LENGTH, ORIENTATION AND SPACING OF LINEAR DUNES IN THE SHANGRI LA SAND SEA, TITAN. D. Rose[1], J. Radebaugh[1], E.H. Christiansen[1], B. Lake[1]. [1]Department of Geological Sciences, Brigham Young University, Provo, UT (janirad@byu.edu).

Introduction: Dunes exist on several bodies in our solar system, including Saturn's moon Titan [1]. Radar imagery from NASA's Cassini mission revealed large seas of linear dunes inhabiting Titan's equatorial regions (30° S to 30° N) [1, 2, 3]. Linear dunes form with their long axes aligned to the average wind direction, and are good indicators of wind and other climate processes in areas where they form [4, 5]. Studies of the dunes on Titan have revealed that winds at the equator blow from west to east [6, 7]. Linear dunes also require a fairly large sand supply [8], leading to questions about the origins of the organic material that make up Titan's dunes [9]. Dune parameters, such as length, width, spacing and orientation, have been used to examine various aspects of dune behavior on planetary surfaces, such as sand availability [10], topographic effects [11] and dune field maturity, or the time it has resided in a set of conditions [12, 13]. NASA is planning a future mission, Dragonfly, to land on and travel across Titan's surface and investigate the Shangri-La sand sea (Fig. 1), so we seek to understand as much as possible before it arrives.

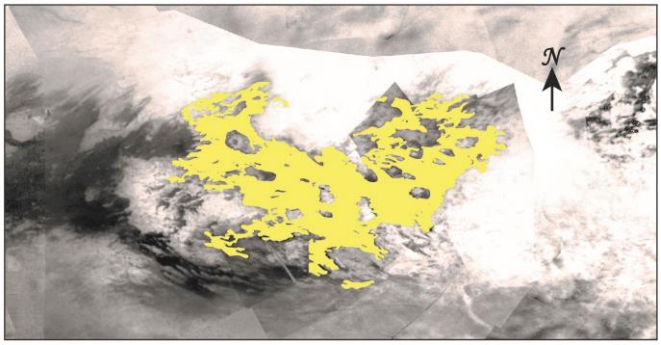

Figure 1. ISS image of Titan's surface. The Shangri La sand sea is outlined in yellow. The Shangri La sand sea is the focus area of this study.

This study focuses on the lengths, orientations and spacings of dunes in Shangri La, establishing basic statistical data for each of the measurements as well as examining what these data reveal.

Dune Length: Dune length was measured in ArcGIS by tracing linear dunes expressed as Cassini SAR (Synthetic-Aperture Radar)-dark lines in SAR image strips to create a line-based shapefile. About 50-54% of the dune field was available to be traced. Previous studies have traced dunes from end-to-end [6, 7, 14] or in a global survey [15]; this study measured every visible dune in as much detail and fidelity as possible (Figure 2). Variations in SAR resolution at the edges of SAR strips and general SAR coverage meant that about 3.6% of the dunes that were traced represent cut-off dunes and/or inaccurate lengths. Geodesic length was calculated for each line in ArcGIS, giving an average length of 36.4 km, a maximum length of 404 km and a minimum of 2.2 km. Dune lengths in Shangri-La are right skewed (Fig. 3): dunes below 25 km in length are most prevalent. The majority of the dunes lie between 6 and 24 km, with an average length of 15 km (Fig. 3 inset). Long dune lengths suggest a large sand supply for the Shangri La dune field [10], and likely also indicate large amounts of available space to trap sand and grow dunes [8]. An apparent lack of surface liquid in the equatorial regions allows for dune fields to spread and grow very large, in comparison to Earth where surface liquid constrains dune field morphology [16].

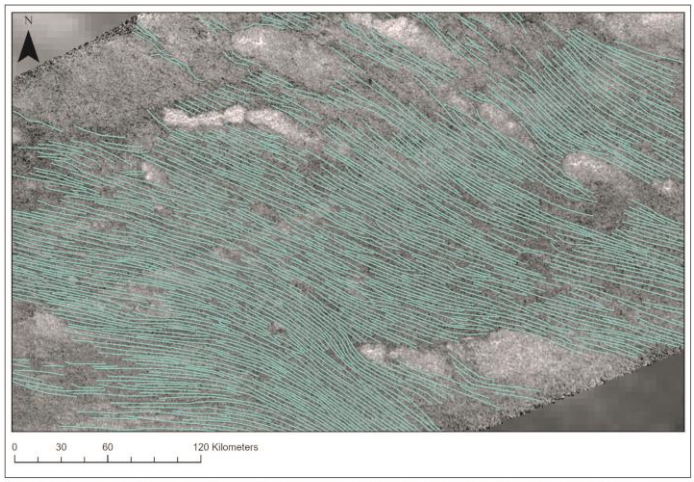

Figure 2. Example area where dunes were traced as accurately as possible on a SAR strip. This area is typical of dune-tracing throughout Shangri La for this project.

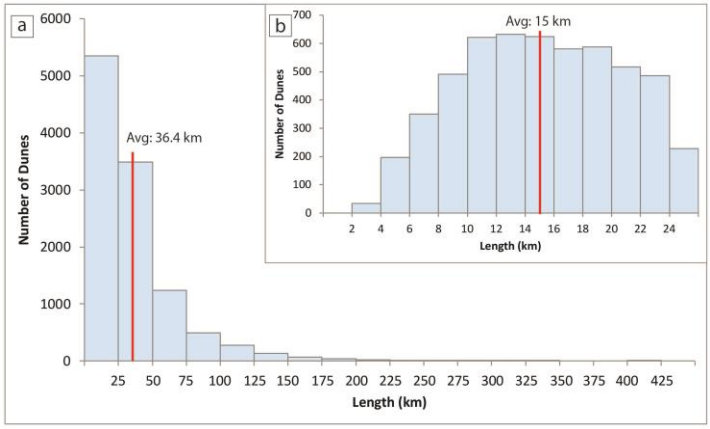

Figure 3. a) Dune lengths are right skewed. b) Lengths below 25 km are most prevalent.

Dune Orientation: Orientations were calculated by applying the Linear Directional Mean tool in ArcGIS to the line shapefile, then converting the resulting vector dataset to an X-Y point cloud and interpolating average compass direction over the dune field area. The

interpolated map (Fig. 4) shows average compass direction for the dunes in Shangri-La.

Visible patterns include a noticeable split between north- and south-facing dunes on the far right edge of Shangri La, where the dune field abuts the Xanadu region. Dunes along the northern edge of the dune field trend northward, along with dunes on the western edge. The bulk of the dune field has east-west oriented dunes (purple-orange).

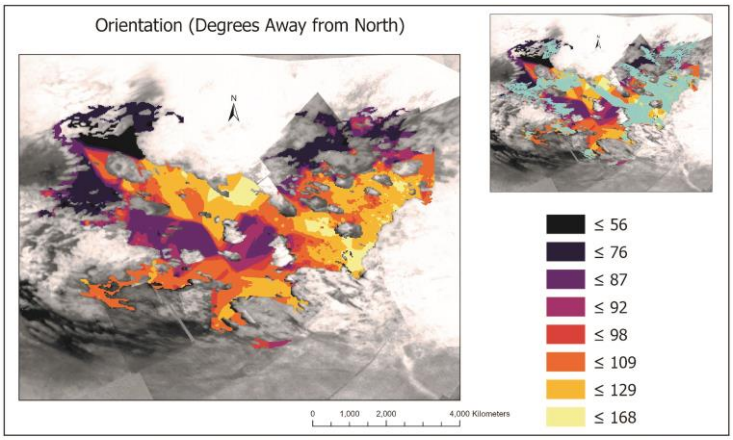

Figure 4. Inverse Distance Weighted (IDW) interpolation for the Shangri-La dunefield in degrees from north. Traced dunes shown in blue.

Dunes have an average orientation of 101.5° from north, consistent with other studies westerly sand-transporting winds. More detailed study of dune orientation has the potential to provide a deeper understanding of atmospheric processes at the surface of Titan, as well as how dunes interact with underlying topography.

Dune Spacing: Average dune spacing was calculated by tracing new lines perpendicular to the dunes, each line crossing 10 traced dunes. The average spacing determined across each 10 dune span was retained as a point centered on the spanning line and was used to create an interpolation map in the same manner as the orientation map. (Fig. 5). Smaller spacing values are yellow and larger spacings are red. Values are averages and measurement lines are not evenly spread over the dune field, so this map serves only as a general indicator of spacing. Only a portion of the Shangri La dune field has been measured thus far.

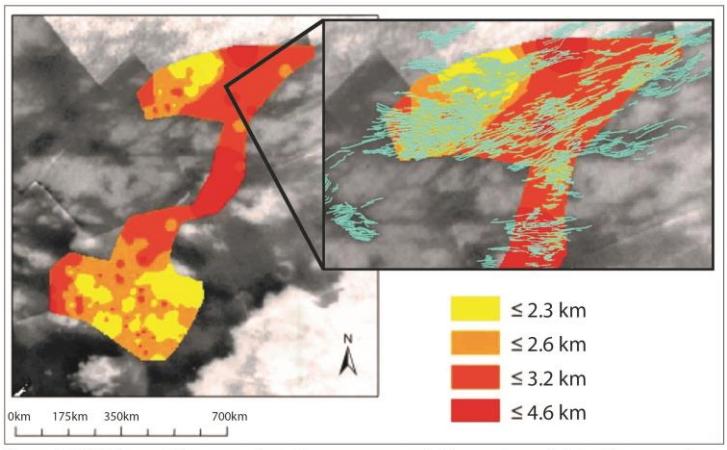

Figure 5. IDW Interpolation map of spacing measurements. Dunes shown in blue for comparison. Map represents only a small portion of the Shangri La sand sea.

The average spacing for the measured area (Fig. 5) is 2.5 km, with a maximum of 4.6 km and a minimum of 1.6 km. The most frequent average spacing values occur between 2 and 3 km (Fig. 6). These values agree well with previously measured spacings of 1 to 3 km on Titan [1, 2, 13, 14, 16].

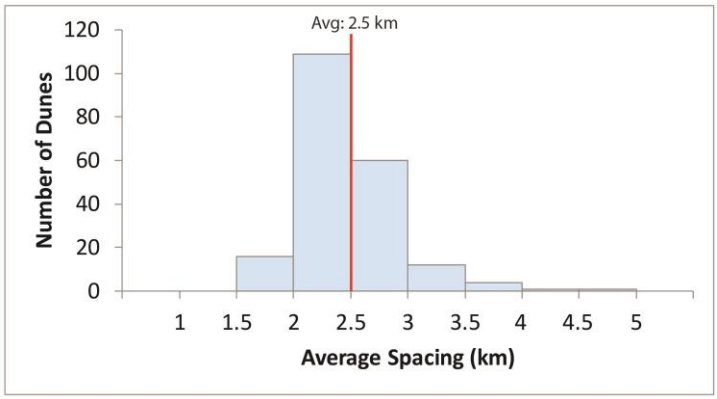

Figure 6. Histogram showing dune spacing lengths. Data is slightly right-skewed.

Spacing of linear dunes may be affected by obstacles and position in the sand sea [14]; more detailed measurements of dune spacing could reveal possible correlations relating to sand supply and interactions with underlying topography.

More detailed statistical regressions [e.g. 16] on this new dataset should yield important information on sand collection in Shangri-La.

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