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Comparative Planetary Atmospheres of Pluto and Triton

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Abstract

Both atmospheres of Pluto and Neptune's largest satellite Triton have cold surfaces with similar surface gravities and atmospheric surface pressures. We have updated the Zhu et al. *Icarus* **228**, 301, 2014) model for Pluto's atmosphere by adopting Voigt line profiles in the radiation code with the latest spectral database and extended the model to Triton's atmosphere by including additional parameterized heating due to the magnetospheric electron energy deposition. Numerical experiments show that the escape rate of an atmosphere for an icy planetary body similar to Pluto or Triton is quite sensitive to the methane abundance and planetary surface gravity. Together this leads to a cumulative effect on the density variation with the altitude that significantly changes the atmospheric scale height at the exobase together with the exobase altitude. The atmospheric thermal structure near the exobase is sensitive to the atmospheric escape rate only when it is significantly greater than 10^{26} molecules s^{-1} above which an enhanced escape rate corresponds to a stronger radial velocity that adiabatically cools the atmosphere to a lower temperature.

1. Introduction

In the outer solar system, Pluto and Triton are widely regarded as the largest end-members of Kuiper-Belt objects and as "twins" with thin buffered N2 atmospheres controlled by interactions with surface ice, primarily N2 frost. There are substantial differences between the atmospheres of Pluto and Triton at the microbar level where stellar occultation measurements probe. Pluto's scale height and temperature are about twice Triton's values. In the altitude range 25–150 km the atmospheric structure of Triton has a steep thermal gradient above 50 km altitude, with a nearly isothermal profile below [2]. The upper part of the profile can be explained by downward conduction of heat deposited by magnetospheric electrons and solar UV. However below 50 km, the atmospheric temperature is too cold for any known constituent to radiate away the inferred heat flux from the upper atmosphere. Why Triton has what would appear to be a thick troposphere, while Pluto has at most a thin planetary boundary layer will be discussed [3]. We confirm that magnetospheric electron energy deposition is necessary to explain the Voyager derived 100 K thermosphere on Triton.

References

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