Morphological and physical interpretations of cold dunes on Louth Crater ice cap, Mars. S. Carpy[1], A. Collet[1], M. Massé[1], O. Bourgeois[1], M. Bordiec[1]. [1]LPG, Nantes Université-CNRS (sabrina.carpy@univ-nantes.fr).

Introduction: Louth Crater has a perennial ice cap that undergoes phase changes (condensation /sublimation cycles) during the Martian year. The characterization of cold dunes on this perennial cap could make it possible to specify environmental conditions favorable to their formation. The first part of the study consists of identifying these cold dunes using imaging and orbital topography data, and then associating these results with the scaling laws inherent to the formation of sublimation and condensation waves.

Morphological analysis:

Methods. HRSC imagery at ~10m/pixel and CTX imagery at ~6m/pixel, have been coupled with more precise areas of up to 25cm/pixel for HiRISE images. These are complemented by topographic data: digital elevation model (DEM) ~100m/pixel and MOLA elevation data ~128m/pixel. Data were georeferenced in ESRI's ArcMap GIS software to produce morphological map and analyzed to evaluate cold dunes shape and spatial organization.

Observations. Fresh ice overlies an older, stratified structure (Fig 1.a). This fresh ice is distributed in a non-uniform manner as shown by the kilometrics waves on which are superimposed metrics waves which are both perpendicular to the prevailing wind ((Fig 1.b). The main wind direction was assessed from the barkhane field on the sand mound (Fig. 1.c).

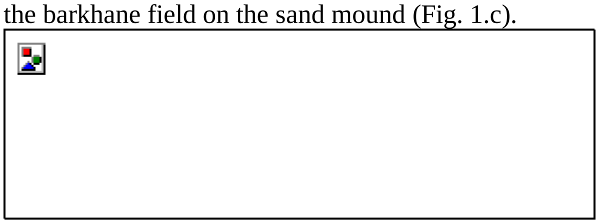

Fig. 1: (a) upper and lower ice cap (b) two wavelengths of cold dunes (c) Mound of sand with barchans.

Scaling laws : In a recent theoretical model [1] we explain the origin and formation of sublimation waves that can be observed on Earth, in ice caves or on Mars. These waves are periodic and oriented with respect to a turbulent boundary layer flow that transports the sublimated vapor without grain transport. Flow thickness is higher than the wavelength size. The modelling allowed the derivation of scaling laws that relate the morphological (wavelength λ) and kinematic (migration velocity v and growth time t_c) characteristics of transverse linear waves to those of their formation environment (viscosity ν, friction velocity u_*, ablation rate q_0/ρ_s). These laws, which are superimposed on the data from the natural examples studied, make these ripples suitable geomorphological markers for various predictions. This model has been adapted to study similar waves created by condensation [2] and results indicate that condensation waves would be larger than sublimation waves.

Discussion: From the scaling laws we obtained in the condensation case, we extract values of friction velocity and flow velocity at a given altitude that can be compared with those extracted from the Martian Data Base over two Martian periods: a period of sublimation (during the summer in the northern hemisphere) and a period of condensation at the end of the summer, beginning of the autumn. The Martian Data Base values are in the same order of magnitude but larger than those we estimate from the model. This can be explained by the gridding of the database which takes place on a global scale larger than the crater. A finer resolution of this geometry would therefore be useful, particularly through the use of mesoscale models.

Conclusion: The observations indicate large bedforms on the ice cap of Louth Crater, on which smaller bedforms appear with an order of magnitude in between: a decametric scale and a kilometric scale. Comparison with numerical results suggests that the larger bedforms are formed by condensation and the smaller ones by sublimation. These condensation and sublimation waves can then be used to validate mesoscale models in small, complex regions such as this type of crater, where topographic and/or seasonal effects can affect climate data. These waves can also be used as geomarkers on other planetary bodies where climatic conditions are not well constrained.

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References: [1] Bordiec M. et al. (2020) *Earth-Science Reviews*, *211*, 103350. [2] Carpy S. et al. (2022). EGU, Abstract #5998.