MORPHOMETRY OF PALEO-DUNES ON NOCTIS LABYRINTHUS SLOPES FROM CASSIS DIGITAL TERRAIN MODELS.  P.-A. Tessoni1, D. Mége1, J. Kozakiewicz2, S. Douet3, M. Pilarska-Mazurek4, K. Choromański1, M. Jozefowicz2, C. Re4, E. Simioni6, G. Cremonese6, and N. Thomas7. 1Centrum Badan Kosmicznych Polskiej Akademii Nauk, Bartycka 18A, 00-716 Warsaw, Poland (pt@cbk.pan.wroc.pl).  2Faculty of Physics, Astronomy, and Applied Computer Science, Jagiellonian University, Krakow, Poland. 3Université Grenoble Alpes, CNRS, Institut de Planétologie et d’Astrophysique de Grenoble (IPAG), Grenoble, France. 4Warsaw University of Technology, Faculty of Geodesy and Cartography Warsaw, Poland. 5ABM Space Sp. z o.o., Toruń, Poland. 6INAF-Astronomical Observatory Padova, Padova, Italy. 7University of Bern, Physikalisches Institut, Space Research and Planetology Division, Bern, Switzerland.

Introduction: The eastern part of the Noctis Labyrinthus (NL) system (Fig. 1) displays 100 m wide aeolian bedforms (Fig. 2,3 – [1]) covering the slopes surrounding plateaus and mesas. These features are well visible on CTX images. They are associated with layered deposits interpreted as pyroclastic [1].

High-resolution Digital Terrain Models (DTMs) are necessary to characterize them and retrieve information from their morphology (e.g., paleo-wind direction). Stereo-derived DTMs from HiRISE, based on individual image resolution 0.25-1 m, [2] are ideal, but cannot be used in many sites since very high-resolution results in low coverage. The CaSSIS instrument, onboard ExoMars TGO [3], offers native stereo capability [4] with individual image resolution 4.5 m. Here we investigate whether CaSSIS DTM quality and resolution is sufficient to make this dataset suitable to study aeolian bedforms as well [4].

Datasets and Methods: Three CaSSIS DTMs were produced following the method described in [4, 5]. Selected DTMs were further refined using photoclinometry methods [6]. A HiRISE DTM was also generated using Ames Stereo Pipeline [7] from a stereo-pair located in the same area. Both DTM types show similar aeolian bedforms (Fig. 1). Because they are located on a slope, we performed back-stripping filtering [8] to remove the signal from the slope and isolate topographic changes induced by the bedforms alone. Paleo-wind directions were inferred, where possible, from elevation profiles and stoss-side/lee-side identification. Bedform width was measured on the orthoimages, and heights on the DTM.

Results: Aeolian bedforms found on NL slopes are frequently covered by light-toned material. This material is more frequently observed upslope and displays deltoid-like features (Fig. 2). Downslope, the bedform-like features are exposed and their surface is densely cratered. Transverse Aeolian Ridges (TARs) are found at the foot of the slopes, on topographic lows formed by the bedforms (Fig. 2).

Aeolian bedforms vary in shape and scale. Elevation profiles derived from DTMs reveal asymmetric slopes (Fig. 3). Spacing on C1, C2 and C3 is on average lower (159 ± 54 m) than on the HiRISE image (253 ± 26 m). Bedform height and width is on average lower on CaSSIS DTMs (1.5 ± 0.9 m and 146 ± 48 m, respectively) than on the HiRISE DTM (9.4 ± 1.2 m and 210 ± 46 m, respectively). The statistical trend between bedform height and width of bedforms is the same in the areas covered by the three CaSSIS DTMs; whereas the bedforms on HiRISE follow a different trend (Fig. 4). On C1 and C2, the bedforms display a flat-top with a sharper lee side compared to those visible on C3, which appear smoother (Fig. 3). On the HiRISE DTM, bedforms have a similar profile to C1 and C2 ones, but...
the top of the bedforms display secondary features which corresponds to yardang-like features on the HiRISE image (Fig. 3).

Discussion: Elevation profiles show lee-side/stoss-side asymmetric profiles. On the CaSSIS DTMs, paleo-wind direction indicates downslope transport, whereas transport is upslope on the HiRISE DTM. Cratering density suggests that these bedforms are dunes which are not active anymore. In addition, small-scale erosional features of the dunes visible on the HiRISE image (Fig. 3) indicate enough rock strength to sustain abrasion. Dune strengthening might result from consolidation of volcanic tuff having sand granulometry that accumulated on the surrounding plateaus and was transported downslope [1]. Variations in the height-to-width ratio may result from variations in thickness of the mobilized layer. Grain cementation might result from groundwater flow and mineralization, similar to eroded paleo-dunes in Valles Marineris [8] and in agreement with hydrogeological interpretations in NL [9]. The light-toned material partly covering the slopes (Fig. 2) is morphologically similar to pyroclastic material found in Syria and Daedalia Plana [10], and could correspond to sand-granulometry airfall volcanics transported to the dunes after mineralization occurred.

Figure 3. Relationship between bedform height and width. Bottom: CaSSIS. Top: HiRISE.

Conclusion: The NL slopes display indurated paleo-dunes. At least two types of paleo-dunes are identified, based on morphological characteristics and corresponding to two distinct emplacement modes, with transport dominantly upslope or downslope. Resolution and coverage of stereo-derived CaSSIS DTMs make them suitable to study aeolian bedform accurately enough to retrieve subtle slope variations and interpret e.g. paleo-wind direction.

Acknowledgments: This work was funded by the EXOMHYDR project, carried out within the TEAM program of the Foundation for Polish Science co-financed by the European Union under the European Regional Development Fund.