Supervisor's comments on David Einšpigel's doctoral thesis

Time-domain modelling of global barotropic ocean tides

The PhD project was devoted to numerical modelling of global barotropic ocean tides in time domain. The project was originally motivated by one of the goals of the ESA Swarm satellite magnetic mission aiming at the extracting the ocean-generated tidal magnetic signals from Swarm data. Since the barotropic ocean flow generates the magnetic field on satellite altitudes about one order of magnitude greater than the magnetic field generated by wind-driven ocean circulation, it is natural to begin searching the magnetic field due to tidal ocean flow in Swarm data.

David Einšpigel started to work on the subject of barotropic ocean tides already as the master student but now, as the Phd student, he has concentrated his effort into two directions.

First, he has extended the original master-made code (named DEBOT) for the physical processes of barotropic ocean flow, which were not treated during diploma project. He has included the self-gravitation of the ocean masses and the internal tide drag force into the DEBOT model and showed that these two effect has a non-negligible effect on the patterns of barotropic ocean flow.

David was a member of the research team for solving the ESA-funded project '$Swarm + Oceans$' aiming at extracting tidal ocean signals from Swarm data and interpreting them in terms of tidal ocean dynamics. During David's presentations on the progress meetings, he was asked for many small, but important improvements of his numerical code. One important issue raised by the ESA representative required to make the space and time resolution of model DEBOT as fine possible and compare DEBOT's results with the existing models of the barotropic ocean flow. It turned out that the performance of model DEBOT is comparable with other numerical codes.

David's second effort was devoted to assimilate the altimetry data to the DEBOT model. He proposed a simple, but functioning procedure of how to assimilate altimetry data to the DEBOT model and showed on the comparison with the ocean-bottom pressure data that the assimilation improves the performance of the DEBOT model by factor of 5 at least.

Now, at this stage, the DEBOT model was ready to be involved in the modelling of ocean-generated tidal magnetic field. However, there are two fundamental obstacles, not related to the DEBOT model, to prevent to do this work so far. First, an automatized extraction of tidal ocean signals from Swarm data in time domain is not completed yet. Second, even having extracted the signals from Swarm data, an automatized assimilation of Swarm signals with the help of DEBOT is not functioning yet. The two problems remain open for further investigations.

Was the DEBOT model helpful for interpreting of Swarm data? Despite of the two open problems and despite of 3-year lasting David's pessimism, the DEBOT model is an open source code where the physical properties can be further improved. At the end of the ESA project it appeared that it would be possible to improve the physical model of self-gravitation in barotropic ocean flow on the base of Swarm data.

David Einšpigel has worked on his PhD project systematically, intensively, but mainly independently of me. Me and Libor Sachl consulted his results and achievements once a while, but hardly have any advices to him what to do next. David has collected all possible publications on the ocean-barotropic ocean flow and was able to choose the correct numerical approaches to solve the problem numerically. He has also found the appropriate deap-ocean bottom pressure records against which he has tested the performance of the DEBOT model.

All these reasons bring me to the conclusion that the scientific work of David Einšpigel deserves the highest appreciation. Without any reservation, I recommend the thesis to be passed on to a public defense, and David Einšpigel to be awarded the PhD degree after successful defense.

Dublin, March 29, 2017 Zdeněk Martinec