Atmospheric
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Techniques

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Discussions

Interactive comment on "Munich permanent urban greenhouse gas column observing network" *by* Florian Dietrich et al.

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This paper describes a measurement system and early results from a set of portable, automated ground-based solar infrared spectrometers based on the commercially-available Bruker EM27-Sun. Each spectrometer is housed in an autonomous housing allowing weather-proof operation and full automation. Five such spectrometers are deployed around Munich, Germany to deduce city-scale emissions of CO_2, CH_4 and CO from the upwind-downwind differences of total column amounts of these gases. The paper provides full technical details, building on an earlier 2106 publication. It represents a substantial instrumental development which would be of interest to anyone concerned with quantifying extended-source emissions such as cities or large point sources. It would require substantial effort and funding for others to duplicate the work,

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Discussion paper

so I am pleased to see that the authors agree to make all technical plans, drawings and code available. It does leave me curious whether the authors have any plan to licence the system to a commercial provider – weather protection and automation for solar trackers and the EM27 used here and in TCCON and COCCON networks are not commercially available, but every installation needs one. The paper is clearly suitable for publication in AMT, after minor revisions and extensions and a few technical corrections.

General comments

Section 5.2 describes essential side by side comparisons (they are not "calibrations" per se) amongst the 5 instruments and TCCON FTS at Karlsruhe. These comparisons are of critical importance in evaluating small differences between upwind and downwind measurements, since any instrument bias would be interpreted as a gradient if not corrected. Yet no details of the comparisons are presented, and the reader has no idea of the uncertainty in the bias correction factors. It is essential to present the numerical details from all 6-monthly comparisons between instruments (and occasional TCCON comparisons). This could be done as a table of regression factors for each instrument pair and date. Only then can the reader assess the statistics of these comparisons – their magnitude, stability and reproducibility. The quantitative uncertainty will be essential for later modelling of the measured gradients in any Bayesian inversion scheme.

In section 5.3 and Figure 13 upwind-downwind data are compared, and at L302 the changes during Covid lockdown in 2020 are compared. However without the quantitative intercomparison data requested for section 5.2, it is impossible to assess the meaningfulness of these differences. How are the error bars on the CO_2 enhancements calculated (refer to 5.2 discussion)? I also do not agree that the data show a correlated drop in CO_2 enhancement with traffic congestion from weeks 4 to 12. CO_2 enhancement drop 4-5 weeks earlier, meanwhile the season is changing from winter to spring and presumably CO_2 sources other than traffic also change in this time, such

as home, industrial and commercial heating. The interpretation is too simplistic. Thus I do not agree with the statement "These results prove that our network can detect changes in the urban emissions" – see also the conclusion around L 335. Based on the detail currently presented this conclusion is not valid. However this is not to say it is not possible. The data should be extremely valuable for such interpretations when combined with a city-scale regional model such as described as being under development. I agree that this level of modelling and interpretation is outside the scope of this paper.

Finally, I count the term "world's first" 5 times in the manuscript – this is excessive. I suggest it is OK and sufficient to point his out once-only in the abstract, conclusion, and introduction.

Technical corrections

L15: Suggest rewording " as well as concentration gradients between sites upwind and downwind of the city."

L59: TCCON measurements are made at a resolution of 0.02 cm-1

L92: "Reed sensors in the inner cover COUNT these signals. . ."

L93: "Reed sensors INDICATE the absolute position." There are several more cases of present perfect tense where simple present is normal English usage – a copy editor should pick these up.

L119: As described in the current text, the system could not operate for several hours around noon in the southern hemisphere unless the whole instrument is rotated 180° to point north, with software able to handle this switch. Presumably this is the case - I suggest the text be clarified to make this clear. Further, why is the range (30-300°) not symmetric around North?

L138: Unclear wording ("cannot" should be "can not"), I suggest either that small change or "They can control temperature to a constant level. . . as well as condense

C3

(not condensate) water vapour ..."

L178: ... with two INDEPENDENT software COMPONENTS, OPUS and Camtracker, to control. ...

L207: Very little detail of the spectrum retrieval with GFIT is given. This is OK if it follows the Wunch and Hedelius references exactly, but any variations from those procedures should be described because they will impact on accuracy and precision. In particular, when is the analysis done? – vertical pressure-temperature-humidty profiles only become available after a few days, but the text sort-of implies the fitting is done the same day in a pipeline process.

L219: "respectively" is not needed here, remove.

L230: "pure emissions" is not quite the right wording, I suggest ".. this setup cannot be used to determine the emissions of the central city of Munich separate from its outer surrounds".

Fig 8 L2: The urban area itself is largely contained (provide a %?) within the green inner dotted circle in the centre.

L236: OCO-2 and OCO-3

L254: with the parameters a to d to be fitted.

L270: See general comments, this section should be expanded to include actual regression coefficient and statistics.

L292: Can you provide the actual starting dates and numbers of measurements, rather than "a little bit later" and "a little bit less".

L302: See general comments.