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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Estimating Upper Silesian coal mine methane emissions from airborne in situ observations and dispersion modeling" *by* Julian Kostinek et al.

Anonymous Referee #2

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GENERAL COMMENT

The manuscript describes a study to estimate methane emissions from the Upper Silesian coal mining area using an air craft campaign. Two flights encircling the region have been conducted that measured methane concentrations up- and downwind in the plume. High resolution model simulations were used to relate the observations to possible emission locations, and in this way estimate the emissions for the chosen campaign day. Studies like this are highly relevant for climate research since the help to obtain insight in an important source of atmospheric methane, the second most important greenhouse gas after carbon dioxide. The subject is therefore well within the

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Discussion paper

scope of ACP, and could be published after some minor changes.

The used method is rigorous and robust. The description of the air craft flights is very informative, including the reasoning behind the flight plan. The simulations are based on combination of a trajectory model (FLEXPART) driven by a high-resolution meteorological model (WRF), where the later is also guided by wind lidar profiles taken during the same campaign. This gives trust that the simulations are as close to reality as can be expected from such simulations. Also the estimate of the emissions is done rigorous and seems hardly guided by a priori assumptions.

The results show that using such campaigns it is in principle possible to make a rather accurate estimate of actual emissions in a region with a large number of small sources that together aggregate into a major plume. Since the campaign is not more than a snap shot, it cannot be expected that these results can be extrapolated to for example a yearly total. However, could the authors give some reflection on how to use this kind method to do so? Could these campaigns be regularly repeated, or would for example regularly performed soundings (with FTIR or AirCore) be an alternative?

DETAILED COMMENT

Lines 80-86: Is there information available on how the EDGAR inventory estimated these CH4 emissions? In section 4.4 a comparison is made with E-PRTR. Since the later is more "specific", one could argue that it is more accurate. Aren't these numbers then not used in EDGAR?

Section 4.1: The WRF model assimilates wind profiles from the 3 lidars. This gives trust in the quality of the simulations, but how essential are these in the end? If these were not used, what could roughly be the change in the results?

Figure 5: Temperature is 2-4 degrees biased ($\sim$ 1%). Is that problematic for computing air densities etc? Think it should be related to the error estimates in section 4.3. Observed temperature is used in eq. 10 for the in-situ observations, should assimilated

temperatures then be used in the simulations?

Line 190: Where is the source index i used in the emission rate φ_i ? I guess that both emitted mass and emission time are source dependend.

Line 209: What do we learn from d_s? Much more observations than sources, so in theory overdetermined problem. If d_s equals number of sources, is the estimate than exact?

Lines 239-240: This is a correct description of the Jacobian, but has that been used in the error estimates described in this section?

Figure 7, right panel: what is the background color, emissions from EDGAR ?

Line 280: Why not Fig 6 and Fig 9 as two panels next to each other?

Line 297. A scatter plot with x for afternoon vs morning would be useful to see if the algorithm estimates emissions to be present from the same locations, and how different these are.

Line 298. What is meant with "... neither flight can be used on its own ..." Here a remark could be placed that in the next section the morning and afternoon flights are analyzed together.

Section 4.6 The estimated emission totals have an uncertainty of 16% (std.dev.) Could this value be related in someway to a yearly total? For example, how many campaigns would be needed to come within an accuracy of say 2% over the year?

SPELL AND GRAMMER

line 11: no comma: "... flights due to ..."

line 25: ".. processing, and transport .."

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