Geophysical Research Abstracts
Vol. 17, EGU2015-10217, 2015
EGU General Assembly 2015

Sedimentation waves formed by katabatic winds on the North Polar Cap of Mars

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Complex feedbacks between katabatic winds and the cryosphere may lead to the development of sedimentation waves at the surface of ice sheets. These have been first described, and named snow megadunes, in Antarctica. Complementary investigations of topographic data, optical images, spectroscopic data and stratigraphic radar soundings reveal that these sedimentation waves generally migrate upwind in response to enhanced accumulation on their upwind sides and reduced (or net ablation) on their downwind sides.

On Mars, the North Polar Cap exhibits two wavelengths of such sedimentations waves. (1) The larger ones are several tens of kilometers in wavelength and several hundreds of meters in amplitude. These large bedforms confer a stunning spiral-shaped topography to the NPC. They have been interpreted as cyclic steps systems associated with katabatic jumps. (2) The smaller ones are tens of kilometers in wavelength and several tens of meters in amplitude. They are superimposed on the larger ones and are probable Martian equivalents of terrestrial snow megadunes. These specific bedforms have morphologic, stratigraphic and dynamic similarities with underwater sedimentary antidunes.

Sedimentation waves on Earth and Mars result from the interaction between katabatic winds and the redistribution of ice at the surface of the NPC. Ice sublimation and condensation play an important role in the development of sedimentation waves on the NPC, due to the low atmospheric pressure, low temperature and low water vapor content at the surface of Mars. We are currently developing a numerical model based on the coupled implementation of fluid dynamics and H_2O mass transfer by sublimation and condensation. The model is designed to explore the implication of the interaction between katabatic winds and water vapor diffusion/transport on the development of sedimentation waves on Mars and could be extrapolated to Antarctic conditions.