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Atmospheric Measurement Techniques Discussions

Interactive comment on "High-precision monitoring of compliance with fuel sulfur content through UAV measurements of ship emissions" *by* F. Zhou et al.

Anonymous Referee #1

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Ship emission is a broadly investigated topic due to its significant effect on climate, air quality and hence people's health and welfare. It is especially important to monitor in Emission Controlled Areas (ECAs) whether the ships comply with the regulations or not. In this context the authors did an important and relevant research that might have scientific significance, which is, unfortunately, not reflected in current version of the manuscript.

Even the title is sloppy: "High-precision monitoring of compliance with fuel sulfur content through UAV measurements of ship emissions" Should be rather: "High-precision monitoring of compliance with fuel sulfur content regulations/limitation/standards

through UAV measurements of ship emissions"

1. Introduction

The literature review is poor. For example: Page1, line20: Year of citation is 2005. Add current data here since anthropocentric SO2 emission might changed significantly during 14 years. Pg1, ln25: "some regulation went into effect" - needed to be re-phased.

Pg2, ln4: "To cope with..." ???

The overview of techniques (Pg2, ln15-ln26) is incorrect. The optical methods (LIDAR, UV cam, DOAS) can measure only the SO2 emission rate. For emission factor calculation simultaneous CO2 emission rate measurement is needed preferable on the same parcel of the plume. It can be implemented by open path FTIR technique but it is quite challenging. Another solution could be to model the CO2 emission rate based on the ship's technical properties and sailing characteristics. Then the SO2 or S emission factor (EF) as well as the fuel sulphur content (FSC) can be calculated.

Pg2, ln25: What is the effect of NOx sensor on FSC measurement?

In addition, several UAV application have been done before that must be mentioned here. As a summary; a new and more precise Introduction is needed.

2. Measurement:

Avoid mini-sniffer term. Sniffing technique supposes an airflow through the analyzer. In this context the CO2 analyzer can sniff but the SO2 sensor definitely cant. Better to use sensing or electrochemical sensing terms.

This section is also incomplete. What sensors were used? Manufacturers, types, characteristics? The description of the sniffing technique (Pg5) is poor and incomplete. For example, the proper handling of the water vapor interference with CO2 measurements is crucial. How did the authors handle that?

Ln13: "calibrated 3 month or 180 working hours apart" ??? - why is this big difference?

I miss evidences of laboratory experiments where the sensors were calibrated and tested, effects of environmental factors (temperature, humidity) were investigated as well as interference of other components (water vapor) was checked.

4. Results

The authors claimed that they measured 20 ships. Why only 6 plumes were presented here? It is not clear how the authors accepted or discarded results. What were the main steps of the consideration? On the other hands, the main strength of the work that the authors compared their plume measurements with the chemical analysis of the fuel. The authors did not mention the biggest challenge of the technique, namely how can we synchronize the time variations of two different measurements (SO2 and CO2) in order to calculate their ratio. In case of broader plume parcels (and thus longer measurement time) during conventional sniffing technique the uncertainty of the integrals are negligible, so more or less exact ratio can be calculated. On the other hands, the sensing technique provides narrow peaks of both components where the uncertainty of the integral is significant.

How can the authors describe the differences in the time variation of the two components (see the figures on Pg10)? In Plume 5 and Plume 6 the CO2 sensor was saturated at different concentrations (1900 vs 5000 ppm). What was the reason?

As a summary; although the authors did significant efforts and they have some good results this work is still not ready for publication. I encourage the authors to consider my comments and fix the weaknesses of the paper. A completed and corrected description of this work would be worth to publish in AMT.

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