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Session G02 (Mass transport and mass distribution in the Earth system)

Insights from GRACE and GPS data on the seismic cycle and mantle rheology

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Invited presentation

With the advent of GRACE satellite gravity, measurements of mass displacements within the Earth system are now available. Although they are dominated by mass variations within the fluid envelopes, they also contain the fingerprints of solid Earth processes such as large earthquakes.

Taking the example of the Sumatra December 2004 and March 2005 earthquakes, we show that GRACE detects well the mass variations resulting from large-scale co-seismic and post-seismic deformations and provides a unique view of the mantle viscous response to the earthquakes. From a multi-scale analysis of the GRACE geoids until September 2007, we evidence a fast growth of the geoid around the Sumatra trench, which cannot be fully explained by previous visco-elastic relaxation models based on an analysis of GPS measurements of crustal deformations alone. The GRACE data suggest more deformation at depth than previously modeled, which we explain by a lower mantle viscosity and a small amount of afterslip at the downdip extension of the co-seismically ruptured fault planes.

These results underline the complementarity of satellite gravity and surface geodetic and geophysical data for solid Earth deformation studies, and the broad prospects of their joint analysis to better understand the seismic cycle, especially in subduction zones, and better constrain the Earth's viscosity profile.