Seasonal variations of sub-surface seismic velocities observed by the SEIS-InSight seismometer on Mars

N. Compaire, L. Margerin, M. Monnereau, R. F. Garcia, L. Lange, M. Calvet, S. C. Stähler, N. L. Dahmen, N. Mueller, P. Lognonné, M. Grott, T. Spohn, W. B. Banerdt

AGU FALL MEETING

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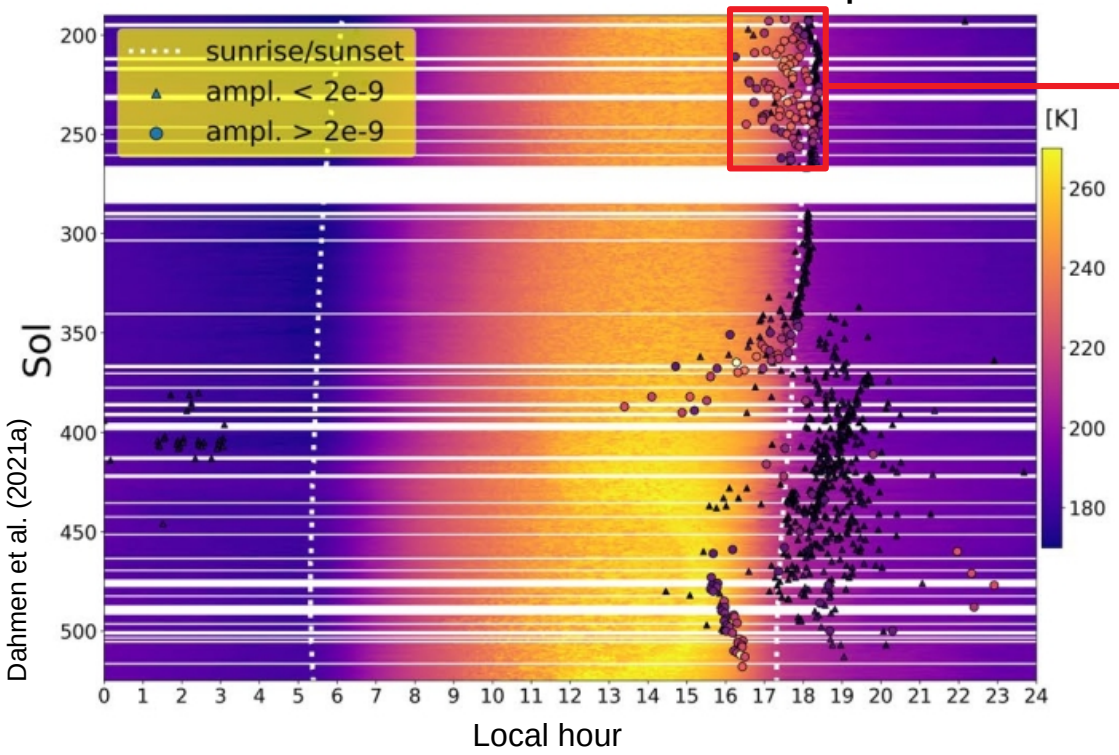
CONTEXT AND MOTIVATION

Previous studies succeed to apply seismic interferometry methods to InSight-SEIS data on Mars for crustal Imaging applications (*Suemoto et al., 2020; Deng & Levander, 2020; Compaire et al., 2021a; Schimmel et al., 2021; Knapmeyer-Endrun et al., 2021*).

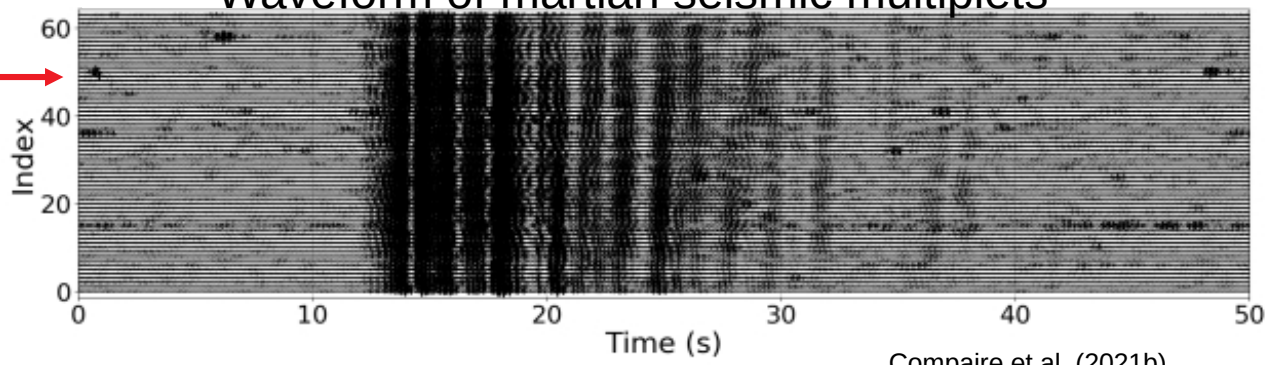
A continuous monitoring of the seismic velocities on Mars using the seismic ambient noise is motivated by the detection of thermally induced high frequency seismic multiplets (Dahmen et al., 2021a) presenting a strong stretching of their waveforms across the mission time-line.

Distribution of the seismic multiplets



Dahmen et al. (2021a)

Waveform of martian seismic multiplets



Compaire et al. (2021b)

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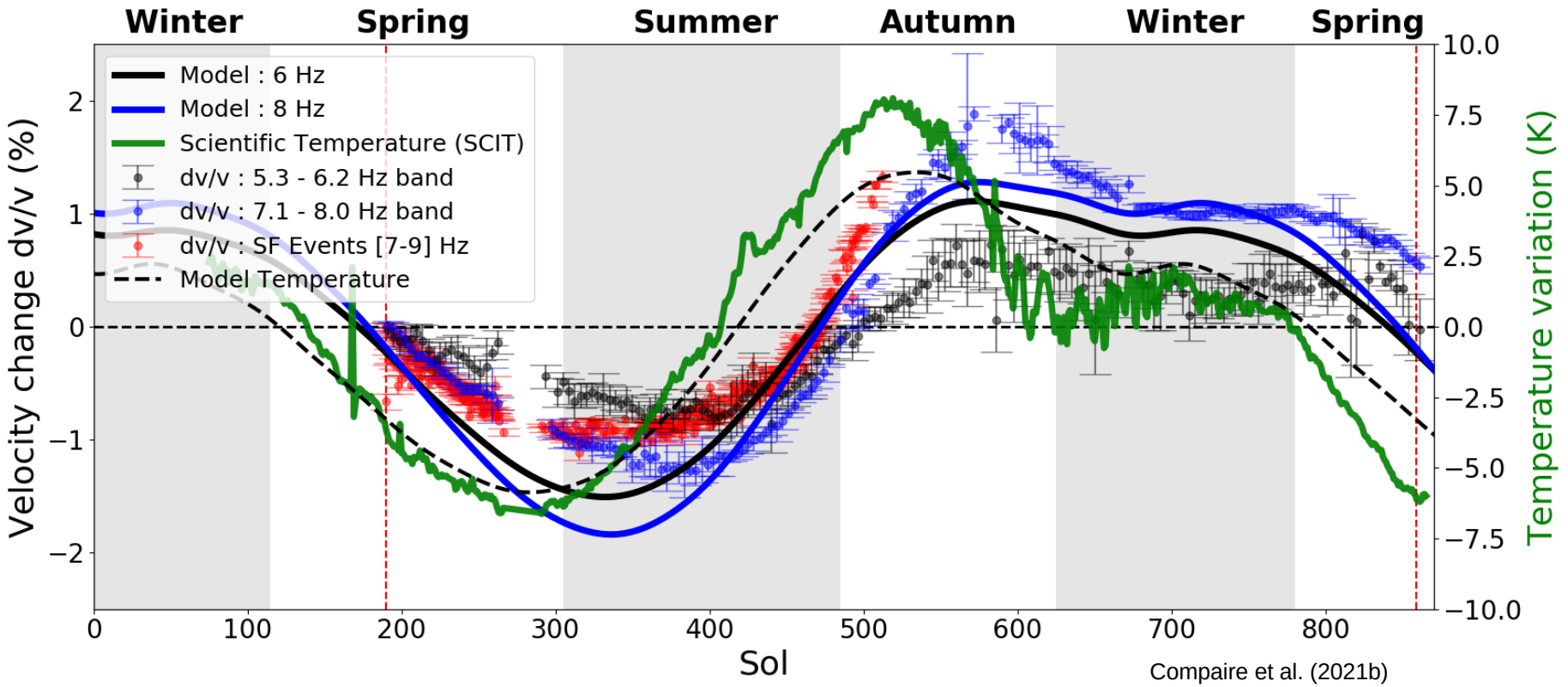
KEY RESULTS

Using Coda Wave Interferometry in the seismic multiplets and a frequency-based approach of Passive Image Interferometry in the ambient seismic noise we detect a strong seasonal variation of the seismic velocities, consistent between the two datasets. We can model these variations as a **thermoelastic response of the martian regolith** due to changes in the thermal forcing by the Sun. The model reproduce quite well the **positive correlation** and the time-delay with the surface temperature as well as the high amplitude of the velocity perturbation.



Compaire et al. (2021b)

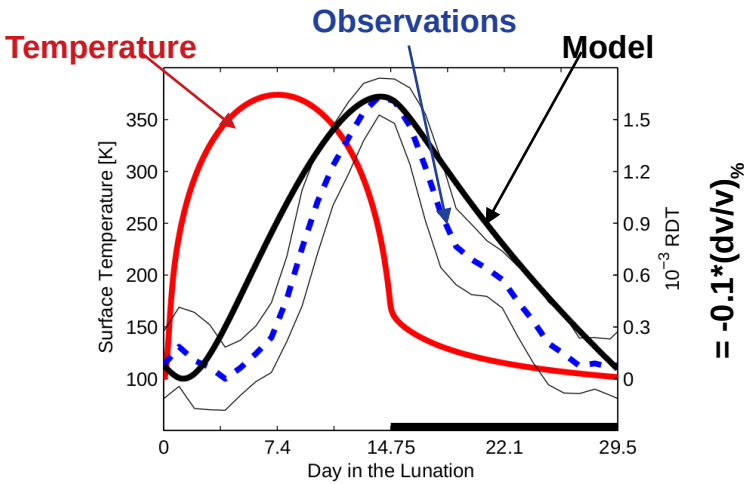
DISCUSSION

Interest for the InSight mission

- This observation provides a link between the thermal and elastic properties of the martian subsurface under InSight and opens the way to a joint inversion of the velocity and thermal conductivity profiles,
- Our model also allows us to put some constraints on the nature of the seismic ambient noise recorded at InSight.

Comparison with the Moon

- *Sens-Schönfelder and Larose (2008)* observed a clear **anti-correlation** between the surface temperature on the Moon and apparent velocity changes of the order of 0.1-0.2%,
- To explain their observations they invoke the temperature dependence of elastic moduli,
- On Mars, this effect is expected to affect only marginally the seismic properties of the martian regolith (perturbations of the order of 0.01-0.02%),
- The contrasting observations between Mars and Moon is important topic for future investigation on the mechanical properties of extraterrestrial regoliths.



(Sens-Schönfelder and Larose, 2008)

Contact information : nicolas.compaire@hotmail.fr