Atmos. Meas. Tech. Discuss.,
doi:10.5194/amt-2020-300-RC2, 2020

Atmospheric Measurement Techniques Discussions

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

Anonymous Referee #2

Received and published: 4 November 2020

General comments:

In this study, Dietrich et al. report on a novel permanent urban greenhouse gas monitoring network using EM27/SUN spectrometers inside an automated enclosure system in Munich. They carefully describe the technical innovations from a previous design as well as results from a successful testing campaign and long-term operations. It is clear that the presented systems are a significant improvement and hold the potential to facilitate such measurements in many cities and regions in the future. The paper is clearly structured and very well written and it fits perfectly into the scope of AMT. Although the technical aspects are overall excellent, there is unfortunately a major point of concern that should be addressed before publication. The authors have made very strong statements that the manuscript itself does not address. For example, the claim

that the presented systems and approach allows to determine urban greenhouse gas emissions 'in any city worldwide'. More instances of such sweeping statements are given in the specific comments section. I recommend that the authors revisit these statement and provide additional data and explanations to support them. On the other hand the author could also choose to let the fully supported and very impressive results, e.g. increased data availability, continuous operations during COVID-lockdown, tracking of XCO2 enhancement changes speak for themselves.

Specific comments:

L1 – Consider removing 'the'

L8 – This study does not establish that this technique by itself allows to quantify emissions. For example, how well can annual emissions be estimated when observations have a clear-sky (and maybe seasonal) bias.

L21 – Although it is an impressive measurement system for total column CO2 and CH4, it seems far from proven that this technique and system as a 'new standard for determining GHG emissions', given the complexity and challenges in urban environments.

L27 – Gurney et al. did not claim that urban areas contribute more than 70% of GHG emissions, but rather that 'Cities account for more than 70% of global fossil fuel emissions'. There are other non-urban and non-fossil fuel sources that contribute significantly to global GHG emissions, like land-use and land-use change (CO2), agriculture (CH4, N2O), etc. Please correct this statement or provide a reference for your claim.

L59 – Do all TCCON stations use this very high spectral resolution in their operations?

L64 – How can you be sure that you will be able to assess the effectiveness of mitigation strategies? Could the atmospheric modelling framework not be insufficient to achieve this, if for example urban heat island effects are not correctly modelled. Furthermore, are the planned emission reductions in Munich large enough to significantly alter XCO2, XCH4, XN2O and other greenhouse gases.

L147- Consider rephrasing for readability

L177 - See L147

L219 - consider removing 'respectively'

L230 - What is meant by 'pure emissions'? Does this refer to net emissions of the city of Munich?

L236 – 'OCO-2' is repeated here

L252 (eq1) - Why was such a simplified fitting approach taken here, when more suitable and well-established methods are widely used to determine seasonal variations and trends in atmospheric CO2 records? For example, as described in Nakazawa et al. 1997 and references therein (https://doi.org/10.1002/(SICI)1099-095X(199705)8:3<197::AID-ENV248>3.0.CO;2-C).

L257 - The word 'hotspot' seems not to be optimal to describe data density

L264 - It would be worthwhile to explain if this refers to 52% of all days since automation or all sunny/suitable days since automation, in any case a very impressive result.

L281 - Adding the pollution rose plot for CO2 enhancement of the station inside the city could also be very interesting here to learn about the source distribution inside the city limits.

L293 – How much less data is available for southern station

L296 - This study does NOT show the drastic impact on GHG emissions, but mere a decrease in local GHG enhancements. There are many other possible reasons for changes in GHG concentrations other then emission changes. It is reasonable to assume here that the concentration enhancement change is due to emission changes, but this should be stated carefully and other potential sources of uncertainty have to be included when referring to emissions.

L302 - Please provide the R2 for this relationship. Also, looking at figure 14 it seems clear that CO2 enhancements decreased strongly in week 6 and 8 already, well before the lockdown period, while congestion was above 25%, i.e. fairly normal. A scatter plot of the two quantities could be a useful addition in the supplemental information of this paper.

L304 - See comment L296, L302, this study does not establish a decrease in emissions within Munich. Further modelling (including biospheric CO2) and assessment of uncertainties seems necessary before the authors should claim that they have proven that their system is sufficient to track emission changes. The authors later refer these uncertainties, so they seem aware of this problem, so why make such a strong claim here? Being able to reliably track XCO2 enhancement changes during COVID lockdown with an automated system is already an excellent achievement in itself.

L327 - This statement completely ignores the potentially large impact on CO2 concentrations by the urban biosphere, that has been found to be an important CO2 sink (and sometimes source) in urban areas, for example, Miller et al. 2020 (PNAS, https://doi.org/10.1073/pnas.2005253117).

L335: No data set of traffic emissions was presented in this paper. I agree that the seen decrease in congestion makes emission reductions extremely likely, but this should be stated carefully. Also the decrease does not seem to be concurrent.

L342: It is unclear how this study has established that column measurements can be used in 'any city worldwide. It seems apparent that the concentration gradients in the total column for smaller cities might be too small to detect reliably or the CO2 emission signal might be masked due to biospheric uptake in cities in the tropics. What about cities with very strong aerosol loads, like Beijing, would the EM27SUN be able to penetrate dense smog?

Interactive comment on Atmos. Meas. Tech. Discuss., doi:10.5194/amt-2020-300, 2020.