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Bathymetry and Composition of Titan's Hydrocarbon Seas from the Cassini RADAR Altimeter

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The Cassini RADAR's altimetry mode has been successfully used for probing the depth and composition of Titan's hydrocarbons seas. In May 2013, during the spacecraft's T91 flyby of Titan, the instrument demonstrated its capabilities as a radar sounder, presenting a unique opportunity to constraint the depth and composition of Titan's second largest sea, Ligeia Mare. Later, observations of Kraken Mare and Punga Mare were planned and executed in August 2014 (T104) and January 2015 (T108), respectively. While most of the seafloor was not detected at Kraken, suggesting the sea was either too deep or too absorptive in these areas to observe a return from the seafloor, shallow areas near Moray Sinus did show subsurface reflections. At Punga Mare, a clear detection of the subsurface was observed with a maximum depth of 120 m along the radar altimetry transect.
Herein we present a re-analysis of altimetry data acquired over Ligeia Mare and, earlier in the Cassini mission (in December 2008 during T49), over the southern Ontario Lacus. Depths measurements and liquid composition are obtained using a novel technique which makes use of radar simulations and Monte Carlo-based inversions. Simulation is based on a two-layer model, where the surface is represented by a specular reflection and the seafloor is modeled using a facet-based synthetic surface, including thermal noise, speckle effects, analog to digital conversion (ADC), block adaptive quantization (BAQ), and allows for possible receiver saturation. This new analysis provides an update to the Ku-band attenuation (the Cassini RADAR operates at a wavelength of 2 cm) and results in a new estimate for loss tangent and composition. We found a value of specific attenuation of the liquid equal to 0.14 ± 0.02 dB/m and 0.2 ± 0.1 dB/m, which is equivalent to a loss tangent of $4.4\pm0.9\text{x}10^{-5}$ and $7\pm3\text{x}10^{-5}$ for Ligeia Mare and Ontario Lacus, respectively.
Assuming that Titan's liquid bodies are composed by a ternary mixture of methane, ethane, and nitrogen, these values of loss tangent are consistent with a composition of 69% of methane (CH4), 14% of ethane (C2H6) and 17% nitrogen (N2) for Ligeia Mare and 47% of methane (CH4), 40% of ethane (C2H6) and 13% nitrogen (N2) for Ontario Lacus.