MONITORING OF GREENHOUSE GASES AND ISOTOPIC SIGNATURES IN URBAN CARBON CYCLES- A CASE STUDY IN GLIWICE, POLAND

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Introduction

Monitoring of greenhouse gases, particularly carbon dioxide (CO_2) and methane (CH_4), including their atmospheric concentrations and isotopic composition, has become more than a scientific curiosity. Atmospheric physics and advanced analytical technologies play a crucial role in this process, enabling precise measurements and detailed analysis of air composition. One of the institutions conducting advanced research in this area is the Institute of Physics – CSE at the Silesian University of Technology, where the MONCO2 project is currently being carried out. The initial tests and measurements of the concentrations of major greenhouse gases are underway, along with analyses of their isotopic composition. This will facilitate the identification of their sources and the modeling of atmospheric processes in future.

Description of the Work or Project

One of the key components of the research infrastructure developed during the implementation of the MONCO2 project includes the following instruments: a GMP343 probe installed on the roof of the Institute of Physics, a CO_2 sensor, and an air sampling collector. Measurements are carried out both in real time and through biweekly air sample collection, which are subsequently analyzed using spectrometric methods. These measurements enable the determination of radiocarbon (^{14}C) levels and comparison with the ^{14}C content of background (clean) air. In the Gliwice area, a significant depletion of atmospheric ^{14}C concentration has been observed—this is known as the Suess effect.The second method employed involves the analysis of air samples using Cavity Ring-Down Spectroscopy (CRDS)—one of the most precise spectroscopic techniques for measuring trace gas concentrations. Currently, the CRDS analyzer is undergoing testing and calibration. CRDS enables simultaneous determination of CO_2, CH_4, and water vapor concentrations, as well as the isotopic composition of carbon in atmospheric air. This technique provides highly accurate results and allows for high-frequency measurements—up to several times per second. Continuous monitoring is conducted, which makes it possible to observe variations in gas concentrations on daily, weekly, and seasonal timescales.

Conclusions

High-resolution measurements of CO_2 and CH_4 also enable the investigation of the carbon cycle in urban environments. In cities, the carbon cycle is particularly disrupted due to significant anthropogenic emissions, primarily from the combustion of fossil fuels. Through precise monitoring and control of these emissions, it becomes possible to optimize processes related to carbon uptake, for example by vegetation or urban green spaces. The study of stable isotopes further allows for the differentiation of these processes across various urban zones—such as areas with abundant vegetation versus industrial districts.

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