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Sand Dune Elevations on the Earth, Mars, and Titan

Deirdra Fey

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Introduction

Sand dunes are observed on many places in the solar system. They are found on bodies with atmospheres and are formed through wind processes. Dunes can tell us about the geological process on the planets they inhabit. Dunes are found on many worlds, including Earth, Mars and Titan. For Titan, the dunes are a major geologic feature, covering most of the equatorial region. Titan's sand dunes are at a much higher elevation than the rest of the surface. By comparing the dune elevations of Mars and Earth, we hope to determine the reason for the higher than average dune elevations on Titan.

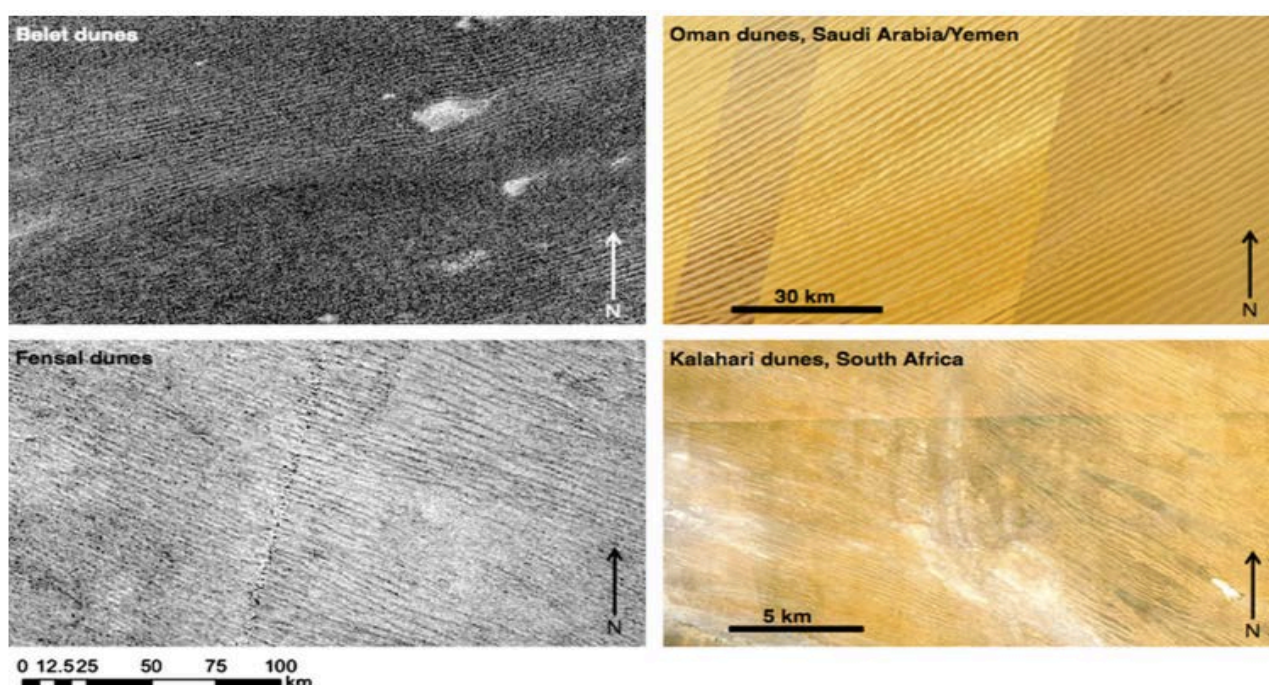


Figure 1 (Le Gall et al. 2012): Picture of linear dunes on Titan (left) compared to linear dunes on Earth (right).

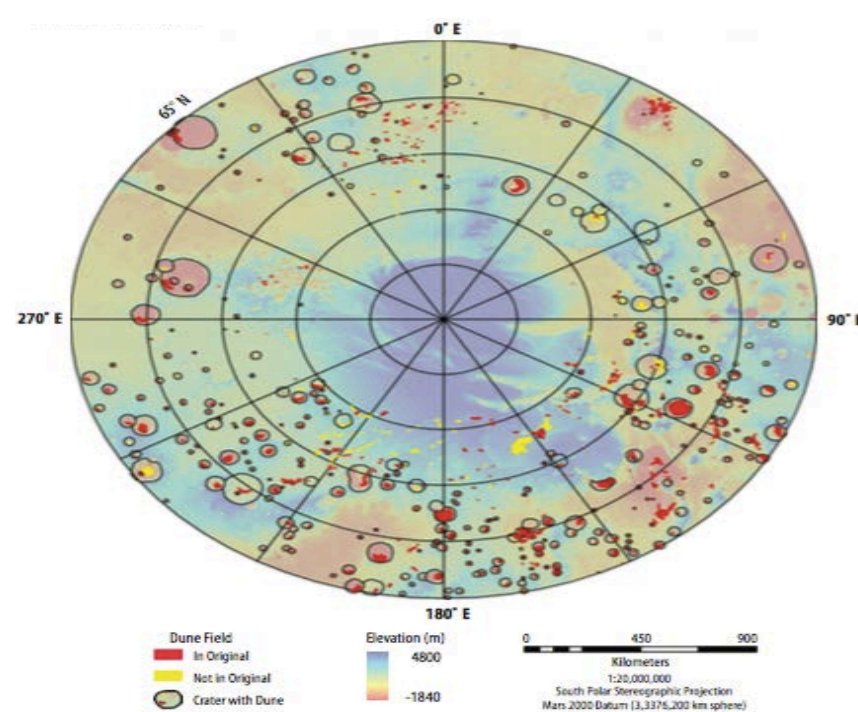


Figure 2 (Mars Global Digital Dune Database: MC-30 R.K. Hayward, L.K. Fenton, T.N. Titus, A. Colaprete, and P.R. Christensen) shows the locations of sand dunes on the South Pole of Mars.

Titan's sand dunes are at higher elevation than the rest of the surface. Could moisture be the cause?

Method

The location for the sand dunes were gathered from Muhs (2007) for Earth and the USGS Global Digital Dune Database for Mars. The locations were then put into QGIS in order to extract the elevations for each dune region to be compared to the elevations of the rest of the surface.

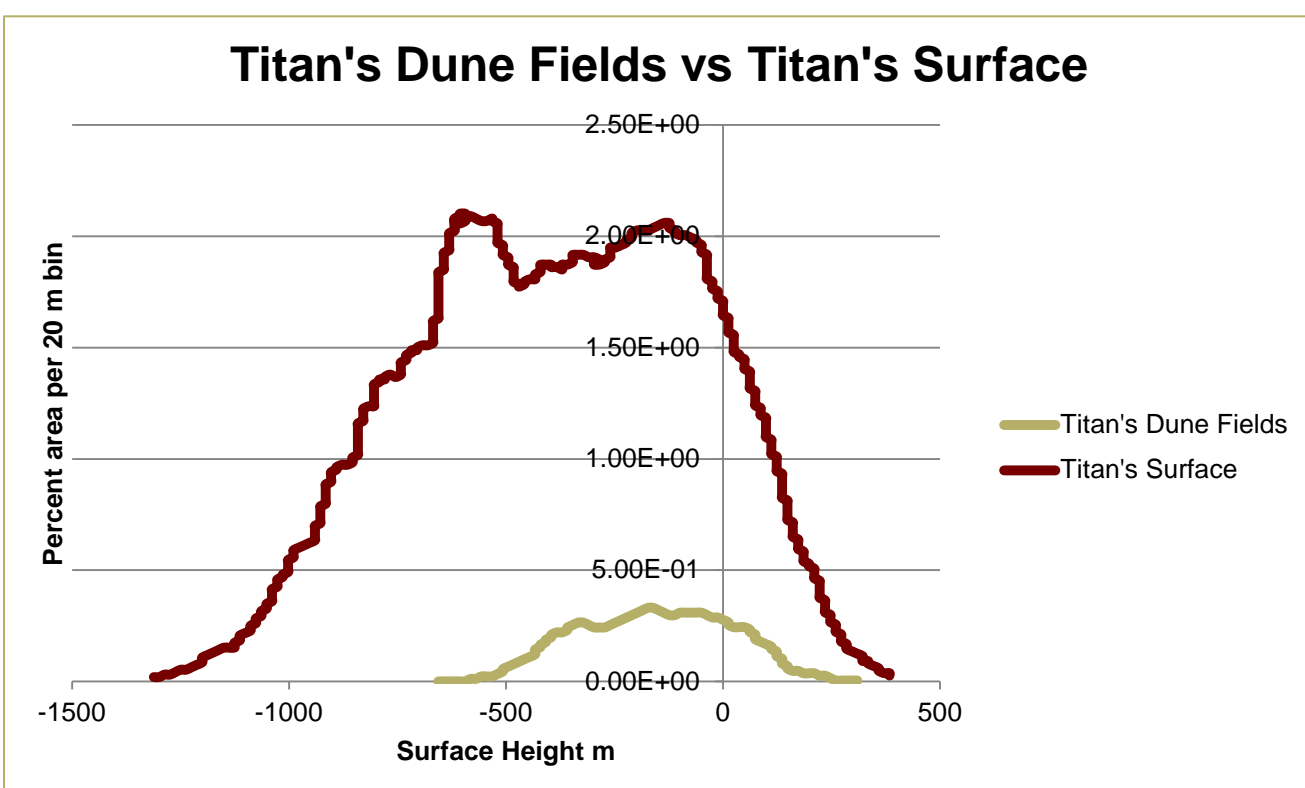


Figure 3: Figure from Le Gall et al. (2012) shows the elevation of the dune fields of Titan (gold line) compared to the rest of the surface (maroon line). The dune fields are at a higher elevation than the rest of the surface.

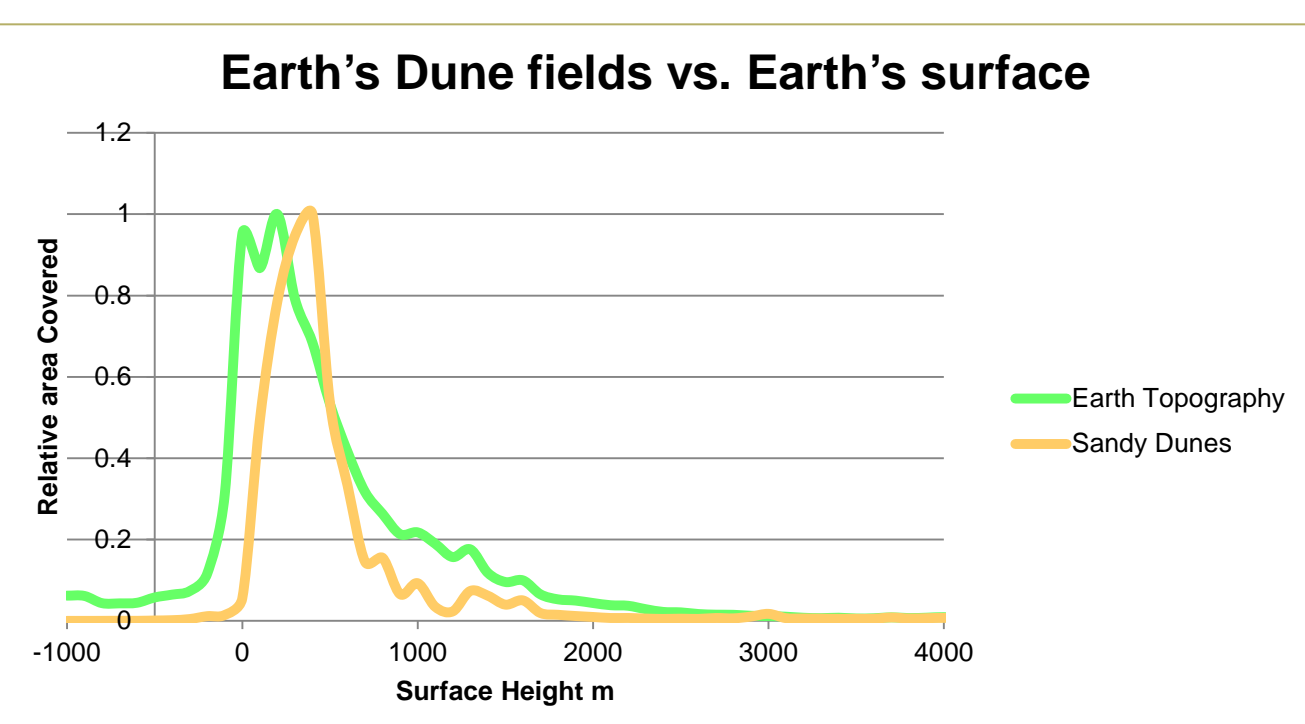


Figure 4: The elevation of the Earth's continents (green line) compared to the elevation of sandy dunes (orange line). The sandy dunes are at a higher elevation than the rest of the Earth, similar to what is observed on Titan.

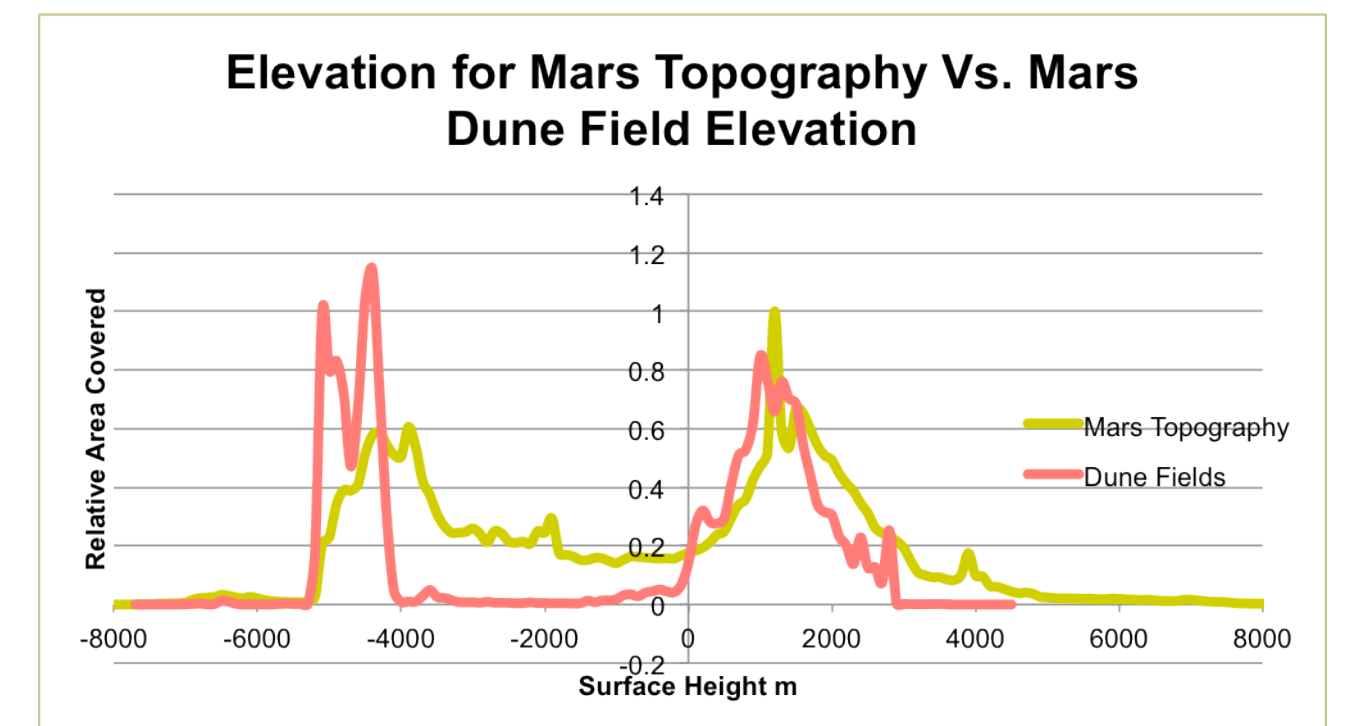


Figure 5: The elevation of Martian dune fields (pink line) compared to the Martian topography (yellow line). The equatorial and south pole dune fields (elevation above 0 m) are approximately at the same elevation as the rest of the surface. The north pole dune fields (elevation below 0 m) are at a lower elevation than the rest of the north pole, although there is more uncertainty in these calculations.

	Average	Standard Deviation	Mode
Earth Sandy Dunes	589.10	0.438	400
Earth Topography	556.08	0.341	200
Mars Dunes (elevation < 0)	-4360.41	0.336	1000
Mars Dunes (elevation > 0)	1256.02	0.296	-4400
Mars Topography (elevation < 0)	-3188.36	0.261	-4200
Mars Topography (elevation > 0)	1958.17	0.264	1200
Titan Dune Fields	-152.00	0.254	-160.82
Titan Surface	-381.29	0.041	-593.81

Table 1 shows the average elevation and the standard deviation for each of the three bodies. It also shows the most common elevation.

Conclusions

After analyzing the histograms, the relationship between the elevation of Titan's dune fields and its surface resembles the one between the sandy dunes and the surface of Earth. Mars has sand at similar or lower elevations than the surrounding regions. Since Earth and Titan are the only two worlds in the Solar System with liquids on their surface, this could mean that moisture may have a factor in dune elevation. Sand may be trapped in moist lowlands, and only move to form dunes in drier highlands.

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