A PLUTO THERMAL MODEL; C. J. Hansen[1] and D. A. Paige[2], ([1] Jet Propulsion Laboratory, [2] Dept. of Earth and Space Sciences, UCLA).

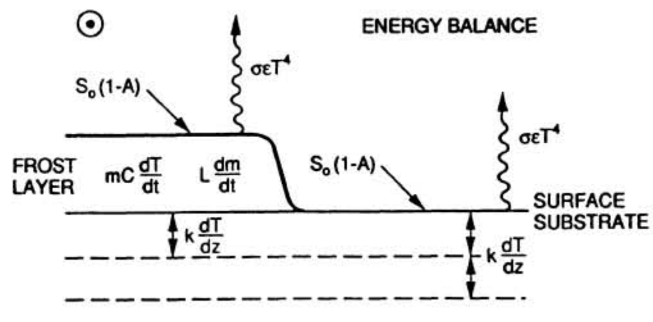
The recent discovery of nitrogen on Pluto [1] suggests that Pluto's volatile cycles may be similar to those on Neptune's moon Triton. Here, we report the first results of our efforts to apply a thermal model that we developed to study the seasonal nitrogen cycle on Triton[2] to the case of Pluto. The model predicts volatile behavior as a function of time to calculate frost deposit depth, polar cap boundaries, temperature of the frost and substrate, and atmospheric pressure, assuming nitrogen frost deposits in solid-vapor equilibrium with nitrogen in the atmosphere.

The thermal model is based on the Leighton and Murray diurnal and seasonal formulation for heat balance of the polar caps on Mars. This model solves the frost energy balance equation, incorporating solar insolation, thermal emission, heat conduction between layers in the substrate and between the substrate and the frost deposit, the heat capacity of the frost deposit, and the latent heat of condensation and sublimation. The primary input parameters are the albedo and emissivity of the frost, the albedo and thermal inertia of the substrate, and the total nitrogen inventory. Pluto and Triton's similar sizes, densities, and diurnal periods. These bodies also have similar insolation rates when Pluto is at Perihelion. Consequently, very few changes were required to transform our Triton model into a Pluto model.

On Triton we learned that the thermal inertia of the substrate plays an important role in the partitioning of volatiles between the polar cap deposits and the atmosphere, thus significantly affecting atmospheric pressure. As with Triton, assuming bright, dark, or transparent seasonal frost deposits on Pluto results in significant variations in the locations of seasonal and permanent polar caps. This sensitivity may be advantageous for clearing up ambiguities in the properties and behavior of polar caps on both bodies. One early Pluto conclusion is that although the nitrogen atmospheric pressure may vary by orders of magnitude over the course of a Pluto year, nitrogen is not likely to freeze out completely at any season.

The output of our thermal model calculations can be compared to a number of Pluto observations, including: maps of albedo features observed during a series of Pluto - Charon mutual events[4,3], atmospheric pressure measured from the stellar occultation[5] can be compared to predicted atmospheric pressure, and the disk-integrated albedo may be compared to long-term observations of the variability of Pluto's brightness as seen from the earth[6].

1. Owen et al, BAAS 24, No. 3, 961, 1992.
2. Hansen and Paige, Icarus 99, 273-288, 1992.
3. Buie, Tholen, and Horne, Icarus 7, 211, 1992.
4. Young and Binzel, Icarus in press, 1993.
5. Mills, Hubbart and Elliot, 1988.
6. Buie and Tholen, Icarus 79, 23-37, 1989.



$$m_f C_p \frac{dT}{dt} = S_0(1-A) - \varepsilon\sigma T^4 + L\frac{dm}{dt} + k\frac{dT}{dz}$$

Fig. 1 This diagram illustrates the terms in the heat balance equation for seasonal N_2 frost and bare soil in the Pluto and Triton thermal models.