

Observing the spatial distribution of UFP downwind of active coal mine ventilation shafts in Poland

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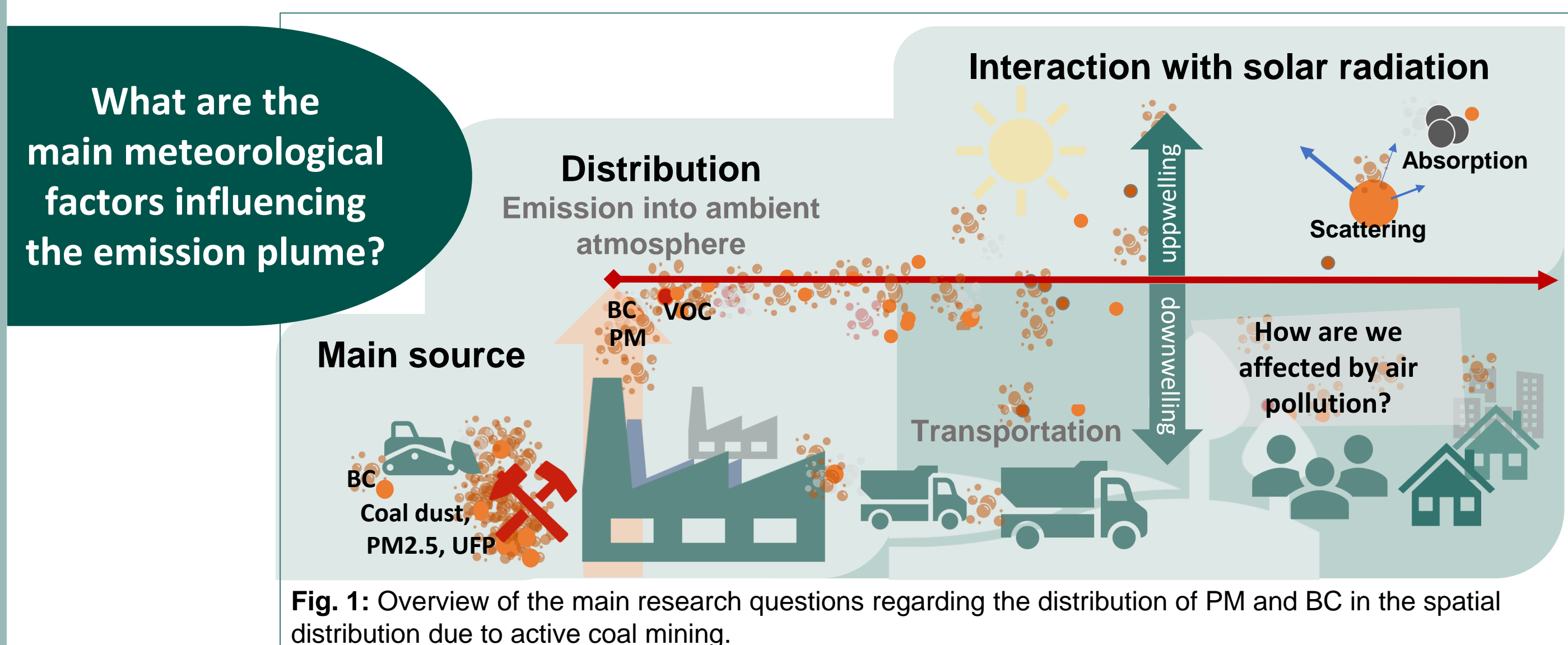
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Introduction

- The production and processing of coal cause adverse effects to all beings and to the environment.
- Intensive amounts of gases and airborne pollutants, like particulate matter (PM), are emitted into the atmosphere, which ultimately lead to a significant reduction of the air quality.
- So far, little is known about the level of air pollution regarding PM concentrations and different sizes (ranging from UFP to coarse mode) and black carbon (BC) in the spatial distribution, especially at further distances (several 10 km) away from the emission spots caused by active coal mining.



Methodology

Investigations as part of the METHANE-To-Go-Poland (MTG-Poland) project, funded by the United Nations Environment Programme (UNEP) and in cooperation with the DLR

- The helicopter borne measurement system HELiPOD (Pätzold et al., 2023, Fig. 2, Tab. 1) was used for studying meteorological parameters, radiation and surface properties, trace gases as well as aerosol particles during two periods in June and October 2022.
- The measurement flights were performed downwind (perpendicular and in parallel to the current wind direction, see Fig. 3) of four different coal mine ventilation shafts in the Upper Silesian Coal Basin (USCB) in south Poland. An area that still contributes to one of the most important coal producers in Europe.

Choice of measurement strategy and instrumentation

Tab. 1: Parameters derived from HELiPOD application during MTG-Poland

Position and orientation	Atmospheric parameters	Surface properties
Altitude, position, attitude, magnetic fields	Temperature, humidity, wind vector	Temperature, infrared images, visible images
Aerosol	Radiation	Trace gas, greenhouse gas
Number concentration of different sizes from 5 to 11 nm up to 1 µm, PM ₁ , PM _{2.5} and PM ₁₀ , equivalent BC	Solar up and down, infrared up and down	Ozone, methane, carbon dioxide

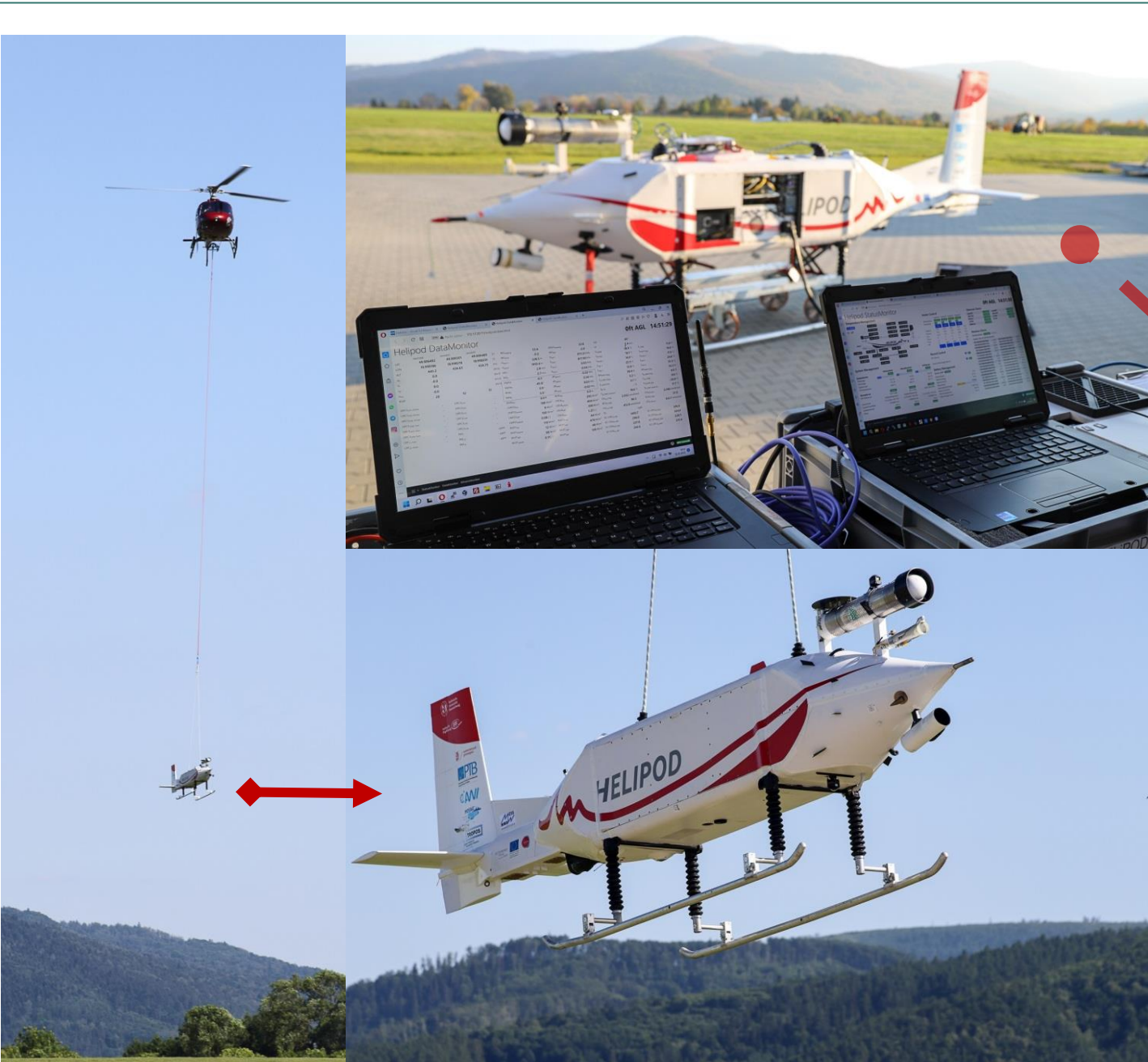


Fig. 2: HELiPOD operation and before take-off at the EPBA airport during the MTG-Poland experiment in October 2022. Photos: Lutz Bretschneider

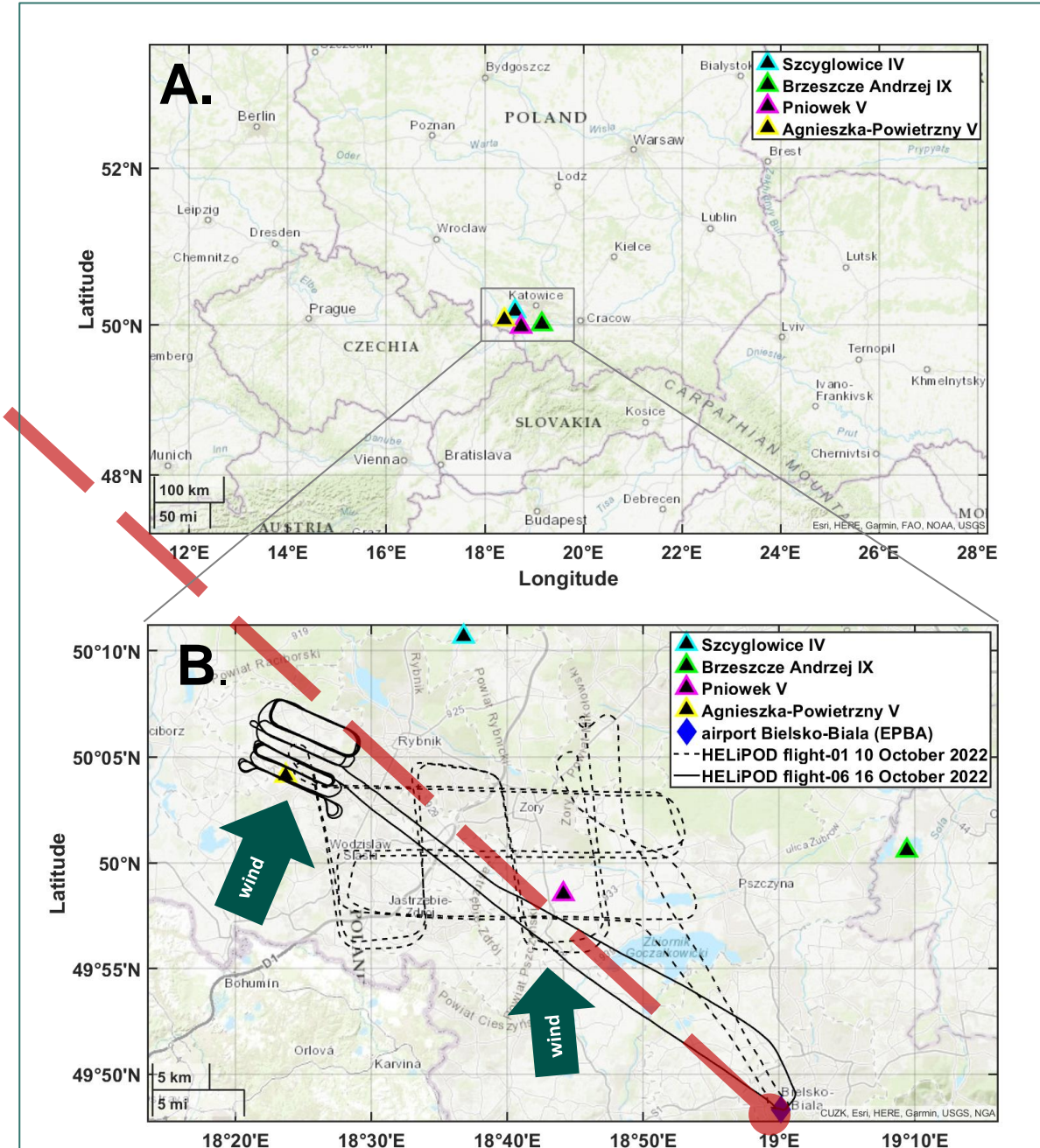
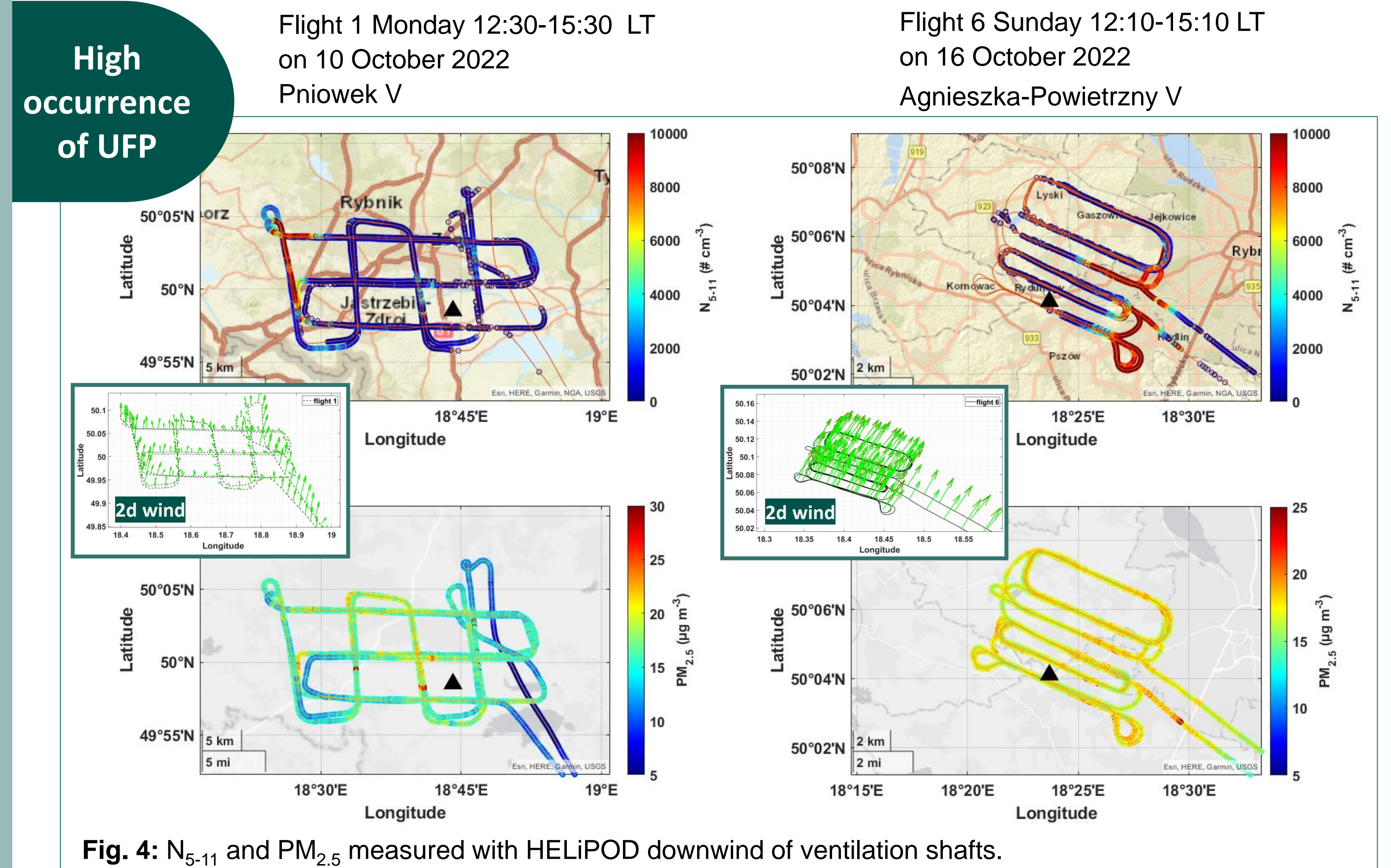


Fig. 3: Map presenting the position of the four ventilation shafts in the USCB (A). Example of two performed research flights with HELiPOD (B).

Preliminary results of UFP investigation during MTG-Poland

- A statistically significant study of the spatial variability of aerosol particles was obtained during 17 research flights on different times of the day and distinguishing days of the week, covering ~50 h of sampling time.
- UFP appearance with particle diameter of 5-11 nm (N_{5-11}) was strongly influenced by the current wind field and atmospheric boundary layer (ABL) stability.
- Two examples of HELiPOD flights are presented regarding the spatial distribution of N_{5-11} and $PM_{2.5}$ observed during midday (~12 to 15 LT, respectively), but on different days of the week.
- $PM_{2.5}$ calculated according to Bretschneider et al. (2022), showed higher appearance during weekday in relation to the emission plume induced by coal mining.
- Highest concentrations of N_{5-11} occurred downwind of highly frequented roads and large communities.



Outlook

The post-processing of the data set is still pending but the next steps of interpretation imply, amongst other topics, investigations concerning correlations between aerosol particles and

- turbulence
- ABL stability
- additional emission sources apart from coal mining activity
- radiation budget
- trace gases like ozone
- daily and seasonal dependence.

A better understanding of these processes is urgently needed for closing current existing knowledge lacks between top-down and bottom-up approaches.

References

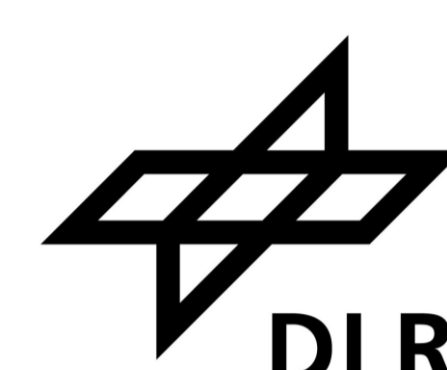
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