João de Teixeira da Encarnação

Publication Summary

In Teixeira da Encarnação et al. 2016, the habitability of the Swarm satellites to observe changes on Earth's gravity field is for the first time demonstrated. This research was one in cooperation with five international research institutes (Institute of Geodesy (IfG) of the Graz University of Technology (TUG), Astronomical Institute (ASU) of the Czech Academy of Sciences (AVCR), Astronomical Institute of the University of Bern (AIUB), Aerospace Faculty of the Delft University of Technology (TU Delft) and School of Earth Science (SES) of the Ohio State University (OSU)), within the context of a project initiated and lead by me. Since publishing this article, I have taken the leading role securing funding from the European Space Agency (ESA), through the Data, Innovation and Science Cluster (DISC), to develop the methodology to best combine the individual gravity field solutions from each research institute and routinely produce monthly models for the foreseeable future. The Swarm gravity field models constitute an independent source of gravimetric data from dedicated mission (Gravity Recovery And Climate Experiment (GRACE) and GRACE Follow On (GRACE-FO)). Although their spatial resolution is much lower, the Swarm models are still able to describe monthly variations of Earth's gravity field within a few millimetres geoid height, when compared with GRACE. This has proven to be particularly beneficial in monitoring mass transport processes during the gap between the periods when GRACE and GRACE-FO were and are (respectively) collecting data.

My contribution to Ditmar, Encarnação, and Hashemi Farahani 2012 demonstrates that the influence of temporal aliasing caused by errors in the Atmosphere and Ocean De-aliasing (AOD) models, needed to remove rapid-changing gravity variations that are impossible for GRACE to observe, cannot explain the unexpected low quality of the gravity field models, compared with pre-launch predictions, particularly in what concerns the striping artefacts. Additionally, the results of this publication contrast with other similar studies in the sense that it is clear that different gravity field estimation approaches have different sensitivity to different error types. In case of our method, the acceleration approach, the in-situ character of the observation equation ensures the effects of temporal aliasing are mitigated, while the integrating nature of the traditional variational equations approach accumulate AOD model errors, magnifying their influence. For this reason, other studies have identified errors in the AOD models are the primary cause for the striping artefacts. On the other hand, the effects of orbit errors, particularly in the form of centrifugal accelerations, are critical to the acceleration approach. This is because the orbit is taken as observations, while in the variational equations approach the orbits positions are co-estimated with the gravity field model.

My contribution to Gunter et al. 2011 for the first time explores the possibility of using numerous satellites equipped with Global Positioning System (GPS) receiver to augment dedicated gravimetric satellite missions. We demonstrate that the current accuracy of GPS observations is insufficient to provide meaningful improvements, unless a large number of satellites is used (in the order of hundreds). However, future and multiple Global Navigation Satellite System (GNSS) systems should be accurate enough to make it possible to provide enough information to resolve sub-weekly to daily low-degree solutions with sufficient accuracy to observe, for the first time, global atmospheric mass transport processes. This would essentially mean that AOD models could be replaced with these observations, with the associated benefits of a much more accurate and realistic description of high-frequency mass transport processes, and consequential improvements in the quality of gravimetric monitoring of lower-frequency processes, such as hydrology.

Highlighted publications

1. **Teixeira da Encarnação, J.**, Arnold, D., Bezděk, A., Dahle, C., Doornbos, E., Van Den Ijssel, J., Jäggi, A., Mayer-Gürr, T., Sebera, J., Visser, P., Zehentner, N., (2016). “Gravity field models derived from Swarm GPS data”. In: *Earth, Planets Sp.* 68.1, p. 127. DOI: 10.1186/s40623-016-0499-9.

2. Ditmar, P., **Encarnação, J.**, Hashemi Farahani, H., (2012). “Understanding data noise in gravity field recovery on the basis of inter-satellite ranging measurements acquired by the satellite gravimetry mission GRACE”. In: *J. Geod.* 86.6, pp. 441–465. DOI: 10.1007/s00190-011-0531-6.

3. Gunter, B. C. B., **Encarnacao, J.**, Ditmar, P., Klees, R., Encarnaçao, J., Ditmar, P., Klees, R., (2011). “Using Satellite Constellations for Improved Determination of Earth's Time-Variable Gravity”. In: *J. Spacecr. Rockets* 48.2, pp. 368–377. DOI: 10.2514/1.50926.