Possibility of transient liquid water on the dark subpolar dune fields of Mars. Sz. Bérczi (1,2), T. Pócs (1), A. Horváth (1,3), Gánti T.(1), A. Kereszturi (1,4), A. Sik (1,4), E. Szathmáry (1,5), *(1)* Collegium Budapest (Institute for Advanced Study), H-1014 Budapest, Szentháromság tér 2. Hungary, *(2)* Eötvös University, Inst. of Physics, Cosmic Mat. Sp. Res. Gr. H-1117 Budapest, Pázmány 1/a. Hungary, *(3)* Konkoly Observatory, H-1525 Budapest Pf. 67, Hungary, *(4)* Eötvös University, Dept. Physical Geography, H-1117 Budapest, Pázmány 1/c. Hungary, *(5)* Eötvös University, Dept. of Plant Taxonomy and Ecology, H-1117 Budapest, Pázmány 1/c. Hungary (bercziszani@ludens.elte.hu)

1. Introduction: MGS, MEX, MRO images of the South Polar region of Mars revealed a wide range of defrosting phenomena. Studies of MOC, HRSC, HiRISE, MOLA and TES datasets made it possible for us to distinguish various transient phenomena: fans, Dalmatian spot, seepages and spiders. Some of these formations were interpreted alternatively by “dry-cold” and “wet” models. Here we compare and unify some of the models in order to explain a complex process in which dark spots are the source of linear “seepages-like” slope streaks in some dark dune fields.

2. Observations: In late winter or at early spring, growing dark structures appear on seasonal CO_2 ice cover. Some of them are diffuse and fan-shaped, while others are circular and confined slope streaks emanates from them [1].

The observed characteristics of the analyzed features are: (1) low albedo markings on the seasonal frost-covered surface where the albedo values are between 0.1 and 0.15 [2,3], (2) from winter to spring they grow in size and disappear with the disappearance of seasonal surface frost early summer, (3) occurrence on dark mantled terrain or on intracrater dark dune fields, (4) they show internal structures with a darker central part, surrounded by a lighter, outer ring, (5) their diameters are between a dozen and some hundred meters, (6) yearly reoccurrence of features in the analyzed sites is between 50-65%.

Besides morphometric analysis, the surface temperature was also investigated around these features. In connection with the changes in TES temperature records, two stages can be distinguished in the evolution of the phenomenon: 1. while the surface temperature is around 150 K, diffuse fans emanate from the dark features, 2. after the surface temperature starts to rise considerably (to about 200-240 K and more), the CO_2 ice cover becomes thinner and on the dune slopes sharp-edged, dark seepage-like structures can be observed.

3. Interpretation:

3.1. Kieffer’s cold-dry model: Christensen et al. [4] interpreted the appearance and temporal development of some kinds of spots and fans by CO_2 defrosting and outburst. Outbursts are produced by the CO_2 jets in their model [5], according to which the early spring sunshine penetrates into the CO_2 ice and becomes absorbed at the bottom. There the absorbed solar heat increases the temperature and at the sublimation point of the CO_2, gas phase appears. The high-pressure gas erupts from below the dry ice layer and releases itself into the atmosphere. During this jet activity the flowing gas drags fine dust particles from below the CO_2 ice. The stream of the outpouring gas jet may be modified by the winds which divert the stream of its way up and deposits dust in the direction of the wind. As a result, on the top if the ice fan-shaped tails are forming. These fans of dark material covering on the frosted surface witness both out bursting gas and wind affecting its pathway.

3.2. Wet model for the seepage-like structures: Confined, sharp edged spots and streaks are present when CO_2 only partly covers the surface or does not exist at all, suggesting a layered structure of the seasonal frost: thin H_2O ice below the thicker CO_2 ice [6]. We observed the appearance of streaks at some dark spots. They started from circular spots and followed descending direction. Our suggestion was that such streaks may be formed by the seepage of liquid water/brine below the thin ice crust. The atmospheric pressure on the observed dunes is too low (varies in a year between 4,6 and 5,5 mbar) for pure liquid water. But below the ice cover, dense brine may be liquid ephemerally. The formation of the descending streaks may also be the result of a moving fluid, moving wetted grains or even moving front of phase change.

4. Combined model: We propose a new model that incorporates both the Kieffer CO_2 jet [7] and DDS-seepage [8] models. The important stages of events in this synthetic model are the following: 1. During autumn the temperature decreases and first H_2O, later CO_2 freezes onto the surface forming a layered structure. 2. In springtime the sunshine causes the outburst of CO_2 gas jets (forming the fans), and the disappearance of the upper CO_2 layer there (forming dark spots). 3. As spring advances the stronger insolation absorbed by the dune surfaces warms up the dune grains at the localities where earlier the gas jets formed a hole in the CO_2 ice. In this stage a very thin ephemeral water layer may form on the grain surfaces, below the water ice, and between the liquid and the roofing solid ice thin water vapor layer may also appear. During this period the liquid layer itself, or the lubricated grains may seep down, or even the front of the phase change may move downward – forming the slope structures. 4. By the end of spring the surface ice disappears but between the grains ice or liquid water may still be present in some mm depth for a very brief period of time. 5. In the last phase all the near-surface H_2O is sublimated or evaporated.

This synthetic model explains better the sequence of observational phenomena than either the dry gas jet or the wet seepage model could have done alone. Of course, there are still open questions: Why do early spots without fans exist? Can the water vapor and water ice insulate the liquid phase and from the cold air sufficiently? What is the possible composition of the seeping brines that can stay liquid at the low temperature?

5. Astrobiological outlook: Strongly bonded adsorbed water [9] may form thin veneer on the Martian surface. Solid-state greenhouse effect [10] may also increase the temperature, but the possible values are unknown. The heat insulator capacity of the thin water ice layer and the duration of the liquid phase is also unknown. The decreasing volume of the melting ice may produce a thin water vapor layer between the liquid water and the covering water ice, providing even lower heat conductivity for the full system. The possible presence of ephemeral near/surface seasonal liquid water on Mars is of high importance for any kind of possible life [5,11,12], but unfortunately the available data are not sufficient for a firm conclusion yet.

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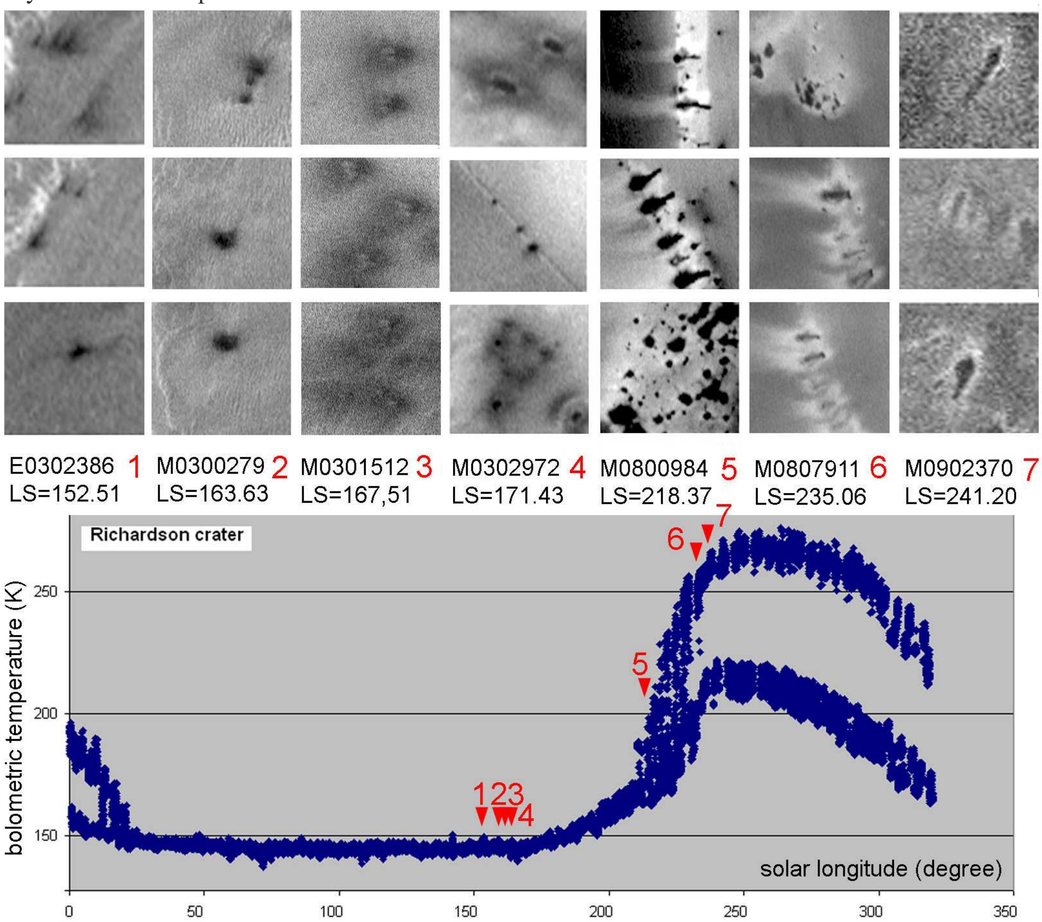

Figure: The correlation between TES bolometric temperatures (below) and spot morphology (top, where subsets are 300x300 m); 1,2,3,4 mark the first; 5,6,7 the second phase of spot development