

**OPINION**  
**of the Thesis work**  
**for obtaining the scientific degree "Doctor "**  
**in the professional field 4.1 Physical sciences, Meteorology,**  
**by defense procedure at the Faculty of Physics (FzF)**  
**of Sofia University "St. Kliment Ohridski "**

**Reviewer:** Assoc. Prof. **Maria Petrova Kolarova**, National Institute of Meteorology and Hydrology (NIMH), Sofia

as a member of the scientific jury according to Order № 38-127 / 16.03.2023 of the Rector of Sofia University and according to the decision of the scientific jury taken at its first meeting on 24.03.2023 г. (Protocol No1)

**Topic of the dissertation** “Climate changes and projects for the 21st century in the region of the Black Sea and the Balkan Peninsula”

**Author of the dissertation:** Mirna Matov, full-time doctoral student in the professional field 4.1 Physical sciences, Meteorology

**1. General description of the submitted materials**

The doctoral candidate Mirna Matov has submitted a dissertation and an Author's Abstract (in Bulgarian and English), as well as the mandatory tables for the Faculty of Physics from the Regulations for the conditions and procedures for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski". Diplomas for obtaining Bachelor and Master degree, list of citations to the dissertation, short CV and 17 other documents supporting the applicant's achievements are also presented.

The documents submitted for the defense by the candidate comply with the requirements of the Academic Staff Development Act (ZRASRB), the Regulations Act for the Implementation of ZRASRB (PPZRASRB), the Rules of Procedure and the Regulations on the Terms and Conditions for Acquisition of Scientific Degrees and Academic Positions at Sofia University “St. Kliment Ohridski” (PURPNSZADSU).

**2. Information about the Candidate**

Mirna Matov holds a Master's degree in "Meteorology" at the Department of Meteorology and Geophysics of the Faculty of Physics of the University of St. Kliment Ohridski" since 2018, has a bachelor's degree in the specialty "Astrophysics, meteorology and geophysics" since 2016.

From 2019 to 2023, Mirna Matov is a full-time doctoral student in the Department of Meteorology and Geophysics of the Faculty of Physics of SU "St. Kliment Ohridski" with research supervisor Prof. Dr. Elisaveta Peneva.

Since 2017, she has been working at the Children's Science Center "Muzeiko" as an educational team coordinator and communicator of science for children using informal learning methods, creates and leads educational programs, and works with school groups. I consider this activity of the candidate as a very good assessment of M. Matov's work as a teacher and promoter of science.

### **3. General characteristics of the candidate's scientific achievements**

The topic of the dissertation work is related to climate change, global warming and the effects on the Balkan Peninsula and the Black Sea region, a topical issue related to climate assessments in the 20th and 21st centuries. The studies on long term changes of basic parameters such as temperature, precipitation, sea level pressure and surface wind for the Black Sea region and the Balkan Peninsula for 2 periods, the first (1979-2005, characterizing the modern climate) and the second (2011- 2100, associated with climate projections for three 30-year periods) are realized on the basis of output data from the simulations with the ALADIN5.2 regional climate model for two of the RCP (Representative Concentration Pathways) scenarios (RCP 4.8 moderate and RCP 8.5 pessimistic), defined in AR5 of the IPCC. Modeling of climate change in AR5 of IPCC is based on scenarios of expected radiative forcing (RF) at relevant levels of 8.5; 6.0; 4.5 и 2.6  $W/m^2$ .

The climate scenarios describe expected changes (based on simulations, analysis and assessments) in mean annual surface temperature, precipitation, surface pressure and wind speed under the two scenarios (RCP4.8 and RCP 8.5) for the three 30-years periods (2011-2040; 2041-2070; 2170-2100) for the Black Sea region and the Balkan Peninsula.

A comprehensive analysis of the trends of these parameters depending on the used scenarios is made, as well as an evaluation of the error of the used model based on ERA-Interim meteorological analysis of the ECMWF data. An analysis of the consequences of climate change for the Black Sea region and the Balkan Peninsula was performed, based on a study of winter conditions and icing in the Black Sea, categorization of the Winter Severity Index (WSI) in the region, projections of changes in intensity of the seasonal centers of action (Siberian maximum and Mediterranean minimum) in the Black Sea region and changes in wind speed and the frequency of very strong wind events (over 20 m/s).

Available data for the 20th century and the beginning of the 21st century were used, as well as climate projections under both IPCC scenarios until the end of the 21st century. Statistical estimates for the three considered periods of the considered climate scenarios for the 21st century are presented in tables.

On the topic of the dissertation, Mirna Matov participated in 4 scientific publications, two of which are in journals with an impact factor (*Atmosphere* and *Climate*) and are included in SCOPUS, with one citation. In these publications M. Matov is the first and second author, respectively, co-authorship with her scientific supervisor assoc. prof. E. Peneva, and it can be seen that she has a substantial share in them. Results of the dissertation were reported by M. Matov at 5 international and national conferences.

M. Matov is the only author in the published doctoral conference of SU "St. Kliment Ohridski" from 2019, an extensive article of 32 pages (in Bulgarian) on the topic "Climate projections for the 21st century for surface pressure and wind based on data from the CORDEX project". The work is related to an assessment of the expected climate changes in two of the considered meteorological elements - sea level pressure and surface wind for the region of Europe with a focus on the Balkan Peninsula in the 21st century. Some of these results are an essential part of the thesis and are included in chapter 4 of the thesis.

The candidate has participated in two scientific projects, one of which is under the National Scientific Program "Protection of the environment and reduction of the risk of adverse phenomena and natural disasters". Scientific results on this issue have been published in an article with first author M. Matov in materials of the EnviroRisks 2020 conference.

The scientific publications included in the dissertation satisfy the minimum national requirements (*under Art. 2b, paras. 2 and 3 of ZRASRB*) and respectively the additional requirements of the Faculty of Physics at Sofia University "St. Kliment Ohridski" for acquiring the scientific degree "Doctor", in the professional field "Physical Sciences" - Meteorology. No plagiarism was found in the dissertation, abstract and scientific papers submitted at the competition.

#### **4. Analysis of the scientific and scientific-applied achievements of the candidate related to this application.**

The dissertation has a volume of 127 pages and includes an introduction, nine chapters and a list of cited literature (*150 literary sources are cited*), 69 figures and 14 tables. Additionally, a list of the candidate's achievements, a list of publications and participation in conferences, schools and projects are attached.

The dissertation contains indisputable scientific and scientific-applied contributions, which can be summarized as enriching existing knowledge and obtaining new knowledge and scientific achievements in practice.

More specifically, the summarized contributions are:

- Estimation and systematization of the expected changes in surface temperature, wind speed, sea level pressure, precipitation for the 21st century for three 30-year periods (2011-2040, 2041-2070, 2071-2100) for the Balkan Peninsula - Black Sea region under two climate scenarios RCP4.5 and RCP8.5 have been made and a trend of increasing temperature and decreasing pressure was found.
- Analysis of the of Black Sea freezing and sea-ice cover have been estimated (*in the Northern part*) and the classification of the intensity of winters through the Severity Index (WSI) has been updated based on different data (meteorological measurements and satellite data). The relation with the specific synoptic conditions have also been analyzed.
- The influence of the seasonal centers of action - Siberian maximum and Mediterranean minimum on the winter conditions in the Black Sea region and changes in their intensity are described, finding that the influence of the Mediterranean depression is significant and, according to the RCP4.5 scenario, the Mediterranean center of action decreases in intensity to the end of the 21st century (the winter pressure in the Mediterranean shows an increasing trend), and the frequency of stormy wind phenomena increases until the end of the 21st century.

Part of the results in the dissertation were used by the World Bank in compiling the National Disaster Risk Profile in Bulgaria in Chapter 4 Climate Change and Disaster Risk.

**Statistics of publications** – 4 publications (3 co-authored, in 3 of them are the first author, 1 - publications in extended text at scientific forums, independent (in Bulgarian), participation with reports in 5 conferences and seminars (national and international), participation in 9 scientific schools and courses, training seminars, etc., national finalist in the FameLab Bulgaria 2019 competition as a science communicator.

### **5. Critical remarks and recommendations**

I have no Substantial critical remarks.

### **6. Personal impressions of the candidate**

I don't have direct personal impressions of the candidate, but I think she did very well in her pre-dissertation defense. I highly appreciate her work as a promoter of science for children and students. The candidate's dissertation and professional CV leave a clear impression of a

young scientist with active scientific potential and prospects for a successful future scientific career.

### **7. Conclusion**

After reading the presented dissertation work, Abstract and other materials, and based on the analysis of their scientific and scientific-applied contributions, contained in them, I confirm that the scientific achievements of the candidate fully meet the requirements of ZRASRB and Regulations for its application and the relevant Regulations of Sofia University "St. Kliment Ohridski" for acquiring the educational and scientific degree "Doctor".

I give my positive assessment of the dissertation work.

### **OVERALL CONCLUSION**

Based on the above, I recommend the scientific jury to award the scientific degree "Doctor" in the professional field 4.1 "Physical Sciences" - Meteorology to Mirna Matov.

12. 06. 2023 г.

Reviewer:: .....

(Assoc. Prof. Maria Kolarova)