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Pressure effects on SEIS-INSIGHT instrument, improvement of seismic records and characterization of gravity waves from ground displacements

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Mars atmospheric pressure variations induce ground displacements through elastic deformations. The various sensors of INSIGHT mission were designed in order to be able to understand and correct these ground deformations induced by atmospheric effects. Particular efforts were done on one side to avoid direct pressure and wind effects on the seismometer, and on the other side to have a high performance pressure sensor operating in the same frequency range than the seismometer.

As a consequence of the high performances of both instruments, their very efficient protection systems against direct atmospheric disturbances, and the low Mars background seismic noise, INSIGHT mission is opening a new science domain for which the ground displacements can be used to perform atmospheric science.

This study presents an analysis of pressure and seismic signals and their relations. After a short description of the pressure and seismic sensors deployed by INSIGHT, we present an analysis of these signals as a function of local time at INSIGHT location.

Then, the background and event like coherent signals between Pressure and seismometer sensors are interpreted in terms of various atmospheric excitations and induced ground deformation processes. Different methods to remove the pressure effects recorded by SEIS sensors are presented, and their efficiency is estimated. Finally, we demonstrate that the pressure and ground deformations measurements can be used to decipher between various atmospheric excitation types (meteorological pressure variations, acoustic and gravity waves) and characterize these. Effects of the local sub-surface structure are also suggested by the data analysis.