IGiK–TVGMF: A MATLAB® GUIs package for computing, analysing and modelling temporal variations of gravity/mass functionals from GRACE satellite based global geopotential models

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Abstract

The determination, analysis and modelling of temporal variations of gravity/mass functionals (TVGMFs) are one of the most important tasks within the Earth-science disciplines. This contribution describes a MATLAB package, named IGiK–TVGMF (Institut Geodesy, Kartographie und Geoinformatik – TVGMF) under development, offering the possibility of analysing and validating TVGMF from Global Geopotential Models (GGMs) data computed by the German Research Centre for Geosciences (GFZ) (Gravity Recovery and Climate experiment) satellite gravity mission data.

The IGiK–TVGMF comprises of three graphical user interfaces (GUIs) developed with the use of MATLAB R2017a App Designer. The first GUI, named the TVGMF–Computation is the main interface, in which different TVGMFs can be determined at an individual point or on a grid of points based on GRACE-based GGMs from seven computation centres. Different parameters and filters can be specified in this GUI. The second and third GUI, named the TVGMF–Analysis/PCA/EOF and the TVGMF–Analysis/SA, respectively, were developed to analyse and scale the TVGMFs using the Principal Component Analysis/Empirical Orthogonal Function (PCA/EOF) and the Seasonal Adjustment (SA) methods.

Results and outcomes obtained from the IGiK–TVGMF can be redistributed and/or modified under the terms of the GNU Library General Public License 3.

Keywords: GGM, GRACE, gravity/mass functionals, GRACE satellite based global geopotential models, MATLAB®, GUIs package, analysis, seasonal adjustment

Introduction

The determination and the analysis of temporal mass variations within the Earth system are one of the main scientific objectives in the Earth-science related disciplines. For example, the Gravity Field and Climate Experiment (GRACE) satellite mission launched in March 2002 with its pioneering observation technology (satellite to satellite tracking in a low-low mode) provides valuable data for the determination of temporal variations of mass functionals (TVGMFs). The GRACE satellite mission was operated for three times longer than its initial planned duration. In October 2017, GRACE satellite ran out of fuel, and the mission was terminated. However, it emphasizes the need for the GRACE Follow-On (GRACE-FO) satellite mission, which has been launched on 22 May 2018 (http://grace.jpl.nasa.gov/mission2018/), for longer term sustainable information on TVGMFs. The IGiK–TVGMF is available as an open source that can be redistributed and/or modified under the terms of the GNU Library General Public License 3.

In order to determine and analyse TVGMFs using GGMs from GRACE mission data, an appropriate computational tool is essentially needed. However, main limitations of currently available softwares and interactive online tools developed for the computation of static GMMs and TVGMFs can be as follows:

− The currently available softwares were mainly developed to determine static gravity functionals. Thus, in order to compute TVGMFs using these softwares, users may need to conduct a preprocessing or modify GRACE-based GGMs. Moreover, these softwares do not allow users to determine temporal variations of mass functionals from GRACE-based GGMs. Furthermore, for some of these softwares, users may need to determine TVGMFs from already GRACE-based GGMs, so these softwares do not allow users to determine temporal variations of mass functionals from GRACE-based GGMs. Furthermore, for some of these softwares, users may need to determine TVGMFs from already GRACE-based GGMs, which would be very time consuming and manpower consuming.

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Taking into the consideration these limitations, the main objective and motivation of this contribution are to develop a novel MATLAB package, named the IGiK–TVGMF, for the determination, analysis and modelling of TVGMFs. This MATLAB package allows users to compute and analyse thirteen types of TVGMFs at a single point or on a grid of points using GRACE-based GGMs.

The IGiK–TVGMF: A MATLAB GUIs package

The IGiK–TVGMF comprises of three graphical user interfaces (GUIs) developed with the use of a MATLAB R2017a App Designer (https://www.mathworks.com/products/matlab/app-designer.html). Different parameters, e.g. the Degree–Centre (CC), the reference model, the system of units and the geographic system, can be selected in this GUI.

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− A competition between TVGMFs from the IGiK–TVGMF, GRACE/GRACE-FO Science Team Meeting 2018, The Helmholtz Centre Potsdam – GFZ German Research Centre for Geosciences, Potsdam, Germany, 9–11 October 2018

Data used and methods

The IGiK–TVGMF: A MATLAB GUIs package

Examples of the validation of TVGMFs determined with use of the IGiK–TVGMF

Conclusions and future developments

The IGiK–TVGMF is a novel MATLAB package developed for the determination and the analysis of TVGMFs using GRACE-based GGMs. It handles all available monthly GRACE-based GGMs from seven computation centres.

The IGiK–TVGMF can be easily updated by including new GGMs developed from GRACE/GRACE-FO mission data.

A very good agreement between TVGMFs determined from the IGiK–TVGMF and the corresponding ones from the GRACE/GRACE-FO and ICGEM softwares was obtained.

The IGiK–TVGMF overcomes some of the limitations of currently available softwares and interactive online tools developed for the computation and the analysis of TVGMFs.

In this GUI, the seasonal, long-term and unmodelled components of the TVGMF analysed as within or beneath numerical values that can be easily read or understood.

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