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BUILDING MARTIAN SEISMOGRAMS FROM CALIFORNIA AND NEVADA SEISMIC EVENTS: Inversion of the Californian crust using InSight Mars Structure Service routines

Alice Jacob (1), Mélanie Drilleau (1), Taichi Kawamura (1), Philippe Lognonné (1), Perrin Clément (1), Menina Sabrina (1), John Clinton (2), Éric Beucler (3), Nobuaki Fuji (1), and Eléonore Stutzmann (1)

(1) Institut de Physique du Globe de Paris, France, (2) Institut für Geophysik ETH, Zürich, Switzerland, (3) Laboratoire de Planétologie et Géodynamique LPG, Nantes, France

Successfully landed on Mars on past November 26th 2018, the NASA's Discovery Interior Exploration using Seismic Investigations, Geodesy and Heat Transport (InSight) mission is dedicated to the study of the Martian interior. The main instrument, the Seismic Experiment for Interior Structure (SEIS) seismometer is designed to record the Martian seismic activity from different seismic sources: atmospheric turbulences, meteorite impacts and tectonics/thermal contraction.
The understanding of the seismic source characteristics is mandatory to constrain the deep interior of the planet. Since SEIS will be the lonely seismometer at the surface of Mars, the inversion approaches are different from what is performed on Earth, where the large seismic networks allow robust triangulation methods. Therefore, the greater uncertainties on Mars, and the non-linearity of the problem (single station), imply the use of probabilistic inversion process such as Markov chains Monte Carlo (McMC) methods. In order to efficiently process the incoming SEIS data, Routine operations are split into two services: the Mars Structure Service (MSS) and the Marsquake Service (MQS), which are responsible for defining structure models and seismicity catalogs, respectively. These 2 services are developing tools to estimate the seismic properties of Mars, i.e. the epicentral distance, the depth and origin time of the seismic event, and the seismic velocity profiles as a function of depth.
Pending for the first Martian seismic records, we propose to use transformed Earth data, such as California large earthquakes and Nevada nuclear events. The dataset stands for faulting activity and meteorite impacts sources respectively. To mimic real Martian record, three processing are made on these raw data. First, an amplitude scaling is made to set the quake magnitude. Second, a frequency shift is realized to amplify the energy at high frequency. Third and finally, the modeled Martian seismic noise is added to the waveforms. This noise relies on pre-landing estimates of noise generated by the sensors, electronic system, environment, and nearby lander.
The arrival times of body waves and surface waves are then extracted from the 'Martian seismograms' and implemented in the MSS inversion algorithms. We finally compare the resulting inverted crustal model to the previously published regional models of California.