Poor air quality have an adverse impact on human health, the ecosystems and climate. Exposure to airborne particulate matter (PM) and ozone (O_3) is associated with increase in mortality and hospital admissions due to e.g. respiratory and cardiovascular diseases. It is thus desirable to accurately forecast PM and O_3 concentrations to alert the sensitive population of the onset, severity, and duration of unhealthy air and to encourage the public and industry to reduce emissions-producing activities. European Directive (2008/50/EC, CAFE) suggests the use of modeling in combination with fixed measurements "to provide adequate information on the spatial distribution of the ambient air quality". Within this proposal we address the combination of modelling with observational data using data assimilation (DA) to produce the most probable representation of one of the most problematic pollutants (PM_{10}, $PM_{2.5}$ and O_3) in Poland.

The previous project undertaken by the authors of this proposal has developed an air quality forecasting system that works operationally for the area of Lower Silesia (SW Poland; https://powietrze.uni.wroc.pl/), where it supports the local authorities in air quality management, and the forecasts are available for the entire Poland. The system is based on meteorological model Weather Research and Forecasting (WRF) coupled with chemistry (WRF-Chem). The system forecasts the air concentrations of various atmospheric pollutants (e.g. $PM_{2.5}$, PM_{10} and ozone) and has access to the online measurements gathered by the local authorities. However, the measurements have been used only for evaluation of the air quality forecasts. Within this project we will test three methods of data assimilation: Optimal Interpolation, 3D-Var, and Kalman Filter for Poland. Meteorological and chemical observations (ground and satellite) will be applied in this project.

An ideal data assimilation system would allow a simultaneous assimilation of meteorological data and concentration of species into a meteorological-chemical model. However, joint data assimilation of both meteorological and chemical data has not been conducted to a large extend, and it is not clear how much interactions could occur among meteorological and chemical state variable when assimilating both chemical and meteorological data. As a result, the potential feedbacks of chemical data assimilation on meteorological forecasts have not been fully investigated yet. This is one of the issues we want to undertake in this project proposal with the state-of-the-art model WRF-Chem.

According to our best knowledge, assimilation of chemical measurements to CTMs has not been reported for Poland and is still very limited for other regions. The focus on Poland is important because of its specific anthropogenic emission structure, with hard coal being a dominant fuel used e.g. in residential combustion. There are several studies on data assimilation for different regions of the globe, which usually focus on short term episodes of high air pollution concentrations. Here, we will focus on both long term simulations and short air quality forecasts using the operational air quality forecasting system developed within the LIFE-APIS project. The added value of data assimilation on long term and short term simulations will be assessed. If it is possible to improve the air quality forecasts using real time measurements, this will further improve the performance of the existing LIFE/APIS system.