

OPINION
for dissertation work
for acquiring the scientific degree “Doctor”
Professional field: 4.1 Physical Sciences, Scientific Major Meteorology
by defense procedure at the Faculty of Physics
of Sofia University "St. Kliment Ohridski"

The Opinion was prepared by: Assoc. Prof. Reneta Dimitrova, PhD, Sofia University "St. Kl. Ohridski", Faculty of Physics, member of the scientific jury according to Order No. № 38-188/25.04.2023.

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

Author of the dissertation: Viktoria Kleshtanova

I. General description of the presented documents

1. Submitted documents

The candidate Viktoria Kleshtanova has submitted a thesis and an Author's abstract, as well as the mandatory tables for the Faculty of Physics according to the Regulations for the terms and conditions for acquiring scientific degrees and holding academic positions at SU "St. Kliment Ohridski". A total of thirteen other documents were submitted, including three articles in full text, certificate that an article was accepted for publication, a Graduate diploma for the acquisition of the educational qualification degree "Master", statement of authorship, application, orders for enrolment, transformation and extension of doctoral studies as well as plagiarism references (in type of official note and certificate from the scientific supervisor).

The documents submitted by the candidate for the defense fully comply with the requirements of the Law for the Development of Academic Staff in the Republic of Bulgaria, Regulations on the Implementation of the Law for the Development of Academic Staff in the Republic of Bulgaria and the Regulations for the terms and conditions for acquiring scientific degrees, and occupying academic positions at SU "St. Kliment Ohridski", which gives me the reason to prepare an opinion on the presented dissertation work.

2. Personal details of the candidate

Viktoria Kleshtanova received the educational-qualification degree "Bachelor" in the Scientific Major "Astrophysics, Meteorology and Geophysics" in July 2016 and successfully completed the Master's program "Meteorology" at SU "St. Kliment Ohridski" in April 2018. She also acquired the qualification "Physics and Astronomy Teacher" in May 2016 from the Faculty of Physics of Sofia University "St. Kliment Ohridski". Viktoria Kleshtanova continues her studies and scientific activity as a full-time doctoral student enrolled by order of the Rector ПД 20-43/07.01.2019. Latter, the doctoral program was transformed into part-time (ПД 20-729/12.03.2021) and extended by one year (ПД 20-840/18.04.2022) until 01.04.2023. Along with the research work on her dissertation, the doctoral student worked as a meteorologist at Energovia EOOD (2017 - 2018) and later joined the team of the Department "Forecasts and information service", Sector "Meteorological Forecasts" of the National Institute of Meteorology and Hydrology (NIMH), where she started as a weather forecaster and latter was appointed as assistant (20.04.2022). She actively participates in the operational and scientific activities of NIMH to this day. Besides her six publications, Viktoria Kleshtanova participates in 8 international and national forums, two training courses and two summer internships in the Executive Agency "Fighting Hail" and TV MET by Project (Student internships of the Ministry of Education and Science). She has also indicated participation in one international and 5 projects funded by Bulgarian sources. The candidate was the principal investigator of three of the projects that was funded by the National Program "Young Scientists and Postdoctoral Students".

3. General characteristics of the candidate's scientific achievements

The topic of the dissertation is actual in the context of the aerosol-cloud interactions, which are still one of the major challenge in numerical models. The limited knowledge of important submicron-scale processes, from aerosol emissions and their precursors to precipitation formation, makes the study of cloud condensation nuclei (CCN) a recognized necessity. The conducted research can be characterized as applied science, as two of the chapters also have a theoretical focus.

CCN data, registered in the Basic Ecological Observatory (BEO), located on Mount Musala, have been analysed for the first time in Bulgaria. Regularities in the distribution were found and the extremes (minimums and maxima) of the concentration of CCN were determined. The obtained

distribution of CCN was associated with different synoptic conditions and circulation features in the country. A description of a nucleation system using known empirical laws was also presented.

The candidate is the co-author of six articles, three of them in open access journals with impact factor – one with a Q2 ranking - Journal of Atmospheric and Solar-Terrestrial Physics, one with a Q3 ranking - Comptes Rendus de L'Academie Bulgare des Sciences and one in conference proceedings with SJR=0.16 - AIP Conference Proceedings. Another article published in the Bulgarian Journal of Meteorology and Hydrology is also presented. The articles have between 3 and 6 authors, but Viktoria Kleschanova is the lead author in all articles, which is proof of a substantial contribution to the publications. One article is under review for the impact journal Crystals, but could not be considered until be accepted for publication.

In conclusion, I can say motivated and definitely:

- a) the scientific publications included in the dissertation fully meet and even exceed the minimum national requirements (according to Art. 2b, par. 2 and 3 of the Law for the Development of Academic Staff in the Republic of Bulgaria) and the additional requirements of Regulations for the terms and conditions for acquiring scientific degrees, and occupying academic positions at SU "St. Kliment Ohridski" in the relevant scientific field and professional direction;
- 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 in the specific Regulations at SU "St. Kliment Ohridski")

Teaching activity data were not provided in the submitted documents, but such are not required by the Law for the Development of Academic Staff in the Republic of Bulgaria, Regulations on the Implementation of the Law for the Development of Academic Staff in the Republic of Bulgaria, and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski".

5. Content analysis of the applicant's scientific and scientific-applied achievements contained in the materials for participation in the competition

The thesis is 111 pages, presenting 50 figures and 7 tables. It consists of an introduction, 10 chapters, and a list of bibliography with 129 sources (6 are websites). Chapter 1 presents

relevance of the problem and formulates the objectives of the thesis. Chapter 2 presents the current state of the problem, give definition of the CCN and various methods and theories for their prediction are presented. Chapter 3 introduces the methodology and data sources used. The next four chapters present the dissertation's original results. Chapter 4 relates the distribution of CCN to two selected synoptic conditions in the country. Chapter 5 presents a method for determining the source of an aerosol using the inverse trajectories of air masses with the HYSPLIT model. In Chapter 6, the extremes in the concentration of CCN averaged on mean day-night and mean hourly scales are determined by month at a certain classification. Again using the HYSPLIT model and reverse trajectories, the air masses are grouped into different categories. An original classification was obtained according to the source - continental or marine, as well as depending on the altitude, consistent with the main atmospheric layers used in the synoptic. Chapter 7 proposes the application of a fundamental law to the resulting distribution of CCN according to the data used. Chapter 8 presents an analysis of data from precision experiments already published on heterogeneous nucleation. Three different models were applied to these data. The remaining chapters present a conclusion, contributions of the thesis, publications and participation in events.

The abstract consists of 53 pages including references of 57 titles (5 are websites), and correctly reflects the content and contributions of the dissertation work.

As noted in item 3, most research tasks relate to applied science and can be characterized as an application of theory in practice. The last chapter can be defined as an enrichment of scientific knowledge in theory. Four scientific contributions are formulated based on the results obtained in the dissertation.

1. A correlation has been established between the maxima in the concentration of atmospheric aerosols, the backward trajectories of air masses, and the synoptic conditions during 2016.

2. Dependencies have been found between the extremes in the concentration of aerosols and the types of Jenkinson-Collison-Types circulation.

3. High correlation coefficients have been found between a parameter from Twomey's equation and the temperatures at Moussala and Borovets.

4. A jump in the time scale from one nucleation mode to another is obtained in an analysis of published data from precise experiments on heterogeneous nucleation.

In general, the contributions of the thesis can be defined as an enrichment of existing knowledge and an opportunity to apply some of the scientific achievements in practice.

6. Critical notes and recommendations

My only substantive critical note is that Chapter 8 Analysis of data from heterogeneous nucleation is not directly related to the thesis. I agree that the conclusions drawn could be used in future studies, but it is not clearly described how the obtained dependence of the number of nuclei as a function of saturation based on analysis of published data from laboratory experiments will be applicable to real conditions. It is mentioned that the applied overvoltage is analogous to the gas-phase saturation without specifying quantitative correspondences between the experiment and the saturation in the atmosphere related to cloud formation, which could be the connection with the content presented in the present dissertation. Moreover, the article presenting this research is in the process of peer review.

I would also note a few more non-essential notes to the work. It is useful to indicate the rank of the listed journal with impact factor (the same journal sometimes has a different rank in different fields) in the list of publications related to the thesis, and also to note the official name of the journal *Comptes Rendus de L'Academie Bulgare des Sciences*. The citation of most of the Internet sources is incomplete (102, 103, 114) or incomprehensible (81 Scopus - Document search). There are also a few typographical and stylistic errors, inevitable for a voluminous work. It is not indicated in the chapters of the dissertation in which articles the relevant results and contributions are presented. These notes in no way detract from the value of the dissertation.

7. Personal impressions of the candidate

I have known Viktoria Kleschanova since her student years as an excellent student and an ambitious young scientist who strongly pursues her dream of working as a forecaster. She has great potential and precision in the performance of any given task, which is a prerequisite and a clear prospect for a successful future research career.

8. Conclusion

After having familiarized myself with the presented thesis, Abstract and other materials, and based on the analysis of their significance and the scientific and scientific-applied contributions contained in them, **I confirm** that the scientific achievements meet the requirements

of the Law for the Development of Academic Staff in the Republic of Bulgaria, Regulations on the Implementation of the Law for the Development of Academic Staff in the Republic of Bulgaria and the Regulations for the terms and conditions for acquiring scientific degrees, and occupying academic positions at SU "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, abstract and 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 professional field 4.1 Physical sciences, Scientific Major Meteorology to **Viktoria Kleshtanova**.

20 June 2023 г.

Prepared the opinion:

Assoc Profr PhD Reneta Dimitrova