Mass transfers associated with the 2010 Mw 8.7 Maule earthquake by the GRACE mission

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Abstract: Time-varying satellite gravimetry (GRACE, GRACE Follow-On) provides a unique way to study the Earth dynamics from the monitoring of its mass redistributions at intermediate spatial and temporal scales (of the order of a few hundred kilometres, every 10 to 30 days). In subduction zones, the oceanic plate initiate its movement towards the mantle depths, forming downwellings within the internal convective system. Our work aims at better understanding and documenting deep deformation processes leading to great earthquakes.

Satellite gravimetry data complement surface geodetic and seismological observations by providing a better sensitivity to deeper motions and by recording slow mass transporting deformations throughout the volume around plate boundaries. For instance, the visco-elastic response of the mantle has been observed during, and after, the very large earthquakes that occurred, thanks to GRACE records, since 2003. Recently, the GRACE sensitivity at depth has done it possible to replace the giant rupture of Tohoku-Oki earthquake (Mw 9.1, March 2011), within a regional sequence of mass transfers propagating over a few months from the subduction zone depths to its surface. Significantly larger than predicted from geodetic and seismological observations, this movement includes a pre-seismic phase at about 250 km depth, attributed to a large-scale stretching of the Pacific Plate progressing through the mantle in the months prior to the rupture.

Here, we investigate whether similar variations in the gravity field can be detected prior to the Maule earthquake(Mw 8.7, February 2010), and if they are again compatible with a propagation of motion from depth to surface and interior of the oceanic plate during the co- and post-seismic phases. The sources separation is based on their specific time-space characteristics, and makes use of gravitational gradients to depict the geometry of the anomalies. To interpret the evidenced anomalies, we will analyze the variability related to the water cycle over the areas under consideration, as well as an analysis of the striping errors in the geoid models, and confront the gravity signals with surface deformations from GNSS data.

Keywords: Spatial geodesy, Gravimetry, Geodynamics