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Comment on amt-2022-186

Anonymous Referee #1

Referee comment on "Electrochemical sensors on board a Zeppelin NT: in-flight evaluation of low-cost trace gas measurements" by Tobias Schuldt et al., Atmos. Meas. Tech. Discuss., https://doi.org/10.5194/amt-2022-186-RC1, 2022

Summary

"Electrochemical sensors onboard a Zeppelin NT: In-flight evaluation of low-cost trace gas measurements" evaluates the performance of a suite of sensors installed in a hatch box within the bottom of an airborne platform. The focus here is on NO and NO2 measured by Alphasense electrochemical sensors. Six units are flown together underneath the Zeppelin and intercompared. Other aspects, including results from a reference mid-infrared MIRO instrument, were described in a related paper by the authors. Many papers have been published in recent years on low-cost gas and particulate matter sensing, along with their calibration and correction for spurious environmental dependencies. In my opinion, the manuscript is well written and scientifically sound, although the scope is fairly limited. The most novel aspect is airborne deployment in Zeppelin flights, which took place in Germany.

Main

My main comment is that it feels like the reference MIRO data from the flights is underutilized in terms of validating the performance of the electrochemical sensors, especially since laboratory test data is not included. Some thoughts on this point:

- While the intercomparison of the six setups in Figure 4 is interesting, is the conclusion about setup #2 performing best also supported by comparing against MIRO MGA? What do those results look like?

- Corrections were derived to remove dependences on T, AUX, and dRH/dt without using MIRO, and compared against manufacturer recommended corrections. This is advantageous in avoiding requiring use of a reference instrument. However, can MIRO be used independently here to evaluate how well this correction approach works?

- What can be said about stability of the ECS sensors and derived calibration during or between flights.

Minor

I am not completely sure what data was used to generate the figures. On L265 it talks about only showing setup #2. L160 talks about excluding #4, #6, and partly #5. Which sensor setups are included in Fig 3, 5-7?

Similarly, Figures 4 and 6 seem to be showing aggregate data over all the flights. This could be clearer. How many individual flights and hours of data are included? Is any data excluded?

Figure 1(a) what is the height and width of the hatch box?

L160 "From this correlation analysis it is evident that the sensors of setups #4, #6 and partly #5 provide erroneous data."

This is not obvious to me. Figure S2 in particular is referenced in the sentence before, but is hard to read both in terms of the font size within the figure and having a fairly brief figure caption.

Figure 6; is top panel with y-axis label ‘Accuracy / ppb’ showing the +/- 2 standard deviations as shown in the bottom panel? This should be clearer.

“Evidently, with the manufacturer’s correction, amount fractions in the low ppb range cannot be quantified (Fig. 6) predominantly due to the high offset of -19.76 ppb.”

I don’t understand this point since an offset affects low ppb as well as high ppb measurements equally and does not determine the sensitivity of the measurement. It could be an issue if readings are filtered to be above zero.

Acknowledgements: WRF is not directly mentioned in the main text, although perhaps it was run to generate the wind field in Figure 7. EURAD-IM is not mentioned.