

Interactive comment on “Trends of HCl, ClONO₂
and HF column abundances from ground-based
FTIR measurements in Kiruna (Sweden) in
comparison with KASIMA model calculations” by
R. Kohlhepp et al.

Anonymous Referee #1

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General Comments

This paper presents 14 years of total columns of HCl, ClONO₂, and HF measured at Kiruna, Sweden using FTIR solar absorption spectroscopy. Long-term trends for these species are derived by fitting a linear function and annual cycle to the data, while bootstrap resampling is used to estimate the precision of the results. The column measurements and the trends for all three species are compared to simulations

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by the KASIMA chemical transport model. KASIMA reproduces the ClONO₂ and HF columns, but underestimates the HCl columns. A positive trend is measured for HF, and the trend derived from KASIMA agrees within the combined errors. For HCl and ClONO₂, negative trends are measured, consistent with decreasing emissions of CFCs and HCFCs. KASIMA also finds negative trends, but underestimates them relative to the FTIR measurements, which is attributed to the sampling and stronger annual cycle observed by the measurements. This is a concise study that provides new information on the abundances and trends in stratospheric chlorine and fluorine species. I recommend publication in ACP after the minor comments below are addressed by the authors.

Specific Comments

Page 1490, line 11: This sentence “The relative trends were calculated on the basis of the linear fit result on 1 January 2000” is unclear. Clarify what is meant by calculating the trend based on the value of the linear part of the fit on 1 January 2000. Also Page 1494, lines 22-23.

Page 1493, line 11 and Figure 1: Define what is meant by the height-dependent sensitivity. Does Figure 1 show total column averaging kernels or sensitivity as defined by Vigouroux et al., ACP, 2008?

Page 1493, line 22: State which errors term(s) constitute the statistical error. Does statistical error = random error? What are the total errors? Is there a reference for how the errors are calculated? Explain why the ClONO₂ error is so much larger than those for HCl and HF.

Page 1493, Section 3: State whether the KASIMA model profiles were smoothed by the FTIR averaging kernels and a priori profiles, as described by Rodger and Connor, JGR, 2003.

Page 1494, para 2: State here how the evolution of CFCs and HCFCs is treated in the

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model. Page 1499, para 1 indicates that they are prescribed. That information could be included here.

Page 1494, para 2: State what model data are extracted for the comparisons – at the nearest model gridpoint to Kiruna (if so, state latitude and longitude), or an average of nearby gridpoints?

Page 1494, line 15: Explain, or give a reference for, why a third order Fourier series is used to account for the annual cycle, rather than, for example, a simpler sinusoidal function.

Page 1494, lines 20-24: This section would benefit from revision to clearly define the absolute trend and the relative trend. Why is p2 the relative trend? Isn't it the linear trend? Is it divided by p1 to get the relative trend? But neither p1 nor p2 has an explicit dependence on time, so what is meant by "the linear part of the fit on 1 January 2000"?

Page 1496, para 2: Can you explain how it is possible for the HF trend from 1996-2002 can be the same as the trend from 1996-2009, when there is no trend from 2002-2009? This seems mathematically unlikely.

Page 1496, lines 12-13: Why is August-November defined as summer? The vortex dissipates well before August and can start to reform in the fall.

Page 1496, lines 14-15: How does the KASIMA summer trend compare with the KASIMA summer trend for FTIR days only?

Page 1498, lines 14-16: Why not compare FTIR and KASIMA stratospheric partial columns? Does prescribing the lower boundary condition mean using a fixed 0-7 km partial column for KASIMA or a mixing ratio at 0 km or 7 km? Clarify. State approximately what percentage of the total HCl column is represented by the lowest 0-7 km. Is this also the case for HF and ClONO? If so, provide the same information.

Page 1499, line 5: Define the WMO 2007 Ab scenario.

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Page 1499, line 23: Are the HCl and ClONO₂ trends statistically significant?

Page 1499, line 26: What is meant by "all methods used here"?

Technical Corrections

Frequently throughout the paper, "respectively" is used in an incorrect and confusing way. Check, and if necessary, revise all sentences that use respectively. In many places, it can be deleted. Explanations for correct usage can be found in grammar references, for example, "Respectively is an adverb meaning either "in particular" or "in the order given." In writing, we use it when giving a comparison for which there are an equal number of elements on either side of the comparison. In other words, if the sentence has four elements, there are really two sets of two things being compared. Respectively comes at the end of a sentence and is preceded by a comma." from <http://www.uhv.edu/ac/newsletters/writing/grammartip2008.03.25.htm> or <http://www.oup.com/us/samplechapters/0841234620/?view=usa>

Page 1490, line 2: TOTAL columns

Page 1490, line 6: state that KASIMA is a chemical transport model

Page 1490, line 27: change "absolute values" to "total columns" throughout the paper, as this is a more meaningful description of the quantity being compared.

Page 1490, last paragraph: It would be more logical to discuss the agreement between the modeled and measured columns before discussing the agreement in the trends. Make this the second paragraph in the Abstract?

Page 1491, line 2: "have been suspected to be able" is awkward – "have been known to", "have been predicted to"

Page 1491, line 4: in THE Southern Hemisphere spring, which

Page 1492, line 24: as A source of radiation

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Page 1493, line 17: usually DOFS (degrees of freedom for signal) rather than DOF

Page 1494, line 8: “using . . . analyses until 2002 respectively from 2003 on, . . .” is unclear - rewrite

Page 1494, line 21: “As can be seen from Equation (1), the parameter . . .”

Page 1495, lines 5 and 14: change function (1) to Equation (1)

Page 1495, line 23: “fluorine, unlike the case for chlorine and bromine.”

Page 1496, line 23: time series IS cut

Page 1497, lines 4, 16, 17; Page 1498, line 24, Page 1499, line 11; etc.: stick with HF, HCl and ClONO₂ throughout, once the chemical symbols are defined

Page 1497, lines 18-19: It is not clear what is being compared here – clarify: “And on the other hand, the absolute trends agree within their errors, like the ones from the measurements:”

Page 1498, line 9: change catch to capture

Page 1498, line 10: “is more pronounced in the data than in the model results.”

Page 1498, line 17: “processes, for example, wash-out, have . . .”

Page 1498, line 28: delete first

Page 1499, lines 8 and 22: correct the use of “respectively”

Page 1499, line 27: change It to This

Page 1500, line 1: change station to measurements

Page 1500, lines 3 and 10: correct the use of “respectively”

Figure 1 caption: Define sensitivity. Give the solar zenith angles of the six spectra?

Figure 2 caption: Correct the use of “respectively”

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 1489, 2011.

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