

REVIEW
of a dissertation
for the acquisition of the educational and scientific degree "Doctor"
in professional direction 4.1 Physical sciences - Meteorology,
by defense procedure at the Faculty of Physics (FzF)
of Sofia University "St. Kliment Ohridski" (SU)

The review was prepared by: **Prof. Dimiter Enchev Syrakov**, NIMH, in his capacity as a member of the scientific jury according to Order No. 38-127 / 16.03.2023 of the Rector of Sofia University and according to the decision taken on the first jury's meeting of 24.03.2023.

Dissertation topic: **"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 materials

1. Data on the submitted documents

The candidate, Mirna Matov, has submitted a dissertation and an abstract in Bulgarian and English, as well as the mandatory tables from the Regulation on the terms and conditions for acquiring scientific degrees and holding academic positions of SU "St. Kliment Ohridski" and for the Physical Faculty. A total of 17 other documents supporting the applicant's achievements are also presented.

The documents, submitted by the candidate for the defense, correspond to the requirements of the ZRASRB, PPZRASRB and the Regulations for the terms and conditions for acquiring scientific degrees and occupying academic positions at SU "St. Kliment Ohridski" (PURPNSZADSU).

2. Information for the Applicant

Mirna Matov was born in 1993. In 2012, she entered the Faculty of Physics of the SU, department of "Meteorology and Geophysics", and in 2016 she received a bachelor's

degree, and in 2018 - a master's degree with an estimation above 5.50. From February 2019 until now, Matov is a doctoral student at the same department, supervised by Assoc. Prof. Dr. Elisaveta Peneva.

3. General characteristics of the candidate's scientific achievements

The dissertation is mainly devoted to a very current topic - climate change, and more precisely to two climate projections for the region of the Balkan Peninsula and the Black Sea for three 30-year periods of the 21st century - 2011-2040, 2041- 2070 and 2071-2100. The projections are for two of the IPCC scenarios, namely RCP4.5, which is considered optimistic, and RCP8.5, which is considered pessimistic. Four meteorological parameters are monitored – surface air temperature, precipitation, sea level pressure and surface wind speed. In addition, the cases of freezing of the Black Sea, an index of the severity of winters in the region, changes in the intensity of seasonal centers of action in the Black Sea region and changes in the frequency of stormy wind phenomena are also investigated. No plagiarism has been proven in the submitted dissertation and abstract (two reports on found similarity are attached, prepared by the Matov's scientific supervisor Assoc. Prof. E. Peneva, whose conclusions are that there is no plagiarism).

4. Characteristics and assessment of the candidate's teaching activity

There is no requirement in PURPNSZADSU for teaching activity of doctoral students. However, the Matov did demonstrations on atmospheric pressure, wind and clouds during an "Open Day" at the Faculty of Physics. In addition, Matov works at the "Muzeiko" Children's Science Center as a coordinator of the educational team, where she communicates science for children through informal learning methods, creates and leads educational programs, works with school groups and individual visitors and is one of the leaders in the museum's planetarium.

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

The work is structured in an introduction, five chapters and a conclusion. Additionally, a list of the candidate's achievements, a list of her publications and participation in conferences, schools and projects, as well as a list of the literature used, are attached.

The overview in the first chapter named "Relevance of the problem" is very thorough, based on a large number of publications and websites (over 130 publications and over 10

websites, additional websites are indicated in the text itself). In addition to world research on climate change, Bulgarian achievements in the field are also presented.

The paragraph 1 of chapter 2 "Methodology and data sources" is also very informative. This paragraph details the approaches to creating climate projections – global and regional climate models, nesting, scenarios and much other important information. The archives from which the information was taken are also described - the MED-CORDEX project, the MeteoFrance ALADIN5.2 model, the various versions of the ERA re-analyses, etc. A table of all downloaded archive files is also given. The second paragraph is devoted to the information used in the last chapter of the dissertation. The third paragraph of this chapter is essentially an introduction to the following third chapter, where definition of the statistical characteristics used in the comparisons between the projections and the current climate is given.

The third chapter presents the results of a methodologically correct action – assessment of the ability of the selected ALADIN 5.2 model to correctly describe the modern climate. In it, for each of the meteorological elements listed above, the average fields from the ERA-interim reanalysis, the corresponding results of the ALADIN simulations, the differences between them, the average seasonal characteristics and the multi-year variations for the period 1979- 2005. The graduate uses the term "inter-annual variation", which I consider incorrect. Inter-annual variation is usually understood as the variation of different values (here month, days, hours etc.) within the year. In tables 3.1 to 3.4 (in the dissertation it is wrongly written as Table 4.4) the values of the two selected statistical characteristics – BIAS and RMSD – for all years and by seasons are presented. Here, I have a remark about the colors in these tables (different degrees of red for the positive values and blue for the negative ones, respectively) - it is incorrect to color the RMSD at all because this quantity is always positive (square root). Thus, in Table 3.1 there is a kind of misunderstanding: according to BIAS the model underestimates the reanalysis (blue colors), and according to RMSD it seems as overestimation. However, the overall results show that the ALADIN 5.2 model satisfactorily simulates the current climate and can be used in assessing climate change under different climate projections.

In chapter 4 "Projection of the climate in the Balkan Peninsula - Black Sea region until the end of the 21st century" conclusions are made about the future climate changes that can be expected in the 21st century in a uniform way. The results of the climate simulations for the four meteorological elements under the two IPCC scenarios are presented: RCP4.5 (optimistic) and RCP8.5 (pessimistic). The century is divided into three 30-year periods: 2011-2040, 2041-2070 and 2071-2100. For each element for each period, 5 images of the same type are presented and interpreted – mean fields according to RCP4.5, according to RCP8.5, the

difference between these two fields and the differences between the projections and the historical period 1979-2005 assumed to be the current climate. Tables 4.1 to 4.4 present the statistics for the three periods under the two scenarios, which is the most important result of the study. The RMSD color remains red. This is essentially the most important achievement of the dissertation, considering the title of the dissertation, and is the first contribution according to the respective list. I value it very highly and define it as "enrichment of existing knowledge".

The fifth chapter has a rather diverse character and is not always related to climate projections. The first paragraph is devoted to the winter conditions in the Black Sea - the appearance and evolution of the ice cover and an attempt to relate it to the winter severity index - WSI. Many diverse sources of data were used here – measurements, satellite images, works of other authors. These results were combined with published data for the 20th century, and the multiyear variation of the ice sheet was reconstructed. The multi-year course (1926 – 2021) of the winter severity index with a general trend towards a decrease is also restored. The attempt to link the ice cover with WSI turns out to be unsuccessful, so the author analyzed synoptic conditions during several of the heaviest glaciation periods using synoptic maps downloaded from the German Meteorological Service website showing the defining influence of the Siberian Anticyclone and of cyclones with a northern trajectory. These are the second and third contributions of the dissertation, which I also highly appreciate and define as "new knowledge and application of scientific achievements in practice". The second paragraph of this chapter is devoted to changes in the intensity of the seasonal centers of action that have an influence in the Black Sea region - the Siberian maximum and the Mediterranean depression. Their variations for the winter period, as well as the climate projection of the pressure according to the two IPCC scenarios, have been studied in detail. The influence of the Mediterranean depression is found to be significant but decreasing in intensity until the end of the 21st century (winter pressure in the Mediterranean shows an increasing trend). For the future climate by the end of the century, the model estimates a strengthening of the Siberian maximum, which the doctoral student defines as strange, considering the general warming, and a weakening of the Mediterranean minimum. This is the content of contributions 4 and 5, which I also estimate highly. The last paragraph of this chapter is devoted to changes in the wind regime, but only under the RCP4.5 scenario. The change in wind speed is not large, but the strongest winds above 20 m/s in the modern climate have decreased, while an increase in the frequency of these winds is observed for the future period. This is the last contribution formulated by the doctoral student, which is also quite interesting.

Mirna Matov has 4 publications, two of which are in impact journals - *Atmosphere* (SNIP=0.951) and *Climate* (SNIP=1.211). Both are included in Scopus and the first one has 1 citation. Both articles have three authors, with the first authors being the doctoral student and her scientific supervisor. Without underestimating the merit of Prof. Peneva, I consider that the main contribution is the work of Mirna Matov.

Here, I would like to express my bewilderment. In my opinion, the most important achievements in the dissertation are the climatic changes of the four selected meteorological elements during the three future periods. But this did not find a worthy place in Matov's publication activity. Only one publication, a report on the second doctoral conference, which collection is published by the SU University Publishing House, presents the results of the climatic changes of two of the four meteorological elements - the pressure at sea level and the surface wind, and that in Bulgarian. The topic of Black Sea freezing is best covered - two of her articles and reports at 4 international conferences contain these results. The latest work by Peneva and Matov is dedicated to the influence of the Mediterranean depression on the precipitation regime of the Balkan Peninsula for the period 1901-2021. Its results are not part of the dissertation work, but they have definitely sound climatically.

Additionally, the doctoral student has participated in a large number of conferences (some of them educational) and in two projects, the first of which is the National Scientific Program "Protection of the Environment and Reduction of the Risk of Adverse Events and Natural Disasters" funded by the Ministry of education.

6. Critical notes and recommendations

There are quite a lot of spelling mistakes, which is easy to understand and is normal for such a large volume of the dissertation. However, they do not spoil the good impression of the work done. In two places, the numbers of the tables are wrong, and on p.74, fig.4.7 it is wrongly written "at the mean pressure at sea level" while considering the multi-year course of precipitation.

My recommendations are: the results of Chapter 4 to be presented in at least two articles in English and submitted to relevant high-impact journals.

7. Personal impressions of the candidate

I do not know the doctoral student and have no personal impressions of her. I saw her for the first time at the pre-defense of her dissertation. But her presentation and the materials contained in the dissertation and in the publications deeply impressed myself with the enormous

amount of work put in, the interpretation of the results and the good layout of the dissertation and the abstract.

Only the results of Chapter 4 are sufficient and fully meet the requirements for a doctoral dissertation. Here we have additional chapter that is quite interesting and contains not quite ordinary facts and conclusions.

8. Conclusion

After reading the presented dissertation work, 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 ZRASRB and The Regulations for its application and the relevant Regulations of the SU "St. Kliment Ohridski" for acquiring the educational and scientific degree "Doctor". In particular, the candidate satisfies the minimum national requirements in the professional direction and no plagiarism has been found in the dissertation work, abstract and scientific papers submitted for the competition.

I give my positive assessment of the dissertation work.

II. GENERAL CONCLUSION

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

01.06.2023

Reviewer:

(Prof. Dsc. Dimiter Enchev Syrakov)