Międzynarodowa Środowiskowa Szkoła Doktorska
przy Centrum Studiów Polarnych
w Uniwersytecie Śląskim w Katowicach

ul. Będzińska 60
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Project number: IEDS/2025/IGF/B

Title of PhD project: Identification of predictors for high atmospheric pollution episodes

Providing institute: Institute of Geophysics, Polish Academy of Sciences

Requirements:

1. MSc degree in physics, geophysics, physical geography, or a related field
2. Experience in script writing (Python, MATLAB)
3. Proficiency in using mathematical tools
4. Fluent spoken and written English
5. Ability to work independently and in a team
6. Creativity and ability to think critically and analytically
7. Willingness to build and develop a research network

The following will be considered as additional strengths of the candidate:

1. Confirmation of the acquired knowledge in geosciences (diplomas, theses, scientific publications, conference presentations, participation in research projects)
2. Experience in fieldwork or recreational activities related to operating unmanned aerial vehicles
3. Experience in numerical modelling, remote sensing and/or statistical analysis

Description of the tasks:

1. Searching for and analysing existing meteorological and geophysical data sets
2. Processing data from measurements conducted at ground stations of IGF PAN
3. Operating unmanned aerial vehicles (UAVs) during measurement campaigns
4. Participating in the design/improvement of instrument payload for UAVs
5. Contributing to the development of advanced statistical data analysis methods within the project
6. Preparing scientific articles and promotional materials
7. Presenting research results at national and international conferences
8. Expanding knowledge in the field of research through literature studies, workshops, summer schools, etc.
9. Actively participating in scientific collaboration at national and international levels
10. Assisting with daily tasks at the Department of Atmospheric Physics

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Summary of the doctoral project:

The PhD project will be conducted under the research project 'Meteorological and geophysical predictors for high and extreme atmospheric pollution episodes' funded by the National Science Centre of Poland and led by Artur Szkop.

Atmospheric aerosols consist of solid and liquid particles suspended in the air. They play a crucial role in shaping weather and climate on Earth and also impact human health and quality of life. The World Health Organization (WHO) estimates that air pollution causes approximately seven million premature deaths worldwide each year. Various techniques have been developed to measure atmospheric aerosols, which can be divided into two main categories: in situ (direct) and remote sensing. The in situ measurements are typically conducted at ground level or near the surface (such as on measurement masts) to obtain continuous data. Measurements in higher atmospheric layers, using airborne platforms, generally rely on single flight passes (soundings) and cannot provide continuous data across various altitudes. Remote sensing techniques utilize electromagnetic radiation with wavelengths comparable to aerosol particle sizes—such as visible light—to measure optical aerosol parameters. Depending on the light source, these properties can be averaged across an air column (e.g., solar photometers or passive satellite sensors measuring sunlight) or obtained using laser-emitting LIDAR (Light Detection And Ranging), which provides vertical profiles of aerosol optical properties. LIDAR systems vary in design, but most commonly used models are unable to measure aerosols in the lowest few hundred meters of the atmosphere. Thus, obtaining continuous and detailed aerosol data in the lower troposphere presents a complex challenge, leading to a shortage of consistent information on near-surface pollution transport. This deficiency hinders reliable modelling and forecasting of aerosol concentrations.

In this project, we propose a method for obtaining complete profiles of aerosol microphysical properties, particularly in the lowest atmospheric layer directly interacting with the surface. This region contains most aerosol sources, especially during winter smog events. Missing near-surface portions of vertical profiles will be reconstructed using an interpolation technique developed by the project supervisor, combined with measurements obtained from unmanned aerial vehicles (UAVs), commonly known as drones. The collected data will be used to identify, through advanced statistical techniques, conditions that are highly predictive of elevated aerosol concentrations near the surface. The results of this research will be valuable in atmospheric pollution modelling, particularly in determining aerosol concentration and evolution near the surface. Additionally, they may contribute to improving pollution forecasting, which is strongly dependent on aerosol transport in the atmosphere.

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The selected candidate will: (i) Compile and analyse existing meteorological datasets (surface values and vertical profiles of temperature, pressure, and relative humidity) as well as geophysical datasets (optical and microphysical parameters of atmospheric aerosols), including those generated within the project. (ii) Actively participate in the development of a measurement instrument set for UAVs and contribute to data collection and analysis. (iii) Develop, together with supervisors, advanced statistical data analysis methods to identify predictors of high atmospheric aerosol concentrations.

Other information:

The work will be carried out under the supervision of:
dr hab. Aleksander Pietruczuk, alek@igf.edu.pl, IGF PAN dr Artur Szkop
aszkop@igf.edu.pl, IGF PAN

Contact to the IEDS office: +48 32 3689 380, e-mail: polarknow@us.edu.pl.

More information regarding the admission to IEDS:
https://www.mssd.us.edu.pl/en/admission-2025-2026/.