EPSC Abstracts
Vol. 12, EPSC2018-919, 2018
European Planetary Science Congress 2018

Energy balance in Saturn's upper atmosphere

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Abstract

Like for giant planets in our solar system, the energy balance in Saturn's upper atmosphere (its thermosphere) remains hitherto largely unknown, with temperatures exceeding the values expected from solar heating by 200–300 K [9]. Considerable energy is supplied to the polar regions via atmosphere-magnetosphere coupling processes, but General Circulation Models have highlighted the difficulty in distributing this energy on a fast spinning planet from pole to equator due to the strong Coriolis forces [7, 4]. Using the Saturn Thermosphere Ionosphere General Circulation Model (STIM) [3, 4, 2], we show that the addition of zonal momentum drag in the calculations can sufficiently reduce the Coriolis-barrier to allow for pole-to-equator transport of energy, thus producing a good match with the observed exospheric temperatures. Such momentum drag could result from the dissipation of atmospheric gravity waves recently identified from Cassini Ion and Neutral Mass Spectrometer (INMS) [8] observation in Saturn's thermosphere during the final proximal orbits [5]. The need for additional wave-induced momentum drag in upper atmosphere wind calculations has previously been highlighted for Earth [6] and Venus [1] and is in our study for the first time applied to a giant planet upper atmosphere model.

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