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Observations of turbulence from MHD to kinetic scales in the solar wind and terrestrial magnetosphere

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We report on observations of solar wind magnetic turbulence by Ulysses, Venus Express and Cluster. The latter mission also provides observations of turbulence in the Earth's magnetosheath. The targeted time intervals span three years at solar maximum (1999-2001) and two years at solar minimum (2007-2008). Data from Ulysses is also analyzed for the previous minimum phase of the solar cycle (1997-1998). The study is carried out in the framework of the FP7 project STORM. The analysis approach includes lower order analysis methods, like the power spectral density (PSD), and higher order ones, like the probability distribution functions (PDFs) and fractals. The results of our survey are organized in catalogues available on line (http://storm-fp7.eu/targeted-databases) and organized as a function of the time interval, mission and targeted system (solar wind or terrestrial magnetosheath). When the level of magnetic fluctuations in the solar wind is high the PSD spectra are not affected by the instrumental noise at higher frequencies thus Venus Express and Cluster provide a reliable sampling of the scales in the vicinity of the ion Larmor radius (provided the Taylor hypothesis is satisfied). In the MHD range some time intervals allow sampling of scales in the vicinity of the autocorrelation length, in the solar wind and the magnetosheath. In-depth studies based on PSD, PDFs and fractal spectra included in the databases provide statistical trends for various turbulence properties. We discuss: (1) spectral properties of solar wind turbulence in the MHD/inertial range and comparison between fast and slow wind (from Ulysses and Venus Express); (2) scaling properties of PDFs and their fourth order moment in the MHD and kinetic range in the solar wind and terrestrial magnetosheath; (3) spectral properties of turbulence in the kinetic range of magnetosheath turbulence; (4) radial evolution of MHD range turbulence in the solar wind. One conclusion is that the spectral scaling of magnetic fluctuations in the MHD/inertial range is consistent quite often with the Kolmogorov or Kraichnan power laws although some statistically reliable differences are reported between fast and slow wind samples. Nevertheless, the probabilities of magnetic fluctuations show large departures from Gaussianity suggesting intermittency, thus possible fragmentation of the multiplicative processes leading to multi-scale transfer of energy and/or lack of self-similarity in the MHD range. Robust evidence is also provided for non-Gaussianity in the kinetic range.

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