ABSTRACT OF THE HABILITATION THESIS ENTITLED

Grounding Multiscale Climate Studies through the Integration of Methodological Approaches Based on the Principles of Synoptic Climatology

Meteorology and Climatology at Alexandru Ioan Cuza University of Iași (UAIC) have deep historical roots, having been taught as a university course within the Faculty of Geography since 1949. This tradition was first established through the academic activity of Professor Ion Gugiuman, who opened new research directions in regional and urban climatology during the second half of the 20th century. Through his work, numerous valuable researchers from Romania (such as Octavia Bogdan, Elena Erhan, and Elena Mihai) developed and defended doctoral theses in climatology at Iași. His successors as heads of the related disciplines, Elena Erhan and Liviu Apostol, further consolidated this tradition, strengthening UAIC's national standing as a reference center for geographical climatology.

As an alumnus of this institution, and with nearly 25 years of teaching and research within the geographical climatology school at UAIC—where I also earned my doctoral degree with a thesis on the climate of the Siret Corridor—I have been deeply committed to fostering compatibility between teaching and scientific research, both developed within the field of meteorology and climatology.

In this endeavor, teaching has primarily served as a mean in identifying and mentoring future collaborators, through the supervision of numerous undergraduate and master's theses—many of which have subsequently developed into scientific articles—as well as through the coordination of research teams within national projects addressing topics characteristic of the Iași climatological school, namely the urban climate of cities in the western Moldavian region. At the same time, the research results obtained through these efforts have been, and continue to be, integrated into teaching activities.

The results obtained in the field of climatology support this habilitation endeavor as a necessary step not only for personal professional development but also for strengthening the academic tradition of the Geography School at UAIC.

The habilitation thesis advanced here is structured into three main chapters:
(1) Academic achievements over the entire professional activity (18 pages);
(2) Scientific contributions in the field of synoptic climatology (58 pages);
(3) The career plan for the forthcoming professional stage (11 pages).

The first part presents a synthesis of the scientific results obtained, emphasizing their originality and the context in which they were developed. The challenges encountered within Romania's ever-changing research environment are discussed as key factors shaping the author's current scientific profile. The scientometric dimension is illustrated through impactful, internationally visible articles, citations, and research projects obtained in competitive calls. The research results have been disseminated through monographs, collective volumes, and textbooks, confirming the author's role as a promoter of climatology in Romania. The contribution to science popularization is also highlighted. This direct research activity is further substantiated by the number and relevance of citations of the author's work, as well as by active involvement in the peer-review process for prestigious journals in the field of climatology.

To summarize the academic achievements, it is worth noting that my internationally relevant scientometric indicators are well above the institutional and national averages in the field of Earth Sciences. According to the Web of Science, I reached an H-index of 16 and more than 690 independent citations; according to Scopus, an H-index of 18 and over 829 citations. Data from Google Scholar indicate more than 1,500 citations and an H-index of 22, with 43 scientific papers having at least 10 independent citations. Furthermore, based on the most recent institutional assessment, the cumulative AIS (Article Influence Score) for the 18 articles published as main author (first author, corresponding author, or co-author with equal contribution) amounts to 25.3 points.

It is important to note that the presented results also meet the criteria for habilitation under the future regulations scheduled to take effect in 2026 (five first-author articles with a cumulative AIS of 5.47 points, a Web of Science H-index greater than 9, and two research projects led as principal investigator).

The long-term focus set on topics related to synoptic climatology, which have represented the core direction of the scientific interests, is presented extensively ***in the second part*** of the habilitation thesis. The personal scientific contributions in synoptic climatology, but also their integration into multiscale climatic studies are presented here as the main pillar supporting the habilitation endeavor from scientifically point of view.

This chapter offers an extensive synthesis of results obtained in more than 15 scientific articles and two books published during the last part of doctoral research and during the postdoctoral period. These contributions mark the transition from classical climatography to dynamic, interdisciplinary approaches, using modern tools (R, Python, GIS, remote sensing, objective classifications of atmospheric circulation) and up to date methodological approaches.

This part is structured in two sections. The first presents the main methodological approaches currently used to assess the state and dynamics of the atmosphere, including teleconnection indices, atmospheric circulation classifications, cyclone tracking, and the assessment of air movement using climate modeling techniques. For each of these topics, my personal contributions are highlighted, as advanced in various publications spanning from my doctoral research to the present time.

A key aspect of this contribution resides in the transition from expert-knowledge/manual/subjective classifications of atmospheric circulations (applied during the PhD research) to objective approaches, as implemented in studies developed and published during the postdoctoral period, particularly inspired by the results of the COST 733 action. Utilizing these tools, a rethinking of atmospheric circulation over Romania is proposed, emphasizing the increased frequency of high-pressure conditions and the reduced frequency of westerly circulation at the surface. Additionally, the role of upper-level tropospheric conditions in shaping precipitation patterns in Romania was clarified through the investigation of the contributions of upper-level troughs and cut-off lows to rainfall occurrence.

The second part is devoted to integrating these synoptic climatology approaches across multiple spatial scales—from hemispheric to local—into the foundations of climate studies. Insights into atmospheric dynamics provide the necessary basis for transitioning from traditional climatography to modern climatology. The multiscale approach presented in this chapter reflects a perspective specific to geography.

Firstly, examples are provided at hemispheric and continental scales, highlighting the results of two articles published in prestigious journals. The role of solar activity in the long-term variability of the air pressure field is investigated, showing that the North Atlantic centers of action respond to solar input, reaching maxima or minima during periods of high or low solar activity, respectively. A novel contribution of the second article is the demonstration of a link between changes in atmospheric circulation and cloud cover. In summary, atmospheric circulation patterns are modified by the northward displacement of pressure centers over Europe, resulting in a pronounced increase over the eastern part of the continent, a key region in the Eurasian climate system.

Secondly, the relationships between atmospheric circulation and various climate phenomena—such as air temperature, wind, precipitation, hailstorms, and dust concentration—at national and regional scales are presented, based on a series of published articles. Among these results, the classification of synoptic patterns leading to heatwaves or coldwaves in Romania (using HYSPLIT trajectories), as well as patterns associated with hailstorms, proves particularly useful from an operational perspective in weather forecasting, providing an overview of these major extreme weather events.

A relevant example of applying the synoptic climatology approach to climate studies is the investigation of the five weather patterns most frequently associated with

hailstorms in northeastern Romania: two of these are primarily driven by very high atmospheric instability, while the remaining three are mainly explained by the steering flow at mid- or upper-levels. This work also highlights, in detail, the role of the Carpathian Mountains in convective initiation under favorable unstable conditions, identifying them as a major contributor to storms affecting the western part of Moldova.

Additionally, the application of the synoptic climatology approach to local climate studies is presented, focusing on the identification of atmospheric circulation types that favor the occurrence of temperature inversions in northeastern Romania and the Eastern Carpathians (Siret Valley and Brașov Depression). This research also contributed to understanding the drivers of air pollution in Iași, highlighting the role of temperature inversions in the accumulation of pollutants. At the local scale, an innovative explanation was provided for the positive air temperature anomaly in the Cotnari region, attributed to the dynamics of hydraulic foehn. Similarly, the synoptic conditions responsible for the extreme cold spot at Teșnița in the Dorna Depression were thoroughly described, emphasizing the potential for cold extremes in the Carpathians, which are currently slightly underestimated due to limited observations in critical areas.

The potential applications of the synoptic climatology approach to environmental topics are also explored, including the impactful case study of the 2017 wind-driven soil erosion and investigations of atmospheric drivers of bird migration.

In summary, the scientific part of this habilitation thesis demonstrates that grounding climate studies in approaches specific to synoptic climatology adds significant value to geographical climate research, which otherwise risks being limited to climatography—a largely static representation of an atmospheric environment that is inherently dynamic.

In the final chapter, the post-habilitation career plan is outlined, aiming to achieve a better balance between teaching and scientific research, which during the postdoctoral period had shifted predominantly toward the latter, while maintaining consistent engagement in institutional activities.

As a summary of the directions for future research, the main objectives for the next ten years are highlighted:

a. Reaching the threshold of 20 H-index in WoS with a total of 1000 independent citations in the Web of Science. I firmly believe that beyond these thresholds, scientometric evolution becomes irrelevant, especially in the context of scientific research in Romania, and these thresholds are ones that can ensure advanced expertise-level involvement in any project or international collaboration.

b. Publishing 5 articles classified Q1 by AIS as first author (two of these have been published to date) and at least one Q2 article together with each of the future doctoral students who will be first authors in these publications.

c. Participation in at least one international conference organized in a university or research center other than the host institution and participation in an international conference organized abroad at least once every 2 years. In addition, the coordination of each doctoral student in participating in at least one relevant scientific event at a continental/global level (EGU, EMS, AMS).

d. Participation in project competitions or supporting the process of participating in such competitions at least once every 3 years.

Iași

7 of November 2025

Assoc. Prof. PhD. Lucian Sfică