ONGOING MEASUREMENTS OF DUNE WIDTH AND SPACING ON TITAN REVEAL DUNE FIELD PROPERTIES.

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Introduction: Saturn's moon Titan is home to many landforms similar to those found on Earth. One of Titan's most notable landforms are dune fields, which cover perhaps 20% of Titan's surface [1-5]. These dunes are linear in form and can stretch to hundreds of kilometers in length [6]. They are located in equatorial regions and can be found between latitudes of ±30º [1,2,4,5]. Modeling of dune parameters on Titan, such as dune width, spacing, and length have yielded important results concerning dune field maturity [6-8]. The emerging pattern analysis results and the uniformity of dune form across Titan indicate these dunes may be in an equilibrium condition that has persisted for a long time [8]. The duration of aeolian dune processes on Earth is also relatively long lived [9], so how Earth-like processes relate to those on Titan is the subject of current study [7-10]. The following are results from a pattern analysis study of Titan's dunes, presented along with a new method for measuring crest spacing of Titan's linear dunes.

Methods: New measurements of dune width and spacing have been obtained, using Cassini Synthetic Aperture Radar (SAR) in the USGS program ISIS, for two main sand sea regions. The first is in the Fensal Sand Sea, east of Xanadu, with measurements so far from the T25 swath (20º S - 20º N, 32º W - 49º W, Fig. 1a,b) and the second is from the Belet Sand Sea, the 2500 km long collection of sand west of the Xanadu terrain, with measurements so far from the T8 swath (5º S - 10º S, 189º W - 315º W). This is a continuation of a previous study, in which dune width and spacing were measured in various locations in six different SAR swaths across Titan [8] and build on similar measurements by Le Gall et al. [4]. The Savage et al. [8] study utilized measurements obtained at approximately 5 km intervals, yielding ~7,000 each width and spacings [8]. Dune widths were measured from one light/dark boundary to the next across SAR-dark areas perpendicular to the long axis of the dunes. After widths were measured, interdune spacing was obtained for each region using the same method, across SAR-bright areas. Crest-to-crest dune spacing was approximated by adding the average dune width for a particular degree of latitude to the average interdune spacing for that same degree of latitude [8]. These methods were used because Cassini SAR resolution (~300 m.) is not good enough to distinguish actual dune crests.

Current measurement methods differ from those of Savage et al. [8] in that crest-to-crest spacing is now done by measuring from one SAR light/dark boundary to the next SAR light/dark boundary perpendicular to the long axis of the dunes (Fig. 1c). Dune widths were measured as in [8], across each dark feature (Fig. 1c), and width and spacing was measured from the same starting point (Fig 1c). We believe this will provide us with a more accurate measurement for crest spacing, and will enable us to precisely correlate dune width and spacing.

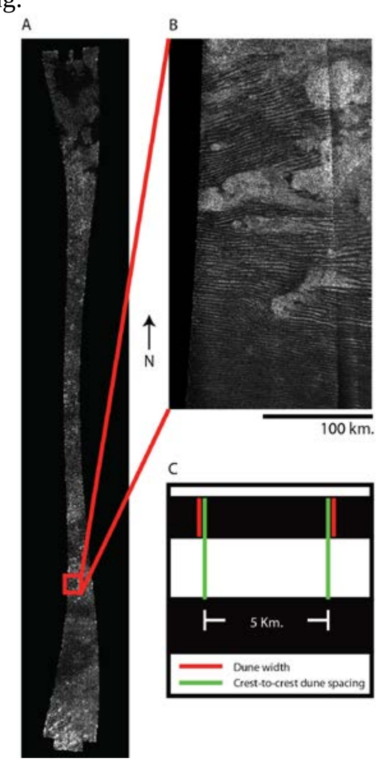

Figure 1 A) Cassini (SAR) T25 swath. B) Close up view of a sample area where measurements were made. C) Illustration of our new method for measuring dune crest-to-crest spacing.

Interdune areas in the Fensal region (Fig. 2c) are easily deciphered by the contrast of SAR-light interdunes and SAR-dark dunes. However, distinguishing interdunes from dunes in the Belet Sand Sea is much more difficult because there are SAR-dark interdunes. This is likely because there are such high volumes of sand in this region that there are sandy interdunes. There is contrast in the Belet dunes, making it possible to discern dunes from interdunes. However, some contrast could result from SAR-bright optical glints (Fig. 2b), which occur when a SAR beam hits a slope that is perpendicular to the direction of illumination. Measurements in the T8 swath are made by changing the contrast levels in ISIS to better distinguish SAR-bright areas and by making careful interpretations to avoid mistaking a glint for a SAR-light area.

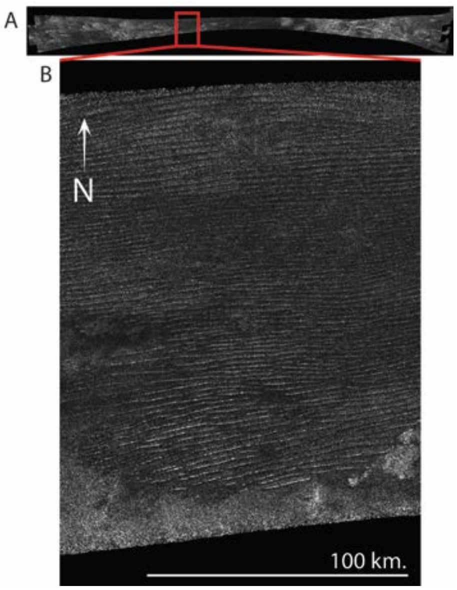

Figure 2 A) Cassini (SAR) T8 swath. B) Close up image showing Belet dunes and sandy interdunes with glints present at the bottom of the image.

Results and Discussion: Using the new method, we have 2326 measurements in Fensal of each dune width and spacing, made on the T25 swath ranging between 20º S and 18º N latitude. Dune widths are on average 1.38 km and the average dune spacing is 2.66 km. We have also made 77 measurements in the T8 swath between latitudes of 5º S and 10º S and longitudes 189º W – 315º W. These have an average dune width of 1.21 km and an average dune spacing of 2.71 km. Results from T25 and T8 are comparable to average width and spacing values across Titan and are consistent with the study by Le Gall et al [4]. When we plot interdune fraction (interdune width divided by dune spacing) per degree of latitude our results appear to be consistent with those of Le Gall et al. (Fig. 3; [4]), that used data from across Titan, in swaths T21, T23, T25, T28, T43, T44. Both plots in Figure 3 show a trend of increasing interdune fraction toward high latitudes, starting at ~7º S and continuing north to ~15º N and starting at 8º S and continuing south to 18º S. The plot from Le Gall et al. (Fig. 3a) has a fit for data points from 7º S to 14º N with an R^2 of 0.73. Our plot (Fig. 3b) has two trendlines, one on data from 7º S to 14º N, as in Fig 3A [4], with an R^2 of 0.69, and another on data from 8º S to 18º S, with an R^2 of 0.92. That the southern trend is strong in Fig. 3B is likely a result of our dataset being restricted to the T25 swath, while values from elsewhere on Titan have skewed the southern latitude global populations in Fig. 3A.

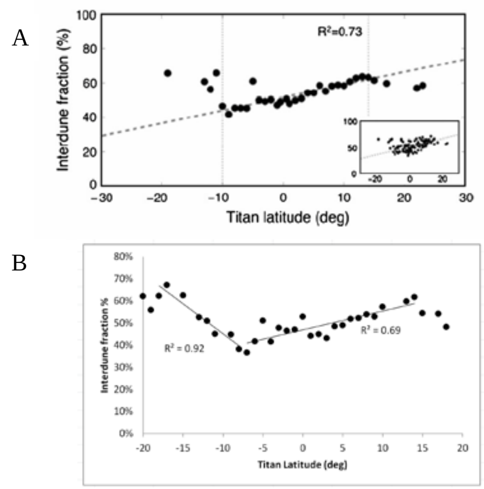

Figure 3 A) A figure by Le Gall et al. [4] plotting average interdune fraction with latitude for a broad cross section of Titan (T21, T23, T25, T28, T43, T44), as latitude increases to the north interdune fraction also increases. B) A plot of interdune fraction with latitude for the T25 swath only, using 2326 measurements from our new method of measuring dune spacing. Results are consistent with Le Gall et al. [4], with a stronger trend apparent from -8 º to -18º latitude.

Conclusions: Our average of dune widths and spacings for isolated regions in the Fensal and Belet sand seas and our average interdune fraction vs. latitude are consistent with previous studies. Results from this study and those from Le Gall et al. show interdune fraction percent increases with increasing latitude, perhaps a result of increasingly damp conditions toward higher latitudes, especially toward high northern latitudes [4,11]. We plan to complete measurements of all dunes in the T8 swath, the Belet Sand Sea, a region lacking parametric measurements. This will help expand the database of dune parameters across Titan. It will also help us make inferences about Titan's long-term climate and dune stability conditions and could be used to help us understand similar processes on Earth.

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