



Universidade de São Paulo
Instituto de Astronomia, Geofísica e Ciências Atmosféricas
Departamento de Ciências Atmosféricas

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Dear Prof. Jakub Langhammer.
Chair of Habilitation committee
Charles University, Faculty of Science

This is my evaluation of Dr. Michal Belda's Habilitation thesis "Modeling the Climate System Across Scales" of the Department of Atmospheric Physics, Faculty of Mathematics and Physics, Charles University, Prague. The Habilitation thesis is presented in the form of nine peer-reviewed articles published between 2014 and 2022. These articles are scientifically connected by the application of numerical models from the global scale to the micro-scale, passing across regional scale.

The thesis is organized as follows: an abstract followed by an Introduction; Chapter 1 focuses on the studies applying Köppen-Trewartha climate classification to the global climate models assessment; Chapter 2 includes studies based on regional climate models; Chapter 3 summarizes the efforts to simulate local features of climate by using LES (Large eddy simulation) models. These chapters are followed by conclusions.

The thesis introduction is dedicated to a brief review of the principles governing the numerical prediction of the climate system and associated uncertainties. It discusses that uncertainties arrive from various features such as unknown chemical and sub grid scale processes to the internal variability of the real system and model themselves. It contextualizes the effort of global projects to provide a large number of global (CMIP initiative) and regional (CORDEX) climate simulations as a way to reduce the uncertainties of present and future climate projections.

Chapter 1 presents an evaluation of global models over Europa and it is based in three articles. The conceptual Köppen-Trewartha climate classification, which incorporates the links between the climate and vegetation, was applied to assess the ability of global models from CMIP to represent the present climate and their future projections. The experience in applying Köppen-Trewartha methodology motivates Dr. Belda to organize a review article to solve gaps in the literature related to the nomenclature, climate zone definitions and their numerical value thresholds.

In Chapter 2, the limitations of global models in providing future climate projections of local features of the climate due to computational costs of refined global simulations are analyses. The use of dynamic downscaling through regional climate models (RCMs) allows



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the refinement of horizontal grids for specific regions of the globe. Chapter 2 is based on three peer-reviewed publications. These publications focused on analyzing CECILIA and ENSEMBLES RCM simulations. The first article presents the validation and RCMs intercomparison to represent the observed present climate over Europe. The climate change signal provided by CECILIA RCMs was assessed in the second article, while the large experience of working in coordinating RCM projects for downscaling global models over Europe (as EURO-CORDEX) was summarized in a third article.

Chapter 3 discusses the limitations to obtaining long terms climate simulations for scales from tens to hundreds of kilometers and the approach need to solve the climate at local scale, or micro-scale (horizontal scales of the order of tens of meters). One way to simulate micro-scale phenomena is by using large eddy simulation (LES), which may be applied to study urban heat islands and air quality problems. The studies conducted in this scale are presented in three peer-review papers. The first is dedicated to validation against observations (infrared camera) and sensitivity tests (model domain and parameters), the second describes an observational campaign and model validation, and finally, the model response to changes in physical parameters was investigated in the last one.

The Habilitation thesis submitted is well structured and contextualized, making clear the application of adequate methodology (observations, numerical simulations and methods) to study from global to micro scale climates. The thesis highlights the contributions of Dr. Belda to the field of numerical modeling across different scales, which is certificated by your research papers published in various renowned international journals. The ability of Dr. Belda to lead and also to contribute to collaborative research projects (CECILIA, ENSEMBLES, EURO-CORDEX, and TURBAN) is well demonstrated in the thesis. The plagiarism audit (Turnitin report) has not shown any serious scientific misconduct regarding copying.

Based on previous considerations, I recommend the acceptance of Habilitation thesis by the university.

Sincerely yours,

Prof. Dr. Rosmeri Porfirio da Rocha

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