Review of Ph.D. thesis

Numerical modeling of free oscillations applied to superconducting-gravimeter data in a low-frequency seismic range

by Eliška Zábranová

The work deals with the question of what can be learned about the anelastic structure of the Earth and seismic-source parameters of three recent large earthquakes from the records of superconducting gravimeters (SG) organized under the Global Geodynamics Project. The solution method is based on the comparison of synthetic ground motion accelerograms in vertical direction with observed SG records for ultra-long free oscillations. The aims of the thesis are described in details in Introduction of the thesis.

The thesis documents a large amount of work done by E. Zábranová with the results published in peer-reviewed journals. Three published papers on the subject of the thesis are included in the second part of the thesis. The text of the thesis is written in a rather compact way which makes reading of some parts longer. This is the reason that some notions and methodological details are not introduced in the thesis. My questions and comments are probably due to 'short writing' of the thesis. The following comments should be considered as of minor importance and they are not intended to depreciate work undertaken by E. Zábranová .

(1) E. Zábranová developed a new method of computing eigenfrequencies and eigenfunctions of the SNREI model based on Fornberg's (1996) scheme for discretizing ordinary differential equations. The new method was tested against the traditional Runge-Kutta numerical integration implemented in the Mineos software package and a good agreement in numerical results was achieved between the two approaches. A reader of the thesis may appreciate to know what are the advantages and disadvantages of the new method in comparison to the traditional one. Can they be specified?

(2) How does the new method differ from the method developed in the framework of the diploma project? If I remember correctly, the previous method was also based on Fornberg's scheme.

(3) The traditional method based on the Runga-Kutta integration allows the integration to start on a sphere inside the Earth in the case where the eigenfrequencies and eigenfunctions of the SNREI model are computed for higher-degree modes. The reason is that the energy of higher-order eigenmodes is located closer to the Earth's surface and the integration starting from the center of the Earth may result in numerical overflows. Such a modification is not considered in the thesis. Can the new method be used for computing higher-degree eigenmodes without above modification?

(4) There is no clear reason why the elastic tidal Love numbers are introduced in the thesis (e.g. section 1.5.4). I understand the tidal contribution to the SG records was filtered out by applying the high-pass Buttherworth filter. Or, were other tidal corrections based on the elastic tidal Love numbers applied?

(5) Reading Sections 1.6 and 1.7 was confusing for me. In my view, a more comprehensive overview on the quality factor should be given. What is definitely missing are the definitions of used notions such as the modal and fiducial frequencies. How are they defined?

(6) Chapter 2 summarizes the formulas for computing synthetic accelerograms as adopted from two literature sources. This is a 'cook book' for numerical coding, in principal, nothing

for deep understanding. I read this section twice with certain confusion. For instance, I cannot find the definition of the vertical and radial components of an accelerogram in Figure 2.1. They should be the same on a spherical earth which is probably not the case considered in the figure. I guess a reader may appreciate if there is a note at the beginning of this section that a reader not interested in the summary on computing synthetic accelerograms may wish to advance to Chapter 3.

(7) A part of the analysis of SG records were performed by applying Hann's filter, Butherworth's filter and some kind of time averaging. None of this data analysis steps is documented by mathematical formulas. Can the associated formulas be shown and explained how they were applied to SG records?

(8) What is the conclusion from the comparison of Figures 3.7-3.9? Which time interval is optimal? Why not intuitively: the longer the better?

The second part of the thesis consists of three published papers which passed through international-journal reviews. In my view, there is nothing more to be reviewed. These publications document that the Ph.D. project of E. Zábranová brought new scientific results. I particularly appreciate the last two papers for providing clear messages.

In summary, the thesis demonstrates that E. Zábranová can work as an independent scientist. Without any reservation, I can recommend that the thesis be passed on to a public defense. However, I expect that the questions raised above will be answered during the defense.

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