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Influence of elastic lithosphere on the expected gravity signal from dynamic interior of Mercury

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Mercury is today the least known terrestrial planet of the Solar System – however in the upcoming decade there will be two missions dedicated to study this planet: MESSENGER (NASA) and BepiColombo (ESA). Since none of those missions includes a lander to enable a seismometer deployment, our only information about the interior structure will be indirect from gravity and geodetic measurements. We have focused on the question what information could be obtained from gravity/topographic inversion about the coupled dynamic system of a convecting lower mantle and the induced undulations of the core-mantle boundary (CMB). Because the elastic lithosphere of Mercury has presumably grown significantly in comparison to Earth or Venus, we had to develop – using the framework of internal loading theory – appropriate approach which combines a viscous mantle flow with a thick elastic membrane deformation. If one is able to remove the crustal gravity signal, the remaining geoid and topography anomalies can be then interpreted in terms of density distribution in the mantle and undulations of the CMB. However, today we have no global gravity and topography data of Mercury available to allow for such an inversion. Therefore, we have studied unit load response functions for up- and downwellings as well as inversions of the synthetic mantle convection gravity signature in the radially averaged approximation (Pauer et al., 2006). This provides us with some insight into the characteristics of the possible dynamically generated gravity signal. The information on the CMB shape from the proposed gravity analysis can be e.g. useful to answer the fundamental question whether the present heat transport in Mercury is by convection or conduction

and it can place additional constraints on the possibility of a thermoelectric dynamo (Stevenson, 1987).

Reference: Pauer et al. (2006), Modeling the dynamic component of the geoid and topography of Venus, J. Geophys. Res., 111, E11012. Stevenson (1987), Mercury's magnetic field: a thermoelectric dynamo? Earth Planet. Sci. Lett., 82, 114.