SLOPE STREAKS ON MARS: SEASONAL DEPENDENCE OF FORMATION RATES. T. Heyer[1], M. Kreslavsky[2], H. Hiesinger[1], D. Reiss[1], H. Bernhardt[3], and R. Jaumann[4], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, [2]Earth and Planetary Sciences, University of California – Santa Cruz, USA, [3]School of Earth and Space Exploration, Arizona State University, USA, [4]German Aerospace Center (DLR), Berlin, Germany. (thomas.heyer@uni-muenster.de)

Introduction: Slope streaks are gravity-driven dark or light-toned features that form throughout the martian year in high-albedo and low-thermal-inertia equatorial regions of Mars [1, 2]. The distinctive features originate from point sources on slopes steeper than ~20°, follow the topographic gradient, extend or divert around small obstacles, and propagate up to maximum lengths of a few kilometers [3]. The streaks brighten with time, sometimes become brighter than their surroundings, and fade away over timescales of decades [4]. In contrast to recurring slope lineae (RSL), which gradually extend over time [e.g., 5], a growth, or reactivation of existing streaks has not been observed. Slope streaks have never been observed in a terrestrial environment although some analogs have been proposed [6-8]. Based on diverse orbital observations since the 1970s, a number of mechanisms including granular and aqueous flows have been proposed to explain their formation. The proposed mechanisms comprise avalanching of dry material [e.g., 1], as well as flows of different mixtures of water, dust, and salt [e.g., 8-10]. In order to evaluate potential triggering mechanisms, time constraints of the formation process were analyzed in a previous study [2]. Slope streaks were found to form sporadically, i.e., randomly, throughout the martian year. The increasing amount of high-resolution repeat images covering streak-bearing regions on Mars now allows further evaluation of slope streak activity and formation conditions. Here we report measurements of seasonal streak formation rates at the Olympus Mons aureole, as well as at Nicholson crater, and analyze seasonal activity in comparison to environmental conditions at the surface.

Data and Methods: We used the Multi-Temporal Database of Planetary Image Data (MUTED [11]) to identify areas with high spatial and temporal coverage of high-resolution images (≤20 meter/pixel). Within the dust-rich equatorial regions, we found six areas with both slope streak activity and an adequate number of images to determine seasonal formation rates in multiple martian years. For each area, 12 to 24 image pairs, with a maximum time span of 180° solar longitude (L_S) were identified. Due to the high areal coverage and the nearly homogeneous spatial resolution, CTX images were used to unambiguously identify newly formed slope streaks. All images were processed, coregistered, and cropped to the same area using ISIS-3. For each site, new streaks were identified by visually comparing image pairs that cover the overlap area at different times. Based on the acquisition date of the images and the number of newly formed slope streaks, the formation rate was retrieved for each image pair, respectively.

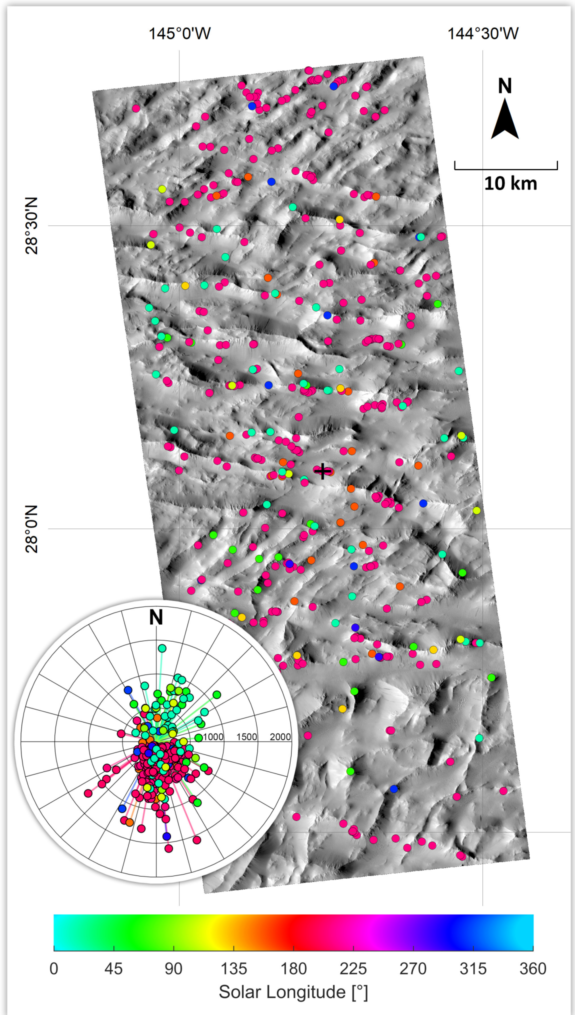

Fig. 1: Seasonal streak activity at the Olympus Mons aureole (site B). The color of the dots refers to the seasonal occurrence of the streaks. Seasonality was calculated as the mean solar longitude of the image acquisition dates between which new streaks were formed. The polar plot shows the orientations and lengths [m] of all identified newly formed streaks.

In order to compare streak activity at different sites, the formation rate was normalized using the overall number of slope streaks within the overlap area. The normalization is similar to that of [12] and accounts for differences in topography and abundance of suitable surface material at different sites.

Results: We identified 2,021 newly formed streaks in 98 image pairs at study sites in the Olympus Mons aureole (sites A-E in Fig. 2) and in Nicholson crater (site F). Streaks were found to form at a long-term rate of about 2-7 % per streak per martian year. Our observations confirm the conclusion by [2] that slope streaks form throughout the entire martian year (Fig. 2). However, our observations also show distinctive seasonal peaks of slope streak formation in multiple consecutive martian years, including high formation rates during autumn (L_S ~190°). During this time, slope streak activity exceeds the long-term formation rate multiple times. The highest seasonal formation rate of 0.16 % per streak per sol was observed at the Olympus Mons aureole (site A) during autumn (L_S 155-242°) of Mars year 30. At sites B, E and F, streaks were found to form on opposite slopes during opposite seasons of the martian year. The comparison of streak activity with modelled environmental surface conditions based on the Mars Climate Database (MCD [13, 14]) indicates a correlation between slope streak formation and seasonal surface temperatures as well as wind intensities.

Discussion/Conclusions: We observed seasonal variations in slope streak activity at intermediate latitudes (25°N to 32°N), as well as at the equator, and found high formation rates during autumn (L_S 180-270°) in up to four consecutive martian years. During this time, streak formation rate is several times higher than the observed long-term formation rates. We found new streaks forming on opposite slopes depending on season. This distinct spatial and temporal distribution is unlikely to be triggered by sporadic mechanisms. The inhomogeneous distribution indicates that changing environmental conditions at the slopes affect the formation of the streaks throughout the year. Seasonal variations of streak activity could be a result of varying intensities of a single process, e.g., seasonal formation of brines [8], destabilization of accumulated dust due to strong near-surface winds [1] or gas flows generated by thermal creep [15]. The observed streak activity could also be explained by the interaction of multiple processes. The strong year-to-year variability in the seasonal cycle of slope streak formation suggests a strong effect of changing climate conditions on slope streak formation potential and/or triggering, regardless of the specific formation mechanism.

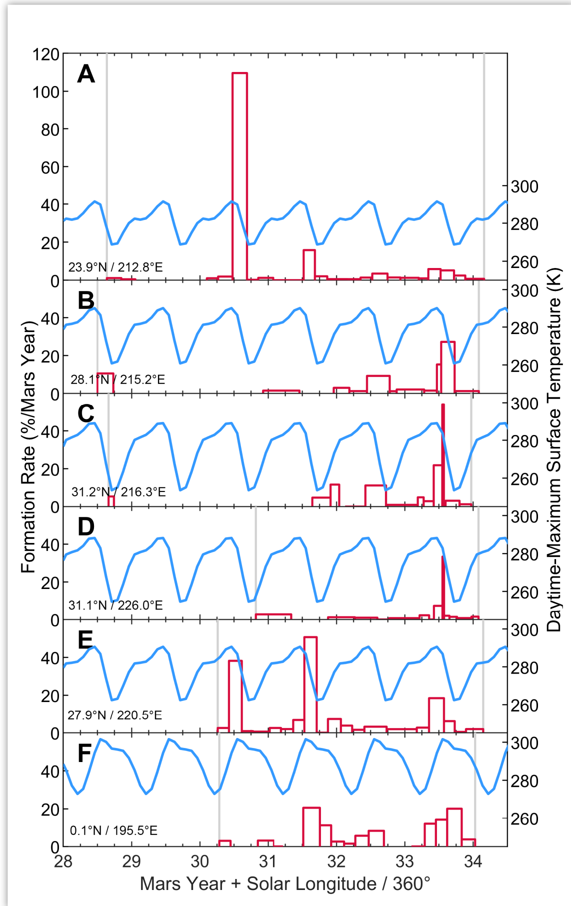

Fig. 2: Seasonal variations in streak activity (red bars) in comparison to the daytime-maximum surface temperature (blue curves) at study sites in the Olympus Mons aureole (A-E) and in Nicholson crater (F). Streak formation rates refer to the number of newly formed streaks per streak per time interval between consecutive images. Daytime-maximum surface temperatures, as an indicator of the seasonality of the study sites, are based on simulations by the MCD [13, 14].

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