~~Statistical Analysis of Particle Injection and the Substorm Current Wedge.~~

Network Analysis of SuperMAG Stations and Correlation with ENA Temperature Maps

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Motivation

- Energetic Neutral Atoms (ENA) Temperature Maps provide a great opportunity for magnetotail observation and provide a global context for in situ magnetotail observations.
- SuperMAG Network Analysis shows the ionospheric response to different geomagnetic activities.
- Network Analysis is a method used here to explore the connections between two stations (represented as nodes) during geomagnetic disturbances.
- Features in the temperature maps can be put into more ionospheric context spatially and temporally.

Network Analysis Procedure

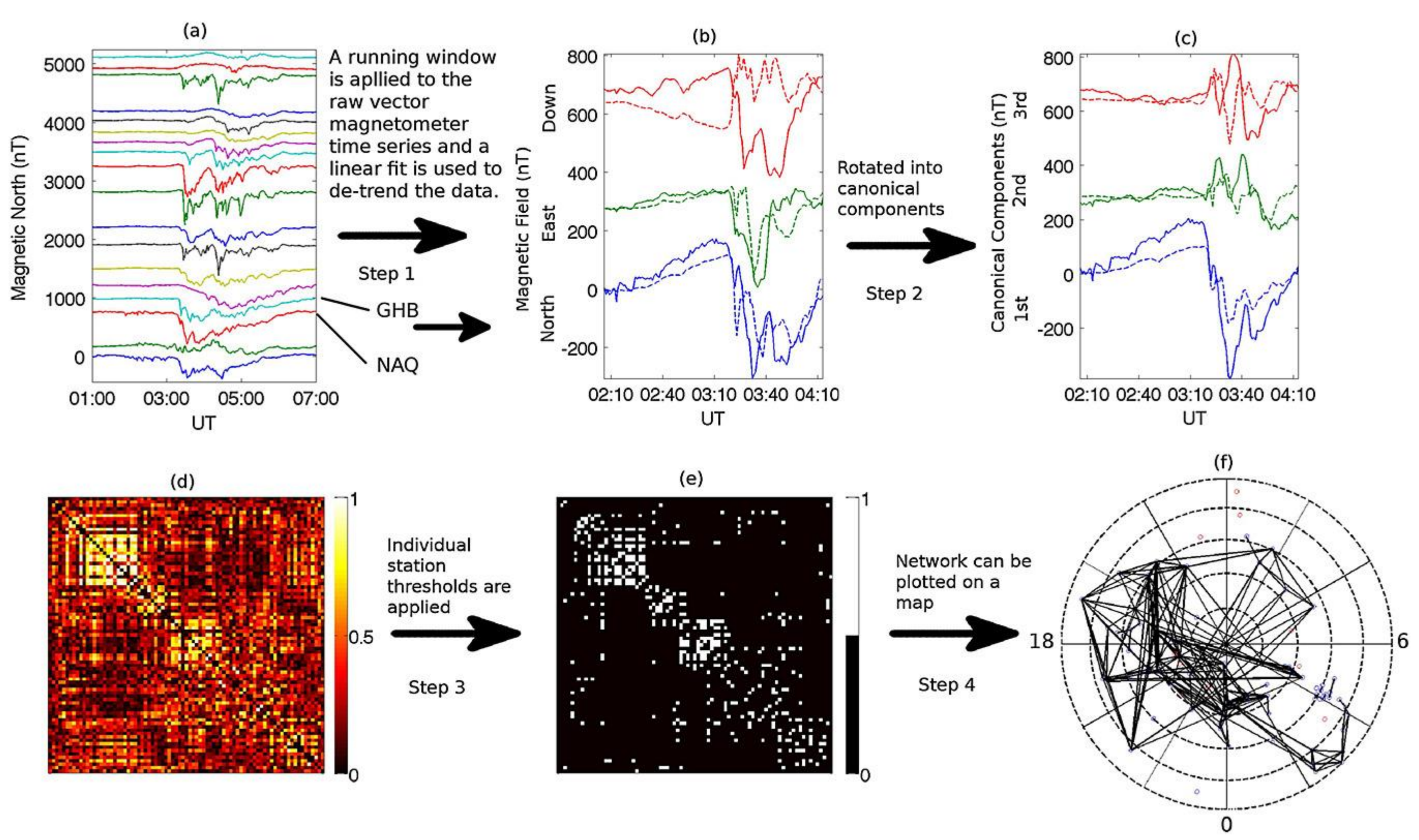

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Fig. 1: taken from Dods et. al, 2015, the figure highlights the steps taken to generate a network of connection from the SuperMAG stations.

October 10th 2014

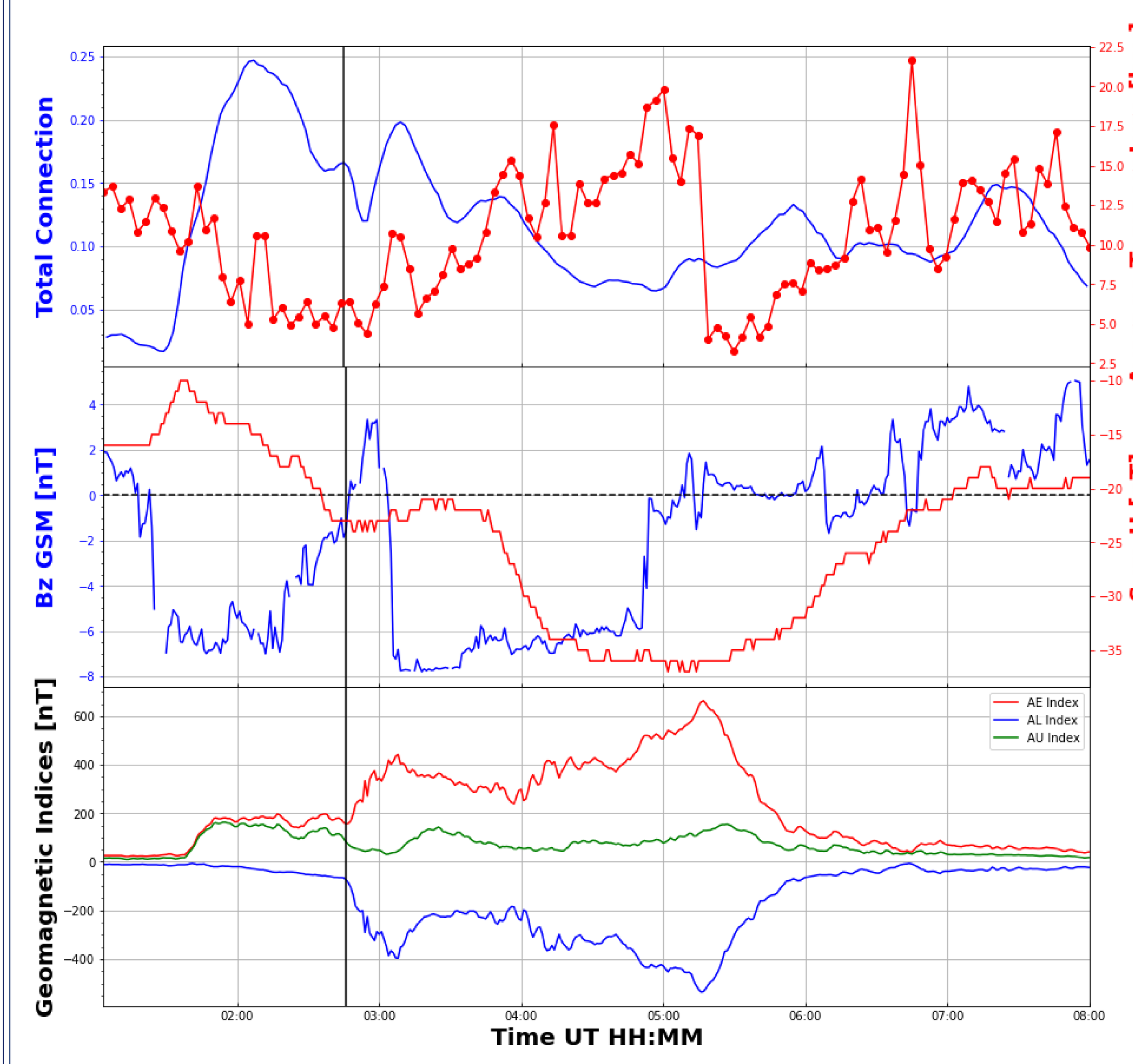

Fig 2: Analysis of the substorm of 10/10/14. The substorm event was taken from the Ohtani & Gjerloev (2020) list of substorms. The time of onset is ~ 2:47 UT (vertical line). The first panel shows the total connection of the network (blue) and averaged temperature from the ENA maps (red). The second panel shows IMF Bz (blue) and Sym-H (red). The last panel shows AE,AU and AL indices. Sharp drop in temperature value can be attributed to the changing field of view from one TWINS instrument to the other.

Correlation with SuperMAG Network Analysis

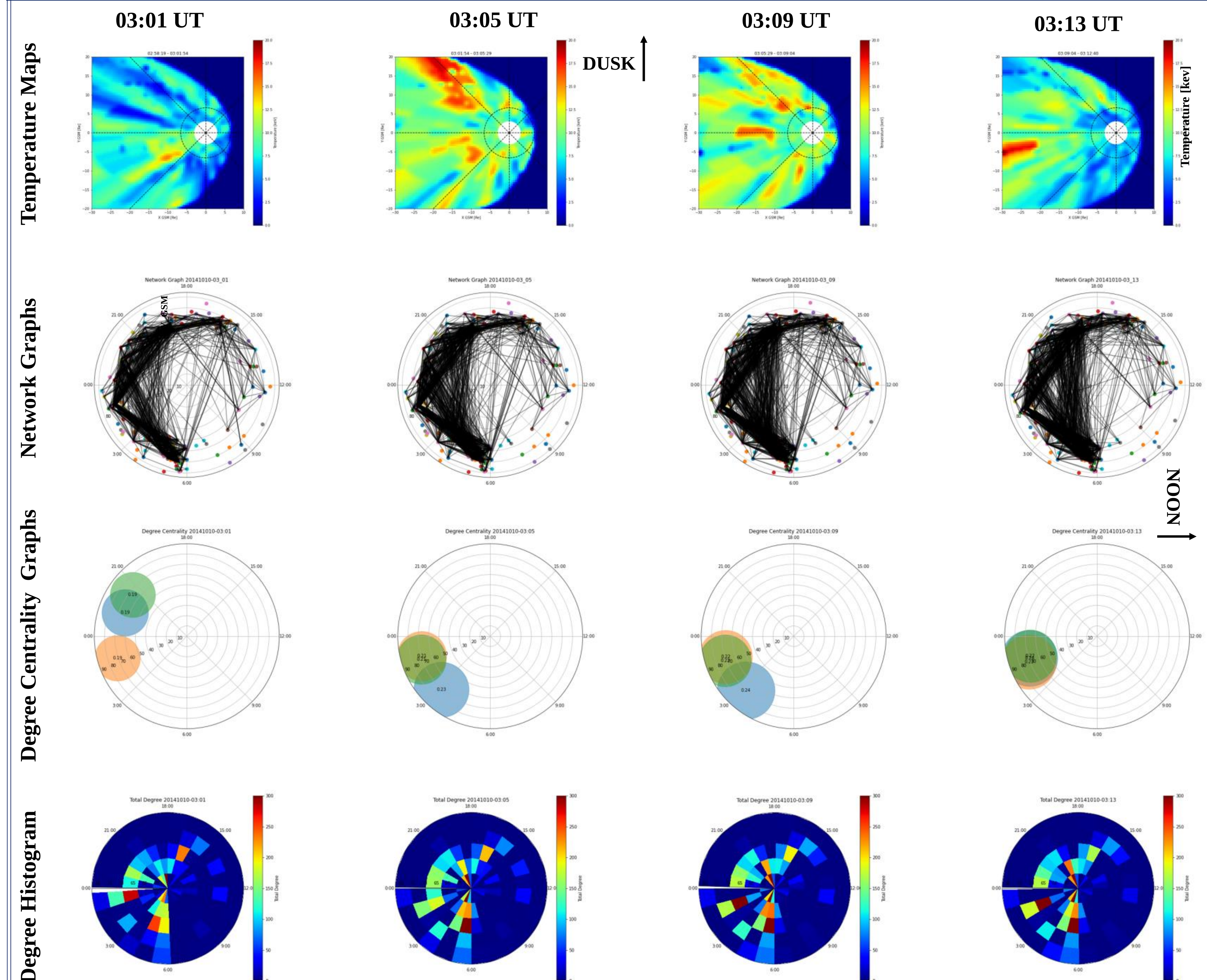

Fig. 4: Network diagram, degree centrality and degree histogram are plotted for the last four temperature panels in fig. 3. The orientation for all images are the same, with the sun to the right and dusk at the top. The first row are the ENA-derived temperature maps, second row is the network graphs, third row is the degree centrality, and the last row is the degree histogram. Degree histogram bins the number of connections and degree centrality highlights the 3 most active stations (nodes).

ENA Temperature Maps

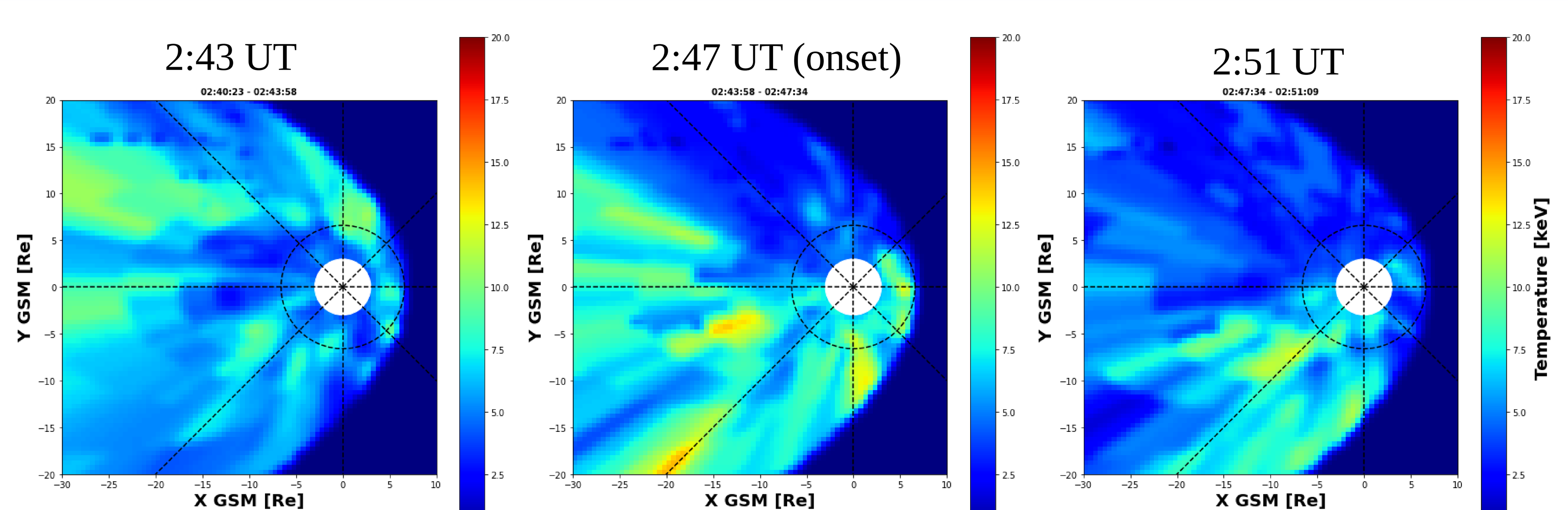

Fig. 3: Temperature maps of the magnetotail around the time of substorm onset. The black dashed circle is geosynchronous orbit. The white circle centered at Earth has a radius of 3 R_E and blocks out the region where the temperature map calculations are not valid. Alight increase in the temperature map can be seen from the first to second panels just before substorm onset. A more pronounced enhancement in ion temperature is observed around 3:05 UT when AE index increases, so those intervals are selected for network analysis (shown in the upper right).

Conclusions

- Temperature maps of the magnetotail were generated using ENA data from the TWINS mission.
- October 10th, 2014, substorm event was analyzed. Substorm onset was around 02:45 UT.
- Increase in the temperature map shortly after onset in the timeseries average.
- Consistent spike in temperature values following southward turning of IMF after onset.
- Network formation in the nightside shortly after onset as seen by the spike in total connection in Figure 2.
- Higher degree (connection) concentration at post-midnight over time.
- Connections in the pre-midnight sector concentrated in mid-latitudes (50-70 degrees) but more activity at high latitudes in the post-midnight sector.
- Top 3 most active stations located around 0-3 MLT consistent with location of features seen in the temperature maps. However, total connection appears to be anti-correlated with average temperature (Fig. 2)

References

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