MERCURY TIDE PARAMETER ESTIMATION FROM LASER ALTIMETER RECORDS. O. J. Stenzel[1], I. Hall[1], M. Hilchenbach[1], [1] Max Planck Institute for Solar System Research, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany, stenzel@mps.mpg.de.

Introduction: Planet Mercury is subject to strong tidal forces due to its close, 3:2 resonance, orbit around the sun. The tidal displacements of the planetary surface are related to the internal mass distribution of the planetary interior and thus measurements of this displacements can be used to infer information about the interior structure. In our work we try to estimate the Love number h_2 using a model that has been used to estimate the Love numbers for the Moon [1].

Data and Methods: We use data from the MESSENGER Laser Altimeter (MLA) [2] after reprocessing the space craft's position and pointing, taking care of pointing aberration and relativistic effects. For comparison and to model the possible errors in finding the tidal parameters, we use simulated shot modulated by various error sources like offsets and statistical errors.

Current Progress: We are able to correctly derive h_2 from simulated laser altimeter measurements that are distributed as the MLA data (Fig. 1). Simulated shots experiments show that outliers in the input data set can offset h_2, depending on their frequency and magnitude. Gaussian noise is unproblematic when deriving h_2. The sensitivity to outliers poses a problem for the analysis of measured data. We use filtering techniques and train machine learning algorithms to find and eliminate outliers [3,4]. A difficulty with the MLA is the fact that it only covers the northern hemisphere. The equatorial region in which the tidal displacement is largest is only sparsely covered (Fig. 2). This is limiting the accuracy with which we can estimate h_2. The data availability will improve once BepiColombo [5] arrives in Mercury's orbit and its laser altimeter BELA [6] goes operational. We plan on using that data once it gets available [7].

Acknowledgments:

This work is supported by DLR under grant: 50QW1901. PDS data used in this work: Neumann G. (2016), urn:nasa:pds:mess_mla_calibrated::1.0, 10.17189/1518580

References: [1] Thor, R. N. et al. J Geod 95, 4 (2021). [2] Cavanaugh, J. F. et al. Space Sci Rev 131, 451–479 (2007). [3] Stenzel, O., et al., EGU21-14749, https://doi.org/10.5194/egusphere-egu21-14749, 2021. [4] Stenzel, O. and Hilchenbach, M. EPSC2021-688, https://doi.org/10.5194/epsc2021-688, 2021. [5] Benkhoff, J. et al. PSS 58, 2–20 (2010). [6] Thomas, N. et al. Space Sci Rev 217, 25 (2021). [7] Thor, R. N. et al. A&A 633, A85 (2020).

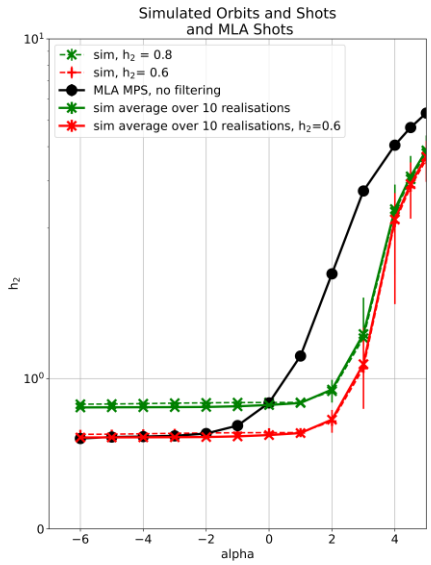

Figure 1: Love number h_2 for simulated and measured laser altimeter records on Mercury at different parameters for topography regularization. The simulations are based on two different tide regimes: one with a Love number h2=0.6 and one with h2=0.8. The tides are correctly recovered from the simulated data at lower, that means less rough, regularization. The MLA data is more sensitive to regularization than the simulated data.

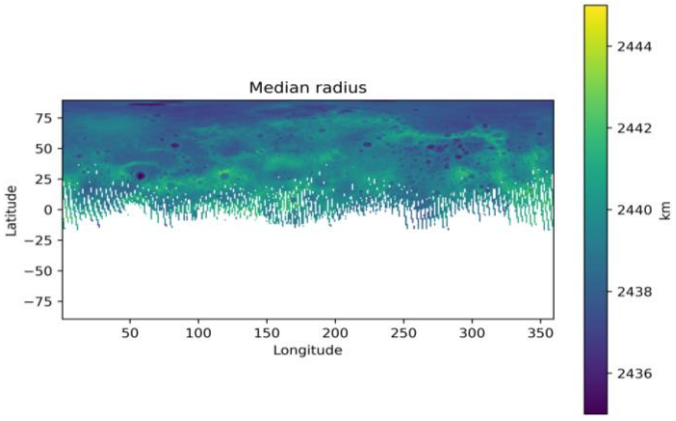

Figure 2: 1 deg grid topography modeled from the MESSENGER Laser Altimeter (MLA) data. The MLA measured mostly on the northern hemisphere.