COMBINED USE OF CASSINI RADAR ACTIVE AND PASSIVE MEASUREMENTS TO CHARACTERIZE TITAN MORPHOLOGY

B. Ventura[a], D. Casarano[b], C. Notarnicola[a,c], M. Janssen[e], F. Posa[a,d], and the Cassini Radar Science Team[e]

[a]Dipartimento Interateneo di Fisica, Via Amendola 173, Bari, Italy.
[b]CNR-IRPI, Via Amendola 122 I, Bari, Italy
[c]EURAC-Institute for Applied Remote Sensing, Viale Druso 1, Bolzano, Italy.
[d]Politecnico di Bari, Via Orabona 4, Bari, Italy.
[e]Jet Propulsion Laboratory, Pasadena, California, USA

Keywords: Cassini Radar, radiometer, Titan landscape, inversion algorithm, electromagnetic models

1. Introduction

An important result of Cassini Radar observations is the detection of lake-like features, most likely constituted by liquid hydrocarbons, thus supporting the hypothesis of a methane cycle similar to water cycle on Earth. These areas, which resemble terrestrial lakes, seem to be sprinkled all over the high latitudes surrounding Titan's pole. The abundant methane in Titan's atmosphere combined with the low temperature, 94 K, lead scientists to interpret them as lakes of liquid methane or ethane, making Titan the only body in the solar system besides Earth known to possess lakes.

2. Methodology

In this work, scattering models and a Bayesian inversion algorithm are applied in order to characterize lake and land surfaces. The possibility of combining the SAR data with radiometric ones on both lakes and neighboring land areas is also presented.

In particular, lakes backscattering is described in terms of a double layer model, consisting of Bragg or facets scattering for the upper layer and the Integral Equation Model (IEM) model for the lower one. Furthermore, by means of a gravity-capillary wave model, the Donelan-Pierson model, the wave spectra of liquid hydrocarbons surfaces are introduced as a function of wind speed and direction. The theoretical radar cross section values are compared with the experimental ones collected by the radar in order to estimate physical and morphological surface parameters, and to evaluate their compatibility with the expected constituents for Titan surfaces [1]

This electromagnetic analysis is the starting point for a statistical inversion algorithm which allows determining limits on the parameters values, especially on the optical thickness and wind speed of the lakes. The physical surface parameters inferred by using the inversion algorithm are used as input to a forward radiative transfer model calculation to obtain simulated brightness temperatures.

The observed and computed brightness temperatures are compared in order to address the consistency of the observations from the two instruments and to determine the coarse characteristics of the surface parameters [2, 3].

In this algorithm, the starting point is the map of optical thickness derived from the SAR images. The simulated brightness temperature is calculated by applying the forward radiative transfer model to this map with the same hypotheses with which the optical thickness map was derived. The simulation is also carried out on the neighboring land areas by considering a double layer model including a contribution of volume scattering. Each layer is described in terms of dielectric constant values, albedo and roughness parameters with the hypothesis of water ice ammonia on layers of solid hydrocarbons and organic compounds like tholins. The analysis is applied to the areas detected on flybys 25 and 30.

3. Results

One important result arises from the analysis of the inverted optical thickness on deep lakes. In this case, found values of optical thickness can be considered limit values because, beyond the value of 6 a complete attenuation can be considered. This limit value is important as it is stable even if the other parameters vary. Starting from this point, posing the condition of a complete attenuation of the second layer, i.e. fixing the value of the optical thickness, the algorithm can be used to estimate the wind speed. The values vary between 0.2 to 0.5 m/s [1].

The first results also show a good agreement between the simulated data and the measured brightness temperature for both the liquid surface and the surrounding areas. In the last case, a good agreement is obtained only if the contribution from volume scattering is included.

References

[1] C. Notarnicola, B. Ventura, D.Casarano, F. Posa , Cassini Science Radar team, "Cassini Radar Data: Estimation of Titan's lake features by means of a Bayesian inversion algorithm", *IEEE Transactions on Geoscience and Remote Sensing*, in press.

[2] H.A. Zebker, L.C. Wye, M.A. Janssen, Cassini Radar Team, "Titan's surface from reconciled Cassini microwave reflectivity and emissivity observations", in press.

[3]B. Ventura, D. Casarano, C. Notarnicola, F. Posa, M.A. Janssen, Cassini Science Radar team, "Inferring Titan's surface features by means of Bayesian inversion algorithm applied to radar data", in *SAR Image Analysis, Modeling and Techniques IX, edited by Claudia Notarnicola, Francesco Posa, Proceedings of SPIE vol. 6746* (SPIE, Bellingham, WA, 2007) , Article CID 67460A-1-11.