MARS, WIND AND ICE: SEASONAL PROCESSES AND THE EFFECTS ON POLAR DUNE MIGRATION AT SCANDIA CAVI.

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Introduction: The action of the wind is one of the dominant processes shaping the surface of Mars today. At the poles sand transport occurs inversely with seasonal CO_2 ice processes. The north pole of Mars is home to many active dune fields including Olympia Planitia and Olympia Undae. Understanding how the migration of dunes are effected by seasonal CO_2 ice can further our knowledge of the relationships between seasonal polar processes and the martian atmosphere and climate. In this study, we have investigated the dune migration at Scandia Cavi (-150° E, 78° N) and the effects of seasonal CO_2 ice on the dune activity during the time periods 2008-2018.

Study Region: The dune field present at Scandia Cavi (*Fig. 1)* dominantly contains linear dunes elongating from barchan and transverse dunes. Our study region, where dune migration was measured, is ~3 km in width and ~8 km in length and is an extension of the Olympia Undae. The study site is of interest as it has previously been studied for active megaripples [1] and provides the opportunity to investigate the relationship between seasonal processes and dune changes.

Data and Methods: *Datasets.* We have used HiRISE (High resolution Imaging Science Experiment) [2] images (0.25 m/pixel) from 2008-2018 to quantify dune migration in units of m/Earth year. We used a HiRISE Digital Terrain Model (DTM) combined with orthoimages, available from the HiRISE node of the Planetary Data System (PDS) for dune migration measurements. Both HiRISE and CTX (Context Camera) [3] images (5-6 m/pixel) have been used to investigate CO_2 ice coverage on the dunes (*Fig.1)* across the varying time periods, giving context to the study site.

COSI-Corr. Dune migration was measured using the DTM and ortho-images combined with COSI-Corr [4] (change detection software) over multiple time periods from 2008-2018 (*Table 1)*. Stacked profiles have been analysed and averaged to give the dune lee-face displacement and subsequently the migration rate.

Dune Migration and sand fluxes: There was some variation in the dune migration rates for each of the time periods (*Fig. 2),* with average migration rates of 1.8, 2.0, 2.2, 1.3, 2.0 myr^{-1} for ΔT_1, ΔT_2, ΔT_3, ΔT_4, ΔT_5 respectively and these measurements are higher than previously calculated average migration rates on Mars [5]. These mean migration rates are similar for each of the time periods, although slightly less for ΔT_4, suggesting that the migration is fairly constant. Average sand fluxes for each of the time periods are 35, 37, 42, 25, 39 $m^3m^{-1}yr^{-1}$, respectively for ΔT_1, ΔT_2, ΔT_3, ΔT_4, ΔT_5. Interestingly, for ΔT_2 and ΔT_3, the direction of the migration reverses. During T_1, T_4 and T_5 the dunes are migrating east to

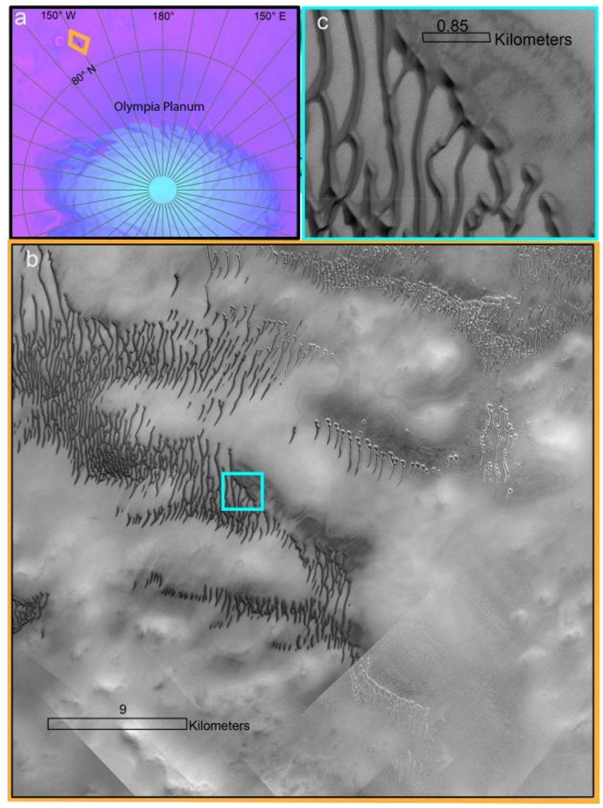

***Figure 1.** (a) Context image showing the location of the study site in relation to the north pole ice cap (MOLA topographic image). The orange box shows the extent of b. (b) CTX mosaic showing the dune field and changes in ice coverage over time. Blue box shows the location of c. (c) HiRISE image PSP_009739_2580 showing the region where dune migration was measured.*

east north east and during T_2 and T_3 the dunes are migrating west, west south west. This suggests there has been a change in the dominant wind direction.

HiRISE Images	Time between images (days)	L_s first image	L_s Second image
ΔT_1- PSP_009739-ESP_027461	1381	116.9	120.2
ΔT_2- ESP_027369-ESP_036217	689.5	116.9	117.8
ΔT_3- ESP_027461-ESP_036217	651	120.2	117.8
ΔT_4- ESP_027461-ESP_053755	2048.5	120.2	114.8
ΔT_5- ESP_03617-ESP_053755	1366	117.8	114.8

***Table 1**: The time periods for which dune migration was measured.*

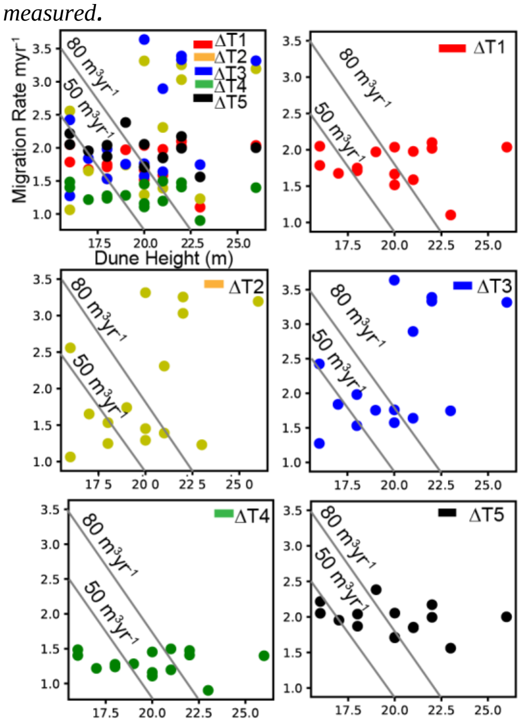

***Figure 2:** Dune migration rates for each time period the migration was measured. Sand fluxes are shown by the grey lines.*

Seasonal CO_2 Ice Coverage: Figure 3 shows the variation in the ice coverage on the dunes over summer when sand is largely frost-free, however during the winter the dunes become covered by ice, visible in some of the CTX images; (P13_006232_2581). In the HiRISE images, small ice patches are still visible on some of the slip faces during the early summer. It is likely these ice patches have not yet sublimated due to being sheltered from solar insolation by the steep crest of the dunes. The size of the ice patches changes in each of the images (*Fig.3)*. Collectively, the autumn-winter ice is likely limiting sand mobility and therefore most of the dune activity is likely to be during the spring and summer when the ice has sublimated, which is consistent with other observations for this region [5].

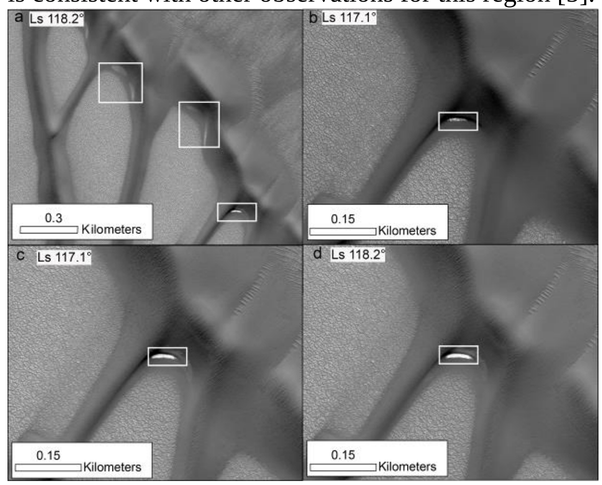

***Figure 3.** (a) CO_2 ice patches on the dunes, HiRISE image ESP_036217_2580. (b) Small ice patch showing sublimation has occurred, HiRISE image PSP_009739_2580. (c) Ice patch visible in ESP_027369_2580. (d) Larger ice patch visible ESP_036217_2580. White boxes outline the areas with ice or frost patches.*

Conclusions: We have shown the dune field to be migrating ~2 myr^{-1} in a bimodal direction due to a dominant reversing wind regime. We have observed seasonal CO_2 ice covering the dunes in CTX images and ice patches visible in HiRISE images, likely reducing dune migration to the spring and summer [5]. Our observations and measurements suggest that there is a range of processes simultaneously acting on this polar dune field influencing dune activity on seasonal, annual and interannual timescales.

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References:[1] Silvestro.S, et al. (2019) 50th LPSC Abstract#1800.[2] McEwen, A. S. *et al.* (2007) *JGR*, 112(5), 1–40. [3] Malin, M. C. *et al.* (2007), *JGR*, 112(5), 1–25.[4] Leprince, S. *et al.* (2007) *IEEE J. Geosci. Rem. Sens.*, 45(6), 1529–1558. [5]Chojnacki, M. *et al.* (2019), 47(5), 1–4.