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Introduction: The InSight (Interior Exploration using Seismic Investigations, Geodesy and Heat Transport) lander is providing an unprecedented set of high frequency records of ground deformations, pressure and wind at the surface of Mars [1]. We explore this data set in order to search for infrasound signals. To do so, we use the expected ground deformations induced by acoustic waves [2,3] to target such signals simultaneously observed on SEIS and pressure records.

Dataset: The data used in this study are ground velocity records from SEIS-VBB sensors, pressure and wind speed and direction from APSS sensors. Only periods during which these sensors are operating at high rate (20 sps for VBB, 10 sps for Pressure and 0.5 sps for wind) are considered, covering the InSight sol range 183-580. The data are filtered in three different frequency bands 0.4-0.8 Hz, 0.8-1.6 Hz and 1.6-3.2 Hz

A priori constraints and methods: The ground deformations induced by atmospheric pressure perturbations moving at wind speed have been previously investigated [4,5]. These investigations allowed to estimate the vertical compliance (ratio of ground vertical velocity to pressure) as in the 0.02-0.8 Hz range. This information is used to predict the compliance of acoustic waves in the 0.4-3.2 Hz range, thus constraining the expected amplitudes of ground velocity for an acoustic pressure perturbation. Our search focus on acoustic waves propagating horizontally through the compliance effects expected for such phenomena. We first detect all compliance events by a previously used method [5]. Then, only the events with compliance values around the one predicted for acoustic waves are selected.

A careful selection to avoid various types of other signals: The data processing and selection presented above allow to restrict the potential infrasound candidates to 3536 compliance events. In order to reduce the contamination by wind signals [5], we use the fact that the phase relation between signals along vertical and horizontal components of SEIS for this noise source is known and stable. This phase (close to 170°) is different from the one expected from compliance effects (90°). We thus apply more stringent selection of the data enforcing that the phase relation between SEIS components is close to the one expected for acoustic compliance events. In order to better decipher between usual pressure perturbations moving at wind speed and acoustic waves, and to reduce wind noise, we kept only the compliance events during which the wind speed is lower than 6 m/s. In that way the expected vertical compliance for pressure perturbation is much lower than the one for acoustic waves allowing a clearer selection of events based on observed vertical compliance values. After these two additional selection criteria only 32 compliance events are remaining from the automated process. These events are visually selected to remove remaining SEIS glitch signals, wrong estimates of vertical compliance in the automated process, and potential wind signals.

Results: The overall selection process allowed to identify 4 potential infrasound candidates, two in the 0.4-0.8Hz range and two in the 0.8-1.6Hz range. An example of such a dtection is presented in Fig. 1. All these candidates, as well as many others discarded due to larger winds, are associated to a pressure drop in InSight data. These pressure drops being due to convective vortices, we investigate the hypothesis that the infrasounds could have been generated by the convective vortices. To do so, the back azimuth of the polarization of SEIS signals is compared to the azimuth direction of the vortex center at the time of the infrasound detection. Other observations, such as the frequency content of potential infrasound signals, are also used to try to demonstrate this link between infrasounds and convective vortices.

Conclusion and future work: This hunt of infrasound signals is using already known ground response to pressure perturbations moving with winds, and physical models of ground response to acoustic waves, in order to detect compliance events ascribed to horizontally propagating acoustic waves. A drastic selection of these events is performed to avoid various potential noise sources. All the potential infrasound candidates are associated to the pass of a convective vortex. We use a simple model of infrasound production by a vortex to test the hypothesis of such phenomena relative to observed quantities.

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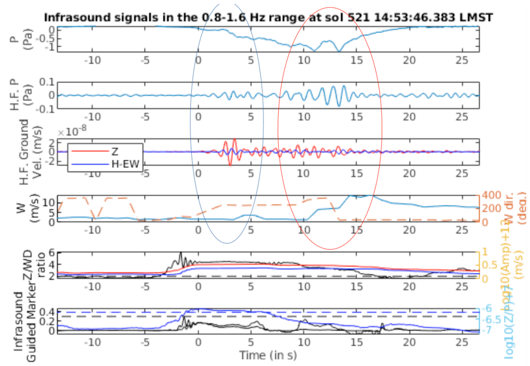

Fig. 1: Example of infrasound candidate signals (circled in blue). From top to bottom, pressure record high pass filtered above 0.005 Hz; pressure record band-pass filtered in the 0.8-1.6 Hz range; vertical (in red) and East (in blue) components of ground velocity band-pass filtered in the 0.8-1.6 Hz range; wind direction (brown dashed curve) and speed (blue curve); vertical over East component amplitude ratio (in black) and vertical (in red) and East (in blue) amplitudes in logarithmic scale; compliance marker (in black) as defined in [4] and vertical compliance (in light blue). Blue ellipse indicate the potential infrasound signals detected by the method, whereas red ellipse is indicating potential contamination of both SEIS and pressure measurements by wind because wind speed is increasing at that time