

Atmos. Chem. Phys. Discuss., referee comment RC2
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Comment on acp-2022-281

Anonymous Referee #2

Referee comment on "Understanding greenhouse gas (GHG) column concentrations in Munich using the Weather Research and Forecasting (WRF) model" by Xinxu Zhao et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2022-281-RC2>, 2022

The paper compares wind and EM27/SUN data at 5 sites taken as part of the Munich Urban Carbon Column Network in August 2018 with a >400m resolution WRF model with emissions. The goal is top down verification of CO₂ and CH₄ emissions, that are challenging given that these are long lived species that are influenced by long range transport and also local sources. The analysis is detailed analysis is presented well and valuable particularly in identifying conditions of uniformity ion regional air masses when a "gradient" method is explored, that may be useful operationally for top down verification. The paper should advance GHG verification strategies.

I do have the following questions and concerns that demand further clarifications by the authors:

- A more careful explanation of the CO₂ bias would be useful as it appears to be constant and obviously a statement that it cancels out.
- Was CO measured with the EM27 as this would provide an independent constraint? If not then this should be mentioned as an additional valuable data to collect as new EM27's can do this together with CO₂ and CH₄.
- For methane the EM27 measures the total column, including the stratosphere where it falls off. TCCON does correct for this using HF that unfortunately the EM27 does not measure. The gradient method and analysis assumes this is constant and this should be clearly stated with citations (Saad et al). If this correction is not made the observations should be biased a low. The authors find a slight +ve bias "while in general the

observed values are slightly higher, with a linear regression slope of 0.73 and a negative MB (-1.8 ± 4.0 ppb). This small bias could be caused by the initial and lateral boundary conditions from CAMS, or due to unknown or underestimated emissions" The possible reasons for this should be explained more clearly.

- There are many EM27 model studies of optimized fluxes such as Taylor et al, Viatte et al that are cited. Another very relevant study Heerah et al JGR Atm 2022 <https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021JD034785> that uses distributed EM27 data and WFR model to do systematic comparison with winds and inverse modeling for dairies should also be cited.