EGU2020-19119
https://doi.org/10.5194/egusphere-egu2020-19119
EGU General Assembly 2020

Emissions of CH4, CO2, C2H6, CO and isotopic signatures in the Upper Silesian Coal Basin, Poland

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The Upper Silesian Coal Basin (USCB) represents one of the largest European CH_4 emission source regions, with a total sum of 500 Gg CH_4/a released by individual coal mine ventilation shafts. During the CoMet (Carbon Dioxide and Methane Mission) campaign in late spring 2018, airborne in-situ measurements were carried out aboard the DLR research aircraft Cessna Caravan. The Cessna was equipped with a cavity ring-down and a quantum cascade laser system to measure CH_4 and CO_2, as well as related tracers such as CO and C_2H_6. Additionally, air samples were collected and analyzed for greenhouse and trace gases, including isotopic ratios of CH_4 and CO_2. Meteorological parameters were measured with a boom mounted sensor package.

During nine research flights, CH_4 emissions were studied by using an airborne Mass Balance Approach. Depending on the wind situation, different areas of the USCB region were targeted. To account for the lower part of the plume not accessible by the aircraft, a number of vans with mobile in-situ measurement systems conducted ground-based measurements in a coordinated manner. The derived methane emission estimate agrees well with bottom-up inventories like the Emission Database for Global Atmospheric Research (EDGAR) and the European Pollutant Release and Transfer Register (E□PRTR). The CO_2 emission estimate is at the lower end of the inventories. The CO emission estimate is higher than inventory values.

From simultaneous methane and ethane measurement the emission ratios of different subregions of the USCB could be determined. The emission ratios range from 19 to 290 CH_4/C_2H_6 and are, thus, quite variable within this coal basin. From the analysis of collected flask air samples the isotopic composition of CH_4 emissions was determined. Isotopic signatures of Polish USCB CH_4 emissions are between -52.7‰ and -49.4‰ for $\delta^{13}C$ and between -241‰ and -178‰ for δD. Samples taken in the Czech part of the USCB had a δD isotopic ratio of around -309‰, hinting at a

larger influence of biogenic sources in this region.