COMPARATIVE ANALYSIS OF LONGITUDINAL DUNES ON SATURN'S MOON TITAN AND THE NAMIB DESERT, NAMIBIA. C. Spencer[1], J. Radebaugh[1], R. Lorenz[2], S. Wall[3], J. Lunine[4], and the Cassini Radar Team, [1]Brigham Young University, Department of Geological Sciences, Provo, UT 84602 *spenchristoph@gmail.com*, [2]Johns Hopkins University Applied Physics Lab, Laurel, MD, [3]Jet Propulsion Laboratory, 4800 Oak Grove Dr., Pasadena, CA 91109, [4]Lunar and Planetary Laboratory, Univ. of Arizona, Tucson, AZ 85721.

Sand Seas on Titan: Beginning in 2005, the Cassini Titan Radar Mapper has discovered sand seas made of thousands of longitudinal dunes in the equatorial regions of Saturn's Moon Titan [1,2,3]. The dune forms observed by Cassini are similar in morphology and scale to longitudinal dune fields found on Earth [2,4,5,6]. These dunes are concentrated in the low latitudes and appear to cover as much as 40% of these terrains and 20% of Titan's total surface [4,5,6]. The longitudinal dunes of Titan have heights of roughly 100 meters, widths of 1-2 kilometers and lengths from <5 to nearly 150 kilometers [2,3,4,5].

In order to better understand the formation of these landforms and the implications for wind strength and direction on Titan, we analyze similar features found in the Namib Desert on Earth.

Namib Desert Geography and Climate: The Namib Desert is located on the southwest coast of Namibia in southwest Africa. For the most part the desert is composed of a massive sand sea covering over 34,000 km^2 [7]. The sand sea is made up of mostly longitudinal or linear dunes with minor transverse, barchan, and star dunes [7]. Precipitation in the Namib Desert ranges from 15mm/yr to the south, 14mm/yr to the north, and 23mm/yr in the interior. The Namib has a general wind direction from south-southwest to southwest along the coast and swings around inland southwest to west southwest for the greater part of the year (January to March and October to December); however, during April to September periodic winds blow from the north-northeast to east-southeast [8].

Longitudinal Dunes of the Namib Desert:

The longitudinal (linear) dunes of the Namib Desert range in size between 100-150 meters high [9] and between 1-3 kilometers apart (measured from Landsat photographs and [7]). These dunes are extremely large in comparison to other longitudinal dunes around the world, which reach only 15-35 meters high [7]. In comparison to the dunes on Titan the dunes in Namibia come closest in comparison considering their size and morphology. Where sand supply is less and/or topography creates an obstacle, barchan, transverse, and star dunes are also present with parabolic (blowout) dunes near the shoreline south of Walvis Bay.

Dune Interaction with Topography: Within the sand seas on Titan we see how the dunes interact with the surrounding topography; diverging and converging around highlands and narrowing together between two near-by highlands [5] (Fig. 1). Similar features are seen in the Namib Desert. Where sand supply is low and/or topographic obstacles are present, longitudinal dunes dominate, with only minor transverse dunes [2,5].

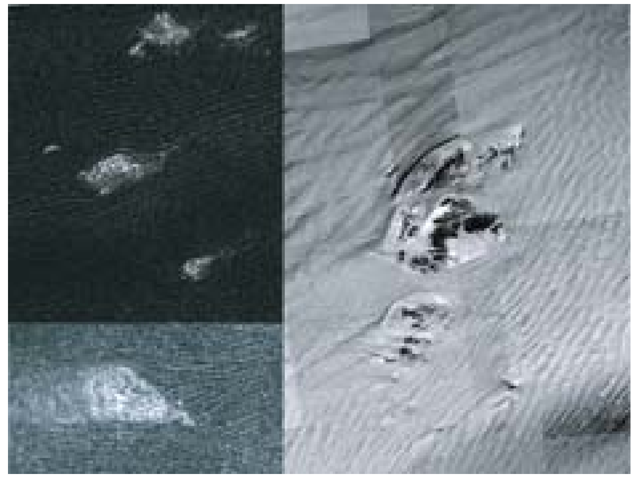

Fig. 1. Dune/topography interaction on Titan (left) and Earth (Namib) (right).

Dynamics of Longitudinal Dunes: It has been widely accepted that two principal wind directions perpendicular to one another are responsible for the formation of the longitudinal dunes; however, much controversy has surrounded the formation of these dunes [7,10,11]. Unidirectional wind hypotheses were proposed in earlier years, but have since been discredited [7,11].

The term longitudinal or linear dune was sub-divided by [11] into lee dunes (small dunes that form behind an obstacle), vegetated linear dunes (covered by vegetation with a rounded profile), and seif dunes (forms from bidirectional winds). Because in the Namib Desert and on Titan we have neither dunes covered with vegetation nor small dunes forming behind obstacles, the most compelling hypothesis for the formation of these longitudinal dunes is the bidirectional wind hypothesis. From the formation of longitudinal seif dunes, it is affected by wind blowing obliquely from both sides of its slopes, meeting the dune at an acute angle and separated over the crestline. Each wind is diverted at the lee slope to blow parallel to the crest in a down-dune direction [11]. Evidence for this hypothesis comes from many different longitudinal dune fields around the Earth, including Australia [13], Namibia [7], and the Sahara [14].

Comparative Analysis of Dune Forms on Earth and Titan: Similarities in the presumably ongoing behavior of dunes around topography on Titan and in the Namib can be seen in Fig. 1. We also seek to understand the evolution of Titan's dunes to their current state. Some have claimed [11,12] some longitudinal dunes are the products of the evolution of barchan and transverse dunes seen in many parts of the world's deserts [15,16,17] including Namibia [8] and the Rub al-Khali (Fig. 2). Due to the lack of barchan and transverse dunes on Titan the analog might fall short. However, because waves and/or fluvial processes eventually destroy the longitudinal dunes on Earth, we are unable to see these dunes in an advanced, evolved state. Conversely, if the dunes on Titan originally began as barchonoid and transverse dunes only to evolve into longitudinal dunes, and with no wave and minor fluvial processes to speak of in the region of the dunes, these dunes will have continued to migrate around the equatorial regions of the planet developing into what can be considered highly evolved and mature dune forms that we see now. This is not the only way in which linear dunes develop [7,10], but due to the apparent lack of other dune types on Titan, this method may be most applicable.

Because the dunes forms seen in the Namib Desert are so similar to those on Titan, a detailed macro- and microanalysis of these dunes on Earth will enable a more concise model for the genesis, evolution, and morphology of the dunes found on Titan.

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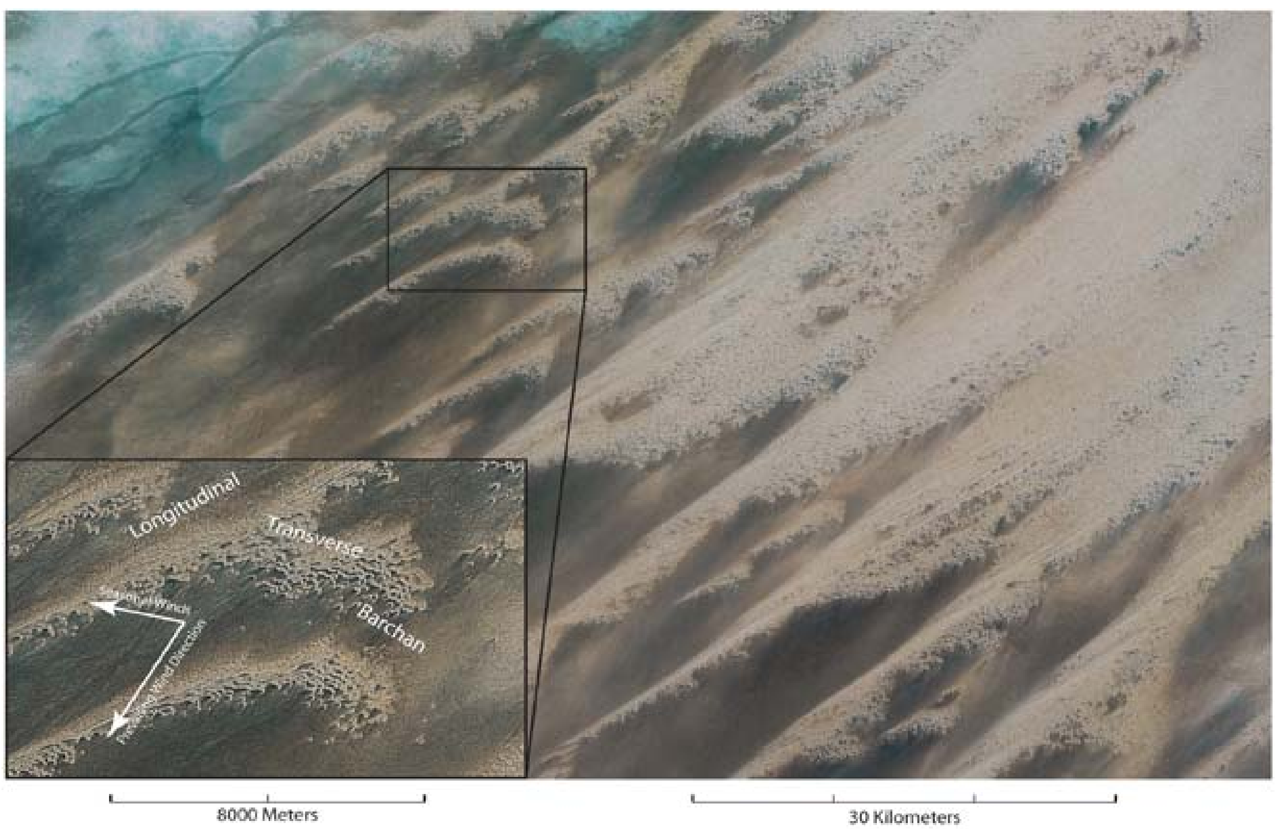

Fig. 3.: Satellite Image of the Rub al Khali, Saudi Arabia. Note the evolution of longitudinal dunes from barchan and transverse dunes. Wind directions obtained from: Dabbagh e.a. 1997. JPL Unpub: http://southport.jpl.nasa.gov/reports/finrpt/Dabbagh/dabbagh.htm.