DIFFERENCES IN SEASONAL CO_2 COVER OF DUNE SLOPES IN MARTIAN NORTHERN POLAR ERG. G. Portyankina[1], C. J. Hansen[2], and, K.-M. Aye[3], [1]Laboratory of Atmospheric and Space Physics, University of Colorado (Boulder, CO 80302, USA; Ganna.Portyankina@lasp.colorado.edu), [2]Planetary Science Institute (Tucson, AZ 85719, USA), [3]University of California in Los Angeles (Los Angeles, CA 90024, USA).

Introduction: Continuous observations of Martian polar areas by the High Resolution Imaging Science Experiment (HiRISE) reveal more and more details about the seasonal activity and how it modifies the polar landscape. North polar erg, the vast sea of dark dunes, covers significant part of northern polar areas. HiRISE images of these dunes show rapid changes of seasonal ice cover in spring [1, 2] and also detectable changes of dunes from year to year [3].

The connection between extensive spring activity and modification of the dunes was assumed by Hansen et al. [4]. The idea is that solid state green house effect mobilizes sand underneath the ice cover and thus destabilizes the material of the slip slope (that is at or close to the angle of repose). It is only after the CO_2 layer - that keeps sand in place - sublimates, the sand avalanches downhill.

Another possibility for the CO_2 layer influencing the shape of an underlying dune is the overburden directly on the crest. In the scenario when slip slope is freed from the seasonal layer earlier than the windward slope, the crest of the dune experiences an additional load of CO_2 ice and can collapse easier.

The aim of the current work is to estimate the timing of ice sublimation from the different slopes of the dunes in different locations and compare it to the timing of the detected changes.

Observations: HiRISE routinely monitors several locations inside the northern polar erg. While there are common trends in spring development of those locations [5], there are also some peculiarities in each location that so far are not fully explained. For example: in most locations the albedo of the slip slope of the dunes is reduced significantly earlier than the albedo of windward slopes. In Kaitain (76.6°N, 89.5°E) however, slip slopes stay bright the longest. So far there is no common model that explains the observed differences. One possible explanation is that the differences arise from the differences in orientation of the dunes.

Model: Our first step is to follow the development of the seasonal ice layer on each side of the dunes. Our model takes advantage of the SPICE system [6] to calculate solar energy input to the surface and Mars Climate Database (MCD) [7] for local weather conditions. Using this we calculate sublimation and condensation of CO_2 at slip and windward dune slopes. We can use digital elevation model (DEM) of the surface if it exists or define our own geometry for the dune model. In this work we considered the dune's slip face to be at the angle of repose and the windward slope to be at 10°. The orientation of dunes was derived from HiRISE images for each location. The dominating importance of this calculation is to take the local aspect angle and inclination of the dune surface into account for the calculation of irradiation. At these high polar latitudes, this has a drastic effect on the total available energy budget over time.

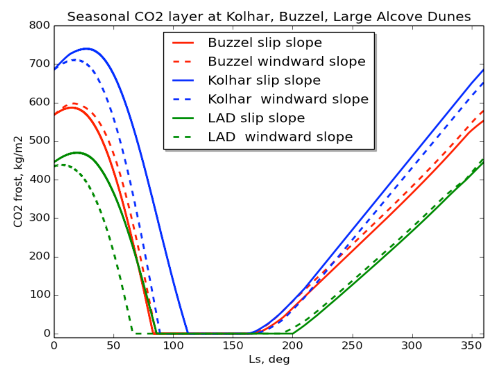

Fig. 1. Seasonal CO_2 ice layer for 3 different locations inside the northern polar erg. Buzzel (84°N, 233°E), Kolhar (84°N, 1°E) and dunes with large alcoves (76°N, 95°E).

Fig. 1 shows CO_2 frost budgets on slopes of dunes in three locations inside north polar erg. The starting CO_2 budget was set to be the same for windward and slip slopes and is taken from MCD. The orientation of dunes in these locations are different: slip slopes' aspect (relatively to the north): Kolhar – 305°, Buzzel - 230°, Large alcove dune site (LAD) - 67°.

Condensation rates in winter are similar for all the surfaces because at each location condensation is mostly governed by the near-surface CO_2 pressure.

Discussion: We have observed that albedos of dune slopes vary during spring [5]. In most locations slip slopes get covered by dark streaks early in spring. This cover will accelerate the sublimation of the underlying CO_2 and significantly change the ratio between CO_2 on slip and windward slopes. In the current simulation albedo of the ice cover was kept unchanged to first determine influence of slope aspect.

The south-west orientation of Buzzel slip slope leads to less condensation there during early spring and hence constantly smaller amount of CO_2 throughout the sublimation period. It is a good candidate location for an over-burden by thicker CO_2 layer on the wind-ward side close to the crest of the dune.

In contrast, slip slopes in Kolhar and LAD experience more condensation in early spring relative to their windward slopes because they stay shadowed for longer time. A thicker ice layer on the slip slope will most probably protect it from erosion during spring. There is however the possibility that heavy ice might slide downslope under its own weight.

The LAD site is the most southern of the three locations and hence ice free the longest.

Comparison of these model results to the HiRISE observations and influence of albedo changes to the model results will be presented.

References: [1] Hansen, C. J. et. al. (2012) Icarus 225, 881-897 [3] Bridges, N. T. et al. (2012) Geology 40, 31-34 [4] Hansen, C. J. et. al. (2011) Science, 331, 575-578 [5] Portyankina et. al. (2012) Icarus 225, 898-910 [6] Acton, C.H. (1996) PSS 44, 65-70 [7] Mars Climate Database (MCD) available on the web: http://www-mars.lmd.jussieu.fr/ [8] Pommerol, A. et. al. (2013) Icarus 225, 911-922