Subject offered for a contract starting october 2016

SUBJECT TITTLE: Lithospheric structure of the terrestrial planets from gravity and topography

Advisor: **WIECZOREK Mark, DR, mark.a.wieczorek@gmail.com**

Second Advisor/ Supervisor:
MICHAUT Chloé, MDF, michaut@ipgp.fr

Host lab/ Team : **IPGP Planétologie et Sciences Spatiales – UMR7154**

Financing: Doctoral contract with or without teaching assignment

For more information go to http://ed560.ipgp.fr, section: Offres de these (PhD offer), You must apply on the Doctoral School website

Presentation of the subject:

The strong, outermost portion of a planet is conventionally referred to as the lithosphere. When loads are emplaced on the lithosphere, such as in the form of volcanoes, magmatic intrusions, or plumes, the lithosphere flexes, with the amount of flexure being controlled by the lithospheric strength. The mass of the load and the associated lithospheric deflections give rise to both gravitational anomalies and topographic relief. By using planetary gravitational and topographic data, it is thus possible to place constraints on the thickness of the lithosphere and to determine how it varies laterally across the surface of a planet.

The thickness of the lithosphere is often quantified by the thickness of an equivalent elastic shell that overlies an inviscid fluid. The elastic thickness is an important quantity for understanding a planet as it is controlled by the planet's internal temperature profile at the time the load was emplaced. Given that the thermal evolution of a planet varies in both space and time, maps of the elastic thickness can be used to constain the evolution of the planet.

This Ph.D. topic aims to investigate the lithosphere of Venus and Mars using global gravity fields and topography determined by recent and historical spacecraft missions, and to interpret the results using recent thermal evolution models of these planets. Though such investigations were performed previously, this thesis will make several important new contributions.

First, this thesis will make use of modern multitaper spectral analysis techniques developed in spherical coordinates. By using these techniques (pioneered by M. Wieczorek and F. Simons) a substantial improvement over previous works that employed simple Cartesian Fourier analysis approaches is expected.

Second, this thesis will develop improved lithospheric loading models. Most previous models have made the simplifying assumption that the surface and subsurface loads were either perfectly in phase, or statistically uncorrelated. It is probable that reality lies between these two end-members, and this work will develop models that take into account the statistical correlation of the two loads. As part of this, the Cartesian approach of Simons and Olhede (2013) will be expanded upon and developed in spherical coordinates. It is anticipated that by taking into account the correlation of surface of subsurface loads, that previous contradictory conclusions drawn by several authors will be resolved.

Third, this work will make use of the most recent gravity and topography models of Venus and Mars. The gravity fields of both of these planets have been improved substantially since many of the initial works were published during the time of the Magellan and Mars Reconnaissance Orbiter missions. Higher resolution gravity models that are now available should allow for improved estimation of the elastic thickness.

Finally, the obtained elastic thickness estimates will be used to estimate the subsurface temperature profile and heat flow. These results will be compared with global thermal evolution models that take into account lateral variations in crustal heat production, crustal thickness, and the presence of mantle plumes.

It is expected that the thesis candidate will participate in the analysis and interpretation of data collected by the geophysical mission to Mars, InSight (M. Wieczorek and C. Michaut are co-investigators and collaborators, respectively).