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Anisotropies of the Taylor Scale, Correlation Scale, and Effective Magnetic Reynolds Number Determination from Solar Wind Magnetic Field Fluctuations

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ACE, Cluster, Geotail, IMP-8, Interball, THEMIS, and Wind data from many different intervals in the solar wind are employed to determine the magnetic correlation scale and the Taylor microscale from simultaneous multiple point measurements. For this study we define the correlation scale as the exponential decay constant of the correlation coefficient as a function of spacecraft separation and the Taylor scale as the radius of curvature of the correlation coefficient values at zero separation. The present determination of the Taylor scale makes use of a novel extrapolation technique to derive a statistically stable estimate from a range of measurements at small spatial separations [Weygand et al., 2007]. Using all the slow solar wind data (<450 km/s) the Taylor scale length is found to be relatively constant (about 1000 km) in all directions to the magnetic field. Reliable estimate could be not be made for the fast solar wind. In the slow solar wind, the correlation scale length is found to be largest (about 2.7x10^6 km) in the direction parallel to the magnetic field and smallest (about 1.0x10^6 km) in the direction perpendicular to the magnetic field. In the fast solar wind (>600 km/s), the correlation scale length is found to be smallest (about 1.3x10^6 km) in the direction parallel to the magnetic field and largest (about 2.2x10^6 km) in the direction perpendicular to the magnetic field. The anisotropies in the turbulent magnetic fluctuations in the solar wind are consistent with slow solar containing mainly two-dimensional turbulence and the fast solar wind having mostly slab type turbulence. The effective magnetic Reynolds number can be expressed in terms of the correlation scale and the Taylor scale. The difference in the Taylor and correlation scale in the parallel and perpendicular direction indicates that the effective magnetic Reynolds number varies with the direction of the magnetic field and has values between 1x10^6 and 8x10^6 . Knowledge of the effective magnetic Reynolds number may be useful in magnetohydrodynamic modeling of the solar wind and galactic cosmic ray diffusion in the heliosphere.