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Atmospheric Measurement Techniques Discussions

Interactive comment on "Determining air pollutant emission rates based on mass balance using airborne measurement data over the Alberta oil sands operations" *by* M. Gordon et al.

Anonymous Referee #2

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General comments

The authors propose an algorithm to retrieve emissions of pollutants by a mass balance approach using aircraft measurements of winds and chemical concentrations. The proposed methodology and the related implementation choices are clearly described through example calculations for two different flights made during an intensive monitoring field campaign. Results are discussed in an attempt of assessing model uncertainties and a comparison to industry reported emission for one of the pollutants is also made. To my knowledge, this manuscript is a very useful contribution to develop new approaches for quantifying air pollutants emissions. The authors also present, in

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the introduction, a good critical review of the main techniques addressing similar tasks in the recent literature, highlighting differences among these methodologies; in particular, their algorithm is described as an improvement of the box method due to the better quantification of uncertainties and to a modified treatment for near surface data. This claim seems to be confirmed in the specific circumstances described in the reported experiments, but indeed it should be better motivated, on more theoretical ground.

Specific comments

Interpolation and extrapolation

At which frequency are the data (wind and chemical species) measured? Are they averaged before interpolation, and how? Table 4 statistics refer to interpolated values of concentration, of wind, or to the final emission results? Methods to extrapolate pollutant mixing ratios seem to highly depend on the considered chemical species, on the flight conditions, on the specific sources in the box area. This is confirmed also by authors' comments (page4787 line8: "The other cases require a proper choice of extrapolation technique based on knowledge of the mixing ratio behavior in this region"). Is this choice subjective and left to the researcher's experience or can something more be suggested by the authors?

Emissions algorithm

It is not clear to me how the box top height is chosen. While for the case study of SO2 emissions this choice seems to be not relevant, on the contrary for CH4 emissions the vertical advection contribution, as reported in Table 6 (third row), is of the same order of the net horizontal advection (difference of the first two rows) for both days. The authors should clarify how the vertical flux is affected by different box top heights. Similar considerations concern the turbulent flux, as suggested by the authors on page 4790 line12 :"there is a large uncertainty in this EC,VT estimation and it is unclear from these measurements if the inversion step change occurs near enough to the box top to necessitate inclusion in the calculated emissions". Finally, also on page 4791line2

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they state “For CH4, the resulting values of EC,M are small relative to the horizontal flux term EC,H, but are large compared to the final calculated emission rate”

Discussion

In general, it seems to me that the proposed methodology is well suited for single and concentrated sources, while for surface-based or diffused emission sources and low altitude plumes the improvement with respect to the other emissions algorithms reported in the literature is not so relevant. Uncertainty quantification: the considerations on the relative importance of the uncertainty terms are very interesting but are they general or case-specific? Finally, the authors should say something on the actual applicability of the TERRA algorithm on different study areas and different flight path designs: for example did the authors try to estimate the emissions for the same study area by using less horizontal data to reproduce a shorter flight path?

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 4769, 2015.