Hyperspectral detection of optical grain size variations over ice megadunes on Mars

Clemence Herny, Marion Massé, Olivier Bourgeois, Sabrina Carpy, Stéphane Le Mouélic
LPGN, France

Complex interactions between the persistent katabatic winds and the ice surface play a major role in the redistribution processes, ice metamorphism and surface mass balance of ice sheets. These interactions drive the dynamics of ice megadunes. Radar stratigraphic soundings reveal an asymmetry in the net accumulation on megadunes. This long-term pattern involves that megadunes crest move upwind as they build up. Megadunes display an enhanced ice accumulation on the upwind side and a reduced ice accumulation or a net ice ablation on the downwind side. The prolonged exposure of ice on the downwind side induces metamorphism by sublimation. Differences in ice grain size, due to metamorphism, can be detected by spectral analysis. The downwind side is characterized by glazed-surfaces and a larger average optical grain size, while the upwind side is characterized by an average smaller optical grain size.

This redistribution pattern of ice has been detected and mapped by multispectral remote sensor data over the whole megadunes fields in Antarctica where megadunes were first described. Terrestrial atmospheric high water vapor content is an issue for spectral analysis. The Martian atmosphere is rich in CO₂ and poor in H₂O. In this study we used hyperspectral remotely-sensed data over ice megadunes on the North Polar Cap of Mars. The 1.25 μm water ice absorption band is deeper on the downwind side than on the upwind side. The observed spectral variations on Martian megadunes attest of the larger optical grain size of ice on the downwind side than on the upwind side. The similarities observed between Terrestrial and Martian megadunes support a common formation and dynamics process.