SPATIAL VARIATIONS OF DUNE PARAMETERS AND RELATIONSHIP TO ELEVATION AND GEOGRAPHIC POSITION WITHIN THE BELET SAND SEA. B. Bishop[1], R.C. Lewis[1], J. Radebaugh[1], E. H. Christiansen[1]. [1]Brigham Young University, Department of Geological Sciences, Provo, UT 84602, b.radleybish87@gmail.com, corbinlewis13@gmail.com.

Introduction: Eolian dune fields found within Titan's equatorial region between +30° latitude cover approximately 15-17% of the moon's surface [1,2]. These dominantly linear dunes are similar in form, size, and radar reflectivity to the large dunes of the Namib, Saharan, Saudi Arabian, and Australian deserts [3, 4]. Terrestrial dune patterns and their variation in width and spacing are the surface expression of the inputs (sediment supply, wind velocities, and topography) controlling the formation and dynamics of the dunes [5, 9]. Analysis of parameters such as dune width and spacing has revealed important aspects of dune-forming processes, regional conditions and relative ages of geomorphic features for Earth [7], Mars [9] and Titan [8]. These studies help us better understand surface-atmosphere interactions, to potentially reveal sediment sources and further constrain sediment transport patterns [7, 8, 9, 10, 11].

Approach: Within Titan's dune fields, initial studies of dune parameters utilizing a broad, global approach have shown that dunes are generally wider at low latitudes (with an inflection point at 7° S) [2, 4, 8, 12, 13] However, the evolution of dune width and spacing as material is transported in the migration direction (west to east) through a given sand sea system is not as well understood on Titan [13]. Likewise, the relationship between dune width and spacing with regional elevation and local topographic obstacles is not well constrained. Using data gathered from Cassini's Synthetic Aperture Radar (SAR), we analyzed the morphometric variation in dunes across one of Titan's major sand seas, Belet.

The Belet Sand Sea is located on Titan's trailing hemisphere between -30° and 25° latitude and 65° and 150° W longitude, and is in a topographically low basin approximately -600 m in elevation [15] (Fig. 1). [4] and [2] describe Belet as the largest sand sea on Titan with an estimated area of 3.3 $\pm$ 0.6 million km^2 and a sand volume of 610,000-1,270,000 km^3, double the size of the combined Arabian sand seas on Earth. Compared to other Titan sand seas, the dune forms in Belet are tightly spaced, exceptionally straight and long and have SAR-dark, sand-rich interdunes in the center of the sand sea [14, 3, 4].

Using a new method developed in ArcMap 10.3 we produced approximately 90,000 new width and spacing measurements in Belet. We incorporated these new measurements with previously collected data across T21 and T8 in our analysis [2, 13]. The SARTopo and altimetry values are averaged into 100 km^2 bins, according to the approximate horizontal resolution [19, 22] (Fig. 1). To allow for greater precision, we are currently only including elevation data that overlaps with dune width and spacing measurements.

Results and Discussion: In Belet, average dune widths are smallest at approximately 10° - 20° N latitude and greatest at approximately 10° - 20° S latitude. This slightly differs from the previously established trends for a global correlation between dune width with latitude (Fig. 2) [2, 4, 8]. Dune widths also show an east-west trend over the Belet region with the larger widths located at approximately 100° - 110° E longitude. The analysis of dune width as a function of elevation shows almost no dependency (Fig. 3). Widths show a very weak dependence on distance from the sand sea margin (fig. 4) Dune patterns in Belet appear to vary as a function of either latitude, longitude, distance from the sand sea margin, or elevation. However,

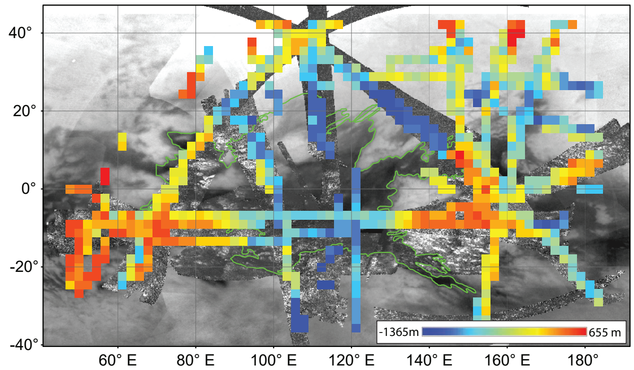

Fig. 1 The estimated maximum extent of the Belet Sand Sea is outlined in green [2]. SARTopo and altimetry data overlie SAR (Synthetic Aperture Radar) swaths with Imaging Science subsystem (ISS) basemap . The topographic data are mapped over the Belet region through T95, and are referenced to the geoid as characterized by [18]. The total number of data points (z = 443,650) is reduced to 8,586 after spatially-joining average values per 100 km^2 bins, given that the horizontal resolution is approximately 10 km [19, 22]. SAR data: T08 , 28 Oct, 2005, T21 , 12 Dec, 2006, T49, 21 Dec, 2008, T61, 5 Aug, 2009.

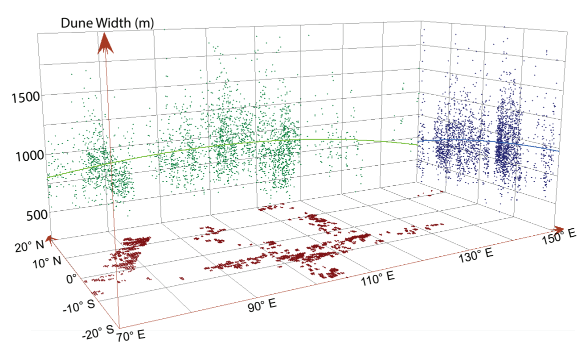

Fig. 2 Dune width measurement locations across the Belet Sand Sea are shown in red and the width values are plotted on the Z-axis. Y-axis is latitude. X-axis is longitude. The second order polynomial trends show the largest dune widths tend approximately toward the geographic center of the Belet region.

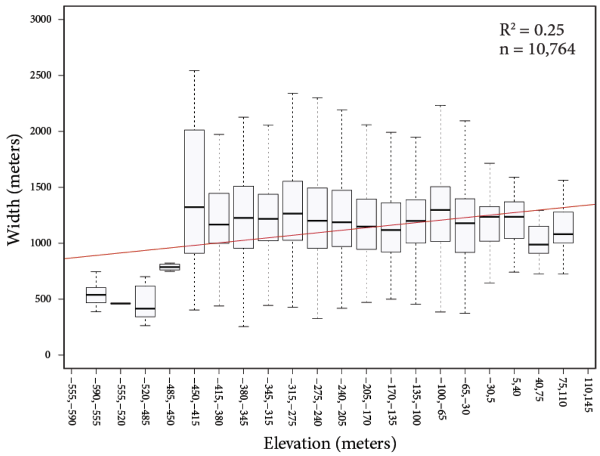

Fig. 3 The dune width and spacing distributions for the Belet Sand Sea are plotted as a function of elevation (bin size = 35 m). Linear regression is derived from the width and spacing means. The nearly non-existent trends over the dataset indicate that more localized factors such as shorter wavelength topography are more effective in forming dune patterns compared to large scale changes in elevation [15].

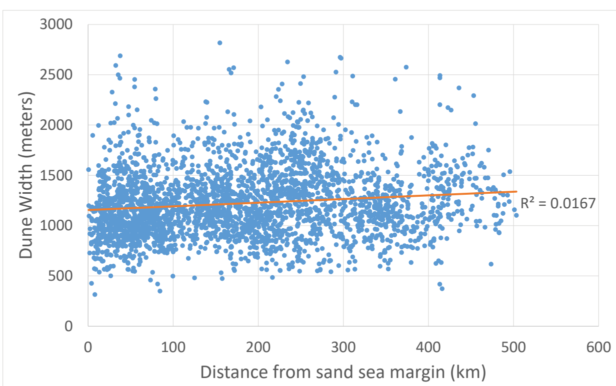

Fig. 4 Dune widths across the Belet Sand Sea plotted as a function of distance from the nearest sand sea margin. Dune widths tend to increase slightly with increasing distance from the margins.

it is more likely the variation is due to some combination of these boundary conditions [9]. The box plot also demonstrates the variability in width distribution as a function of elevation. Notice that different positive and negative trends exist for particular elevation intervals. This may be due to the influence of local topographic obstacles disrupting dune patterns on a relatively smaller scale. Because dunes will sometimes flex around, or thin over obstacles, the impact of slope must also be considered (Fig. 5).

Conclusions: New analyses of dune widths in the Belet Sand Sea corroborate the global correlation between decreasing dune width and latitude. Additionally, we find that variation in dune width and spacing is not only influenced by elevation at the regional scale, but it is also strongly influenced by the local scale and slope of topographic obstacles. Parametric analysis of dune paramaters provides valuable insight to understanding Titan's surface and atmosphere, and how the interaction of these factors influence sand transport patterns. We will continue mapping dune patterns across Belet and potential relationships with boundary conditions such as elevation, geographic position, obstacle interaction, and distance from upwind/downwind margins to further characterize Titan's sediment transport system.

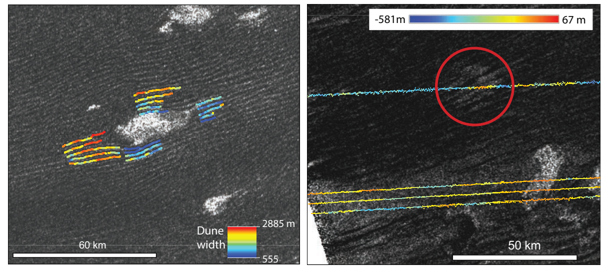

Fig. 5 Left: Radar dark dunes are diverted around the bright topographic obstacles as the dunes migrate from west to east. The variation in dune width measured around the obstacle suggest a dependence on distance and/or relative position to topographic obstacles. ***Right:*** SARTopo profile overlaid on SAR imagery. The data contained in the red circle illustrate how dunes can thin and become more widely spaced when interacting with elevated terrain. This phenomena may be explained by the elevated feature inducing compression and acceleration of wind flow and consequently an increased transport capacity and a net loss of material [4].

References: [1] Rodriguez et al., (2014) Icarus 230, 168-179. [2] Arnold K. 2014 MS Thesis, BYU. [3] Lorenz, R.D. et al., (2006) Science 312, 724-727. [4] Le Gall, A. et al., (2011) Icarus 213 , 608-624. [5] Lancaster (1995) Routledge. [6] Lancaster, N. (1989) A.A. Balkema Rotterdam Brookfield. [7] Ewing, R.C., et al., (2006) Earth Surface Processes and Landforms 31, 1176-1191. [8] Savage, C.J. et al., (2014) Icarus 230, 180-190. [9] Ewing and Kocurek (2010) Geomorph 114, 175-187. [10] Barnes, J.W., et al., (2015) Planetary Science 4:1. [11] Malaska M. et al., (2015) Icarus in press. [12] Mills, Radebaugh and Le Gall 2013 LPSC Abst. 2305. [13] Williams and Radebaugh, J. (2014) DPS Abstracts. [14] Radebaugh J. et al., (2008) Icarus 194, 690-703. [15] Lorenz, R.D. et al., (2013) Icarus 225, 367-377. [16] Kocurek and Ewing, (2005) Geomorphology 72, 94-105. [17] Radebaugh et al., (2010) Geomorphology 121, 122-132. [18] Iess et al., (2010) Science 327, 1367 - 1369. [19] Stiles et al., (2009) Icarus 202, 584-598. [20] Lorenz et al., (2014) Icarus 230, 77-80. [21] Le Gall et al., (2012) Icarus 217, 231-242. [22] Zebker et al., (2008) Icarus 194, 704-710.