Space Grant Fellowship 2024

Final Report

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This report presents a summary of my summer research investigating the magnetosphere – ionosphere (MI) coupling from a global viewpoint. The background of the research is centered around finding alternative ways of understanding the impact of the coupled MI system without relying on in situ measurements. Energetic neutral atoms were employed to create a global snapshot of the temperature profile of proton in the magnetosphere, and network analysis of the SuperMAG magnetic field data was used to map out the ground response to various geomagnetic drivers. Using these two techniques, a one-to-one correlation can possibly be estimated between the signatures seen in the temperature maps of the magnetosphere and the magnetic field variations observed in the ionosphere.

In the proposal that was submitted, the future works were outlined, which included further analysis of two case study events (June 19, 2015, substorm event, and March 17, 2015, Corona Mass Ejection (CME) event), each with different geomagnetic drivers. Along with analyzing two more case study events, defending my dissertation was also proposed.

Over the course of the summer, analyzing two more case study events proved to be more work, especially because there were very little in-situ satellite measurements for those two events. This removes the possibility of providing in-situ measurements as a form of validation of the two global techniques. Instead, we analyzed the isolated substorm event of June 09, 2015. Temperature maps along with network graphs of the events were generated, showing a good correlation between the observed signatures in the temperature maps and the graphs, as seen in figure 1 below. Locations of enhanced temperature in the maps are closely correlated with the locations of increased connectivity in the network maps. In-situ measurements from the GOES satellites also showed a strong agreement with the maps and graphs. The results of this research were presented at the Geospace Environment Modelling (GEM) Workshop 2024, and an abstract has been submitted at the American Geophysical Union (AGU) that's taking place in December.

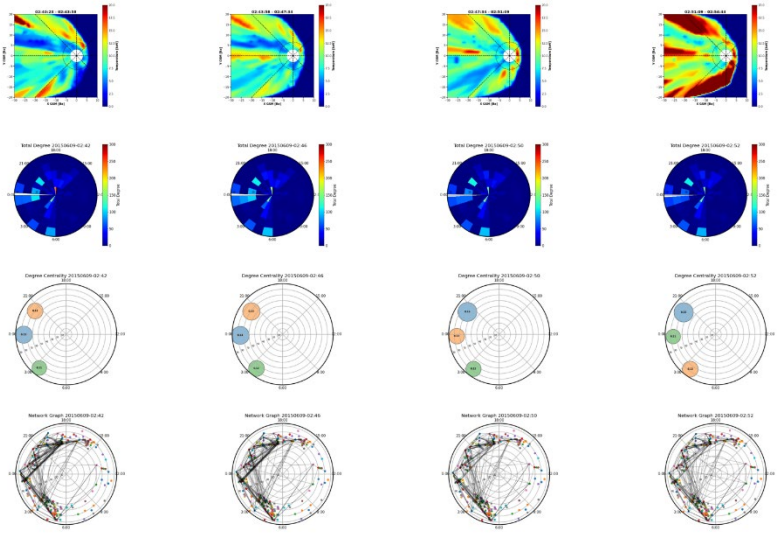

Fig. 1. Temperature maps and network analysis of the June 09, 2015, isolated substorm event. The top row shows the temperature maps for the event, going from 02:40 UT to 02:54 UT. The second row shows the degree histogram, a measure of connections within a 15 degrees latitude by 1-hour MLT bin. The third row shows the degree centrality parameter for the network. This value shows which magnetometer stations (nodes) are most active within the network. The fourth row is the network graph of all the nodes.

Beyond the case study event that was analyzed, further analysis was performed on our previous events to include more in-depth simulations. The results of this analysis have been submitted for publication in the Journal of Geophysical Research (JGR) and is currently under review.

Both of these analyses have also been written up as a part of my dissertation. As things stand, my dissertation needs some minor revisions before sending it off to my committee members in the coming weeks. The next step is to set a date to defend my dissertation and put some finishing touches on my presentation.