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A global topographic map of Titan

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ABSTRACT

Cassini RADAR SARtopo and altimetry data are used to construct a global gridded $1 \times 1°$ elevation map, for use in Global Circulation Models, hydrological models and correlative studies. The data are sparse, and so most of the map domain (∼90%) is populated with interpolated values using a spline algorithm. The highest (∼+520 m) gridded point observed is at 48°S, 12°W. The lowest point observed (∼1700 m below a 2575 km sphere) is at 59°S, 317°W: this may be a basin where liquids presently in the north could have resided in the past. If the deepest point were once a sea with the areal extent of present-day Ligeia Mare, it would be ∼1000 m deep. We find four prominent topographic rises, each ∼200 km wide, radar-bright and heavily dissected, distributed over a ∼3000 km arc in the southeastern quadrant of Titan (∼40–60°S, 15–150°W).

1. Introduction

Many geological, hydrological and meteorological processes are profoundly affected by topography. To fully understand these processes it is desirable to have a global topographic dataset of high and uniform horizontal and vertical resolution: Mars science was revolutionized by the generation of such data by the laser altimeter instrument MOLA, and lunar science is currently benefiting from the data being generated by the Lunar Orbiter Laser Altimeter (LOLA).

Titan displays a range of fascinating and dramatic meteorological and other processes that are evidently affected by topography on various scales. For example, Lorenz et al. (2008) observed that even an early (and highly incomplete) sampling of Titan's river channels suggested a generally poleward trend in flow direction, which is consistent with initial topography data that showed that the poles are topographically lower than the equator (Zebker et al., 2009a). Lorenz and Radebaugh (2009) showed that the equatorial linear dunes are diverted by topographic highs of 100–300 m with slopes of the order of 1/200, but blocked by slopes of 1/50 or more. It is therefore a pity that our knowledge of Titan's topography is and will remain very poor compared with Earth, Mars, Venus and the Moon, where global maps exist. For Titan, such a global dataset must await a future Titan orbiter mission, and radar altimeters have been suggested as priority instruments for such a mission.

While far from global in extent, nor uniform in quality, Cassini radar topography data are now sufficient to assemble a useful topography map at fairly high resolution. Using a smaller subset of these data, Zebker et al. (2009a) determined the low-order shape of Titan's surface with a spherical harmonic analysis, and Lorenz et al. (2011) evaluated Titan's hypsogram. The utility of maps developed from sparse data at Mars was demonstrated pre-MOLA by Smith and Zuber (1996) who studied Mars' shape using a limited number of Viking orbiter radio occultation heights and groundbased radar tracks and determined the character of the north–south dichotomy (see also Aharonson et al., 2001).

Recent applications of topography data (which have used the Zebker et al. (2009a) spherical harmonic solutions) include the effects on winds in a Global Circulation Model (GCM) by, Tokano (2010) and the examination of the spatial extent of liquids on Titan as a function of ocean volume (Larsson and McKay (2013)). Efforts

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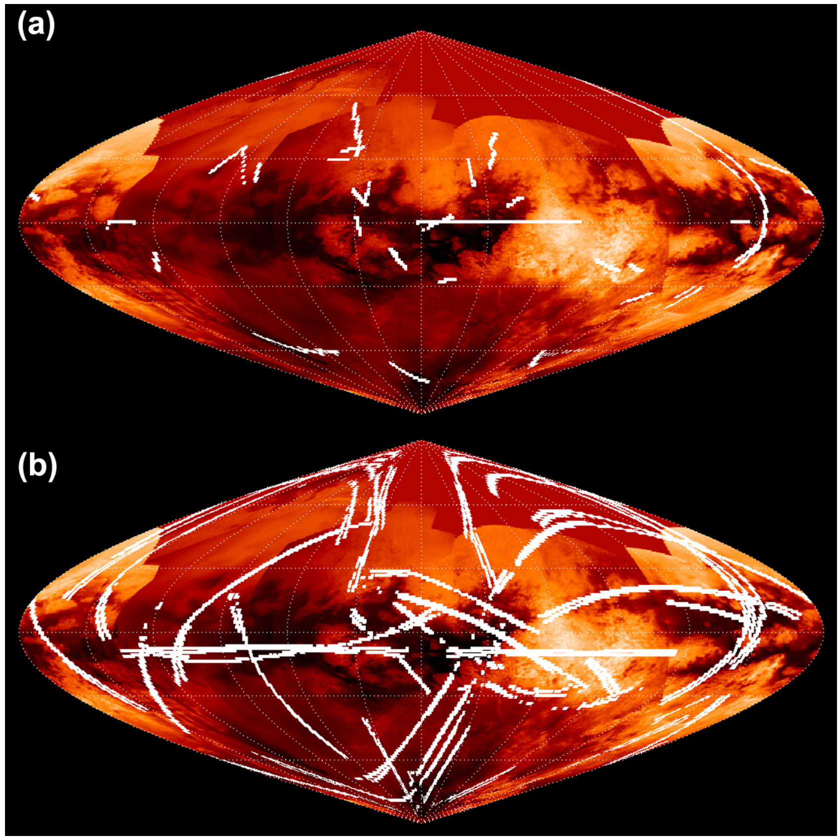

Fig. 1. Topography data coverage on a sinusoidally projected 940 nm albedo map of Titan, centered on the 180° meridian. (a) Altimetry swaths – note the T77 swath along the equator just right of center, and the long T30 swath at the upper right edge. (b) The much more extensive SARtopo coverage.

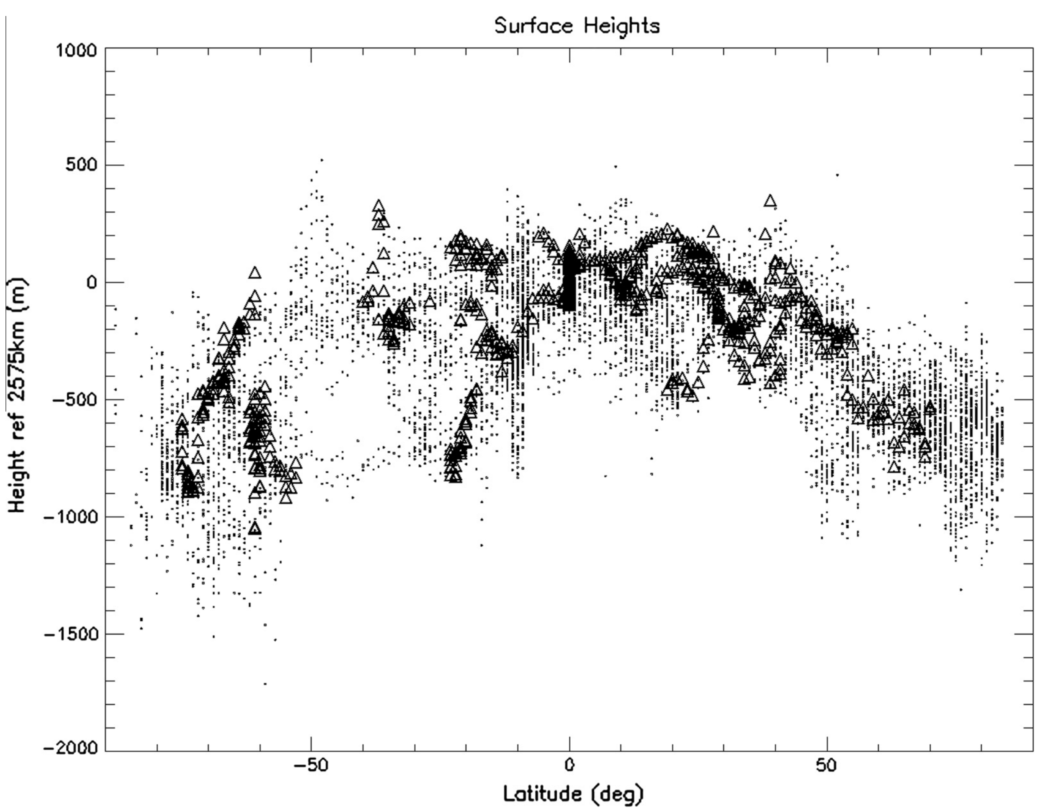

Fig. 2. Surface heights in 1 × 1° bins from SARtopo (small circles) and altimetry (triangles). Both datasets show the oblateness of Titan. (Cf. profiles along lines of latitude in Fig. 5 and longitude in Fig. 6.)