Geophysical Research Abstracts
Vol. 16, EGU2014-7120, 2014
EGU General Assembly 2014

Titan's geoid and hydrology: implications for Titan's geological evolution

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A 1x1 degree altitude map of Titan is constructed from the degree 4 gravity potential [1] and Titan's shape [2] determined by the Radio Science measurements and RADAR observations of the Cassini mission. The amplitude of the latitudinal altitude variations is equal to 300 m compared to 600 m for the amplitude of the latitudinal shape variations. The two polar caps form marked depressions with an abrupt change in topography at exactly 60 degrees at both caps. Three models are envisaged to explain the low altitude of the polar caps: (i) thinner ice crust due to higher heat flux at the poles, (ii) fossil shape acquired if Titan had higher spin rate in the past, and (iii) subsidence of the crust following the formation of a denser layer of clathrates as ethane rain reacts with the H_2O ice crust [3]. The later model is favored because of the strong correlation between the location of the cloud system during the winter season and the latitude of the abrupt change in altitude. Low altitude polar caps would be the place where liquids would run to and eventually form large seas. Indeed, the large seas of Titan are found at the deepest locations at the North Pole. However, the lakes and terrains considered to be evaporite candidates due to their spectral characteristics in the infrared [4,5] seem to be perched. Lakes may have been filled during Titan's winter and then slowly evaporated leaving material on the surface. Interestingly, the largest evaporite deposits are located at the equator in a deep depression 150 m below the altitude of the northern seas. This observation seems to rule out the presence of a global subsurface hydrocarbon reservoir unless the evaporation rate at the equator is faster than the transport of fluids from the North Pole to the equator.
This work has been performed at the Jet Propulsion Laboratory, California Institute of Technology, under contract to NASA.
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