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Microphysical properties of aerosols in the Titan lower atmosphere and surface tholin deposits inferred from Huygens/DISR observations

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Abstract

Based on the comprehensive simulations using the Discrete Dipole Approximation (DDA), we interpret Huygens/DISR measurements during probe descent in terms of scattering on aggregate aerosol particles in the atmosphere and deposited to the surface. Data suggest that in the lower part of the troposphere, large fluffy aggregates containing up to 3000 monomers are present. The surface is likely composed of water ice covered by a thin layer of tholin, which implies the efficient mechanisms of tholin removal.

1. Microphysical model of the Titan aerosol

Based on the non-hydrostatic general circulation model of the Titan atmosphere coupled with the comprehensive microphysical model of tholin haze, including charging, aggregation and capillary condensation, we simulate the vertical, lateral and particle size distribution of aerosols in the troposphere. Optical properties of tholin aggregates predicted by the microphysical model were simulated using T-matrix and DDA techniques. Simulations are compared with *in situ* results returned by Huygens probe, including spectral and polarimetry sounding by DISR instrument. Data suggest that in the lower troposphere, large fluffy aggregates up to 3000 monomers are formed, with their internal structure being increasingly smoothed upside down. This may indicate condensation of methane and other hydrocarbon atmospheric constituents in the pores of fractal tholin particles in the lower troposphere.

2. Scattering at the Titan surface

To evaluate the physical state of the Titan surface in the vicinity of Huygens landing site, several models have been studied: thick tholin layer, ice layer covered by tholin, tholin mixed with mineral and icy sand and wet tholin with admixture of liquid hydrocarbons. The model of the surface elementary volume was generated by a stochastic algorithm, then its optical properties were calculated using DDA technique. After that the obtained local properties of the medium were incorporated into the radiative transfer problem formulated in such a way that the interference effects responsible for backscattering were taken into account. Comparison of the calculation results with DISR data provides constraint, albeit quite broad, to the microscopical properties of both atmospheric aerosols and the upper surface layer.

References

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