EGU23-9082, updated on 23 Apr 2024
https://doi.org/10.5194/egusphere-egu23-9082
EGU General Assembly 2023

Observational Analysis of Small-scale Structures in the Earth's Magnetosheath

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Magnetic flux ropes with a wide range of scale sizes generally have high magnetic helicity, a magnetohydrodynamic (MHD) quantity that characterizes the knottedness of the field lines that can be used to identify flux rope structures. The identification and analysis of structures moving across boundaries such as the Earth's bow shock will give insight into how their properties change across this boundary as well as further our understanding of the interrelation between these structures. Recent spacecraft missions are returning higher time resolution data than before, allowing for more advanced studies of this phenomenon. Using high time-resolution data from the Magnetospheric Multiscale (MMS) mission and Time History of Events and Macroscale Interactions during Substorms (THEMIS) mission, we identify small-scale flux ropes using wavelet analysis and determine how they change across boundaries. Wavelet analysis of single-spacecraft data can produce better resolved time and spatial information that will complement other methods of flux rope identification. Wavelet transforms are performed across hours-long intervals, organized by the orbit configuration of the spacecraft. The resulting spectrograms are then searched to identify small-scale structures. A number of parameters, including duration, scale size, maximum magnetic field, and average plasma temperature of the flux rope intervals identified are also recorded and summarized. Comparing the values of magnetic field, plasma beta, and other parameters at the corresponding times and locations leads to interpretations for the flux rope events such as whether they are compressed, decelerated, or undergo any other changes as they evolve.