the reason should be known, and should be stated here.

Page 4689, Line 26 ff: This ClO maximum at ~70 km seems to appear right at the place where the third ozone maximum is observed (see, e.g., Marsh et al., GRL, 2001), so the reason might be that reaction R2 works faster in the presence of enhanced O3 values.

Page 4690, Line 1-3: again, how significant is the observed ClO enhancement?

Page 4690, Line 17: "... was reasonably explained ..." is not a very precise formulation. Better would be "... is consistent with ..."

Page 4690, Line 18: "... from the stratopause to the mesosphere ..." could be a really small step. What you mean is "... from the stratopause well into the mesosphere, to altitudes of more than 70 km".

Page 4690, Line 22: Again, you should show whether these observations are significant, and then state the significance here instead of the reliability (which is not a well-defined term).

Language

Abstract: the abstract might be more concise if the order was different: (1) line 1-6; (2) line 13-23, (3) line 7-12.

Abstract, Line 7/8: "... stratospheric ClO, with an enhancement during daytime..."

Abstract, Line 9: "... a different ..." → "... the opposite ..."

Abstract, Line 20: "... with averaging ..." → "... when averaging ..."

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Page 4669, Line 2: "... ClO activation on PSC surfaces ..."

Page 4669, Line 20: "... a sensitive observation of the diurnal variation of short-lived ..."

Page 4670, Line 13: "... of the antenna ..."

Page 4670, Line 20: "... sturdy ..." → "... study ..."

Page 4670, Line 22: "Stratospheric diurnal variations observed by SMILES are compared to those observed by UARS / MLS. The diurnal variation of mesospheric ClO is observed by SMILES for the first time from space."

Page 4671, Line 22: "... depends on the temperature ..."

Page 4673, Line 3: "An error in the ClO VMR ..."

Page 4673, Line 23: "... brightness temperature, Ochiai et al., 2012b)."

Page 4674, Line 17: "... of the antenna beam pattern."

Page 4674, Line 19: "... of the SBS is ..."

Page 4675, Line 21 – 25: this sentence is very long – maybe make a full stop after the first "respectively".

Page 4677, Line 7: "...is the transmission coefficient of SWM, ..."

Page 4677, Line 11: "... have identical surfaces with -."

Page 4679, Line 2: "We use measurements whose tangent heights ..."

Page 4681, Line 8: "... sturdy ..." → "... study ..."

Page 4681, Line 14: "... the reference spectrum ..."

Equation 29: try to use same size brackets for both terms

Page 4683, Line 18: "... for the random error E_{random} and the systematic ..."

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Equation 32: it would look better if the '2's were on the 'E's, not on the brackets

Page 4684, Line 24: "The error from the dry-air ..."

Page 4685, Line 19: "Comparing these three instrument functions, ..." (?)

Page 4685, Line 20: "..., the error from the SBS has only a small contribution."

Page 4688, Line 1: "Two months of data from SMILES were ..."

Page 4688, Line 11: "The night-time ClO VMR values are near zero ..."

Page 4689, Line 18: "The stratospheric ClO amount is controlled by the following reactions ..."

Page 4690, Line 6: ".. the error in the ClO L2r ..."

Figure 4: the cyan symbols are difficult to see, maybe use larger symbols or a different color.

Figure 10: is the offset added to UARS or to SMILES?

Figure 11: this figure is too small.

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