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Mid-latitude Ionospheric Disturbances Due to Geomagnetic Storms at ISS Altitudes

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Introduction

Spontaneous charging of the International Space Station (ISS) is dominated by ionospheric electron density and temperature effects at mid-latitude altitudes relative to the 100 km spacecraft plasma environment. ISS solar arrays are charged at high electron density environments due to the increased thermal electron currents to the solar arrays. High electron temperature environments suppress charging because the increased thermal electron currents to the spacecraft have a barrier potential on the charged spacecraft cover glass that restricts the charging currents to the solar cell edges. ISS charging is therefore dominated by high electron density and low electron temperature environments.

In support of the ISS space environment effects engineering community, we are working to understand a number of features of the plasma environment. Of particular interest are geomagnetic storms, which can cause large changes in the plasma and ionosphere. The data sources used to describe mid-latitude ionospheric perturbations for the ISS charging study ("Mid-latitudes") are defined as the extratropical region between ~30 degrees to ~60 degrees magnetic latitude. The goal is to determine how well future charging behavior can be predicted from in situ plasma density and temperature measurements. One aspect of this work is a need to characterize the magnitude of density and temperature disturbances that occur at mid-latitude altitudes (~100 km) over time scales of days, the disturbances that were significant variations occur, and the time period over which the disturbances persist once they occur.

This presentation provides examples of midlatitude electron density and temperature disturbances at altitudes relevant to ISS using data sets and tools developed for our ISS plasma environment study. "Mid-latitudes" is defined as the extratropical region between ~30 degrees to ~60 degrees magnetic latitude. The global ionosonde network provides a good sampling of a wide range of ionospheric conditions over extended periods of time to be easily considered.

Data Sources

Insonde – Critical frequency f0F2 records from ground based ionosondes provide electron density and temperature over periods of a few days.

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CHAMP Digital Ion Drift Meter provides a convenient method for evaluating latitude distributions of electron density and temperature disturbances. Possible ISS solar array charging environments are indicated by the f0/F2 ratio proxy, reductions in the ratio suggest a charging threat. For the geomagnetic storm events shown here the proxy typically indicates a change of at least 10% in the charging level.

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