Marsquake Service for InSight: methods to locate events in a 3D planet. S. C. Stähler[1], M. van Driel[1], J. Clinton[1], D. Giardini[1], A. Khan[1], S. Ceylan[1], M. Böse[1], J. Kemper[1], F. Munch[1], M. Afanasiev[1], M. Wieczorek[2], [1]Institute of Geophysics, ETH Zürich, Sonneggstr. 5, 8092 Zürich, Switzerland (staehler@erdw.ethz.ch, vandriel@erdw.ethz.ch), [2]Observatoire de la Côte d'Azur, PHC-S 6, Route de l'Observatoire, 06300 Nice, France.

Introduction: With the deployment of the SEIS seismometer package by the Insight lander on the surface of Mars, the Mars Quake Service (MQS) has started its work to detect, locate and catalogue Martian seismicity [1]. In preparation, a number of methods to locate seismic events based on polarization (azimuth) and travel time (distance) have been presented [2] and tested in a public blind test. However, both the location methods and synthetic data assumed a spherically symmetric planet [3, 4].

Methods: We computed a synthetic data set in a 3D Mars model including ellipticity, topography, crustal thickness and lateral velocity variations in the crust. This test revealed, that 1D is likely a good approximation for body wave and long period surface waves (T < 80s) travel times, but travel times can be off by as much as a few hundred seconds for shorter period surface waves (50s < T < 15s) with the crustal thickness being the most relevant source of error. For events that only produce a single body wave phase additional to the surface waves, this translates into a significant error in the distance estimation.

Results: In this presentation we argue how we can mitigate this problem by adding a 3D crust on top of the 1D models that fits the gravity data [5] and hence approximate the crustal thickness, how to efficiently compute surface wave travel times for these models and demonstrate the efficacy of this approach in a 3D blind test.

Furthermore, we show how we select a reasonable number of models for probabilistic location methods from a very large set of a priori models based on a clustering technique and how this selection can be updated as the number of events grows.

References:

[1] Clinton, J. et al. *Space Sci. Rev.* 214, 133 (2018). [2] Böse (2016), M. et al. *Phys. Earth Planet. Inter.* 262, 48–65. [3] Ceylan, S. et al. *Space Sci. Rev.* 211, 595–610 (2017). [4] van Driel, *Solid Earth* 6, 701–717 (2015). [5] Wieczorek, M. A. et al. *Science* (80-.). 339, 671–675 (2013). [6] Afanasiev et al. (2018) *Geophys. J. Int.*

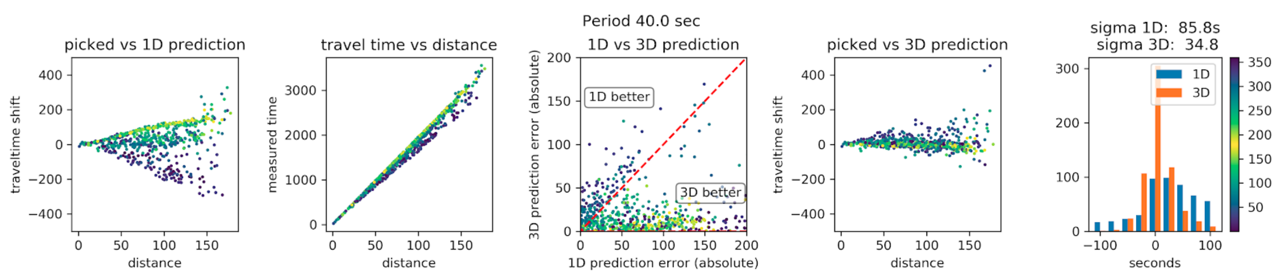

Figure 1: To test the 3D crustal corrections, a full 3D planet model was created, which included Moho topography and 10% random velocity perturbation in the crust. In this model, seismic waves were propagated using Salvus [6]. Rayleigh wave arrivals were picked and compared with predicted arrival times. It can be seen that the effect of crustal thickness variations is significantly mitigated by our strategy.