SA41B-3182 - Plasma heating perpendicular to the magnetic field in the topside ionosphere

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08:00 - 12:20

Moscone South - Poster Hall

ePoster

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Abstract

We investigate wave-particle heating mechanisms of ionospheric electrons and O^+ ions as observed from the Enhanced Polar Outflow Probe (e-POP). First, we present the first in-situ observations of suprathermal (tens to hundreds of eV) electron heating perpendicular to the magnetic field based on measurements from the suprathermal electron imager (SEI) over several months. We identify 30 events (28 in the dayside cusp) of enhanced suprathermal electron fluxes peaking at exactly +/- 90º pitch angles, with energies increasing from tens of eV to 325 eV. These events take place with a time duration of the order of 0.1 seconds. They are associated with parallel suprathermal electron bursts (STEBs) and upward currents. The correlation between perpendicular and parallel suprathermal electrons suggests a scenario in which downward bursts and the associated Alfven waves that drive them provide a free energy source to destabilize plasma waves at electron frequencies, which in turn heat electrons in the perpendicular direction. Second, in order to explain observations of perpendicular O^+ ion heating resulting from broadband extremely low frequency (BBELF) waves, we perform numerical test particle simulations that take into account ion-neutral collisions at low altitudes (~400 km). We argue that the most effective mechanism of ion heating is through cyclotron acceleration by short-scale electrostatic ion cyclotron (EIC) waves with perpendicular wavelengths $\lambda_\perp \leq$ 200 m. The interplay between finite perpendicular wavelengths, wave amplitudes, and ion-neutral collision frequencies collectively determine the ionospheric ion heating limit, which begins to decrease sharply at 540 km altitude as the ratio $\frac{\nu_{in}}{f_c}$ becomes larger than 10^{-3}, where ν_{in} is the O^+-O collision frequency and f_c is the O^+ ion cyclotron frequency. We derive, both numerically and analytically, the ion gyroradius limit from EIC waves. The ion gyroradius limit from a single EIC wave can be surpassed either through adding waves with different $\lambda_\perp$, or through stochastic “breakout” in which ions diffuse in energy beyond the gyroradius limit due to stochastic ion heating from large-amplitude waves.

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