COMPARATIVE MORPHOLOGIES BETWEEN DUNE SLOPE STREAKS AND RECURRING SLOPE LINEAE ON MARS. E. C. Czaplinski[1], C. J. Ahrens[1], V. F. Chevrier[1], [1]Arkansas Center for Space and Planetary Science, University of Arkansas, Fayetteville, AR 72701. (ecczapli@email.uark.edu).

Introduction: Dune slope streaks and RSL on Mars give us insight to subsurface-surface interactions and seasonal changes on Mars, especially since both have been hypothesized to be derived by dry-processes [1,2]. Both dune slope streaks and RSL also show environmental constraints on their morphology. This study compares the two features in regards to their emplacement environment and possible seasonal variability.

Dune slope streaks are linear changes in albedo emanating down the slipface without any clear topographic signature. Slope streaks were first observed in association with dune migration and advancement in Rabe Crater [3]. Based on slipface monitoring in Rabe Crater for one and a half martian years, slope streak activity was found to be limited to the midwinter through midsummer, as few streaks formed in the late summer through fall, and none formed during the winter. This observation suggests that grain flow could be seasonally restricted by several factors including indurated/frozen sand, or weak winds [1]. Similar slope streaks have been observed on dunes in equatorial/midlatitude regions such as Noachis Terra and Nili Patera [4], and slipface grainflow without slope streaks or alcoves have been observed in Meridiani Planum [5].

In similar fashion, recurring slope lineae (RSL) are also dark, narrow streaks on steep (up to 40°) slopes, lengthen during relatively warmer seasons (250 – 300 K) and recur over multiple years [6,7]. To date, few studies have considered comparisions between similarities in the environment in which these streaks are found and the characteristics to which they may form over time, especially if both features are found within the same area (within kilometers).

Methods: In order to determine the location of dune slope streaks for this study, we referenced data from [8], where a global survey of dune slipface features were mapped, including dune slope streaks. We then used the RSL Shape Database in Java Mission-planning and Analysis for Remote Sensing (JMARS) to determine areas where dune slope streaks and RSL overlapped. High Resolution Imaging Science Experiment (HiRISE) coverage was also a limiting factor. We used two main areas in this study based on HiRISE availability and occurrences of both dune slope streaks and RSL: Rabe Crater (35°E, 44°S) and Coprates Chasma (304.57°E, 14.75°S).

For measuring both dune slope streaks and RSL, we rendered several HiRISE stamps over the corresponding area so that multiple martian years were included. Then, we marked individual slipfaces (in the case of dune slope streaks) or origin points (in the case of RSL) as separate occurrences. We used the measuring tool in JMARS to measure the lengths of slope streaks and RSL, which were then totaled for each occurrence within each HiRISE stamp.

Results:

Morphology: Dune slope streaks tend to be thicker streaks, possibly from clustering and merging of smaller, thinner streaks downslope. In Rabe Crater, dune slope streaks are linearly spaced across the slipfaces (Fig. 1A). Lengths of the streaks vary across the dune, not always reaching the bottom of the slipface. The streaks also appear to be perpendicular with respect to the brink of the dune. Dune slope streaks in Coprates Chasma (Fig. 1B) show similar morphologies, but not as extensive or abundant as Rabe Crater (Fig. 1A).

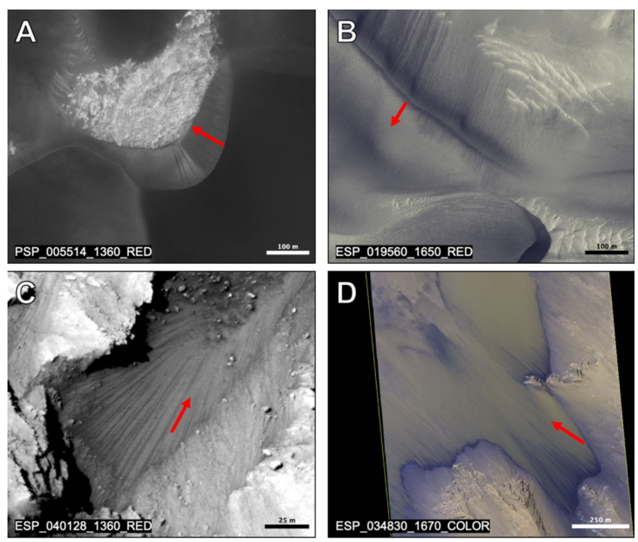

Figure 1: Comparison of dune slope streaks and RSL morphologies and emplacement environments. Red arrows indicate downslope movement. A) Dune slope streaks in Rabe Crater. B) Dune slope streaks in Coprates Chasma. Note the size difference compared to (A). C) RSL in Rabe Crater. D) RSL in Coprates Chasma. Notice the lighter toned apron downslope.

RSL are thin and relatively darker albedo features. RSL in Rabe Crater are found in clusters in small, confined spaces. The RSL slopes are narrow when compared to dune slopes, and appear to nearly converge downslope (Fig. 1C). The streaks in Coprates have been observed to occur on a lighter albedo "apron", which does not change over time and the RSL lengths do not exceed this apron (Fig. 1D). This suggests a limit of material present to generate and emplace the RSL and provides a long-term slope of material to generate RSL.

Environment: Dune slope streaks are typically found on barchan dunes [8]. The dune slope streaks in Rabe Crater occur on mature barchan dunes at the crater interior. Dune slope streaks in Coprates Chasma occur on elongated/irregular (up to 1 km) barchan dunes found north of the RSL field (further into the chasm). The dunes are located in an open dune field with no contact to crater walls, gullies, or alcove material.

RSL in Rabe Crater were observed in small outlets of alcove material, lengthening downslope. We found that the RSL form on lighter-toned "tongues" of material that appear to originate from the mantle rubble. This part of Rabe Crater also has small boulders, which the RSL travel past in a linear morphology. RSL have been observed to originate at spur-and-gully "channeled" rims (i.e. canyons, craters) in Valles Marineris [6,9]. However, our study found that other locations of RSL, including Valles Marineris, have RSL environments that include "open" origins, where no alcove material is present. RSL in Coprates Chasma were observed to differentiate in the emplacement setting in that these RSL were found on wider, lighter-albedo "aprons" with no contact of alcoves and mantled material.

Seasonality: Our definition of seasonality refers to the change in length of the particular dark streak type over time, not necessarily a global seasonal outlook. This gives us insight to the localized changes of dune slope streaks and RSL on a smaller scale rather than generalizing the types.

Rabe Crater dune slope streak lengths were measured on 11 different clusters of streaks (Fig. 2A). Plotting the total length at each of these clusters showed a similar variability in streak length over time, particularly lengthening during warmer seasons. The lengths show a similar trend each year. However, there were several slipfaces where the streaks were not clear, so rather than guessing the lengths, we did not include data in those cases. Dune slope streaks in Coprates Chasma were measured by maximum length over time and were similar to Rabe Crater dune slope streaks in that they lengthened during warmer seasons (Fig. 2B).

RSL in Rabe Crater showed extreme variability in lengths over time (e.g. "RSL4" varied from ~840 m to ~380 m), as we observed the maximum lengths during the warmer seasons as expected (Fig. 2C). However, the lengths were not consistent each year. Similarly, RSL length in Coprates Chasma also varied in length, increasing during the warmer seasons, then fading (Fig. 2D).

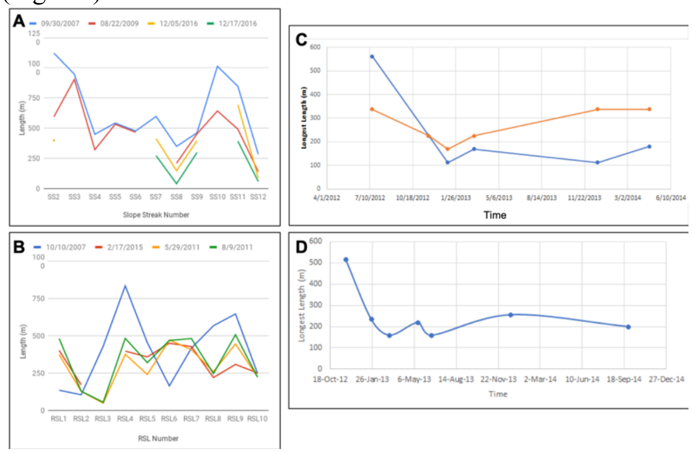

Figure 2: Comparison of dune slope streak and RSL lengths over time. A) Dune slope streak measurements in Rabe Crater. B) RSL measurements in Rabe Crater. (C) Dune slope streak measurements in Coprates Chasma. D) RSL measurements in Coprates Chasma.

Conclusions: Dune slope streaks and RSL show similar characteristics, in that they lengthen over time, and are heavily influenced by warm seasons. However, the morphology, environmental setting of emplacement, and the changes of the lengths over time are interesting to research, especially since both features have been hypothesized to be dry processes. Dune slope streaks at both Rabe Crater and Coprates Chasma are similar in morphology, though more clustered at Rabe Crater (possibly due to the dune field being confined to a crater setting rather than an open chasm). Both sites also show consistency in streak length over time and increases during the warmer seasons. We observed a common morphology involving lighter-toned aprons at every observed RSL site, which suggests a similar falling of slope material and constraint of material present. We also propose two different RSL environments (channeled or open) that could influence length, frequency, and clustering of RSL, and thus processes by which the RSL originate.

References: [1] Cornwall, C. et al. (2018). *Icarus 314*, 311-326. [2] Dundas, C. et al. (2017). *Nature Geoscience, 10*, 12, 903-907. [3] Fenton, L. (2006). *GRL 33*, 20. [4] Cardinale, M. et al. (2012). *LPSC XLIII*, Abstract 2452. [5] Silvestro, S. et al. (2011). *GRL 38*, 20. [6] McEwen, A. et al. (2014). *Nature Geoscience, 7*, 53-58. [7] Stillman, D. et al. (2017). *Icarus 285*, 195-210. [8] Czaplinski, E., & Horgan, B. (2016). *LPSC XLVII*, Abstract 2006. [9] Schaefer, E. et al. (2019). *Icarus 317*, 621-648.