

OPINION
on the Thesis work
for acquiring of educational and scientific degree "Doctor "
in professional field 4.1 Physical sciences, Meteorology,
under procedure for defense at the Faculty of Physics
of Sofia University "St. Kliment Ohridski "

The Opinion was prepared by: Prof. Emilia Georgieva, PhD, National Institute of Meteorology and Hydrology (NIMH), Sofia, member of the scientific jury according to Order № 38-188 / 25.04.2023 of the Rector of Sofia University, and following the decision of the scientific jury at its first meeting on 03.05.2023 (Protocol № 1).

Thesis Theme: "A complex approach to the research of atmospheric aerosols"

Author of the dissertation: Viktoria Lyubomirova Kleshtanova, PhD student part-time in professional field 4.1 Physical sciences, Meteorology

I. General description of the presented documents

1. Submitted documents

The doctoral candidate Viktoria Kleshtanova has submitted a dissertation Thesis, Author's Abstract in Bulgarian and in English, as well as the mandatory tables for the Faculty of Physics from the Rules on the conditions and procedure for acquiring science degrees and holding academic positions in Sofia University "St. Kliment Ohridski". Other nineteen documents were also submitted, including three articles in full text and a certificate for another one in press, short CV, copy of the Diploma of Higher Education in the Master's Degree and its appendices, reference for passed exams and credits from the individual plan, statement of the research supervisor on the plagiarism prevention procedure etc.

The documents submitted by the candidate for the defense comply with the requirements of the Academic Staff Development Act (ZRASRB), the Regulations Act for the Implementation of ZRASRB (PPZRASRB), the Rules on the conditions and procedure for acquiring science degrees and holding academic positions at Sofia University "St. Kliment Ohridski" (PURPNSZADSU), which gives me the reason to prepare an opinion on the presented dissertation work.

2. Personal details about the candidate

Viktoria Kleshtanova acquired Master's degree in "Meteorology" in 2018 at the Department of Meteorology and Geophysics, Faculty of Physics at Sofia University "St. Kliment Ohridski". She

continued her education and research activities at the same Department as full-time PhD student starting on 10.01.2019 (Order of the Rector № ПД20-43/07.01.2019). Later on, the doctorate was transformed as part-time and had one-time expansion before its conclusion on 01.04.2023 (Order of the Rector № ПД20-840/18.04.2022). The scientific supervisor is Assoc.Prof. Vesselin Tonchev, PhD. Since January 2019, the candidate Viktoria Kleshtanova has been working as weather forecaster at the National Institute of Meteorology and Hydrology (NIMH). Since April 2022, she has been holding a position ‘assistant’ at the Department “Forecasts and Information Service” of NIMH.

3. General characteristics of the candidate's scientific achievements

This dissertation work is in the area of atmospheric aerosols, specifically looking at their role as condensation nuclei in cloud formation. Aerosol-cloud interactions continue to be a major challenge for global weather and climate models. The relevance of the topic is determined by the importance of aerosols for climate change and its associated impacts that affect a range of socio-economic activities. The dissertation provides analyses on unique for Bulgaria recent data on cloud condensation nuclei (CCN) obtained from measurements at the Basic Environmental Observatory on Peak Moussala. Relationships between CCN and the synoptic pattern, the type and pathways of air masses over the country and some meteorological parameters were investigated considering different periods of 2016. Viktoria Kleshtanova began with the processing and examination of such data already during her Master's thesis, and later in her dissertation work she upgraded the studies with more complex and wider analyses applying a combined approach. The methods used are statistical analysis of different data, synoptic analysis and weather type analysis, categorization of backward trajectories obtained by the model HYSPLIT, examination of results from meteorological models (GFS, NCEP/NCAR-reanalysis), analysis of some measured meteorological parameters, theoretical expressions for approximation of experimental data with estimations of parameters. The PhD student transferred the experience from the CCN research to the interpretation of existing experimental data on heterogeneous nucleation under electrochemical conditions. Viktoria Kleshtanova shows a good handling of a large set of different in nature data, which implies a good understanding of various physical and electrochemical processes related to nucleation.

The candidate has submitted a list of five articles with the results of the dissertation work - four articles in journals refereed and indexed in world-renowned databases of scientific information (Web of Science and Scopus) and one article in Bulgarian Journal of Meteorology and Hydrology (BJMH), issued by NIMH. Four of the articles have been published - 2 of them in journals with impact factor, Q3 (Group II according to PURPNSZADSU), 1 in a journal with SJR (Group III) and 1 in BJMH. One article is under peer review in journal with impact factor (MDPI Crystals, Q2, Group I).

Kleshtanova is the lead author in all articles, which is proof of her substantial contribution. She presented results of the dissertation at 6 scientific workshops and conferences. The PhD student participated in a significant number of projects (6) related to the theme of the thesis, being the leader in 3 of the projects. She was involved also in the activities of the COST Action CA16202 inDUST.

In conclusion, it can be said with reason and certainty that:

- a) the scientific publications included in the dissertation fully meet and even exceed the minimum national requirements (according to Art. 2b, (2) and(3) of ZRASRB) and, respectively, the additional requirements of the Faculty of Physics Sofia University "St. Kliment Ohridski" for the acquisition of the educational and scientific degree "PhD" in the scientific field Physical Sciences – Meteorology;
- b) the scientific publications included in the dissertation work do not repeat those from previous procedures for acquiring a scientific title and academic position;
- c) there is no proven plagiarism in the submitted dissertation and abstract

4. Characterization and assessment of the candidate's teaching activity (if there is a requirement for this under PURPNSZADSU)

There are no data provided for teaching activities in the submitted documents, but such are not required for the current procedure.

5. Analysis of the scientific and scientific-applied achievements of the candidate contained in the materials related to this procedure

The dissertation has a volume of 111 pages and includes 50 figures and 7 tables. The cited References are 129 (of them 7 internet sites), mostly from the last ten years. The aim of the research is mainly focused on the analysis of data from counter of cloud condensation nuclei on Peak Moussala for the year 2016 and refers to finding patterns in the CCN distribution for different time periods, analyzing extremes, investigating dependencies between CCN concentrations and synoptic conditions, the type of air masses over the country and meteorological parameters. An additional goal is new analysis of available experimental data from heterogeneous nucleation under electrochemical conditions. The Thesis consists of 10 chapters. The first two chapters are of an overview nature, where the candidate demonstrates a very good understanding of the relevance of the problem and knowledge of worldwide research on CCN. In Chapter 3, the methods used for the different type of analysis are outlined. The next four chapters contain the original results on CCN. In Chapter 4, the CCN distribution for a summer and winter month is analysed; the influence of the synoptic situation is discussed for two periods, each of 2-3 days, when higher concentrations of CCN occurred. In Chapter 5, some CCN character-

istics (size distribution, daily variation) for the months of July and December are commented. Backward trajectories obtained by the model HYSPLIT are also analysed in order to classify the type and path of the air masses. Supplementary, the atmospheric circulation is discussed based on the classification scheme traditionally used at NIMH. Composite maps, provided by NCEP/NCAR reanalyses are used for understanding the typical synoptic pattern associated with extremes in CCN concentrations. In Chapter 6, the relationships between the days of 2016 with extreme CCN values and the synoptic circulation is investigated, with the help of the Jenkinson and Collison's weather types (JC-WT) automatic classification for Bulgaria. Again, the candidate applies a combined approach simultaneously analyzing the influence of weather type, air masses - type, pathway and altitude, on extremes in CCN concentrations. Chapter 7 is devoted to the possibility of theoretically determining the number of activated CCN as a function of the supersaturation using an empirical expression - the Twomey equation that is well-known and widely used in the world practice. In Chapter 8, the candidate analyses previously published data that are unusual for the meteorological community. This data is on nucleation under electrochemical conditions, and the candidate has been able to transfer his knowledge from CCN research to reinterpret data from another scientific field. Chapter 9 includes a summary of the most important results, while the last Chapter 10 contains lists of publications, presentations at scientific forums and participation in research projects.

The Abstract has 57 pages and correctly reflects the content, results and contributions described in the dissertation.

The main contributions may be summarized as:

- Relationships between CCN concentrations and type and origin of air masses, as well as synoptic conditions were examined for 2016. It was found that the highest CCN concentrations occur in weather conditions when a baric trough is approaching or already present over the country;

- Relationships between extremes in CCN concentrations, type of weather (JC-WT classification), and type of air mass were investigated. It was found that high CCN values occur for weather types SW, W and NW and for continental air masses in the lower atmosphere;

- Parameters of the Twomey's equation were estimated as a function of the temperature measured at Peak Moussala and Borovets. This enables theoretical determination of CCN concentrations for a given water vapor supersaturation;

- A new analysis of previously published experimental data on heterogeneous nucleation in electrochemical environment was carried out. Relationships were obtained for two characteristic scales as dependent on the overvoltage (supersaturation).

In general, the contributions of the candidate's work can be defined as enrichment of existing knowledge and acquisition of new knowledge, with opportunity to apply some of the scientific achievements in the operational forecaster's practice at NIMH.

6. Critical notes and recommendations

I do not have significant critical remarks. From a technical point of view it has to be noted that there are numerous texts with inappropriate wording in Bulgarian, there are stylistic and spelling errors. However, this does not diminish in any way the research done and the completeness and accuracy of the results obtained.

One question to the candidate: How would you explain the peaks in the CCN concentrations under circulation type SW (southwest)?

7. Personal impressions of the candidate

Victoria Kleshtanova is an ambitious, hardworking and responsible young scientist. She has the skills to work independently and is a reliable member of research teams. She demonstrates a willingness to update and complement her knowledge; is motivated to learn and to apply new methods, seeking also on interdisciplinary ones. Undoubtedly, the doctoral candidate has potential for successful research career with scientific-applied contributions in the operational activities at NIMH.

8. Conclusion

After reading the presented dissertation work, the Abstract and other materials, and based on the analysis of the scientific and scientific-applied contributions, contained in them, **I confirm** that the scientific achievements of the candidate fully meet the requirements of ZRASRB and the relevant Regulations of Sofia University "St. Kliment Ohridski" for **acquiring the educational and scientific degree "Doctor"**. In particular, the candidate satisfies the minimum national requirements in the professional field and no plagiarism has been found in the dissertation, the Abstract and the scientific works submitted for the competition.

I give my **positive** assessment of the dissertation work.

II. GENERAL CONCLUSION

Based on the above, **I recommend** the scientific jury to award **the educational and scientific degree "Doctor"** in the professional field 4.1 Physical sciences, Meteorology to **Viktoria Lyubomirova Kleshtanova**.

24. 06. 2023

Prepared the Opinion:

(Prof. Dr. Emilia Georgieva)