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Quantifying CH_4 emissions from coal-mine ventilation in the Upper Silesian Coal Basin (Poland) using COCCON spectrometers

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The Upper Silesian Coal Basin (USCB), with its coal mines ventilating methane (CH4), is among the largest localized CH4 sources in Europe. The reported emission rates, however, vary broadly among
the emission inventories ranging between 405 ktCH4 (GESAPU, for the year 2010) and 720 kt (EDGAR
v4.3.2, for the year 2017). Thus, independent verification is required to constrain the actual emissions better.
Here, we report on a demonstration study conducted in May/June 2018 in the framework of the CoMet campaign in the USCB. During the campaign, five direct-sun spectrometers of the COCCON-type (Carbon Column Observing Network) were deployed in the region measuring column concentrations of CH4. One of the spectrometers was operated on a van sampling plumes of individual ventilation facilities [Luther et al., 2019]; the other four spectrometers were operated in a
stationary network at a distance of roughly 50 km enclosing the USCB [Luther et al., 2021]. In addition, we ran three wind-lidars in the region to constrain atmospheric transport. The spectrometers detected downwind enhancements of CH4 concentrations unambiguously attributable to coal mine ventilation. For the mobile spectrometer, we used a mass balance method

to infer emission rates for individual facilities. For the network, we used pairwise upwind-downwind
concentration gradients together with air mass trajectory modelling by WRF/FLEXPART to estimate emission rates for groups of facilities. The Tikhonov-based inverse method delivered the diagnostics
for quantifying the information content attributable to the facilities. We show that our approach allows estimating emissions rates with uncertainties of 20-35% largely dominated by uncertainties in
atmospheric transport. This stresses the importance of wind measurements together with the CH4 observations. Overall, scaling our hourly-to-daily emission estimates to a year indicates that they are
greater or equal to the ones reported by EPRTR (European Pollutant Release and Transfer Register).

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