A COMPARATIVE ANALYSIS OF SEDIMENT TRANSPORT AND DEPOSITION TRENDS OF THE NAMIB SAND SEA AND BELET ON TITAN. R.C. Lewis[1], J. Radebaugh[1], E.H. Christiansen[1], E.S. Tass[2], A. Le Gall[3]. [1]Brigham Young University, Department of Geological Sciences, [2]Brigham Young University Department of Statistics, Provo, UT 84602, corbinlewis13@gmail.com, [3]LATMOS, Paris, France.

Introduction: Saturn's moon Titan has striking geomorphological similarities to Earth, including a pervasive set of eolian landforms. On both bodies, large linear dunes form into sand seas, which are sedimentary bodies transported and deposited by eolian processes [1]. On Titan, the sand seas are concentrated in the equatorial region and are very large; for example, the 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 those 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, which is likely a reflection of climatic conditions related to Hadley circulation [6].

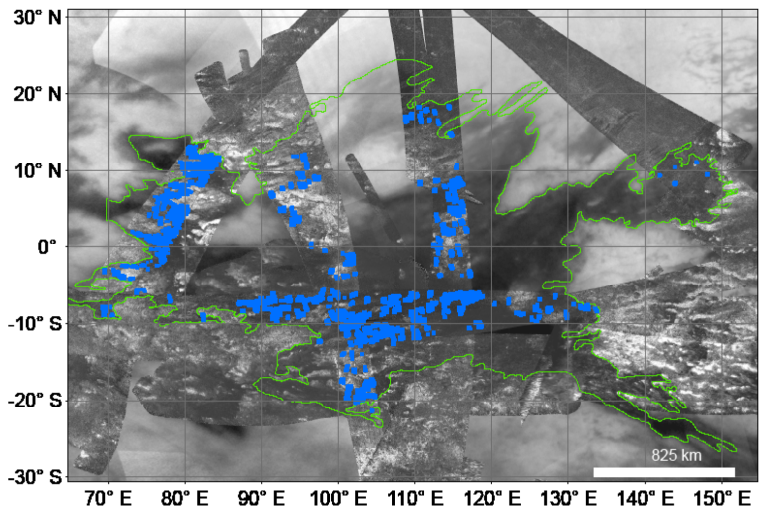

Fig. 1 Width and spacing measurements in the Belet Sand Sea. *The estimated maximum extent is in green and the locations of the dune width and spacing measurments are in blue.*

However, despite different atmospheric and compositional differences, the similarity in the shape and size of linear dunes of the Namib, Arabian, and Australian deserts and the Belet Sand Sea of Titan suggests that comparisons with them will yield a better understanding of Titan's dunes [6,7,8]. The morphology of linear dunes indicates there is the necessary wind strength and direction (with vector winds approximately down the dune) [9,10] and sediment supply [6]. It is thought that the morphology and spacing of dunes could reflect changes in sand supply and availability and wind conditions [11]. Previous studies of dune width and spacing trends have provided insights into dune-forming conditions on Earth [12,13] and Titan [14]. Other factors may also influence the transport of sand, and be reflected in width and spacing trends. An in-depth study of underlying elevation differences and distance from the sand sea margin and their influence on width and spacing trends of the linear dunes of the Namib and Belet sand seas will lead to a better understanding of surface-atmosphere interactions.

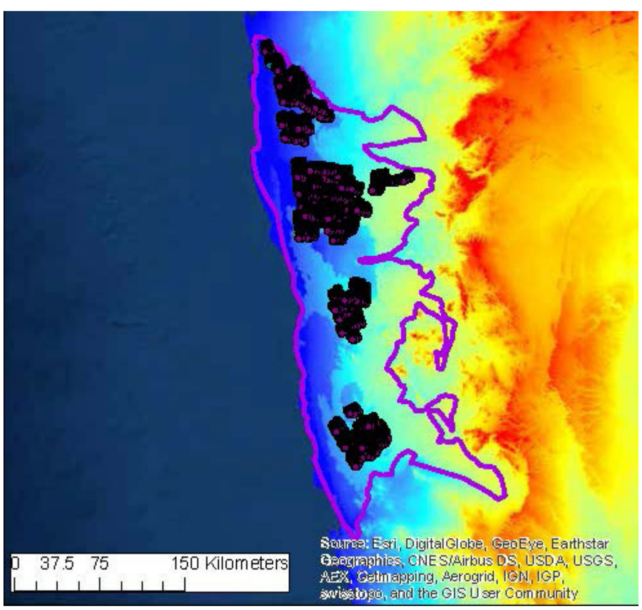

Fig. 2 Dune width and spacing measurements in the Namib Sand Sea of southwest Africa*. The sand sea margin is in purple. The points represent measurement sites. SRTM elevation data is represented by the colored heat map.*

Approach: A previously established trend of dune parameters within Titan's dune fields is that dune widths are generally greater at low latitudes, which also generally correlates with the centers of the sand seas [8,14,15,16]. 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 [17]. Our new method allows for rapid collection of large data sets 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 are then correlated with elevation data and distance from the sand sea margin while controlling for correlation in measurements due to spatial proximity. We used this method in the Belet Sand Sea in conjunction with previously collected data (Fig. 1) and have made similar measurements in the Namib Sand Sea for comparison (Fig. 2). Using this method on Titan and Earth allows for an in depth quantitative comparison.

Results and Discussion: Titan's main dune fields occupy the lowest elevation areas in the equatorial regions, with the exception of Xanadu [18]. There are larger dune-to-interdune ratios at lower elevations across Titan [19]. However, these new analyses of width and spacing according to elevation reveal no statistically significant trends in Belet alone. Additionally, width and spacing according to distance from the closest sand sea margin have no significant trends.

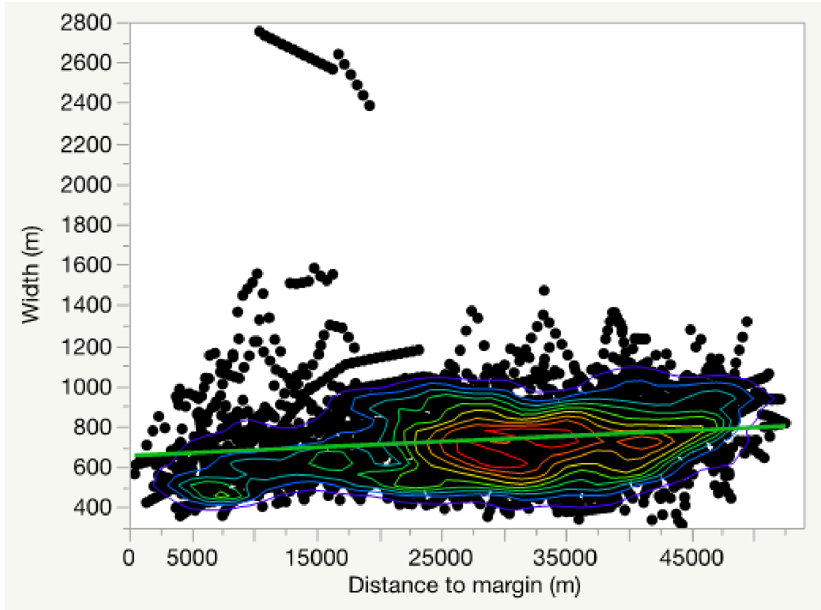

Fig. 3 Dune width according to distance from the sand sea margin in the Namib Sand Sea*. The colored rings are 10% quantiles. The best fit line has an r2 value of 0.023674 and a p-value of 0.005.*

Measurements in the Namib Sand Sea yield significant correlations of width (Fig. 3) and spacing according to distance from the closest sand sea margin as well as in width according to elevation. Additionally, there are significant trends in spacing according to latitude and longitude as well as in width according to longitude; dune width increases with distance from the western coastal margin. This suggests a relationship with proximity to the sediment source, which for the Namib is from the Orange River in the south and the southwest coastline due to longshore drift. The location of wider dunes corroborates results of previous studies, which show the widest dunes are in the center of the sand sea [20]. In the Namib, this suggests influence by variables other than elevation, such as being located in the center, away from the sand sea margin, where sand can collect and dunes can form unobstructed [20].

Linear dunes are dominant on Titan. Titan's wind strength and direction may be stable over longer time periods than on Earth. A sign of dune field maturity, or the self-organization of dunes over time, is uniform dune morphology [12,14], which Titan has. This may indicate that Titan's dunes are much older [14]. Also, small dunes form in short periods of time while long-term, consistent wind conditions are required to produce large dunes [21]. 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 [19,22]. Perhaps Titan's dunes have been similarly forming for many millennia [14].

Conclusions: In the Namib, new analyses of dune widths with elevation and distance from the margins confirm that the greatest dune width, and likely sediment accumulation, are near the center of the dune field. This suggests the proximity to sand sea margin, in addition to elevation, exerts a control on dune morphology. Analyses of Belet reveal no new comparative correlations with these controls. This may suggest a more mature system evolved away from these controls, or more data should be acquired. Further analyses of dune parameters in relation to these controls will allow for a better understanding of sediment transport and deposition patterns in sand seas on Earth and Titan.

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