Geophysical Research Abstracts
Vol. 21, EGU2019-1025-1, 2019
EGU General Assembly 2019
© Author(s) 2019. CC Attribution 4.0 license.

Continuous urban *in-situ* CO_2 measurement at Munich using TDLAS-WMS method and VCSEL laser

Lijuan Lan (1), Jia Chen (1), Xinxu Zhao (1), Yin Bai (1), Homa Ghasemifard (2), and Stephan Hachinger (3)

(1) Environmental Sensing and Modeling, Technical University of Munich, 80333 Munich, Germany (lijuan.lan@tum.de), (2) Professorship of Ecoclimatology, Technical University of Munich, 85354 Freising, Germany, (3) Leibniz Supercomputing Center (Leibniz-Rechenzenturm, LRZ) of Bavarian Academy of Sciences and Humanities, 85748 Garching, Germany

The anthropogenic CO_2 emissions come mainly from cities and their surrounding areas, thence, continuously measuring CO_2 in urban areas is of great significance to study climate change. We have developed a highly precise and compact *in-situ* CO_2/H_2O measurement system, which based on TDLAS (tunable diode laser absorption spectroscopy), WMS (wavelength modulation spectroscopy) and VCSEL (vertical-cavity surface-emitting laser). The sensor removes the need for calibration since the wavelength and laser intensity are calibrated in the system. Multi-harmonic detection is deployed in the system to improve the stability and precision of the measurement [1].

In this work, the continuous CO_2 measurement is taken at Munich city center from January 2018 to January 2019. According to the daily, monthly and seasonal analyses of measurement results, the urban CO_2 is affected strongly by several factors, such as air movements, weather conditions, biospheric respiration and photosynthesis, and anthropogenic activities. The daily maximum values of CO_2 are found in the morning while the minimum in the afternoon. In spring, the CO_2 data has a diurnal cycle with about 25 ppm peak-to-peak value. Since the photosynthesis is the most active and the weather is hot (the highest temperature can reach to 35°C), the summer curve has the most distinct diurnal variations and the highest peak-to-peak value varies from about 380 to 430 ppm. Moreover, summer has the earliest maximum and the latest minimum values among seasons, at around 6:00 am and 18:00 pm, respectively. The autumn diurnal cycle turns to be around 40 ppm with maximum at 8:00 am and minimum at 16:00 pm because the leaves fall away and the photosynthesis is not so active. The winter data has no obvious diurnal cycle but the highest CO_2 value since the photosynthesis almost dies down. The atmospheric temperature is so low (below 0°C) that the PBL (planetary boundary layer) is shallow, which leads to high CO_2 density in urban areas. Furthermore, due to the cold weather, the energy consumptions and CO_2 emissions from the humankind increase in winter.

HYSPLIT (Hybrid Single-Particle Lagrangian Integrated Trajectory) model that calculated with 12 hours backward trajectories is utilized to study the potential CO_2 emission source. Based on the PSCF (potential source contribution function) and CPF (conditional probability function) models, our analyses demonstrate that the local emissions have a great impact on the urban CO_2 concentration. Wind speed and wind direction show clearly that the wind from south, southeast, and southwest increases the CO_2 concentration, indicating the main emission sources are from these directions. High wind speed leads to concentration decrement because the air masses from rural parts purify the air in urban areas.

[1] L. Lan, J. Chen, Y. Wu, Y. Bai, X. Bi, and Y. Li, "Self-calibrated multiharmonic CO_2 sensor using VCSEL for urban *in situ* measurement", IEEE Transactions on Instrumentation and Measurement, DOI: 10.1109/TIM.2018.2863445, 2018.