Geophysical Research Abstracts
Vol. 21, EGU2019-8928-1, 2019
EGU General Assembly 2019

What do magnetic and gravity fields indicate about the Earth's core flow ?

Mioara Mandea (1), Veronique Dehant (2,3), Anny Cazenave (4), Olivier de Viron (5), Alejandro Blazquez (6), Ping Zhu (7), and Ingo Wardinski (8)

(1) CNES, Directorate of Innovation, Applications and Science, Paris, France (mioara.mandea@cnes.fr), (2) Royal Observatory of Belgium (ROB), Brussels, Belgium (veronique.dehant@oma.be), (3) Université catholique de Louvain (UCLouvain), Belgium, (4) Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Toulouse, France (anny.cazenave@legos.obs-mip.fr), (5) Université de La Rochelle, France (olivier.de_viron@univ-lr.fr), (6) Laboratoire d'Etudes en Géophysique et Océanographie Spatiales (LEGOS), Toulouse, France (alejandro.blazquez@legos.obs-mip.fr), (7) Royal Observatory of Belgium (ROB), Brussels, Belgium (zhuping@oma.be), (8) University of Nantes, Nantes, France (ingo.wardinski@univ-nantes.fr)

Magnetic measurements obtained on and about our planet are of great value to probe its deep interior. These observations are useful and, together with gravity measurements, have been used to infer the state of Earth's interior and its evolution. But, it has only recently become clear that models of magnetic and gravity fields, over more than a decade, have reached an unprecedented resolution and accuracy, allowing to gain insight into core-mantle boundary phenomena and core dynamics. Here, we revisit a previous study and take advantage of the availability of more than a decade of data provided, on the one hand, by the CHAMP and Swarm missions and, on the other hand, by the GRACE mission. From the derived geomagnetic models, we have computed the core magnetic field and its temporal variations. We have also emphasized the variability of the gravity field by applying specific post-processing techniques to the initial GRACE-based model.

These geomagnetic and gravity field models rely on different hypotheses and processing from the ones previously used. Over the period from January 2003 to December 2015, covered by both magnetic and gravity data, "virtual magnetic and gravity observatories" (VMGOs) have been built on a global grid. Correlations between the VMGOs series have been computed and we have found correlated temporal variations between gravity and magnetism over large areas. We associate this correlation with the core-mantle interaction and core flows. On time-scales of few years to a decade, both field variations may be linked together by involving processes at the core mantle boundary. Due to the continuous changes in the core-mantle topography, anomalies of tens of nT /year2 and hundreds of nGals can be produced by the core flow and the corresponding mass redistribution, respectively. Both magnetic and gravimetric anomalies can be reproduced by numerical models.

In parallel, the instability in Earth's rotation can be measured through the changes in rotation period, which is the length of day (LOD). The atmospheric excitations, the eustatic variation in sea level, and the nonlinear ENSO oscillation have been evaluated and correlate well with the observed changes in LOD on short (seasonal) timescales. On time-scales of few years to a decade examined in gravity and magnetic field data, climate effects have limited effects; LOD variations at the decadal timescale are related to the core flow. We independently isolated the time variation at LOD from inter-decadal to multi-decadal variation at LOD. The series contain inter-decadal variations that are correlated with local magnetic field observations as well. At inter-decadal timescale, $\sim$6 year oscillations are found, which is interesting and most probably related to the torsional oscillations in the liquid core.