OBSERVATION OF A TRANSITIONAL REVERSAL DURING THE SEASONAL DEFROSTING OF DDS AT THE SOUTHERN POLAR REGION OF MARS. ***A. Horváth*** *(1,2),* ***Sz. Bérczi*** *(1,3),* ***A. Kereszturi*** *(1,4),* ***A. Sik*** *(1,4);* ***E. Szathmáry*** *(1); (1)* Collegium Budapest (Institute for Advanced Study), H-1014 Budapest, Szentháromság tér 2. Hungary, *(2)* Konkoly Observatory, H-1525 Budapest Pf. 67, Hungary, *(3)* Eötvös University, Inst. of Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány 1/a. Hungary, *(4)* Eötvös University, Dept. Physical Geography, H-1117 Budapest, Pázmány 1/c. Hungary (*andras.horvath@colbud.hu*)

Introduction

The new HiRISE images by MRO space probe gave better time resolution of the seasonal surface processes than the earlier MGS and MEX images of the South Polar Region of Mars. In this work we investigate the defrosting seasonal changes of the Dark Dune Spots (DDSs, [1]) at "Inca City" during the southern late winter, spring and early summer. We observed a transitional reversal in the advancing DDS defrosting process, which later continued again till total defrosting (***Fig. 1***).. We suggest that either the sublimation heat loss of great amounts of CO_2 (by defrosting in the earlier period) cools down locally the surface and results in re-freezing of the CO_2 ice, or that such re-freezing is due to the heat absorption of the melting brine in the spots.

Observational evidences

A region of Inca City (81°S, 296°E) on Mars was studied as an area obviously exhibiting the defrosting phenomenon of DDS from wintertime till early summertime. In this selected region first we studied how the DDS patches extend during the defrosting process in 1998-2000, 2007, 2009 [2, 3, 4].

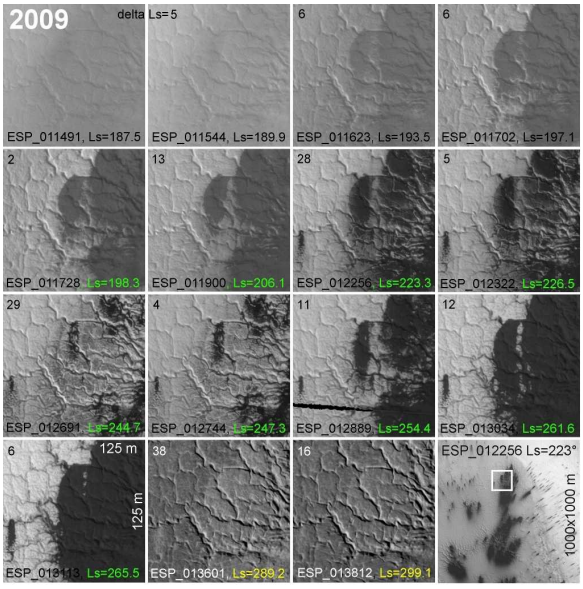

Fig. 1 Sequence of events observed on the HiRISE images of MRO in the Inca City Region. The total Region is visible on the last image. Numbers at the upper left corner of the images show the number of days passed between two consecutive images. (Images are from 07-01-2009 till 07-07-2009)

DDS dark surfaces gradually extended, coalesced and finally ceased to be seen as dark spots. However, we observed that the DDS enlargement stopped for a while (at ***Fig. 1*** 8. frame) and turned back for a shorter period (***Fig. 1*** 9-11 frames), which meant that the surface area of the dark surface shrank for a two weeks.. After reaching a minimal surface area cover (at Fig. 1. 9. frame) the DDSs enlarged again till all the frost vanished finally by early summer (***Fig. 1*** 14 and 15 frames).

We discovered a similar effect in a series of defrosting images in the Richardson crater – shown by Fig. 24 in a paper by McEwen et al (2010) – too [5].

We checked if this effect appeared also in the 2007 Martian defrosting period. As ***Fig. 3*** shows, the effect was observed in this period too. In frame 2 and 3 the dark spots enlarged, but at frame 4 and 5 the surface area of the DDS field shrank down. At frame 6 the defrosting process continues and the dark surface enlarges again.

We measured the mean surface darkness along the defrosting process on a relative scale in all selected areas in ***Fig. 1,*** and in a smaller area in the various regions (see ***Fig. 2: A, B, C***). In ***Fig. 3***, we present the result of another method: we measured the changing extent of dark pixels (red in the fig.) in selected regions.

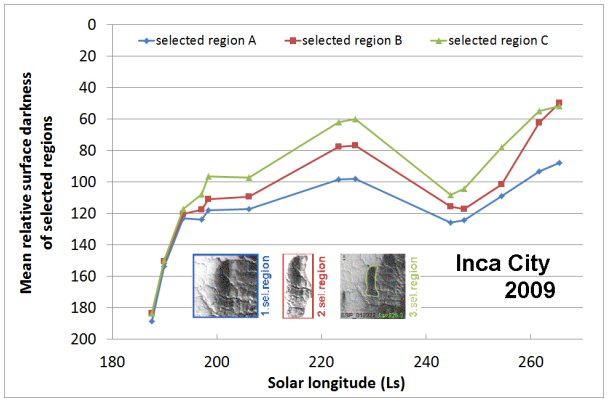

Fig. 2 Changes in the mean relative surface darkness along the sequence of HiRISE images of MRO taken in Inca City Region in 2009 (Fig. 1, the last 2 observations are not indicated here). The vertical axis shows the relative brightness value between 0 (dark) and 256 (bright). We can observe the reversal of the darkening after 226.5 Ls, and temporarily brightening between 226.5 and 244.7 Ls.

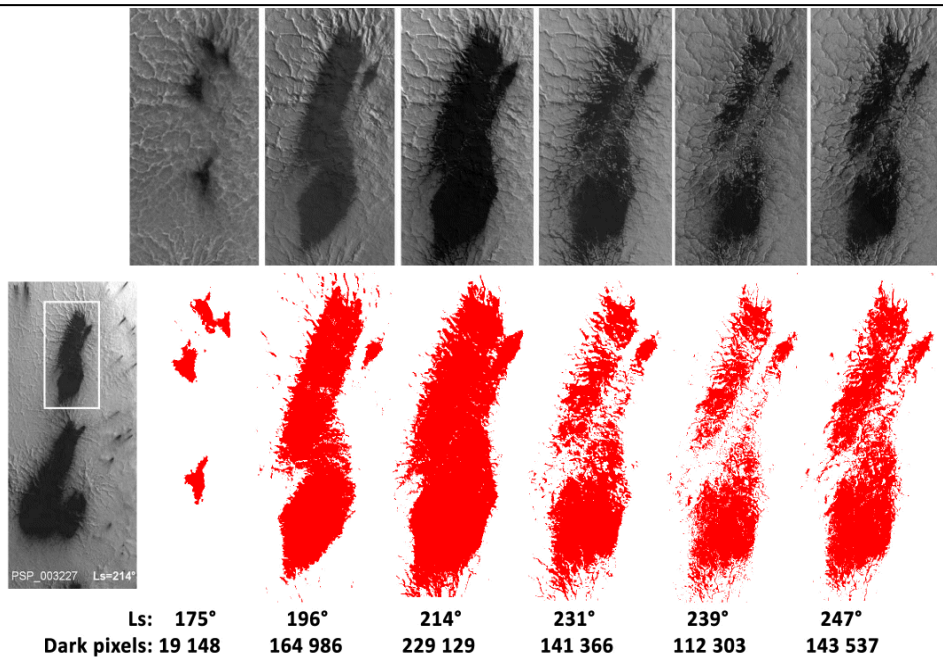

Fig. 3 Time series of events observed on the HiRISE images of Mars Reconnaissance Orbiter at Inca City Region in 2007. (Images are from 28-01-2007 till 29-05-2007)

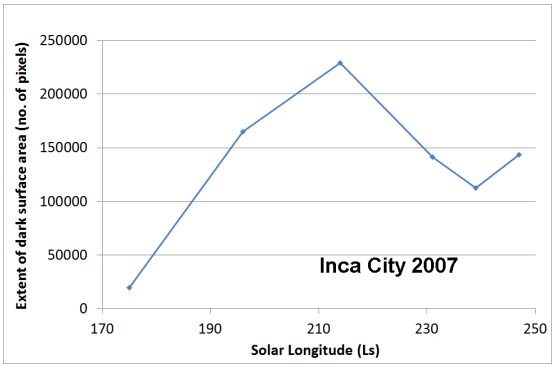

Fig. 4 Changes in the extent of dark surface area (number of red pixels) in a selected dark spot complex during the sequence of the first six HiRISE images taken in Inca City Region in 2007 (Fig. 3)
The reversal of the increasing curve after 214 Ls, and a transitionally decreasing of dark area between 214 and 239 Ls can be observed.

Conclusions

The new details of the southern defrosting phenomenon suggest a model in which the speed of the defrosting process is being changed by some process absorbing heat from the sublimating CO_2 cover. As shown previously, first the thick CO_2 is defrosting in the earlier period of the season, followed by the thin H_2O ice [6-8].

The analyzed images show that some CO_2 refreezes again, as indicated by the decrease in the dark surface area. We suggest two possible explanations.

Sublimation of CO_2 cools down the surface locally and this effect results in re-freezing of the surface, probably by partial CO_2 deposition.

Another possibility also remains open: the formation of the melting brine layer (below the water ice) absorbs some heat and therefore the sublimation of the CO_2 ice temporarily stops. Further studies and calculations are needed to explain the details of the process.

References: [1] **Horváth** A., Gánti T., Gesztesi A., Bérczi Sz., Szathmáry E. (2001) Probable evidences of recent biological activity on Mars: appearance and growing of dark dune spots in the south polar region. 32nd *LPSC* #**1543**, Houston. [2] T. **Gánti**, Horváth A., Sz. Bérczi, A. Gesztesi, E. Szathmáry (2003) DARK DUNE SPOTS: POSSIBLE BIOMARKERS ON MARS? *Origins of Life and Evolution of the Biosphere* **33**: pp. 515-557, Kluwer Academic Publishers, Netherlands. [3] **Horváth,** A. Sz. Bérczi, A. Kereszturi, A. Sik, T. Pócs, E. Szathmáry (2010) Gradual Extension of Dark Dune Spots in the Vicinity of Spiders at the Inca City Region on Mars, *33rd NIPR Symposium on Antarctic Meteorites*, Tokyo. [4] **Horváth** A., Bérczi Sz., Kereszturi A., Sik A., Szathmáry E. (2010) Shielding with Martian snow: suitable temperature and water vapor for possible living organisms. *38th COSPAR*, 2010-5929, Bremen. [5] **McEwen,** A. S. et al. (2010) The High Resolution Imaging Science Experiment (HiRISE) during MRO's Priary Science Phase (PSP), *Icarus*, 205, pp. 2-37. [6] **Kereszturi**, A., Möhlmann, D., Bérczi, Sz., Gánti, T., Kuti, A., Sik, A., Horváth, A. (2009) Recent rheologic processes on dark polar dunes of Mars: Driven by interfacial water? *Icarus* 201, pp. 492–503. [7] **Horváth** A., Kereszturi Á., Bérczi Sz., Sik A., Pócs T., Gánti T., and Szathmáry E. (2009) Analysis of Dark Albedo Features on a Southern Polar Dune Field of Mars, *Astrobiology* **9**/1, pp. 90-103. [8] **Horváth** A., Bérczi, Sz., Sik, A., Kereszturi, A. (2009) "Inca City" DDS Test Region in Mars: New Comparisons by MRO Data, *European Planetary Science Congress* Abstracts, Vol. 4, EPSC2009-0294, 2009, Berlin.