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Extracting information on wind speed and liquid optical thickness on Titan lakes by using Cassini radar data and a Bayesian inversion procedure

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The first two years of the Cassini mission have collected a great amount of data dealing with Titan's surface. Particularly due to high resolution, the analysis derived from the SAR imagery reflects the complex Titan's surface morphology with peculiar features such as: dark and bright areas (Ta, T3), periodic structure ("sand dunes") and, above all, lake-like features, firstly observed during the T16 flyby on 22 July 2006 and good candidates to be filled with liquid hydrocarbons. In this paper, the lakes-like features detected on Titan during the Cassini flybys have been analyzed. The main aim of the paper is to find situations where it could be feasible to infer information about the likely ranges of lake parameters. The presented approach is mainly divided in the following steps:

- electromagnetic modeling of the lakes surface and comparison with measured radar data;
- introduction of the electromagnetic modeling in the inversion procedure based on a Bayesian framework.

The inversion procedure itself is divided into training and test phase. Analysis of the inferred information and determination of the likely ranges for lake optical thickness

and wind speed. The surface response has been modeled by means of a double layer model considering a liquid upper layer. From the comparison between simulated and experimental data the likely ranges of parameter such as dielectric constant, optical thickness, wind speed and roughness which may describe the surface and the lakes are indicated. These results are the starting point for the application of the Bayesian inference methodology. In this case the main aim is to derive the probability distribution and the mean values for lakes parameters and especially for the optical thickness. In the training phase, different regions of interest have been selected from flybys T16 and T19 where small lakes are present. The pdfs derived from areas with lakes and from their surroundings clearly indicate different values of optical thickness whose value varies from 0.2 to 6. In the test phase, the analysis has been also applied to flyby T25 where bigger lakes are present. The inferred values of optical thickness show limit values below 9 confirming the previous analysis. Beyond this value, the signal coming from bottom layer is completely attenuated and consequently no further information can be obtained for the attenuation level of the signal coming from bottom and the resulting optical thickness value. Considering this aspect, information on the wind speed which characterizes the upper layer can be derived. The range in which the pdf is significantly different from zero is 0 - 0.7 m/s, with mean values of wind speed around 0.2 - 0.3 m/s. The mean values may change according to different values hypothesized for the dielectric constant of the upper layer. Future work will be concentrated on the application of this methodology to great extension lakes detected on T29 and T30 flybys and the inclusion of other data such as the radiometric data.