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Detection of hydration spectral signatures with IRS/SuperCam, Perseverance rover: instrument performance

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The Perseverance rover (Mars 2020 mission, NASA) is exploring the mineral diversity of the paleolake within Jezero crater and is searching for potential biosignatures and past habitability evidence. Amongst its science payload, the SuperCam instrument (LANL/USA and IRAP/France) plays a central role in the Mars habitability investigation by providing rapid, synergistic, fine-scale mineralogy, chemistry, and color imaging [1, 2]. In particular, it carries the first near-infrared spectrometer, IRS, to be operated on the Martian surface. IRS is a miniaturized point spectrometer (1.15 mrad field of view) located in the SuperCam's mast unit. Its spectral range (1.3 – 2.6 µm range) covers major silicate, salts and hydrated mineral absorption features [3].

Mineral identifications are performed by analyzing the position and shape of diagnostic absorption bands. The determination of the abundances of mixed constituents requires also a good knowledge of the absolute reflectance value. The actual status of the calibration, released in the NASA's Planetary Data System (Nov. 2021), relies on the observation of the IR White SuperCam Calibration Target (SCCT) [4] as a reflectance reference, and various algorithms to remove anomalous spectral points, atmospheric spectral signatures and to filter the noise, increasing the global signal to noise ratio (SNR). Finally, data are converted into reflectance using a local illumination model.

After about 350 Sols of exploration of the two geologic units Cf-fr and Seitah (up to Feb. 2022), many spectral features attributed to various primary and altered minerals, and salts have been identified in the near-IR range [5, 6]. The detection limit of these spectral signatures is constrained by the calibration of the instrument's sensitivity to environmental parameters, especially the variation of its transmission with the temperature of its subsystems.

We present here the performance of the instrument in terms of sensitivity and detection of hydrated minerals, in the frame of the quantification of their abundance.

References

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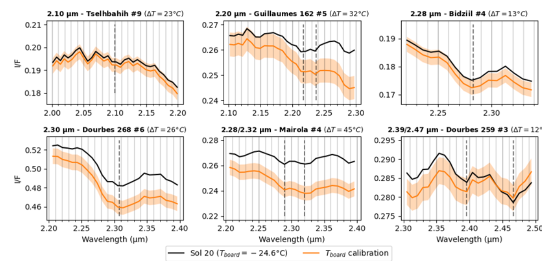

Fig. 1: Comparison of the shape of spectral signatures detected in the 2.1 – 2.5 µm range as a function of calibration method. The black line corresponds to the basic calibration, based only one reference observation (on Sol 20), published on NASA PDS so far. The orange line is the thermal calibration taking into account the sensitivity of the instrument to the temperature of its electronical board (T_{board}). The light orange background represents the standard deviation of the calibration's continuum (corresponding to a constant offset or slope).