

1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: THE INFLUENCE OF ATMOSPHERIC CIRCULATION AND THE THERMODYNAMIC STATE OF THE ATMOSPHERE ON AIR POLLUTION AND PRECIPITATION CHEMISTRY IN THE SUBURBAN AREA OF TORUŃ

1.1. Project goals

The aim of the project is to analyse air pollution and precipitation chemistry in the suburban area of Toruń (central part of Poland) against the background of atmospheric circulation (type of pressure system and direction of air mass advection) and the thermodynamic state of the atmosphere in the years 1996-2005.

1.2. Outline

The living conditions in cities are deteriorating due to the emission of pollutants into the atmosphere. Hence, in recent decades in Poland we have been observing the depopulation of cities, the relocation of their inhabitants to suburban areas. However, air pollution is also high in suburban areas. In addition, water in atmospheric precipitation is acidified as a result of reactions with gases and dust suspended in the air. Air pollution and acidification of atmospheric precipitation cause threats to the environment (rivers, lakes, underground water, soils, vegetation and animals) and to human health. This problem will be analyzed in the suburban zone of Toruń, where, in the town of Konieczynka (Łysomice commune), Nicolaus Copernicus University, together with the Provincial Inspectorate for Environmental Protection, has been conducting research on abiotic and biotic environmental parameters since 1994. The concentration of air pollution in this area depends not only on local emission sources, including those related to agricultural activity, but also on the transport of these pollutants from neighboring urban and industrial centers. The use of the synoptic circulation type calendar (Niedźwiedź, Łupikasz, 2019) will allow us to determine the type of pressure medium (high, low) and the direction of advection on the concentration of air pollutants and the chemistry of precipitation. The reverse trajectory method will be used for this purpose. The uplift of pollutants also depends on the thermal-pressure stratification of the atmosphere. In unstable equilibrium, they are more dispersed, while in inversion situations they are concentrated near the ground surface.

1.3. Work plan

1. Review of the literature related to the air pollution in Poland and the chemistry of atmospheric precipitation.
2. Creation of a database: synoptic maps for Europe (1996-2025).
3. Daily values of air pollution in Konieczynka SO₂, NO₂, PM₁₀ and pH and precipitation chemistry in 1996-2025.
4. Development of a calendar of synoptic situations for Konieczynka from 1996-2025.
5. Analysis of annual courses and trends in air pollution and precipitation chemistry in 1996-

2025.

6. Relationship of air pollution with the direction of advection and the type of pressure medium (circulation type calendar and reverse trajectories).
7. Influence of the thermodynamic state of the atmosphere on the concentration of air pollutants.
8. Case study of days with the highest air pollution and precipitation with very low pH.

1.4. Literature (max. 7 listed, as a suggestion for a PhD candidate preliminary study)

- Grodzińska-Jurczak, Małgorzata & Godzik, Barbara. (1999). Air pollution and atmospheric precipitation chemistry in Poland - A review. *Environmental Review ER*. 7. 10.1139/er-7-2-69. https://www.researchgate.net/publication/233954764_Air_pollution_and_atmospheric_precipitation_chemistry_in_Poland_-_A_review
- Kuchcik Magdalena & Milewski, Paweł. (2018). Zanieczyszczenie powietrza w Polsce – stan, przyczyny i skutki. 182. https://www.researchgate.net/publication/326468455_Zanieczyszczenie_powietrza_w_Polsce_-_stan_przyczyny_i_skutki/citation/download
- Niedźwiedz T., Łupikasa E., 2019, Cyrkulacja atmosferyczna w badaniach polskich klimatologów, *Przegląd Geofizyczny*, *Rocznik* 64, zeszyt 1-2, s. 107-166. <https://yadda.icm.edu.pl/baztech/element/bwmeta1.element.baztech-d6b2e7ed-fd98-4826-9364-491e9f8c8c84>
- Rajmund Przybylak, Rafał Maszewski, 2009, Zmienność cyrkulacji atmosferycznej w regionie bydgosko-toruńskim w latach 1881-2000, *Acta Agrophysica*, 2005, 14(2), 427-447. https://repozytorium.umk.pl/bitstream/handle/item/3735/ActaAgr_171_2009_14_2_427Przybylak-Maszewski.pdf?sequence=1
- Wolfgang Schopp, Maximillian Posch, Sophia Mylona and Matti Johansson, 2003, Long-term Development of Acid Deposition (1880-2030) in Sensitive Freshwater Regions in Europe - Interim Report Phase III - Incorporation of Dynamic Aspects, https://naei.energysecurity.gov.uk/sites/default/files/cat09/0709051324_99120_DEFRA_Report_3.pdf
- Wojciech Zgłobicki, Bogusława Baran-Zgłobicka, 2024, Air pollution in major Polish cities in the period 2005–2021: Intensity, effects and attempts to reduce it, *Environmental Research*, Volume 240, Part 2, <https://www.sciencedirect.com/science/article/pii/S0013935123023010>

1.5. Required initial knowledge and skills of the PhD candidate

- analytical thinking,
- eager to learn,
- open for challenging tasks,
- understanding of meteorology and climatology,
- knowledge of GIS programs,
- knowledge of English (B+ level).

1.6. Expected development of the PhD candidate's knowledge and skills

- the ability to ask research questions and independently search for answers,
- knowledge of statistical programs and the ability to analyze data (big data),
- the use of of GIS software in the spatial analysis of phenomena,
- ability to write scientific articles,
- ability to deliver papers and conduct scientific discussions.