Review of Ph.D. Thesis "*Dynamic models of the earthquake source*" by Mgr. Filip Kostka

Filip Kostka started his Ph.D. project in 2015 under my supervision at the Department of Geophysics, Faculty of Mathematics and Physics, Charles University in Prague. Before that, he conducted his Master's and Bachelor's studies at the same institute, also under my supervision. During his studies, Filip has proven his capability to deeply understand complex physical and mathematical theory far beyond the standard lectures he passed. This includes earthquake source dynamics and Bayesian approaches including Monte Carlo Markov Chain (MCMC) sampling.

Filip's Ph.D. project consists of two parts, covering the modeling of earthquakes on two very different time scales. In the first part, he applied earthquake cycle simulations with rate-and-state friction law to analyze clock advance/delay due to stress changes on a planar 3D fault with heterogeneous parameters. Besides parametric tests, he adapted the numerical model to mimic the evolution of the Parkfield segment of the San Andreas Fault, following a published scenario. He demonstrated that if stress change (e.g., due to a nearby earthquake) affects the fault evolution at the right time within the earthquake cycle, the next system-sized event can be delayed due to previously failed nucleations realized in the form of smaller event(s). He proposed this effect could be responsible for the significant delay of the 2004 Parkfield earthquake by ~10 years. The second part of the thesis is devoted to dynamic rupture simulations of the 2017 Mw 6.3 Lesvos earthquake. Filip determined parameters of an elliptical crack governed by a slip-weakening friction law by modeling near-regional seismograms. The significant contribution is his rigorous analysis of uncertainties in a Bayesian framework. He proposed a way to correctly interpret the resolving power of individual modeling and data ingredients, which could serve as a more general guideline for the proper treatment of modern inverse problems.

Filip is the principal author of two publications devoted to the above-described subtopics. The first paper was relatively smoothly published in the Journal of Geophysical Research-Solid Earth. Contrarily, the evolution of the second paper was more painful. It was first rejected after revision in the Geophysical Journal International. Filip then adapted a more precise finite-difference solver written by his fellow student Jan Premus, and improved the Bayesian approach by reconsidering the model parameterization and refining the MCMC sampling. The calculations were heavy and needed to be redone many times for various reasons, which caused a significant delay. The resubmission of the wholly revamped manuscript was then successful.

Within the Ph.D. studies, Filip has improved his computer skills. He combined Fortran programming and code execution on supercomputers, Python coding for postprocessing, etc. He has improved his English and writing skills. For example, Filip wrote an excellent broad and deep overview of rupture dynamics as the introductory section of his Ph.D. thesis entirely on his own. More than a year-long hard work has paid off – the text could be used as lecture notes, covering the topic at a high pedagogical level. Filip has also gained experience in funding management as he got two student projects from the Grant Agency of the Charles University. He often

demonstrated his pedagogical skills during the department's reading seminars, where he could explain even a complex theoretical paper in an accessible way.

To conclude, I am convinced that Filip Kostka is a promising young researcher deserving of the Ph.D. title. I wish him to find a challenging postdoc position to pursue his scientific career.

Prague, February 2022 doc. RNDr. František Gallovič, Ph.D.