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Evolution of the N2 frost distribution on Triton during thousands of terrestrial years

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1. Introduction

Triton is the largest satellite of the planet Neptune. It is also the coolest body in the solar system, with a surface temperature of about 38 K [10]. These frigid surface conditions suggest that Triton is covered by ices. Spectroscopic observations [1,2,5,8,10] have revealed the presence of N_2, CH_4, CO_2 and CO ices on its surface., with probably CO_2 and CO existing partially as a solid solution with $N_{2,}$ the dominant constituent of the surface. At 38 K, the N_2 ice on Triton's surface is quite volatile and subject to large-scale sublimation and recondensation on Triton in response to Triton's complicated seasonal cycle. However, the repartition of the N2 ice cap on Triton is still unknown, in spite of the detailed images transmitted by Voyager 2 in 1989. Hansen and Paige developed in 1996 a model of the seasonal nitrogen cycle on Triton. They gave an explanation of the seasonal nitrogen distribution with time considering the fresh ice as darker than the substrate. This assumption contrasts with the general idea that the fresh ice has a high albedo. Another hypothesis is that in 1989 during the south summer, the bright material in the southern hemisphere represents an extensive polar cap whereas the northern hemisphere is without frost.

Previously, we have built a 3D model of Triton's atmosphere [11]. This GCM based on a high thermal inertia of the substrate material [9] and the presence of a polar cap in the South and an unfrosted equatorial band [7], manages to reconcile the different observations of Voyager 2 : retrograde surface winds, prograde winds at 8 km, temperature profiles... This elevated thermal inertia allows to keep the heat of the equatorial band during a sufficiently long time and to introduce a phase lag into the seasonal cycle. On the basis of this 3D model, we have built a 2D model which predicts the evolution of the distribution of Triton's N_2 frost over thousands of years. These results are compared with observations and former models[5,6].

2. 2D model's description of the distribution of Triton's N2 frost

This 2D model is a simplified and adapted version from the 3D model. The physical processes in the Triton's atmosphere have been removed. Only the variation of the solar flux, the variation of the latitude of the subsolar point calculated from the new equation of the orbital evolution based on rotationnal elements combined with a relatively complete dynamic solution adapted to Triton [4] and the condensation/sublimation on the ground have been taken into account. This model is calculated for 2 longitudes and 24 latitudes on more 2000 terrestrial years. The emissivity is constant with a value of 0.7. Several simulations have been run with different initial frost distribution and for a same elevated value of thermal inertia.

3. Preliminary results

The first test corresponds to a planet initially covered by N_2 ice. The preliminary results reveal a permanent polar cap in the South. Deposits of N_2 ice also form in the high northern latitudes and the equatorial band still remains unfrosted during time. An asymmetry in the frost distribution appears even with an initial symetric frost distribution. The surface pressure on Triton from 1989 to 2000 increases., as it has been measured by stellar occultations [3]. Previous studies [9] had already shown that a high thermal inertia on Triton was in agreement with this increase of surface pressure. We will also show the results of the 2D model in the case of dark frost.

4. Summary and conclusions

This 2D model with a high thermal inertia gives a possible frost distribution during a long period and explains the evolution of the surface pressure on Triton. These results combined with the results of our GCM will permit to provide a possible understanding of the machine “Triton”. In the future, it will be used for the dwarf planet Pluto.

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comparing the terrestrial worlds reading: chapter 13, celestial profile cards (appendix comparing the terrestrial worlds terrestrial worlds have similar origins.Â Earthâ€™s Atmosphere. Consists mostly of molecular nitrogen (N 2) and oxygen (O 2). Most of Earthâ€™s gas is < 10 km from surface, but a small fraction extends to. 100 km. Presentation on theme: "General Circulation Modelling on Triton and Pluto"â€” Presentation transcript: 1 General Circulation Modelling on Triton and Pluto F. Forget (N. Descamps) LMD, ISPL Paris.Â 33 New calculation of Triton seasonal variations required to compute cap evolutionâ€¦ (Forget et al. 2000).Â Show the sensitivity of the frost distribution to topography (i.e. pressure, geothermal flux assymetry). 37 High thermal inertia model (inspired by Spencer and Moore 1992) Inertia = 500 SI It works ! Show the sensitivity of the frost distribution to topography (i.e. pressure, geothermal flux assymetry) ïŸAlso true for Pluto. 38 Adapting Triton GCM to Pluto Require to add radiative transfer modelling with CH4 (Strobel et al. 1995) Solar heating at 3.3 et 2.3 Âµm (NLTE) NLTE emission at 7.6 Âµm ? Although Triton was discovered soon after Neptune, little was learned about it until the modern telescopic era, and even so, most of the information we have was acquired during the Voyager 2 encounter with Neptune in 1989. Triton is a relatively large moon (1352 km in radius), larger than all the midsize satellites of Saturn and Uranus (200â€“800 km in radius), but not quite as large as the biggest icy satellitesâ€”the Galilean satellites and Titan (1570â€“2630 km in radius).Â There is evidence for â€˜cryovolcanicâ€™ activity creating flows of icy materials that have flooded and buried parts of the surface much like the mare lava flows on the Earth's moon. Triton is one of only three known objects in the Solar System (the other two are Earth and the jovian southern hemisphere, satellite Io) where eruptive activity has been definitely observed. A new mechanism of energy supply to the Tritonian eruptive plumes is proposed.Â This was surprising since at that time deposition of fresh N2frost should have taken place over most of Triton's northern hemisphere (subsolar point was 45Â°S). In contrast, the subliming southern cap was seen as a bright feature. Our new approach to this problem is based on the combination of the energy balance calculations and the laboratory results.Â Triton's polar caps are modeled as permanent nitrogen deposits hundreds of meters thick.