Geophysical Research Abstracts
Vol. 18, EGU2016-3827, 2016
EGU General Assembly 2016

Tools of Thor - more than a hammer: An overview of some analysis methods for turbulence investigation

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In the old Norse mythology Thor was a hammer-wielding god associated with thunder and lightning. THOR is also an acronym for Turbulence Heating ObserveR - a planned space mission dedicated to stydy space plasma turbulence. Whereas the mythological Thor did most of his work with a single tool, Mj\olnir - his hammer, the modern version of THOR is far more versatile. The proposed THOR spacecraft comes with a comprehensive package of instruments to explore the energy dissipation and particle energization taking place in turbulent plasma environments.
This paper presents a more detailed investigation of some of the analysis methods listed in the submitted THOR proposal. To demonstrate the methods, we have used data from existing spacecraft missions like Cluster and MMS to examine and compare single-spacecraft and multi-spacecraft methods to establish proper frames. The presented analysis methods are based on fundamental plasma laws, such as conservation of mass, momentum and energy and do not require any triangulation or gradients based on multiple spacecraft.
Our experience based on Cluster and MMS results show that a well equipped single spacecraft platform, like the proposed THOR mission, very often provides better and less ambiguous results that a constellation of many spacecraft with less capable instrumentation. Limitations in underlying assumptions, such as planarity and linearity, as well as non-optimal spacecraft separation and configurations often limit the possibility to utilize multi-spacecraft methods.
We also investigate the role of time resolution and dynamical range of the measurements used in the methods. Since the particle instruments onboard THOR will have a much better time resolution than existing magnetospheric satellite missions, we infer that THOR will be far better suited to resolve time evolution in plasma structures. This is of particular importance in the solar wind and magnetosheat, where frame velocities can be very high. With a larger dynamical range in many of the measurements, and thus the ability to utilize a larger part of the distribution function to calculate moments, the accuracy of key plasma parameters will also be better in THOR measurements.