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Atmospheric Chemistry and Physics
Discussions

Interactive comment on "Atmospheric measurement of point source fossil fuel CO_2 emissions" *by* J. C. Turnbull et al.

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Summary:

In this study Turnbull et al. investigate different methodologies to derive top-down flux estimates for the emissions of a natural gas treatment plant in New Zealand. Different sampling techniques such as continuous CO2 observations from a Helikite and 14CO2 from this platform as well as 14CO2 and CO2 from ground-based flasks samples and "grass", which serves as an integrative sampler. These observational techniques are well-established and concisely described here. The data collected during different campaigns is then compared to forward modelling results, which use bottom-up CO2ff emission estimates and a lagrangian transport model (WindTrax), which ap-

pears to be moderately suitable to reproduce the observational record, while it better explains averaged quantities and spatial patterns. After this detailed discussion the results are summarised and a few recommendation of potential strategies to improve the used techniques in the future are given.

General comments (minor):

Firstly, the method to derive CO2ff used here, i.e. calculating CO2,ff from D14C observations using equation (1) is a common and established technique (e.g. Levin 2003 (GRL, doi:10.1029/2003GL018477). However, Vogel et al. 2013 (Radiocarbon, doi:10.2458/azu_js_rc.55.16347) found that it is advisable to use d14C whenever possible, especially when the local fossil fuel CO2 offset is large and might be predominantly from sources depleted in d13C. For example, adding 50ppm CO2ff from burning an isotopically "heavy" fuel (e.g. pittsburgh coal, d13C = -25permil) will produce a different ïĄĎ14C value compared to 50ppm from burning an isotopically "light" source (e.g. natural gas, often d13C < -40permil), as the d13C of the CO2 in the samples will be significantly different, which is used to calculate D14C. As CO2 from natural gas can be very isotopically depleted could have a noticable effect? Do you have an estimate of d13Csource in your samples to estimate if this might significant here?

Secondly, the main goals of this study are very well outlined at the end of the introduction (section 1). This study tackles these questions and discusses them, but especially the question of cost and complexity of measurements and how the uncertainty of the top-down flux estimates can be reduced most efficiently could be discussed more clearly (e.g. a more quantitative for the costs) in section 6.

Thirdly, the use of plants as natural integrative samplers is technique which is increasingly used, but has numerous complications. Those shortcomings are discussed in this study, but to fully understand their potential influence it is crucial to have more information about the "grass" sampling here. Which species of grass was sampled and what part of the plant? E.g. whole leafs or just the 20cm of recent regrowth? Have leafs of different grass plants been pooled to get a more representative average?

Overall, the execution and results of this study is of high quality and it includes a sound and careful analysis of the observational and modelling data. Its topic is highly relevant in the framework of developing monitoring tools for anthropogenic Greenhouse Gas emissions. It will surely be of interest to the readers of ACP and I thus fully recommend the publication, after adressing the minor additions/clarifications.

Specific comments:

P29062 – line 26: As this is an approximation please consider changing "decreases D14CO2 by 2.6permil" to "decreases D14CO2 by about 2.6permil"

P29064 – line 2: Please consider adding a reference to Levin et al. 2003 (GRL, doi:10.1029/2003GL018477), who previously used the Radon-Tracer Method to derive two long-term CO2ff flux records for two sites.

P29066 – line 27: How was the measurement precision of 0.1 ppm determined? Is this an instrument specific value or a general estimate from the characteristic of the Picarro G1301 instrument series?

P29069 – P29030: Please add the information about which type of grass was sampled and especially which part of the plant. (See general comments)

P29073 – line 10 Please add information on how the bottom-up flux estimates were derived and why you assume a 3% diurnal variation of the emissions.

P29076 – line 14 Please change R(CO2/CO2ff) to R(dCO2/CO2ff) to reflect that this ratio only comprises the local offset CO2 (dCO2) and not CO2 overall. (Applies also to Figure 5)

P29078 – line 26 How much worse was the model-observervation mismatch when the effective stack height was used?

P29079 – line 28 Please elaborate how you derive the 30% uncertainty and if this

precision is true for all situation or if this is limited to e.g. afternoon values. Given that other point sources have a larger variability than 3% daily sometimes even reoccuring diurnal cycles (e.g. gas power plants, flaring sites in O&G industry) it is crucial to be clear if the 30% would apply there as well.

P29081 – line 19 It might be worthwhile to add that most fossil fuel power plants have an effective stack height well above 100m - typically: 324m-781m (see e.g. Pregger and Friedrich 2009, Environmental Pollution, doi:10.1016/j.envpol.2008.09.027). As you mentioned monitoring this type of site will have to be done further downwind, which will make a well-calibrated transport model and good meteorological data even more important.

Interactive comment on Atmos. Chem. Phys. Discuss., 13, 29059, 2013.