

OPINION

for dissertation work

for obtaining 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. 38-127/16.03.2023.

Thesis theme: "Climate change and projections for the 21st century in the Black Sea region and the Balkans"

Author of the dissertation: Mirna Matov

I. General description of the presented documents

1. Submitted documents

The candidate Mirna Matov 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". Ten other documents were also submitted, including four articles in full text, Graduate diplomas for the acquisition of the educational qualification degree "Bachelor" and "Master", a certificate of passed exams according to the individual plan, an author's reference with the contributions and references for plagiarism (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

Mirna Matov 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 continues her studies and scientific activity as a full-time PhD student enrolled by order of the Rector PД 20-44/07.01.2019 until 01.26.2023. Along with the research work on her dissertation, Mirna Matov works at the Children's Science Center "Muzeiko", as part of the educational team, for the communication of science for children through informal learning methods. She creates and leads educational programs, works with school groups and visitors and she is one of the presenters in the planetarium in the Children's Science Center "Muzeiko". Besides her four publications, Mirna Matov participates in 18 different events, such as international and national conferences and seminars, training seminars and summer schools and in the "Open Day - 2019" in the Faculty of Physics with experiments and demonstrations. She is national finalist in the "Laboratory for fame FameLab Bulgaria" in 2019, one of the largest science communication competitions in the world held as part of the Sofia Science Festival and organized by the British Council.

3. General characteristics of the candidate's scientific achievements

The topic of the dissertation is very actual in the context of climate change, which has an impact on all aspects of human life. The scientific field can be characterized as an applied science. The scientific work discusses global warming and the greenhouse effect and what are the factors that determine them. The available database as a result of the implementation of the Med-Cordex project (regional numerical simulations for the present and climate projections for the 21st century) was used to derive and systematise expected changes in the Balkan Peninsula - Black Sea region. The Black Sea freeze-up phenomenon was quantified, which is a complex indicator of regional climate change. The future changes of the seasonal climatic centers of action Siberian maximum and Mediterranean minimum, which affect winter conditions in the area, were analyzed. Different sources were used for the individual tasks assessments - high-resolution simulations of a regional climate numerical model under two different scenarios (defined by AR5 IPCC 2013), choosing the so-called "intermediate" and "pessimistic" scenarios for the evolution of greenhouse gas

concentrations in the atmosphere in the 21st century - RCP 4.5 and RCP 8.5), synoptic air temperature data from 9 coastal meteorological stations along the Black Sea coast, and data from the ERA-5 global climate reanalysis.

The candidate is the author/co-author of four articles, two of them in open access journals with impact factor and Q2 ranking - Atmosphere and Climate, two in conference proceedings. Mirna Matov is the lead author in 3 of the articles (in one of them she is the only one author) and in one she is the second author, which is proof of her significant contribution to the publications.

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 127 pages, presenting 69 figures and 14 tables. It consists of an introduction and 9 chapters, including a description of the used literature from 150 sources (13 are websites). Chapter 1 presents the current state of the climate change problem worldwide, as well as for the Black Sea region and the Balkan Peninsula. Chapter 2 presents the methodology and used data sources describing the global and regional climate models, as well as the internationally accepted

scenarios for greenhouse gas emissions in the 21st century. The next three chapters present the dissertation's original results. Chapter 3 presents validation of the Aladin 5.2 model climate simulations for temperature, precipitation, pressure and wind of for the historical period 1979-2005 (considered representative of the modern climate) against data derived from the ERA-INTERIM meteorological reanalysis of European Center for Medium-Range Weather Forecasts (ECMWF) for the same period. Chapter 4 presents the estimates of the future change of these meteorological variables in the 21st century (2011-2100) using the Aladin 5.2 climate projections with boundary conditions for scenarios RCP4.5 and RCP8.5. Trends in average temperature, precipitation, surface pressure and wind for the Balkan Peninsula and the Black Sea in the 21st century are analyzed based on the model data. Chapter 5 examines the implications of climate change for the Black Sea region and the Balkan Peninsula, looking at extreme events and winter changes in the Black Sea region, as well as changes and oscillations in the locations of the climate centers of action - the Siberian High and the Mediterranean Depression. An analysis of storm wind trends until the end of the 21st century using Aladin 5.2 climate projections with RCP4.5 scenario boundary conditions is also performed. The remaining chapters present a conclusion, contributions of the thesis, publications and participation in events, and a list of references.

The abstract consists of 57 pages including references of 30 titles (13 are websites), and correctly reflects the content and contributions of the dissertation work.

As noted in item 3, the main scientific and applied research tasks solved in the thesis relate to the significant and actual scientific field related to climate change. Briefly, the main results of the dissertation can be formulated as follows:

1. For the first time, the area and duration of Black Sea freezings since 2006 have been estimated from satellite observations; these results have been combined with published data for the 20th century, and the classification of winter severity has been updated using the Winter Severity Index.

2. Based on high-resolution simulations of a regional climate model, the expected changes in surface temperature, precipitation, pressure adjusted to sea level and wind speed for three decades 2011-2040, 2041-2070, 2071-2100 have been systematized for the region of the Balkan Peninsula and the Black Sea under two scenarios RCP4.5 and RCP8.5. A trend of temperature increase and pressure decrease has been established.

3. Several interesting facts were obtained from the conducted research. It was found that the freezings in the northern part of the Black Sea are related to specific synoptic conditions, and not necessarily to low winter temperatures. A significant influence of the Mediterranean depression in the Black Sea region in winter was established, with a tendency to decrease in its intensity, while the frequency of stormy wind phenomena increases until the end of the 21st century according to the RCP4.5 scenario.

It is impressive that part of the results in this work have already been used by the World Bank in the compilation of the National Disaster Risk Profile in Bulgaria in Chapter 4 - Climate Change and Disaster Risk.

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

I have no critical remarks. I would only note that the text has a rather large amount of typographical errors, unavoidable for a voluminous work. Also, it is not clearly stated in different chapters of the thesis in which articles the relevant results and contributions are presented. Finally, the last publication (Elisaveta Peneva, Mirna Matov and Milen Tsekov, "Mediterranean Influence on the Precipitation Regime over Balkan Peninsula in the period 1901-2021) is presented as submitted in the thesis and the abstract and full bibliographic description should be added. These notes do not detract from the value of the dissertation.

7. Personal impressions of the candidate

I have known Mirna Matov since her student years as a modest and excellent student. Mirna has the abilities of a creative young scientist and a colleague with whom it is always easy and pleasant to communicate. She shows a unique skills for working with children and presenting science in an understandable, fun and attractive way. Mirna has a great potential and clear prospects 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 **Mirna Matov**.

11 June 2023 г.

Prepared the opinion:

Assoc Profr PhD Reneta Dimitrova