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Microstructure of tholin aggregates in the Titan atmosphere retrieved from Huygens/DISR data

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Spectrophotometry and polarimetry data received by the Descent Imaging Spectral Radiometer (DISR) onboard Cassini/Huygens probe, contain valuable information not only about vertical profile and sizes of haze particles, but also on their internal structure. In the previous analyses it has been found that the particles are characterized with relatively narrow distribution of monomer sizes, centered at ~50 nm. Both observations and models suggest that this size remains stable whereas cluster sizes reveal dramatic change from few dozen monomers in the Titan stratosphere to thousands monomers in the lower troposphere. There are also indications that condensation of hydrocarbons below the tropopause may result in formation of droplets with internal structure including mixture of spherical monomers and liquid. In order to establish more strict constraints on the microphysical properties of haze particles in the Titan atmosphere, we have applied a comprehensive radiative transfer model based on discrete dipole approximation (DDA) and calculated scattering and polarization properties of tholin aggregates. Distribution of clusters and monomers in size and vertical profiles simulated by a self-consistent 1D microphysical model taking into account several mechanisms of charging, aggregation and vertical mixing, were adopted. Calculations suggest that while clusters simulated in BPCA approximation, characterized with fractal dimension close to 3, and cluster smaller than 256 monomers, reveal classical bell-shaped polarization curve, for larger clusters the polarization peak fades and shifts to larger scattering angles. However for highly porous tholin particles resulted from cluster-cluster aggregation, polarization curve reveals oscillations smoothed by monomer size distribution. Fitting synthetic radiances and polarization curves based on this model, to DISR data results in strict constraints on both cluster and monomer size distribution, as well as possible filling of pores by condensed volatiles.

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