Simulating Titan and Pluto’s Atmospheres

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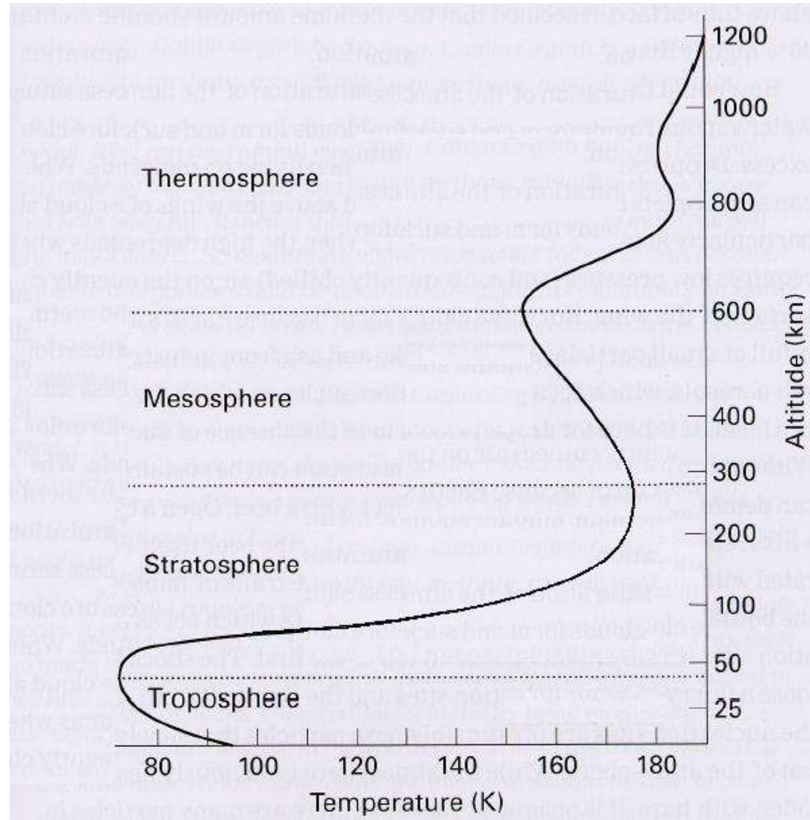
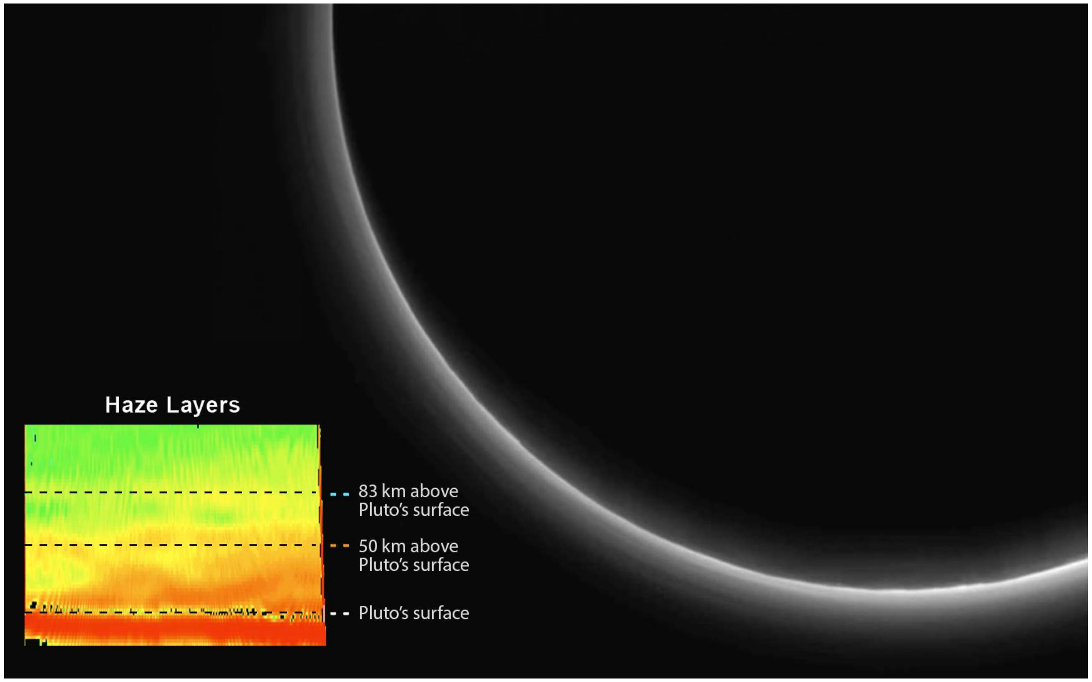
Titan’s Atmosphere

- Temp. profile is similar to Earth
- Surface Temperature of 93 K
- Adiabatic Lapse Rate at Tropos
- N_2 dominated with CH_4, CO_2, CO
- Radiative cooling at Mesosphere



Pluto's Atmosphere

- Surface Temp enough to sublimate N_2, CH_4, and CO_2 ice
- Direct Measurement is difficult
- 1988 12th Mag. Star was occulted by Pluto=Atmosphere observation
- New Horizon: Optically thin haze layers
- Nitrogen is 50X more abundant than any other const.



How to Build a model

1) Radiative process

2) Microphysics

3) Chemical Interations

Aerosel Flux

- Statistical Model breakdown using mass bins
- Continuity Equaiton
- Incorporates Eddy diffusion, sedimation, and Brownian motion

$$\frac{\partial n_p}{\partial t} = -\frac{1}{r^2}\frac{\partial(r^2\Phi(v_p))}{\partial r} + \frac{1}{2}\sum_{i=1}^{p-1} K(u_i, v_p - u_i)n(u_i), n(v_p - u_i) - n_p$$
$$\sum_{i=1}^{N_{max}} K(u_i, v_k)n(u_i) + p(v_p)\delta_{p,1}$$

$$\Phi(v_p) = -V_s n(v_p) - K n_a \frac{\partial(n(v_p)/n_a)}{\partial r}$$

Simulating Titan’s Atmosphere

Growth of Polycyclic aromatic compounds with C_2H, CN, HCCN used for model radicals

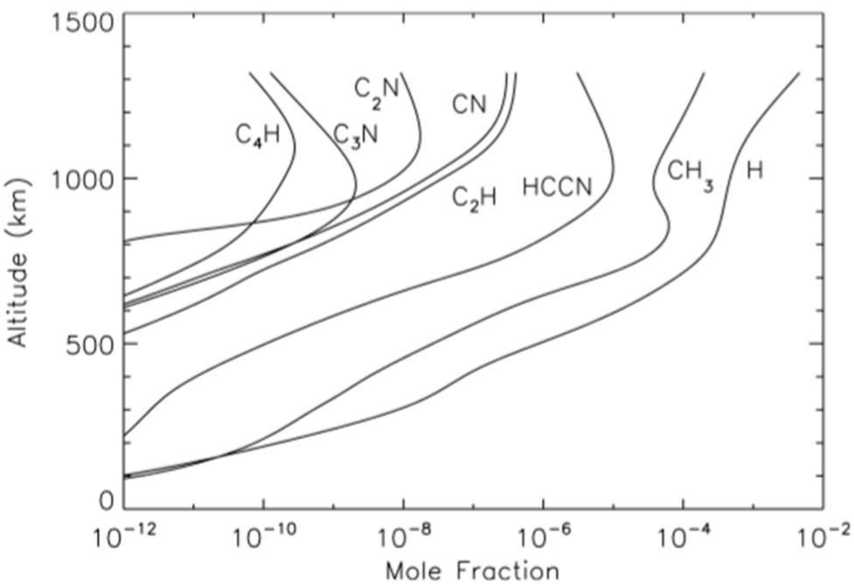


Figure 3. Radical abundances in Titan’s atmosphere from the Lavvas et al. (2008b) photochemical model.

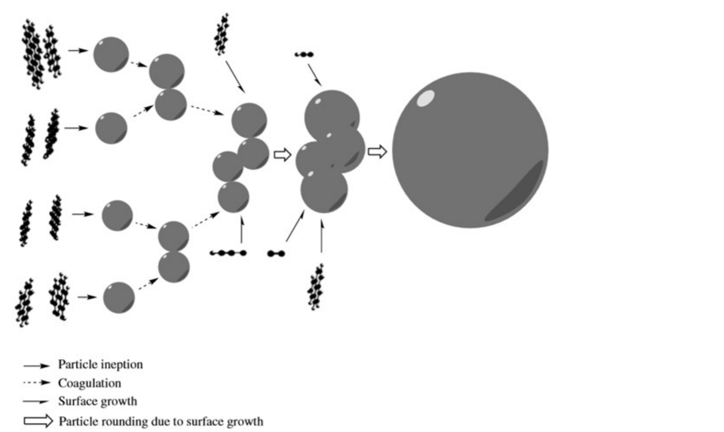


Figure 1. Processes included in the model. In this example, the PACs provide primary particles which then coagulate to form an aggregate. Eventually the surface chemistry acting on the aggregate provides a new, larger primary particle.

Titan’s Model

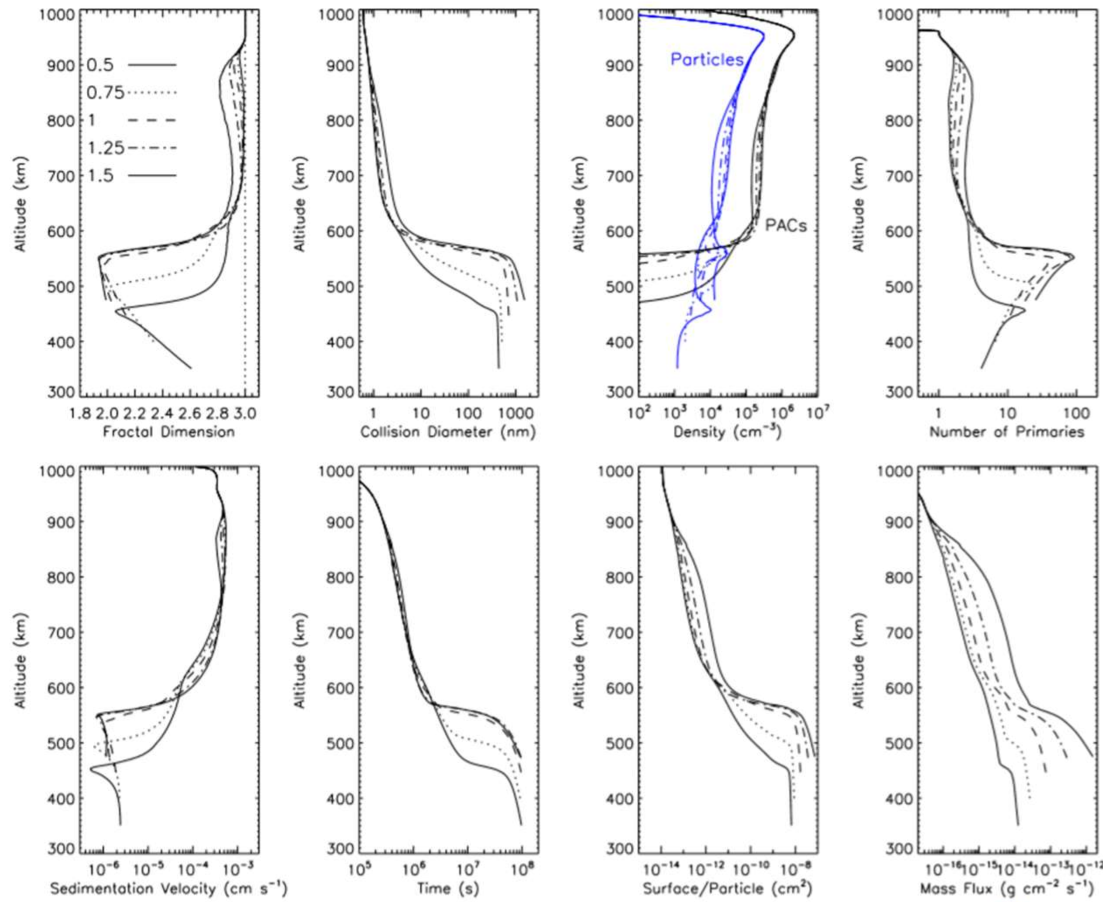


Figure 6. Sensitivity of model results on smoothing factor. The particle density includes the cumulative contribution of aerosols and PACs.
(A color version of this figure is available in the online journal.)

Simulating Pluto’s Atmosphere

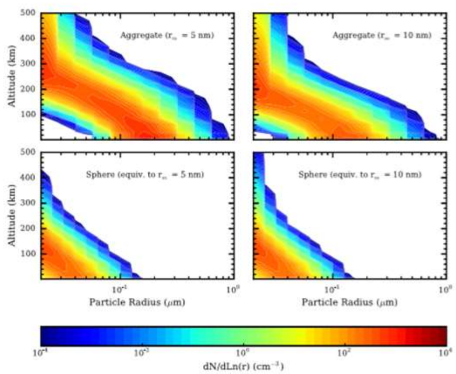


Fig. 3. Particle number density as functions of altitude and particle radius for the (clockwise from the top left) 5 nm monomer aggregate, 10 nm monomer aggregate, 10 nm monomer-equivalent spherical, and 5 nm monomer-equivalent spherical haze solutions computed by CARMA. Particle radius refers to the true radius r_p for spheres and effective radius R_f for aggregates. Number density is expressed in $dN/dLn(r_p)$ for spheres and $dN/dLn(R_f)$ for aggregates. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

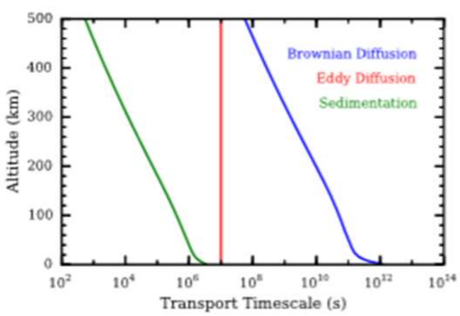


Fig. 2. The time needed to traverse 1 km in the Pluto atmosphere as a function of altitude for an aggregate particle with $R_f = 0.1$ µm, $r_m = 10$ nm, and $D_f = 2$ undergoing (blue) Brownian diffusion, (red) eddy diffusion, or (green) sedimentation. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

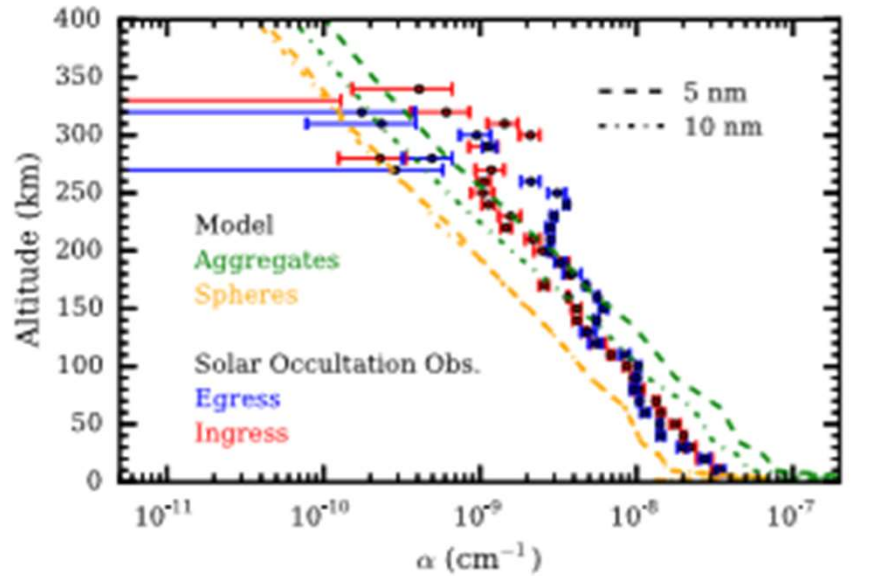


Fig. 4. The extinction coefficients α as a function of altitude calculated from our model aggregate (green) and spherical (orange) particle haze results, for both the 10 nm monomer (dash dot line) and 5 nm monomer (dashed line) cases (and the equivalent cases for spherical particles), compared to that derived from the ingress (red) and egress (blue) solar occultation observations of Gladstone et al. (2016). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Thank you