SEASONAL FORMATION RATES OF SLOPE STREAKS ON MARS. T. Heyer[1], H. Hiesinger[1], D. Reiss[1], H. Bernhardt[1], G. Erkeling[2], and R. Jaumann[3], [1]Institut für Planetologie, Westfälische Wilhelms-Universität, Wilhelm-Klemm-Str. 10, 48149 Münster, Germany, [2]German National Library of Science and Technology (TIB), Hannover, Germany, [3]German Aerospace Center (DLR), Berlin, Germany. (thomas.heyer@uni-muenster.de)

Introduction: Slope streaks are narrow fan-shaped albedo features that occur on steep slopes in high-albedo and low-thermal-inertia equatorial regions of Mars [1]. The distinctive dark and much rarer bright features have a high contrast and sharp edges (unresolved at ~25 cm) to the surrounding surface. Observations revealed that slope streaks are actively forming [2]. Unlike recurring slope lineae (RSL), a growth, or reactivation of existing streaks has not been observed. A number of models have been proposed to explain the formation of slope streaks on Mars. Dry-based models include mass wasting of dust, granular flows or avalanching of heterogeneous dust accumulation along slopes [e.g., 1, 3]. Wet-based models comprise brine flows, mixed water-dusts flows, groundwater, or ground-wetting from salty liquids [e.g., 4-6]. However, none of the proposed models account for all of the observed characteristics. In order to evaluate potential triggering mechanisms, time constraints of the formation process were analyzed in previous studies [7, 8]. Using images taken by THEMIS, HRSC, CTX, and HiRISE, slope streaks are found to form sporadically throughout the martian year [8]. The continuous observation of surface areas enables further comprehensive analyses of seasonal streak activity.

Here we report newly formed slope streaks in six regions within the Olympus Mons Aureole, as well as Nicholson crater, and analyze formation rates throughout the martian year.

Data and Methods: We used the Multi-Temporal Database of Planetary Image Data (MUTED) 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 interannual formation rates. For each area, 10 to 21 image pairs, with a maximum time span of 180° solar longitude (L_s), covering multiple Mars years 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 a uniform area using ISIS3. For each site, new streaks were identified by visually comparing image pairs that cover the overlap area at different times. Figure 1 shows the seasonal occurrence of new streaks at site A within the Olympus Mons Aureole. 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. The formation rate was normalized as the number of new streaks per 668.6 sols (one martian year) per square kilometer of the overlap area.

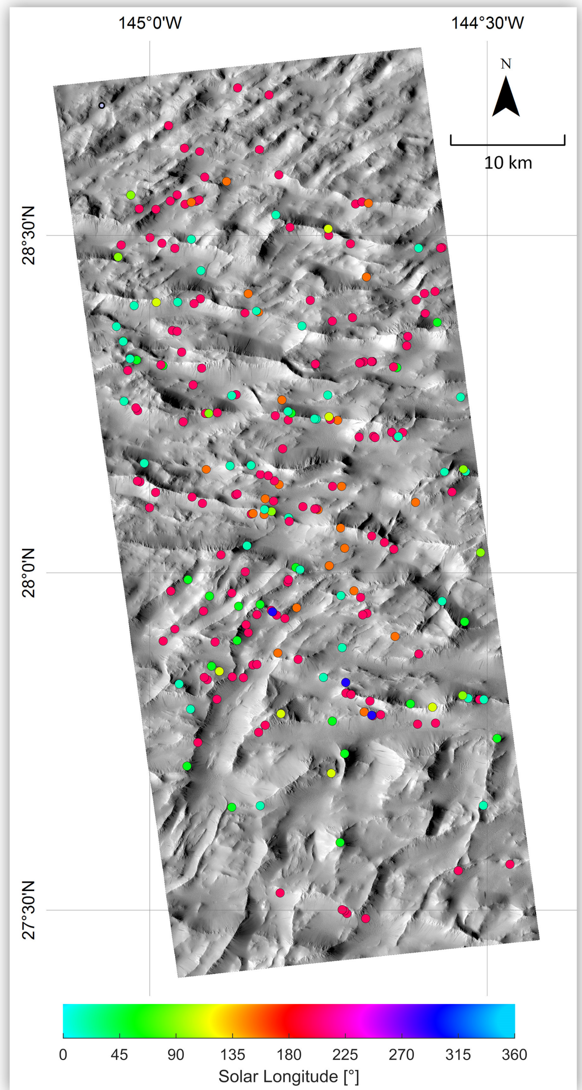

Fig. 1: Seasonality of newly formed slope streaks at Olympus Mons Aureole (site A) between 2007-01-07 and 2016-05-13. Color-coded seasonal occurrence refers to the mean solar longitude of the acquisition dates between which new streaks were formed.

Formation rates were analyzed in combination with climate variables provided by the Mars Climate Database (MCD), including surface temperature, humidity, horizontal wind speed, and wind direction [9].

Results: In total, 1751 newly formed slope streaks were identified in 81 image pairs within the six regions of interest.

Figure 2 shows the seasonal streak formation rates for multiple martian years as a function of solar longitude. At all sites, slope streaks were observed to occur throughout the martian year. Up to six distinct time intervals with new streaks were identified in individual martian years. However, the number of newly formed slope streaks varies significantly within different seasons. Highest formation rates were observed during northern summer (L_s ~180°). During this time, formation rates are 2 to 72 times higher in comparison to northern winter. Based on image coverage, highest formation rates during summer were observed at site A, B, C, and F in three martian years. Sites within the Olympus Mons Aureole (A-E) show generally low formation rates during northern fall (several time intervals without streak formation).

The modelled maximum surface temperatures, here presented as an indicator of the seasonality at the study sites, varies between ~255 K and ~291 K at the Olympus Mons Aureole and ~272 K and ~301 K at Nicholson crater throughout the martian year. At all sites, streak formation rates show a generally good temporal correlation with the maximum surface temperature.

The comparison of the streak formation rates shows different slope streak activity at the study sites. Almost the same qualitative behavior was shown when shallow areas with slopes under 10° (where slope streaks usually not occur [10]) were excluded from the calculation of the formation rates. The highest formation rate of 1.45 streaks per Mars year per square kilometer was observed in northern summer of Mars Year 30 at site A. For the same area, a formation rate of 0.02 streaks per Mars year per square kilometer was observed during northern winter of Mars Year 30/31.

Discussion/Conclusions: Due to the continuous observation of surface areas, seasonal variations in slope streak activity were observed at six sites in multiple Mars years.

Seasonality of slope streak formation could be a result of various proposed triggering mechanism [e.g., 1-6]. High streak activity during northern summer could be explained by temperature related processes, including melting/sublimation of frost or subsurface ice. Variation in streak activity could also be result of seasonal changes in wind speed and wind direction, as well as the occurrence of dust devils.

Finally, seasonal variations in streak activity could be explained by the interaction of multiple processes. In this case, the seasonal productivity of separate processes could interfere and could result in varying formation rates throughout the martian year.

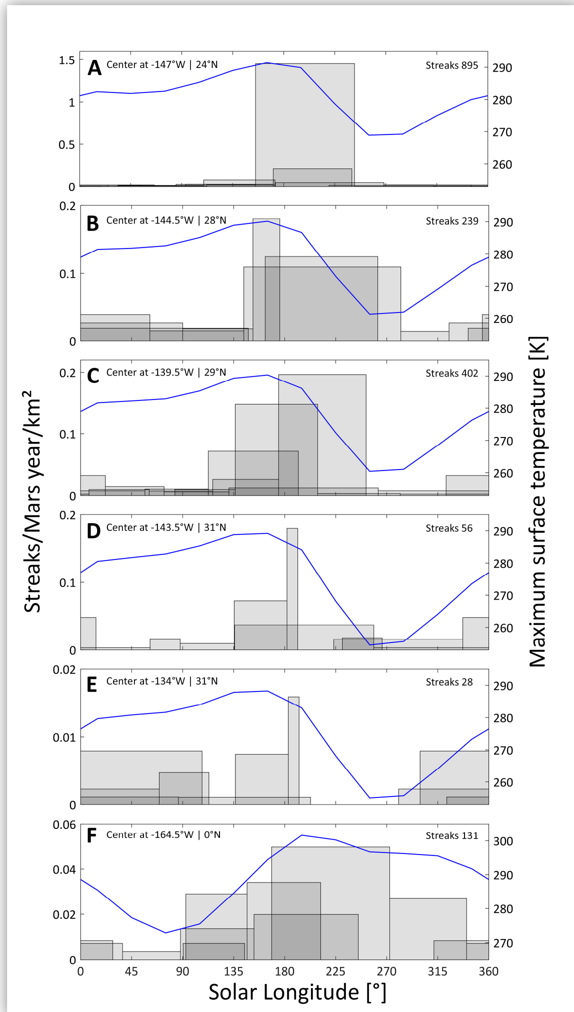

Fig. 2: Seasonal formation rates of slope streaks throughout a martian year (L_s 0 – 360) for study sites A-F. Data from multiple Mars years are folded. Boxes indicate the intervals during which slope streaks occur (box width) and the streak formation rates (box height).

References: [1] Sullivan et al. (2001) *JGR*, 106. [2] Edgett et al. (2000) *LPSC XXXI*, Abstract #1058. [3] Baratoux et al. (2006) *Icarus*, 183, 30-45. [4] Ferris et al. (2002) *GRL*, 29, 10, 1490. [5] Miyamoto et al. (2004) *JGR*, 109, E06008. [6] Kreslavsky and Head (2009) *Icarus*, 201, 517-527. [7] Schorghofer et al. (2007) *Icarus*, 191, 132-140. [8] Schorghofer and King (2011) *Icarus*, 216, 159-168. [9] Millour et al. (2015) *EPSC 2015*, 10, 438. [10] Brusnikin et al. (2016) *Icarus*, 278, 52-61.