THE PLAUSIBILITY OF BOILING GEYSERS ON TRITON;

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Since the discovery of Tritonian cryovolcanic activity in Voyager 2 images in 1989 [1], it was commonly assumed that the geysers on Triton are of condensing type only. In this case the initial state is N_2 vapor, produced by the subliming southern polar cap. Vapor condenses while it cools and accelerates, releasing latent heat which helps acceleration. The energy source for the geysers can be either solar or internal, due to radioactive decay in Triton's extensive core. The corresponding mechanisms of energy supply are the solid-state greenhouses [2] or convection in solid nitrogen [3]. Internal heat source on Triton was estimated to be quite large compared to the absorbed insolation (5-20 %) [4]. Since the heat conduction coefficient of solid nitrogen is 50-100 times less than that of water ice at the temperature of the mantle-cap interface, the temperature gradient in the cap is significantly increased relative to its value of 0.3 K/km in the mantle. This gives the temperature difference of 15-30 K across the nitrogen layer (not taking phase transition into consideration) and thus nitrogen can reach its melting temperature of 63.148 K (at zero pressure) at the base of the cap. In our models we assumed a layer of liquid nitrogen only a few centimeters thick at the base. We applied analytical techniques and used the results of experiments with convecting Newtonian fluids having different Prandtl numbers and rigid-rigid boundary conditions with heating only from below.

For low Rayleigh numbers (laminar regime) experiments with water from [5] were used since the liquid N_2 Prandtl number is about 4, and for high Ra (turbulent regime) results were taken from [6]. Two models were considered: with and without convection in the upper solid part. In both we obtained the steady-state position of the phase front at a depth of a few meters beneath the Tritonian icy surface. A small influence on the front position by the convection in the solid overlayer can be explained by the large difference in liquid and solid nitrogen dynamic viscosities: $\approx 3 * 10^{13}$ Pa s for solid Versus $\approx 3 * 10^{-4}$ Pa s for liquid. Therefore Nusselt numbers, being proportional to the Rayleigh numbers, differ significantly for those two phases. The close approach of the phase front to the surface means that if there is a crevasse in the solid overlayer, a boiling geyser will form. Fissures in solid nitrogen can be produced by the phase transitions between cubic and hexagonal crystalline forms of N_2. This work was supported by a NASA grant.

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