Project Details

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Topic: Pathways of Cold Plasma through the Magnetosphere

Project Title:
The source of warm plasma cloak due to ion heating by EMIC waves

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Summary:
Goal and Objectives: Our overarching goal is to systematically investigate the source of warm plasma cloak due to heating of low-energy ions by electromagnetic ion cyclotron (EMIC) waves. To achieve this goal the following two objectives will be fulfilled. The 1st objective is to investigate in detail the individual cases of O+ and He+ heating and geomagnetic trapping due to dissipation of the He- and H-band EMIC wave energy, respectively. The 2nd objective is to produce the global geomagnetically dependent maps of the O+ and He+ heating and trapping parameters due to interaction with EMIC waves. On the global (MLT, L)-scale and during different geomagnetic conditions, we will quantify the energy and pitch angle ranges of ions interacting with EMIC waves, their densities, the energies per ion gained during EMIC wave events and the resulting increase of pitch angles, the observed distribution functions of those ions, and the concurrent EMIC wave and background plasma parameters including its ion fractions.

Methodology: There are two dominant bands of EMIC waves in the Earth's inner magnetosphere, where the He-band is the dominant one, which is followed by the H-band. The former band effectively heats low-energy O+, and the latter one heats He+. We will analyze all the He- and H-band EMIC wave events observed by the two Van Allen Probes from the beginning through the end of mission. For each event, all the needed wave and plasma parameters, DC magnetic field, and ion distribution functions will be taken from Van Allen Probes during the event. The observational data will be used to separately calculate the damping rates for He- and H-bands due to interactions with O+ and He+, respectively. Our damping rate code will allow us to identify 1) the O+ and He+ energy and pitch angle ranges that contribute most in the damping rates, and so to integrate the observed ion distributions to get number densities of those ions. Then, using the observed frequency spectra of EMIC waves and calculated damping rates, we will calculate 2) the wave energy dissipated during each wave event that gives us the energy per ion absorbed by the heated in the perpendicular to magnetic field direction O+ and He+, and 3) the resulting increase of the O+ and He+ pitch angles that shows us whether an additional geomagnetic trapping of the upflowing ionospheric ions is produced by waves. Finally, using the results from all the individual cases analyzed, the global geomagnetically dependent maps of the wave induced O+ and He+ heating and trapping parameters will be produced.

Van Allen Probes Data to be Used: 1) EMFISIS to get DC magnetic field, the high-resolution magnetic field for waves, and electron number density estimated from the upper hybrid frequency, 2) EFW for electron number density estimated from spacecraft potential, and 3) HOPE to get distribution functions of O+, H+, and He+ and also to estimate the ion fractions.

Relevance and Contributions to the FST: This effort will provide a better understanding of the warm plasma cloak sources by investigating its specific source due to heating of low-energy ions by EMIC waves, and so it is relevant to the FST #2: Pathways of Cold Plasma Through the Magnetosphere. The potential contributions of proposed study to this FST's effort are 1) a quantitative understanding of the source of warm plasma cloak due to ion heating by EMIC waves and 2) the global (MLT, L) and geomagnetically dependent maps of the O+ and He+ heating and trapping parameters due to interaction with EMIC waves that include the energy and pitch angle ranges of ions interacting with EMIC waves, their densities, the energies per ion gained during EMIC wave events and the resulting increase of pitch angles, the observed distribution functions of those suprathermal ions, a likelihood of an additional wave induced geomagnetic trapping of ions, and the concurrent EMIC wave and background plasma parameters including its ion fractions.

Publication References:

no references