A COMPARATIVE ANALYSIS OF SEDIMENT TRANSPORT AND DEPOSITION TRENDS OF THE SAND SEAS OF EARTH AND TITAN. R.C. Lewis[1], B. Bishop[1], J. Radebaugh[1], E.H. Christiansen[1]. [1]Brigham Young University, Department of Geological Sciences, Provo, UT 84602, corbinlewis13@gmail.com

Introduction: Saturn's moon Titan has striking geomorphological similarities to Earth including a pervasive set of eolian landforms. For example, large linear dunes form in sand seas on both. Sand seas are sedimentary bodies that are transported and deposited by eolian processes [1]. On Titan, the sand seas are concentrated in the equatorial region and are very large; for example, Belet sand sea is approximately 3.3 ± 0.6 million km^2 and has a sand volume of 610,000-1,270,000 km^3 [2,3,4]. Most present day terrestrial sand seas are significantly smaller than sand seas on Titan. The largest sand sea on Earth, the Rub' al Khali, covers an area of ~560,000 km^2 [5]. The latitudes of sand seas on Earth also vary much more than sand seas on Titan

Despite different atmospheric and compositional differences, the similarity in the shape, size and spatial trends of linear dunes of the Namib, Arabian, and Australian deserts and the Belet Sand Sea of Titan suggest that the comparisons with them will yield a better understanding of Titan's dunes [6,7,8]. The morphology of the linear dunes indicates necessary wind direction and strength and sediment supply [6]. The morphology and spacing of dunes reflect changes in sand supply and wind conditions [9]. Previous studies of dune width and spacing trends have provided insights into dune-forming conditions on Earth [10,11] and Titan [12]. An in-depth study of elevation and its influence on width and spacing trends of the linear dunes of Earth and Titan will lead to a better understanding of surface-atmosphere interactions.

Approach: A previously established trend within Titan's dune fields is that dune widths are generally greater at low latitudes, which generally correlates with the centers of the sand seas [4,8,12,13,14]. However, the influence of elevation or locations of sand sea boundaries on dune width and spacing is not as well understood on Titan or Earth. Our new method allows for large data collection and better spatial correlation across the sand seas. Using images collected by Cassini's Synthetic Aperture Radar in Arcmap 10.3, we developed a system for measuring width and spacing over large areas every 500 meters along each dune. The data are collected by measuring the distance between segmented lines that trace along dark and bright radar boundaries, indicative of dune margins. The width and spacing measurements, on Titan's surface, are then correlated with elevation data obtained from a global topographic map [15]. We are currently using this method in the Belet Sand Sea on Titan (T49, T61, T91), in conjunction with previously collected data across T21 and T8, and have

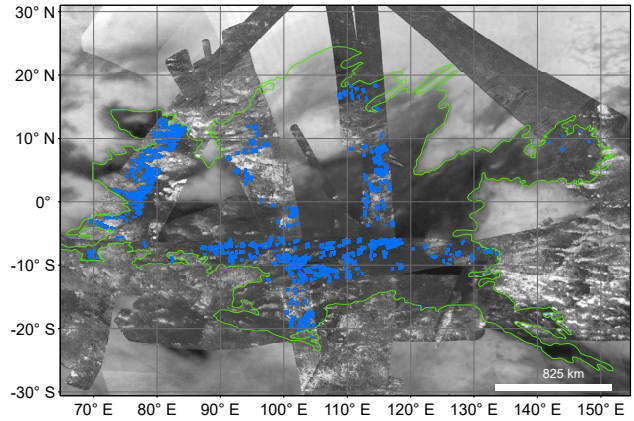

Fig. 1 Width and spacing measurements in the Belet Sand Sea. *The estimated maximum extent is in green and the locations of the dune width and spacing measurments are in blue.*

begun collecting measurements in the Namib Desert on Earth for comparison. We will apply this method to an additional terrestrial sand sea, the Rub' Al Khali. Using this method on Titan and Earth will allow for an in depth quantitative comparison. In addition to understanding spatial trends, we will also compare influential characteristics of the sand seas such as proximity to the sand sea margin and elevation.

Results and Discussion: Titan's main dune fields occupy the lowest elevation areas in the equatorial regions, with the exception of Xanadu [16]. In the Belet Sand Sea, we see a trend of decreasing width and spacing with increasing elevation from the center to the eastern margin, which is also the migration direction, through the system. Larger widths and spacings tend to concentrate towards Belet's center. There are larger dune-to-interdune ratios at lower elevations across Titan [17]. This could be a result of lower elevation in this location or perhaps lower wind velocities, both

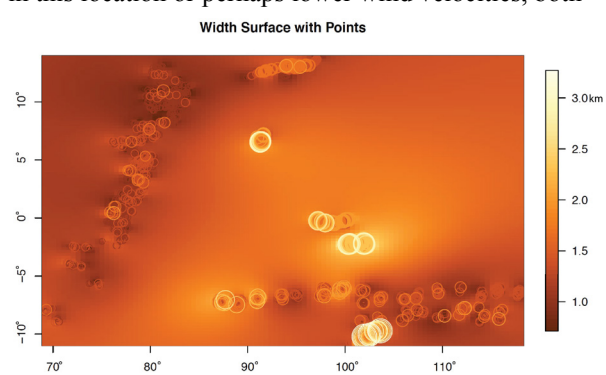

Fig 2. Dune widths and interpolated elevation data of the Belet Sand Sea. *Dune widths are represented by colored rings. The brighter and larger rings represent greater widths. Greater widths concentrate near the center of Belet.*

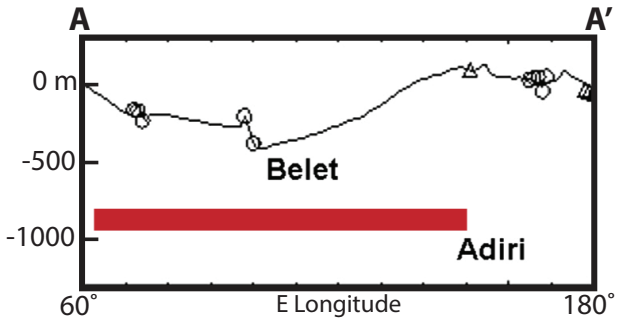

Fig. 3 Profile of interpolated surface height along 0° latitude. *The red bar shows the approximate extent of the Belet Sand Sea. The circles represent SARtopo measurements and the triangles indicate altimetry measurements.*

of which would cause greater sediment accumulation versus bypassing [17,18]. The eastward increase in elevation in the eastern portion of Belet (Fig. 2) may have a strong effect on the dune spatial trends. Preliminary measurements in the Namib Sand Sea suggest a weak relationship between dune width and elevation. In fact, the location of greater dune widths corroborates results of previous studies, which show the largest widths are in the center of the dune field [18]. This may suggest influence by variables other than elevation such as proximity to the sand sea margin.

Due to the dominance of linear dunes on Titan, it appears that sediment supply and wind source are more consistent on Titan's surface than on Earth, where we observe many different types of dune forms within sand seas. Titan's wind strength and direction may be consistent over longer time periods than on Earth. A sign of dune field maturity is uniform dune morphology [10,12]. Also, small dunes form in short periods of time while long-term, consistent wind conditions produce large dunes [19]. In the Namib Sand Sea, the dominant linear features are likely very old, possibly as old as the Pliocene, but are superimposed by younger features such as flanking linear and crescentic dunes [10]. Sediment supply is also a likely factor leading to the dominance of linear dunes on Titan. Linear dunes generally form where sand supply is small [20], however, there can be a range of sediment supply.

Conclusions: New analyses of dune widths in the Belet sand sea support the correlation between dune width and latitude. Larger dune widths and spacings in the center of the Belet Sand Sea suggest that the elevation of the topographic basin constrain dune size. In the Namib, new analyses of dune widths confirm that the greatest dune width and sediment accumulation are near the center of the dune field, suggesting the proximity to dune field margin, in addition to elevation, exerts a control on dune morphology. Further analyses of dune parameters in relation to these controls, and the further delineation of these variables, will allow for a better understanding of sediment transport and deposition patterns in sand seas on Earth and Titan.

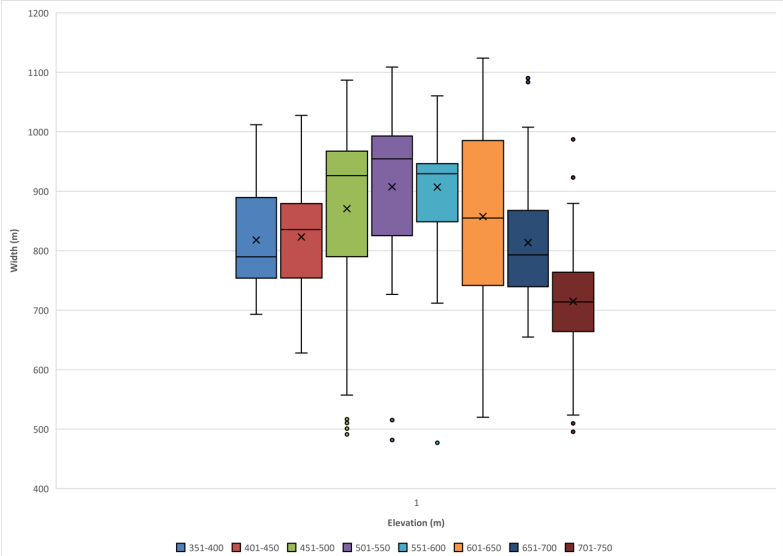

Fig. 4 Box and whisker plot of dune width according to elevation in the Namib Sand Sea. *X represents the mean. The horizontal axis is elevation (351-750 m). Elevation is divided into 50 m bins. Elevation generally increases west-east. The vertical axis is dune width (400-1200 m).The greatest widths occur near the middle of the sand sea at elevations of 500-600 m.*

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