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Quantifying methane emissions from industrial activities: A novel helicopter-borne application for coal mine ventilation shafts in Poland and perspectives

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The Upper Silesian Coal Basin in southern Poland belongs to one of the strongest emitting regions of anthropogenic methane (CH_4) in Europe. A major part of these CH_4 emissions is related to the coal mining industry, which are in focus of the *METHANE-To-Go-Poland* project presented here. For the first time, a unique helicopter towed probe (HELiPOD) was used to capture CH_4 plumes from selected coal mine ventilation shafts. The HELiPOD probe (weight 325 kg, length 5 m) was equipped with a 3D wind anemometer and trace gas in situ instrumentation (Picarro G2401-m and Licor-7700) to measure CH_4 with a high precision (1 ppb) and temporal resolution (up to 40 Hz), which is necessary for a precise calculation of the CH_4 mass flux. In June and October 2022, repeated upwind and downwind probing of the plumes from selected shafts (4 shafts, 16 flights) were performed at different horizontal distances from the source (~500 m - 5 km) and altitudes (~20 m – 2 km). This way, both the inflow amount of CH_4 and the horizontal/vertical dispersion of the CH_4 plumes from the shafts were captured. Depending on wind speed, wind direction and stability, suitable flight patterns were developed for every flight. In addition, two controlled CH_4 releases were successfully carried out to prove the novel measurement concept. Mobile ground-based CH_4 measurements complemented the airborne probing.

In this presentation, mass flux calculations based on measurements from the two airborne CH_4 instruments (with different measurement techniques) will be compared and uncertainties determined. Furthermore, CH_4 mass flux calculations resulting from coinciding satellite measurements (GHGSat: swath width <15 km, spatial resolution <27 m) over the same ventilation shafts combined with high-resolved GEOS-FP wind data are presented. Finally, the uncertainties of the two different top-down approaches (air- and satellite-borne) are compared, in addition to different flight strategies. Comparisons with production data from the Polish coal mine industry are foreseen in near future (bottom-up approach). Subsequently, the same kind of airborne concept is envisaged for the *METHANE-To-Go-Oman* field experiment in autumn 2023, which will focus on CH_4 emissions from the on-shore oil and gas exploration and production in Oman. Our

collected data, funded by the International Methane Emissions Observatory (IMEO), will help coal, oil and gas companies as well as governments, to prioritize their CH_4 emission mitigation strategies, actions and policies.