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Simulations of tholin haze in the Titan atmosphere with non-hydrostatic General Circulation Model

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General circulation model

We present the first numerical model of the Titan atmosphere based on GCM with non-hydrostatic dynamical core. The model is set on the triangular mesh with uniform density and covers altitude range from the surface to 550 km. Gas dynamics equations are solved by semi-Lagrangian method that allows for conservation of mass, momentum and energy with high accuracy. Radiation block of the model is based on TGM model[1] and interactively takes into account optical properties of aerosols. The model is integrated with time step of 6 sec on the 16-processor server with shared memory. The resulting meteorological fields demonstrate superrotation with zonal velocity up to 120 m/s, expected for a slowly rotating planet with dense atmosphere. The remarkable difference from conventional hydrostatic GCMs is the enhanced vertical velocities reaching few m/s above the tropopause. A strong wave-1 tidal feature is responsible for decrease of zonal velocity at the altitude of thermal inversion at 70-80 km, consistent with observations.

Tholin microphysics

Microphysical block of the model provides comprehensive treatment of the tholin haze involving coupled description of coagulation and electric charging. In order to decrease equilibration time, the initial conditions for aerosol distribution in both size and height is taken from the 1D model with similar microphysics.

As the current version of the model does not include photochemistry, tholin haze is assumed to be generated by coagulation from initial building blocks seeded according to a specified source within altitude range 450-550 km. A smooth size distribution of the initial tholin seeds was specified in the range 5-10 nm. Fractal geometry of tholin aggregates results in increasing coagulation rates due to increasing effective projected area and damping the repulsive Coulomb forces between likely charged particles by redistribution of charge over aggregates. A separate mode of size distribution with *r*~50 nm, that may be responsible for the formation of monomers, results from the population of particles possessing a single elementary charge.

Observational constraints

As a first step to constrain the aerosol model by observations, the resulting distribution of the tholin haze was used to calculate the synthetic field of scattered solar radiation inside the atmosphere, which in turn has been compared with Huygens/DISR data[2]. Optical properties of tholin particles with specified geometry and composition are computed based on near-field scattering calculations using the discrete dipole approximation (DDA). Comparison with DISR data suggest that the effective monomer size increases at 60-80 km, which is interpreted as a signature of smoothing the internal structure of aggregates due to condensation of ethane and other trace gases in narrow gaps and pores.

Future plans

A model setup for Titan methane and ethane cycles simulations will be developed in the near future.

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References

[1] McKay C. P., *et al*. (1989) *Icarus* **80**(1), 23-53.
[2] Tomasko, M.G. *et al*. (2008) *Planet. Space Sci.*, 56, 669 – 707.