DI41A-06 - The Mars Structure Service for InSight:Single-Station Marsquake Inversions for Structure

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Abstract

The SEIS seismometer package was successfully deployed on Mars by February 2019. Routine operations are split into two services: the Mars Structure Service (MSS) and the Marsquake Service (MQS), which are responsible for defining interior structure models and seismicity catalogs, respectively. Initial model delivery from MSS is based on a limited dataset of two Marsquakes with a clear P and S arrivals.

Different inversion algorithms were developed by the MSS team in order to retrieve the first 1D averaged model of Mars. Two complementary approaches are considered. One set of models (called M1) is parameterized in seismic velocity and density as a function of depth. A second set of models (called M2) is obtained by parameterizing with geodynamical constraints like temperature and composition. We use Bayesian inversion techniques to obtain robust probability density functions of seismic velocity profiles. Different types of data are considered for these inversions including body waves, surface waves and receiver functions. To characterize what we could learn about Mars' interior structure with only one station and with the first seismic event, we performed inversions of synthetic data following a blind test process, where the interior model and the Marsquake parameters (location, depth, origin time, and moment tensor) were unknown to all team members carrying out data analysis and inversion.

In this presentation we will discuss the results of this blind test in terms of structure and compare different methods developed by the MSS. We will then show results from investigations of the first, real seismic data due to quakes on Mars recorded by SEIS in terms of the structure and quake locations. We will especially focus our investigation on joint inversions made not only with the arrival time, but also with secondary seismic data extracted from the detected events, including apparent attenuation rate and with receiver functions. Of course, much more detailed analysis will be made if Mars seismicity provide us in the near future larger quakes with body wave phases and first orbit surface wave dispersion, and/or one event large enough to record multiple orbit surface waves, and will augment future interiors models of Mars.

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