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Saturn's upper atmosphere from the Cassini/UVIS Grand Finale stellar occultations

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Abstract

A global picture of Saturn's upper atmosphere is necessary to understand the dynamics, energy balance and minor species composition in the thermosphere. Occultation data from Voyager/UVS and Cassini/UVIS have been used to study this poorly known region of the atmosphere. The previous data, however, are largely concentrated at low to mid-latitudes and were obtained sporadically at different times, complicating the separation of temporal and spatial trends. The Grand Finale occultations overcome these limitations as the data were obtained within six weeks in the summer of 2017. Together with the observations from 2016, they provide a vital new look at meridional trends in Saturn's thermosphere. We present temperature and density profiles retrieved from these occultations, including a first look at the polar thermosphere.

1. Introduction

Despite recent advances enabled by the Cassini mission, our understanding of Saturn's upper atmosphere is still relatively poor. In particular, the higher than expected temperatures in the thermosphere, that are also observed on Jupiter, Neptune and Uranus, remain a major problem that has evaded a clear solution. The leading mechanisms to explain these temperatures i.e., the dissipation of upward-propagating gravity waves, auroral heating followed by the redistribution of energy to lower latitudes, and low-latitude electrodynamics, depend on atmospheric dynamics [1]. Circulation in the thermosphere, however, is unknown on global scales due to the lack of observations that could constrain it. The density and temperature profiles retrieved from the occultations that we will present probe the thermosphere from low latitudes to the poles (see Figure 1). They provide a snapshot of Saturn's upper atmosphere at the end of the Cassini mission. The results constitute the most extensive observations of a giant planet upper atmosphere to date. The meridional gradients evident in the data provide the first global constraint on the redistribution of energy and dynamics in the thermosphere.

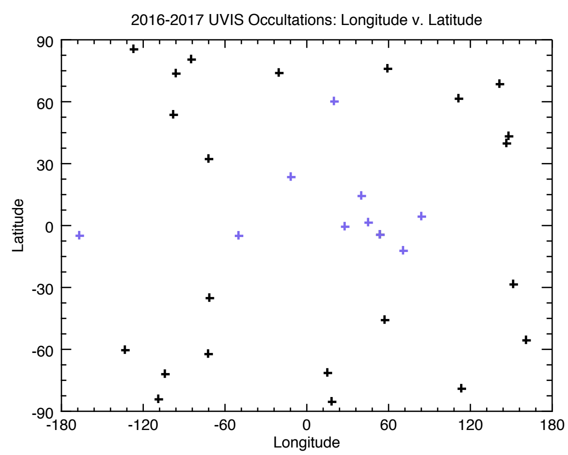

Figure 1: Half-light latitude and longitude of the occultations observed in 2016 (purple) and 2017 (black).

2. Methods

We retrieve the H_2 density and temperature in the thermosphere from the 2016–2017 occultations observed in the EUV channel of the Cassini/UVIS instrument [2]. The cross section of H_2 depends on temperature and we use an iterative method to retrieve the density and temperature profiles, assuming hydrostatic equilibrium. Our method accounts for the change in temperature along the line of sight and the oblateness of Saturn's atmosphere. Details of the retrieval and error analysis are given in Koskinen et al.[3].

3. Summary and conclusions

Our results constrain the shape of the density levels in the thermosphere and temperature as a function of latitude and height. Superimposed on the expected oblate shape of the atmosphere, we confirm that pressure levels are more extended at high latitudes than at low latitudes, indicative of polar heating. Meridional trends in temperature, however, point to surprising high-latitude features that have not been predicted by previous models. We also find evidence of atmospheric waves in many of the occultations that have implications for the momentum and energy balance of the thermosphere.

References

[1] Strobel, D. F.., Koskinen, T. T. and Müller-Wodarg, I. C. F.: Saturn's variable thermosphere, arXiv:1610.07669, 2016.

[2] Esposito, L. W., et al.: The Cassini Ultraviolet Imaging Spectrograph investigation, Space Sci. Rev., Vol. 115, pp. 299-361, 2004.

[3] Koskinen, T. T., Sandel, B. R., Yelle, R. V., Strobel, D. F., Müller-Wodarg, I. C. F., Erwin, J. T.: Saturn's variable thermosphere from Cassini/UVIS occultations, Icarus, Vol. 260, pp. 174-189, 2015.