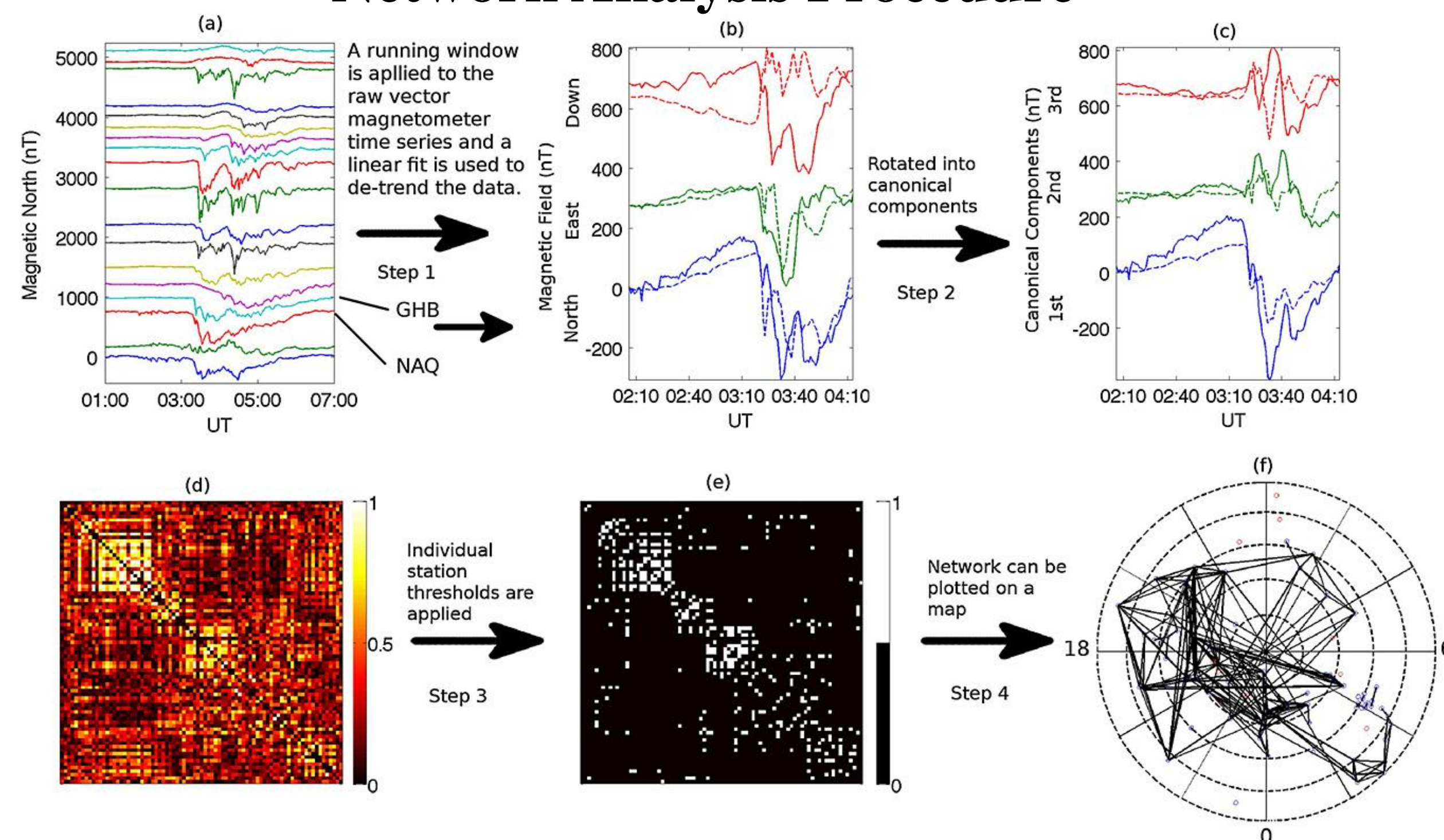




Motivation

- 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



JGR Space Physics, Volume 120, Issue 9, Pages: 7774-7784, First published: 28 August 2015, DOI: (10.1002/2015JA021456)

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

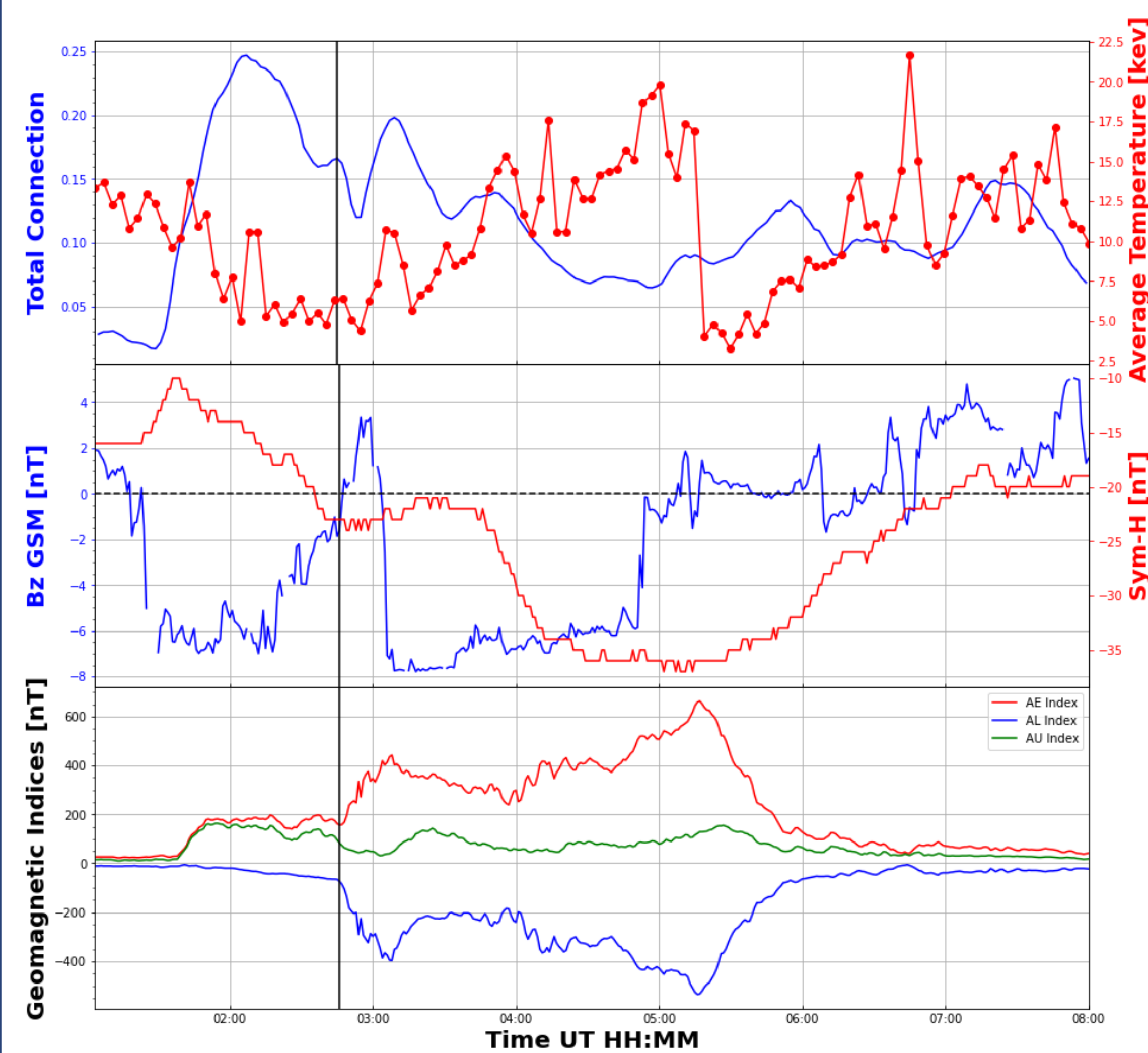
October 10th, 2014 Substorm

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.

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 increase in the 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.
- The ionosphere exhibits the highest network connections between 0 MLT and 6 MLT, within 65–75 degrees latitude, aligning with dawn-side dominance and fast flow observations from the simulation.
- Influential network nodes initially cluster on the dusk side but migrate toward the dawn side as the storm evolves, showing a clear spatial shift in magnetotail activity.

References

- A. M. Keesee, R. M. Katus, M. Floyd, and E. E. Scime (2020), Database of storm-time equatorial ion temperatures in Earth's magnetosphere calculated from energetic neutral atom data. *Journal of Geophysical Research: Space Physics*
- Scime, E., and S. Hokin (1992), Design and calibration of a fast-time resolution charge-exchange analyzer, *Rev. Sci. Instrum.*, 63, 4527.
- J. Dods, S. C. Chapman, and J. W. Gjerloev, *JGR Space Physics*, Volume 120, Issue 9, Pages: 7774-7784, First published: 28 August 2015, DOI: (10.1002/2015JA021456)
- Ohtani, S., & Gjerloev, J. W. (2020). Is the Substorm Current Wedge an Ensemble of Wedgelets?: Revisit to Midlatitude Positive Bays. *Journal of Geophysical Research: Space Physics*, 125(9), e2020JA027902. <https://doi.org/10.1029/2020JA027902>
- Adewuyi, M., A. Keesee, and B. Ferdousi. "Merging Mesoscale Magnetotail Features and Ground B-Field Perturbation Network Connectivity During Substorm Activity." *Journal of Geophysical Research: Space Physics* 129, no. 9 (2024): e2024JA032598. <https://doi.org/10.1029/2024JA032598>.

Acknowledgements

This research was supported by the National Science Foundation (NSF) under Grant 2109543, and the New Hampshire 2024 Space Grant program. Additionally, we acknowledge the support from the National Aeronautics and Space Administration (NASA) under Grant 80NSSC20K1818.

Correlation with SuperMAG Network Analysis

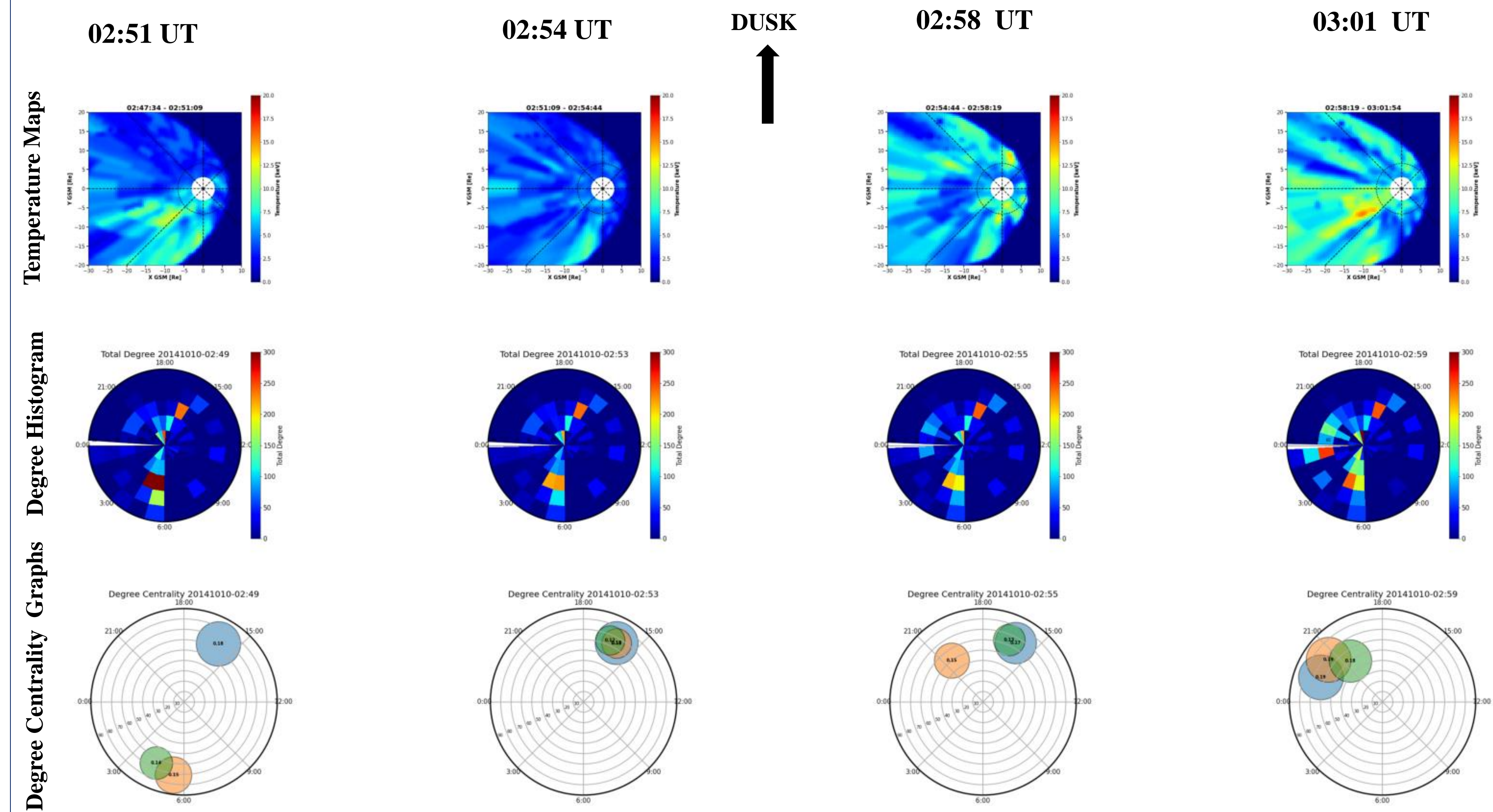


Fig. 3: Temperature Maps, Degree centrality and degree histogram are plotted for approximately the time seen in the simulations below. The orientation for all images are the same, with the sun to the right and dusk at the top. Degree histogram bins the number of connections and degree centrality highlights the 3 most active stations (nodes).

Simulation Results

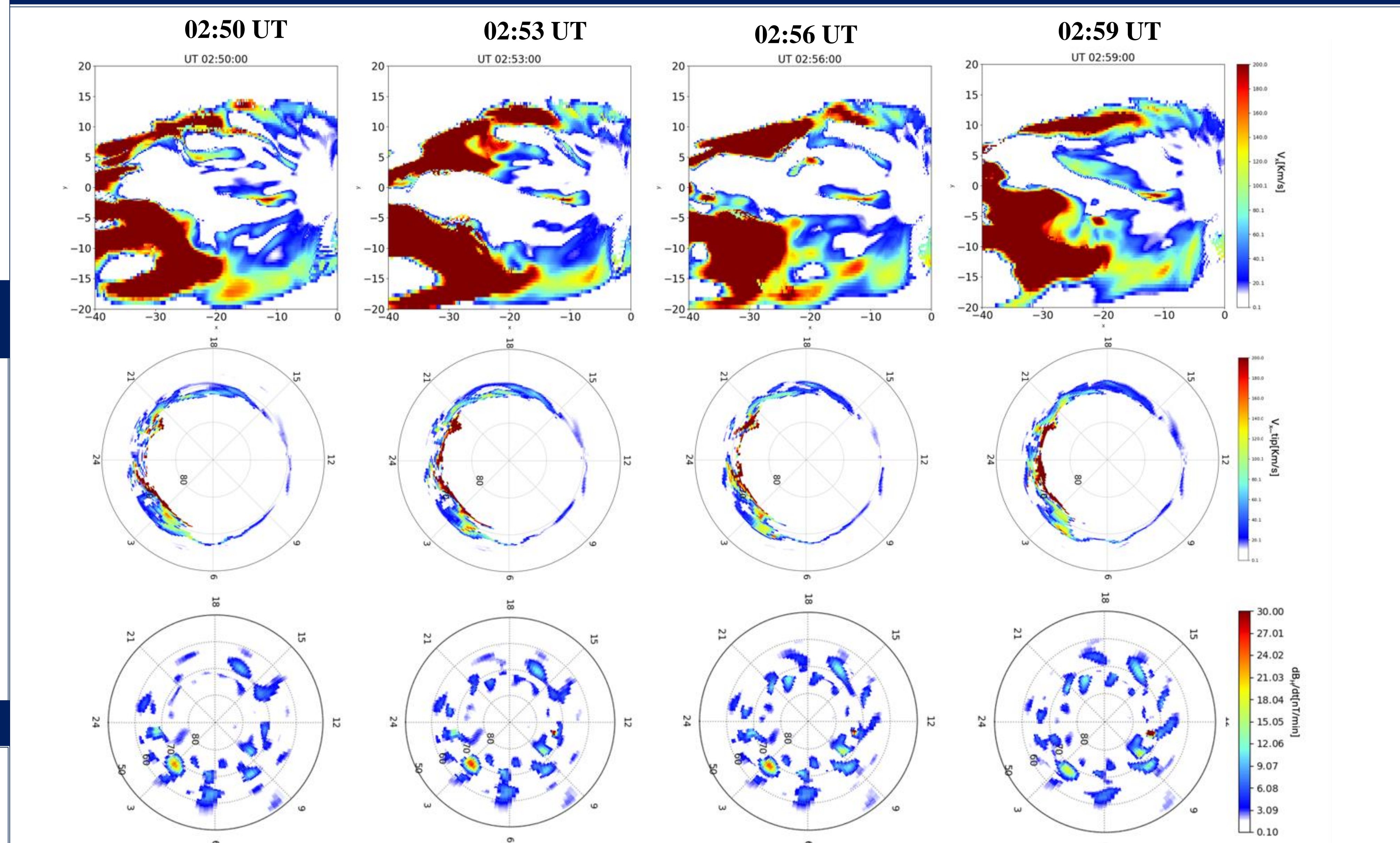


Fig. 4: Fast flows (1st row) and their footprint in the ionosphere (2nd row). The 3rd row shows simulation results of db_H/dt (perturbed horizontal magnetic field) in the ionosphere.