DECORRELATION OF PRESSURE SIGNALS ON SEIS RECORDS AND GROUND COMPLIANCE ESTIMATES. T. Kawamura[1], R. F. Garcia[2], B. Kenda[1], P. Lognonné[1], T. W. Pike[3], B. Barnerdt[4], D. Banfield[5], M. van Driel[6], M. Drilleau[1], A. Horleston[7], R. Myhill[7], N. Murdoch[2], J. A. Rodoriguez Manfredi[8], M. Schimmel[9], A, Spiga[10], E. Stutzmann[1], N. A. Teanby[7], D. Viúdez-Moreiras[8], J. Wookey[7], [1]Institut de Physique du Globe de Paris (35 rue Hélène Brion, 75205 Paris, France CEDEX13; kawamura@ipgp.fr), [2]ISAE-SUPAERO (10, ave E. Belin, 31400 Toulouse, France; Raphael.GARCIA@isae-supaero.fr), [3]Imperial College London, [4]Jet Propulsion Laboratory, California Institute of Technology, [5]Cornell University, [6]ETH Zurich, [7]University of Bristol, [8]Centro de Astrobiología, [9] Institut de Ciences de la Terra Jaume Almera, [10]LMD - Sorbonne Université
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Introduction: Mars atmospheric pressure variations induce ground deformations that are the main source of environmental noise on the InSight SEIS instrument. Phenomena generating pressure variations, such as meteorological wavefronts, gravity waves, convective vortices and small-scale turbulence are covering the whole frequency range of SEIS broadband seismometers. These signals impact the capability of SEIS sensors to detect seismic waves propagating in Mars interior. However, the relation between pressure variations measured by InSight pressure sensor and ground movements measured by SEIS being essentially linear, it is possible to invert both signals to find the transfer function between pressure and ground motion. Then, pressure generated ground movements can be substracted from SEIS records in order to improve their sensitivity to seismic waves.

The transfer function, usually called compliance, depends on the ground properties. Thus, the decorrelation of SEIS records from pressure effects also allows us to constrain the sub-surface properties at InSight location.

Outline of the study: Our study compares two different pressure decorrelation methods applied to Mars synthetic data, and records by both short period and very broadband SEIS sensors. The pressure-decorrelation methods are presented and their differences in terms of underlying assumptions and implementations are explained. Their performances and drawbacks, analyzed on realistic synthetic datasets, are discussed. We plan to apply these methods to real Mars data and use them to retrieve the ground compliance at the InSight landing site over a broad frequency range. Accordingly, we expect to extract elastic properties of the subsurface through the compliance measurements. Wind measurements by the TWINS sensors will be integrated in order to separate the effects of various atmospheric phenomena. Finally, the variations with the diurnal Mars cycle are analyzed.

Theory and Prediction: Theoretical back ground of seismic noise induced by pressure fluctuation was made by Sorrells [1] and Sorrells et al. [2]. They introduce a simple relation between the pressure fluctuation, wind speed and resulting seismic noise.

$$V = -i\frac{c}{\rho}\frac{v_p^2}{2v_s^2\left(v_p^2 - v_s^2\right)}P$$

where V is the ground velocity excited by the pressure fluctuation P and the background wind velocity c. v_p, v_s and ρ represents the P and S velocity of the ground and its density respectively. Thus the equation shows that the ground reacts to pressure fluctuation depending on its elastic properties.

Murdoch et al. [3] and Kenda et al. [4] used the theory and results from high resolution Mars Large Eddy Simulation[5] to evaluate the possible pressure noise that will be observed by InSight and tested their decorrelation method. Murdoch et al used both Green's function approach and the Sorrells' approach to evaluate the seismic noise. They predicted that the pressure noise on Mars to be ~20-40nm/s^2 for the horizontal axes and 0.1-6nm/s^2 for vertical axes.

They also performed a noise decorrelation using optimized FIR filters. They took a part of the trace to tune the FIR filter that best describes the transfer function between the pressure fluctuation and use this to evaluate the seismic noise excited by a given pressure fluctuation. They showed that the signal to noise ratio can be improved by a factor of 5 at 0.001–0.05 Hz bandwidth where pressure noise dominates in the seismic records. Another approach was devolopped based on continuous estimation of a FIR filter by LMS method.

We the two aprroaches will be applied to theInSight data and the noise improvement of SEIS instruments will be described.

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