MULTI-ANGULAR OBSERVATIONS OF MARTIAN BRIGHT SLOPE STREAKS. A. Valantinas¹, N. Thomas¹, A. Pommerol¹, P. Becerra¹, E. Hauber², L. L. Tornabene³, A. McEwen⁴, G. Cremonese⁵ and the CaSSIS Team¹. ¹Physikalisches Institut, University of Bern, Sidlerstrasse 5, 3012 Bern, Switzerland (adomas.valantinas@space.unibe.ch), ²Deutsches Zentrum für Luft-und Raumfahrt, Institut für Planetenforschung, Berlin, Germany, ³CPSX, Earth Sci., Western University, London, Canada, ⁴Lunar and Planetary Lab, University of Arizona, Tucson, USA, ⁵Osservatorio Astronomico di Padova, INAF, Padova, Italy.

Introduction: Bright slope streaks are enigmatic surface features of increased albedo found on Martian slopes in low thermal inertia regions [1, 2]. These elongated features are thought to result from the more common dark slope streaks [3, 4], which gradually fade or brighten with time [5]. In fact, in a few rare cases slope streaks have been observed to have bright and dark sections [1, 5, 6]. The fading rate of dark slope streaks has been shown to be around 40 years [7] but the contrast reversal rate is unknown. Several hypotheses attempt to explain the origin of dark slope streaks: Dry-based models encompass formation through dust mass wasting, avalanching or granular flows [1, 6, 8]; and aqueous models cite subsurface aquifers as sources, lubricated dust flows and ground staining from saline fluids [9-13]. Various properties of dark slope streak populations were studied in detail to address their origin [14-16]. However, little is known about their photometric parameters, i.e., surface texture, roughness and grain size. We address this issue by acquiring multi-angular observations of bright slope streaks using The Colour and Stereo Surface Imaging System (CaSSIS) [17] onboard the ExoMars Trace Gas Orbiter (TGO).

Results: A large survey consisting of ~16,000 hexagons 20 km in diameter provided a base map of all bright slope streak locations in Arabia Terra. We found that some locations underwent significant surface changes spanning several years (e.g. Fig. 1). However, other locations showed minimal change, which points towards heterogeneities within Arabia Terra. Additionally, we have documented ~50 locations of partially dark-bright slope streaks. One such peculiar case is seen in Fig. 2. This example features bright apexes that begin to darken towards the middle, and at the distal ends appear indistinguishable from a dark slope streak. Some streaks exhibit an impact crater or a dust devil track at their apexes. The latter location and a few selected others were targeted by CaSSIS, and will provide the basis for multi-angular observations. Photometric results will be presented at the conference.

Discussion: In the past, the contrast reversal of slope streaks was attributed to either physical fading [5] or viewing geometry effects [6]. Loose snow avalanches on earth were suggested as an analog for the latter. Interestingly, many dark, bright and dark-bright streaks are frequently found on the same slope (Fig. 1 and Fig. 2). This suggests that the origin of their differences is compositional and independent of viewing geometry. If Fig. 2 is an example of a streak in albedo transition it raises the question of why it follows an apex-to-talus brightening pattern. If the streak is affected by atmospheric dust fallout, then the brightening mechanism should be homogenous and affect the whole streak. Otherwise the dust settling and accumulation is not homogenous along different parts of the slope. Another hypothesis could be related to gravity-controlled processes. Particles at the top of the streak might be more easily churned by wind and transported downwards as mass wasting. In both cases, a Digital Terrain Model (DTM) might hold more clues to the dust
transport hypotheses. Alternatively, a mechanism for slope streak brightening might hint at a formation process unrelated to dust. As the streak forms, the material at the top of the streak will always be older. Hence, the talus will remain the least degraded because it was formed last. However, this requires a slow formation process. Slope streak formation time is poorly constrained: numerical modeling suggests streaks can form in as little as 1 hour [10], while repeated observations show new streaks forming within 5 days [20].

Landscape changes such as those shown in Fig. 1 could be related to a dust storm event in 2007. After the dust settled, bright slope streaks are no longer visible because they exhibit a lower albedo difference from the surrounding material than the dark slope streaks (~4% vs. 10%). Later, wind could have resurfaced the area and removed the thin layer of dust. However, this would imply that the composition of the material within slope streaks is no longer the same as that of the atmospheric dust. 

Future Work: We will employ a Hapke model to simulate the photometric parameters of the surface. This will allow us to address the contribution to the albedo of the surface texture and composition independently. A DTM will also be produced from CaSSIS stereo pairs to derive local topography and lighting geometry.


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