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# A novel helicopter-borne application for quantifying methane emissions from industrial activities: Results from measurements of coal mine ventilation shafts in Poland

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The Upper Silesian Coal Basin in southern Poland is one of the strongest emitters of anthropogenic methane ($CH_4$) in Europe. Coal mine ventilation shafts are responsible for a major part of these $CH_4$ emissions, which were in focus of the *METHANE-To-Go-Poland* project presented here. For the first time, the unique helicopter towed probe *HELiPOD* was used to estimate $CH_4$ mass fluxes from selected ventilation shafts based on the mass balance approach. The *HELiPOD* (weight 325 kg, length 5 m) was equipped with a sensor system for measuring the 3D wind vector and in situ methane analysers (Picarro G2401-m and Licor-7700) to measure $CH_4$ with a high precision (1 ppb) and high temporal resolution (up to 40 Hz). In June and October 2022, repeated upwind and downwind probing of four selected shafts were performed within 16 flights at different horizontal distances from the source (~500 m - 5 km) and altitudes (~50 m – 2 km) to capture the inflow and horizontal/vertical dispersion of the $CH_4$ plumes. Depending on wind speed, wind direction and atmospheric stability, suitable flight patterns were developed for every flight. Co-located mobile ground-based $CH_4$ measurements complemented the airborne probing. In addition, two controlled $CH_4$ releases were successfully carried out to prove the novel measurement concept.

In this presentation, top-down mass flux estimates based on measurements from the two airborne $CH_4$ instruments (with different temporal resolution) will be compared and mass flux uncertainties will be discussed with respect to the flight strategies and meteorological conditions. Depending on the surveyed shaft, the calculated $CH_4$ mass fluxes range from 1000 to 3000 kg/h. Subsequently, the top-down mass fluxes will be compared to bottom-up mass flux calculations based on production data obtained directly from the coal mine industry.

Our calculations are an example of the independent emission verification technique and will help coal, oil and gas companies as well as governments, to prioritize their $CH_4$ emission mitigation

strategies, actions and policies. This research has been funded in the framework of UNEP's International Methane Emissions Observatory.