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Atmospheric Measurement Techniques Discussions

Interactive comment on "Use of an Unmanned Aircraft System to Quantify NO_x Emissions from a Natural Gas Boiler" *by* Brian Gullett et al.

Anonymous Referee #2

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General Comments

Gullett et al. present stack emission measurements of CO2, CO, NO2, NO with a UAS, using a non-dispersive infrared optical absorption sensor for CO2 and electrochemical sensors for the other gases. They report good agreement of the measured NOx emissions with the continuous emission monitoring system (CEMS) at the test sites. Both, CEMS and the UAV measurement determine the emission via carbon balance calculations.

The authors, however, do not discuss the additional value of their measurement with the UAV over the CEMS measurement. The CEMS measures the same quantity (NOx emissions) with an up to 18 times lower error (see Tab. 7 of the manuscript). The manuscript thereby does not include the description of a scientific goal or application,

like e.g. the validation of the CEMS measurement, studying the dependence of the NOx emission flux on the distance to the emitting stack, or similar. The feasibility of sampling emission plumes with a UAV was shown in the cited studies of e.g. area sources or volcanoes. In many of these works the absence of a CEMS and/or chemical conversion of the measured quantities along the emission plume motivate the studies.

Further, in my opinion, the scope of this journal demands a more detailed description of the 'extensive laboratory testing to verify performance and suitability' (l. 75, 76 of the manuscript) that was carried out. Especially, since electrochemical sensors are known for their rather unstable performance (see e.g. Jiao et al., 2016, https://amt.copernicus.org/articles/9/5281/2016/) and because the sensor calibration site and measurement site in this study have significantly different gas composition (plume and background air). Drifts, dependencies on environmental factors (e.g. temperature, humidity) and cross interferences with other trace gases in amounts that are typical for the sampled emission plume should be documented in the paper.

Without these points thoroughly addressed I advise against publishing the manuscript in AMT.

Specific Comments

1) Faivre-Pierret et al., 1980 measured volcanic gas and particle emissions with an UAV. 2) The influence of the different time constants (response times) of the sensors on the comparability of the individual measurements should be shortly discussed. 3) l.113: The underlying detection techniques of the CEMS measurements should at least be mentioned. 4) A schematic drawing or photograph of the Kolibri setup would be illustrative. 5) The CO and NO2 values in Fig. 2 should be scaled up by at least a factor of 10 in order to be clearly visible. 6) In Fig. 2 it can be observed that the CO2 concentration reaches the upper end of the sensor's range several times. Is this always considered in the average? 7) l.186, 189: If the progressions of the time series as plotted in Fig. 2 were mostly determined by leaving and entering the plume with the

UAV, the standard deviation of this time series would not be a good measure for the measurement error.

References

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Faivre-Pierret, R., Martin, D. & Sabroux, J.C., Contribution des Sondes Aérologiques Motorisées à l'Etude de la Physico-Chimie des Panaches Volcaniques, Bull Volcanol (1980) 43: 473. https://doi.org/10.1007/BF02597686

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