POTSDAM INSTITUTE FOR CLIMATE IMPACT RESEARCH

P.O. Box 60 12 03
D-14412 Potsdam | Germany
T: +49 331 288 2500
F: +49 331 288 2600
www.pik-potsdam.de

Member of the Leibniz Association

Scientific Directors:
Prof. Dr. Ottmar Edenhofer
Prof. Dr. Johan Rockström

Association Registry Number:
Local Court Potsdam VR 1038 P

Bank account:
Mittelbrandenburgische
Sparkasse Potsdam (MBS)
IBAN: DE69 1605 0000 3502 2355 29
BIC: WELADED1PMB

Potsdam Institute for Climate Impact Research P.O. Box 60 12 03 D-14412 Potsdam

Dr. M.A. Sokolovskiy,
Academic Secretary of the Dissertation Council,
Water Problems Institute
of the Russian Academy of Sciences,
Gubkina Str. 3,
119333 Moscow,
Russia

18 March 2019

Dr. Valentina Krysanova
T:+49 331 288 2515
F:+49 331 288 0000
Krysanova@pik-potsdam.de

Review on the auto-abstract of the doctoral dissertation and dissertation of Yu.G. Motovilov "System of physical-mathematical models of river discharge and its application for hydrological assessments and forecasting"

Dear Dr. Sokolovskiy,

The dissertation of Yu.G. Motovilov is devoted to development of a system of physical-mathematical hydrological models for simulation of river discharge, including models with different levels of complexity and spatial resolution. Namely, it includes the detailed model with spatially distributed parameters and fine resolution for simulation of hydro-thermic regime of snow cover and soils in small watersheds, and an integrated model with semi-distributed parameters for simulation of hydrological processes in large river basins. The key component of the system is the ECOMAG model, which is suitable for modelling hydrological processes in river basins with mixed precipitation and snow melt contribution to river runoff.

Main aspects. The following three main aspects were considered in the study and are described in the dissertation: a) development of the detailed distributed-parameter model representing hydro-thermic regime of snow cover and soils in small catchments intended mainly for modelling of spring flood processes; b) development of the semi-distributed model ECOMAG by aggregation of equations and parameters of the distributed model intended for regional-scale modelling in large river basins, where both snow melt and precipitation are important for runoff generation; and c) development and application of new methods for hydrological assessment and hydrological forecasting.

Importance of the topic. The topic of dissertation represents an important and challenging field of science, which demands application of advanced methods, development of new approaches, and collection and analysis of numerous data including geospatial information. This topic is of a great value, because better

understanding of flow formation processes in river basins and their representation in numerical models are needed for more reliable water resources management based on model applications, and for studying potential impacts of climate and land use change on hydrological processes.

Methods. Yu.G. Motovilov used different advanced methods for the development of models and their testing in river basins. The applied approaches and developed models are based on previous research and models of the leading Russian and international hydrologists such as L.S. Kuchment, E.A. Anderson, Yu.B. Vinogradov, K. Beven, E.F. Wood, A.N. Gelfan and others. Nevertheless, the models described in the dissertation of Yury Motovilov represent an advancement of research in this field. The developed models are transferrable to other regions and are suitable for studying potential climate change impacts at the river basin scale.

Achievement of objectives. It can be stated that the objectives of the study were successfully achieved, as follows from the dissertation, auto-abstract and published papers. As a whole, the dissertation and publications of the author represent significant achievement in hydrological modelling.

Publications. The literature sources used for the work and own citations are included in the lists of references of the dissertation and auto-abstract. They include numerous publications of Yu.G. Motovilov in the Russian scientific literature. Besides, publication of 12 papers in the international referred journals (one as the first author and 11 as a co-author) and 12 papers in the IAHS Publications, as well as numerous presentations at international conferences and workshops indicate on the sufficiently high international standard maintained in the dissertation.

Presentation of material. In general, structure of the dissertation with five Chapters is appropriate. However, the structure of Chapter 1 starting not from a classification of hydrological models or an overview of existing models of different types, but from the description of an own model: the detailed distributed-parameter model for modelling spring floods in small catchments, is a bit strange. Otherwise, the presentation of material is very good. All results are sufficiently illustrated by appropriate graphs and maps, and the discussion of results is prosperous.

International context. The distributed-parameter model for small catchments and the ECOMAG model were applied in the international context: in the framework of the NOPEX project in Sweden and in the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP, https://www.isimip.org/). However, the overview of semi-distributed hydrological models in sections 1.2 and 1.3 of Chapter 1 is quite narrow, especially concerning international scientific literature: there are mentioned only two models: HBV and HYCYMODEL (Bergström, 1976; Fucushima et al., 1991), and one recent paper (Savvidou et al., 2018) and one thesis (Haghnegahdar, 2015) where some other models were reviewed. The overview of models in Chapter 1 could be definitely extended by listing more state-of-the-art semi-distributed hydrological models, which are extensively used nowadays for climate impact assessment and water resources

management (e.g. such models as HYPE, WASIM, VIC, etc.). And a critical comparison of modelling approaches used in ECOMAG and in other semi-distributed process-based models would be helpful to better present the background and context in Chapter 1. Besides, the model intercomparison studies in the framework of ISIMIP, which are very important for climate impact assessment in the framework of IPCC, and where the ECOMAG model was also applied (Gelfan et al., 2017, Hattermann et al., 2017), could be at least mentioned. Nevertheless, these minor comments do not diminish many important merits of the dissertation.

Summary. In general, according to my knowledge, this dissertation can be classified as being at the very good international level in science. The amount of work done is impressive: it is a combination of deep insights in hydrological processes for the detailed distributed-parameter modelling with the aggregation and generalization of approaches for the semi-distributed integrated model ECOMAG. Section 1.2 describing critics of K. Beven and Y.B. Vinogradov related to the description of some hydrological processes using equations of mathematical physics, and their application at non-appropriate scales, different from that for which they were developed, followed by description of ways of solving these problems is very valuable for hydrological modellers. The calibration and validation results presented in the dissertation and in publications of Yu.G. Motovilov are very good. Many applications of the detailed distributed-parameter model to small catchments, and applications of ECOMAG to large river basins, to rivers with cascades of reservoirs as well as for the short-term forecasting are convincing, and allow to conclude that the developed by Yu.G. Motovilov modelling system is a very valuable achievement in hydrological research. There are no doubts that this dissertation is a significant contribution to science, and Yu.G. Motovilow deserves the scientific degree of a Doctor.

Sincerely,

Dr. Valentina Krysanova,

Leading scientist at the Potsdam Institute for Climate Impact Research, Germany

Coordinator of the Water-Regional sector in the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP)

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