Geophysical Research Abstracts
Vol. 21, EGU2019-17611-1, 2019
EGU General Assembly 2019

Analysis for Total Column CO_2 and CH_4 in Berlin using WRF-GHG combined with Differential Column Methodology (DCM)

Xinxu Zhao (1), Julia Marshall (2), Stephan Hachinger (3), Christoph Gerbig (2), and Jia Chen (1)

(1) Technology University of Munich, Munich, Germany, (2) Max Plank Institute of Biogeochemistry, Jena, Germany, (3) Leibniz Supercomputering Center (Leibniz-Rechenzenturm, LRZ) of Bavarian Academy of Sciences and Humanities, Garching, Germany

A quantitative tracking of GHG emissions in urban areas is therefore of great importance, with the aim of accurately assessing the amount of emissions and identifying the emission sources. The Weather Research and Forecasting model (WRF) coupled with GHG modules (WRF-GHG) developed for mesoscale atmospheric GHG transport, can predict column-averaged abundances of CO_2 and CH4 (XCO_2 and XCH4). To assess the precision of WRF-GHG and provide insights on how to detect and understand sources of GHGs within urban areas, WRF-GHG is used to simulate the uptake and emission of atmospheric GHGs in Berlin at a high spatial resolution of 1 km, and the simulation workflow is adapted to this purpose where needed [1].

The simulated wind and concentration fields were compared with the measurements from a campaign performed around Berlin in 2014 [2]. The measured and simulated wind fields mostly demonstrate good agreement and the simulated XCO_2 agrees well with the measurement. In contrast, a bias in the simulated XCH4 of around 2.7% is found, caused by relatively high initialization values for the background concentration field. An analysis using differential column methodology (DCM) [3] works well for the XCH4 comparison, as corresponding background biases then cancel out. From the tracer analysis, the diurnal variation of concentration components from different emission tracers is discussed. The biogenic component plays a pivotal and leading role in the variations of XCO_2. The impact from anthropogenic emission sources is weaker, while for XCH4, the enhancement is highly dependent on human activities. DCM highlights that the XCO_2 signal within the inner Berlin urban area is dominated by anthropogenic behavior rather than biogenic activities.

WRF-GHG is concluded to be a suitable for precise GHG transport analysis in urban areas when combined with DCM. DCM is an effective method, not only for comparing models to observations independently of biases caused, e.g., by initial conditions, but also for detecting and understanding sources of GHG emissions quantitatively in urban areas. In future work, more urban cases are suggested for running WRF-GHG and the mesoscale simulation framework can also be combined with micro-scale atmospheric transports models such that the crucial details of transport patterns and emission sources are studied.

[1] Zhao, X., Marshall, J., Hachinger, S., Gerbig, C., and Chen, J.: Analysis of Total Column CO_2 and CH4 Measurements in Berlin with WRF-GHG, Atmos. Chem. Phys. Discuss., https://doi.org/10.5194/acp-2018-1116, in review, 2019.

[2] Hase, F., Frey, M., Blumenstock, T., Groß, J., Kiel, M., Kohlhepp, R., Mengistu Tsidu, G., Schäfer, K., Sha, M., and Orphal, J.: Application of portable FTIR spectrometers for detecting greenhouse gas emissions of the major city Berlin, Atmospheric Measurement Techniques,8, 3059–3068, https://doi.org/10.5194/amt-8-3059-2015, 2015.

[3]Chen, J., Viatte, C., Hedelius, J. K., Jones, T., Franklin, J. E., Parker, H., Gottlieb, E. W., Wennberg, P. O., Dubey, M. K., and Wofsy, S. C.:Differential column measurements using compact solar-tracking spectrometers, Atmospheric Chemistry and Physics, 16, 8479–8498,https://doi.org/10.5194/acp-16-8479-2016, 2016.