

REU Student: Mina Khan (Mount Holyoke College, Class of 2015)

Project advisors: Professor Barbara Emery and Professor Astrid Maute

Project title:

Calculating Hemispheric Power and Joule Heating using Defense Meteorological Satellite Program (DMSP) F-13 data

Abstract

In this project, we calculate ionospheric Joule heating for a range of Bz Interplanetary Magnetic Fields (IMF Bz) in order to analyze the temporal and spatial variation in Joule heating. Joule heat is the largest heat source in the high-latitude regions, and can exceed the global solar heating from EUV radiation during large geomagnetic storms in the upper atmosphere above 100 km. The Joule heating is estimated from the sum of the auroral and solar extreme ultraviolet (EUV) Pedersen conductances multiplied by the square of the electric field.

We use data from the Ion Drift Meter (IDM) of the DMSP satellite to quantify the relative positions of the cross-track ion drift peaks and convection reversal boundaries. We also compare Weimer 2005 cross-track ion velocities with the IDM observations. We calculate auroral Pederson conductance using the auroral electron energy flux and mean electron energy measurements from DMSP SSJ4 electron particle precipitation instrument. We then correlate SSJ4 and IDM magnetospheric measurements and add polar EUV Pederson conductance to calculate Joule heating. We used six months of IDM and SSJ4 measurements from January to June 2005.

Our integrated electron energy flux (a.k.a hemispheric power) calculations are largest in the morning sector as the aurora is the widest there. We calculated particle Joule heating using auroral poleward and equatorward boundaries and found that the aurora mostly lies in the sunward ion flow region. Hence, the largest particle Joule heating is in the dawn sector as is the auroral electron hemispheric power. The total Joule heating from EUV and particle sources, though, is approximately the same in dawn and dusk regions. Our analysis further shows that the EUV Joule heating in the polar cap anti-sunward ion flow mostly exceeds the particle (or auroral) Joule heating in the equatorward sunward ion flow. We hope to consider DMSP data for a longer time period to refine and solidify our findings.