Geophysical Research Abstracts
Vol. 20, EGU2018-7243, 2018
EGU General Assembly 2018

Estimation of methane emissions in the Upper Silesian Coal Basin using portable FTIR spectrometry and WRF modelling

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Atmospheric methane (CH_4) causes the second largest radiative forcing after carbon dioxide. Concentrations of atmospheric methane have increased by about 150% since 1750. Quantification of the sources of methane is crucial to understand the impact of anthropogenic emissions on global climate change. CH_4 emissions from coal production are one of the main sources of anthropogenic methane in the atmosphere. Poland is the second largest hard coal producer in the European Union, and an important part is the Polish side of the Upper Silesian Coal Basin (USCB). Emission estimates of CH_4 from USCB range from 0.03 kt CH_4/yr to 25.9 kt CH_4/yr and amount to roughly 465.85 kt CH_4/yr. Four ground-based, portable FTIR (Fourier transform infrared) spectrometers EM27/SUN were deployed during a field campaign in August 2017. We operated three instruments in fixed locations, one instrument was deployed on a small truck sampling either downwind or upwind of the ventilation shafts in variable locations. Column-averaged dry-air mole fractions of CH_4 showed enhancements of about 100 ppb and 1700 ppb in five kilometer distance and in close vicinity (approx. 30 m) to the mining shafts, respectively. Dispersion of mining emissions was simulated using the Weather Research and Forecasting model (WRF) in combination with its built-in continuous passive tracer option at 400 m horizontal grid spacing. Here, we report on comparisons between the modeled and measured CH_4 concentration enhancements. In addition, we show various sensitivity studies to test model robustness and representativeness and first attempts to constrain mining emissions by the remote sensing observations.