Comments on "Pressure dependent calibration of the OH and HOx channels of a FAGE HOx instrument using the Highly Instrumented Reactor for Atmospheric Chemistry"

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General comments

The authors describe the pressure dependent calibration of an OH/HO2 FAGE instrument. This is done by using different inlet pinholes which results in a change of the internal cell pressure and by changing the "ambient" pressure in the HIRAC simulation chamber, which also results in a change of the internal FAGE cell pressure while using a fixed pinhole. For the second method the chamber is used as an alternative calibration procedure, using the decay of hydrocarbons (for OH) and HO2-HO2 recombination after photolysis of HCHO (for HO2).

It is shown, that the standard H2O photolysis calibration is consistent with the alternative HC and HCHO method respectively. Additionally it is shown, that the pressure dependence of the sensitivity is the same, independent of the way how the internal cell pressure is changed. Both results have a significant relevance for the data evaluation of HOx measurements performed with LIF-FAGE instruments, especially for flight applications. But it needs to be stated, that these results may strongly depend on the exact design of a specific FAGE instrument.

The main results and data discussion are presented in a good way, but there is, from my point of view, one major issue in the understanding of the paper by using the terms of "two FAGE instruments": "HIRAC FAGE" and "aircraft FAGE". From the information in the paper it's not clear to me if there are really two different instruments (e.g. with different cells/tubes/electronics etc…) or if there is one set of OH cell and HO2 cell, that can be used with different laser systems and the names "HIRAC FAGE" and "aircraft FAGE" are related to the used laser (like Table 1 is suggesting). From the cited paper it looks like the two instruments are the same except of the laser system and the pumps. The use of the names "HIRAC FAGE" and "aircraft FAGE" and the fact that e.g. the "HIRAC FAGE" was used with the 200 Hz and the 5 kHz laser system (page 7976) is confusing. Especially because different cells and inlets could lead to differences in the discussed results. For example in Table 1 it's stated that the H2O photolysis calibration was done with both instruments, but on page 7976, after describing the H2O photolysis method, only the HIRAC instrument is mentioned (but with both laser systems). In contrast to that figure 10 shows CHO2 from H2O photolysis for, as the caption says, the HIRAC (200 Hz) and aircraft (5 kHz) instrument.
Therefore it would be very helpful if the authors add a more precise description of the differences between the two instruments in chapter 2.2 and choose a more conclusive usage of the names in the text and the figures.

Two other general points:

In the supplement the water vapour dependence of the sensitivity is discussed. The result of this discussion is that the water dependence is smaller than the uncertainty of the calibration. Therefore the authors decide not to correct the measured sensitivity with respect to the water vapour. I would suggest to add this conclusion in chapter 5 before the comparison of the H2O photolysis

measurements (which were performed under high [H2O]) with the HC decay method (performed under low [H2O]) and not only later in the text.

The uncertainty is in some figures given as the total uncertainty and sometimes only as the precision. For me it is not conclusive how/why this is chosen.

Special comments:

- p. 7974, line 23: If I understand this right the argument is, that "if" there is any OH generated by the laser, this would be probed within the same laser pulse because the air is exchanged between two pulses at 200 Hz PRF and that this OH would not be affected by the addition of iso-butane because of the short time for the reaction. But would there be any signal expected from the OH which is probed in the same pulse it was generated from? I think that this signal would be very small, at least much smaller than the interference signal given on page 7980. Do you have an explanation for this relatively high interference there?
  If the 5 kHz laser is used, the air is not exchanged between two pulses. Is there any closer analysis for the interference with the 5 kHz laser? On page 7980 you give the information that you don't see any interference signal during the HC measurements with the 5 kHz laser. Is this just due to lower pulse energy?

- p. 7979, line 22: also true for the other HC? Is it possible that there are relevant differences which might have an influence on the comparability of the HC method to the H2O method?

- P. 7980, line 26: its stated, that you don't see an interference signal while using the 5 kHz laser but in the beginning you write, that the HC measurements where only done with the 200 Hz laser system (p. 7976, line 19)

- P. 7985, line 14: how accurate is the assumption that fgate=1? What changes if fgate<1 and what is the fgate for the presented results?

- P. 7985, line 23: shouldn't it be linearly?!

- P. 7986, line 5-8 and supplement: COH=2.1 given here for the HC experiment at 1000mbar with iso-butene is not represented in table S1 in the supplement and differs quite a lot from the two COH values given there for pChamber=1000 mbar (COH=4.02 and 3.08). Is this an additional measurement and why is it so different? Also it is a bit confusing that in the main text the total uncertainty is given with 1sigma and in the graph the precision with 2sigma. (see also comment below, Suppl. Fig 5 / Tab1)

- P. 7987, line 7: how is [OH]inf defined? I don't understand how this is related to the dilution and an increase in the decay.

- P. 7990, line 6, uncertainty of the initial SHO2: could you explain that a little bit more? Wouldn't it be possible to use the mean variation of the "approximately steady state HO2 concentration"?

- Fig 10: Data for the HIRAC 200 Hz and aircraft 5 kHz FAGE instrument are shown. If there is a difference between the HIRAC and aircraft instrument except the laser system, are there any data for CHO2 from H2O photolysis with the HIRAC instrument with 5 kHz laser, as mentioned on page 7976?

Supplement

- P.2 / Fig S1: The measured COH is normalized to 2900ppmv H2O but in the text on p. 2 and the caption of Fig S1 it's stated that the calculated values are normalized to 200ppmv. Is that really the case and if so, why? Shouldn't the dashed line in S1 then cross COH=1 at 200ppmv (or 2900ppmv if it's normalized to 2900ppmv)?
- Fig 5 / Tab S1: The slope for n-pentane = 3.42 +/- 0.85 is exactly the same as for iso-butene at 1000 mbar chamber pressure in the graphs but in table 1 COH from iso-butene is 3.08 and 4.02. Also the slope from the iso-butene graph in the main text doesn't correspond to these numbers (see comment above).
- Tab S2: Could you also add a table for the data of the aircraft 5 kHz calibration measurements (Fig10 b)?

Technical comments

- p. 7976, line 24: a table with the reaction coefficients and literature would give an additional (and more convenient) overview
- p. 7977, lines 7+9: use mbar instead of Torr
- p. 7980, line 10-12: I would skip this sentence, in line 16-17 the same information is given with the direct explanation afterwards
- p. 7980, line 19: maybe add "unnormalized OH signal" because in the figures the signals are presented normalized to the laser power
- p. 7982, line 11: error in the subscript ok k_HO2+HO2
- p. 7984, line 5: short description of what is seen in the graph (before giving results of the regression) would be good, especially because it is, on the first view, a bit confusing that there are not only the results from the H2O calibration in the graph
- p. 7989, line 6: shouldn't it be "error bars" instead of "errors bars"?
- p. 7989, line 11: "than" twice at end of line
- p. 7992, line 2: sentence structure
- Tab 2: add information if 1sigma or 2sigma errors
- Fig 6 caption: add information which FAGE instrument
- Fig 7 caption: "1000 mbar chamber pressure, 293 K chamber temperature"
  add water conc. in chamber to caption
- Fig 8 caption: wrong equation number for plot in (a), shouldn't it be Eq. 7?
- Fig 9 caption: add information about the pinhole diameter for the pressure changes during the standard H2O photolysis calibration

- Fig 10: add information about nozzle changes for H2O calibration method

Supplement:

- P. 2: missing closing bracket behind (DCOH ~-4% (1000ppmv))
- Fig 5: “Comparison of four OH calibration plots…”
- Fig 5: 1sigma precision given, in full text Fig 7 2sigma