Turbulent transport MHD model in a structured three-dimensional solar wind

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Turbulence in the solar wind can play essential roles in the heating of coronal and solar wind plasma and the acceleration of the solar wind and energetic particles. Turbulence sources are not well understood and thought to be partly enhanced by interaction with the large-scale inhomogeneity of the solar wind and the interplanetary magnetic field (IMF) and/or transported from the solar corona.
To investigate the interaction with background inhomogeneity and the turbulence sources, we have developed a new 3D MHD model that includes the transport and dissipation of turbulence using the theoretical model Zank et al. (2012). We solve for the temporal and spatial evolution of three moments or variables, the energy in the forward and backward fluctuating modes and the residual energy and their three corresponding correlation lengths. The transport model is coupled to our 3D model of the inhomogeneous solar wind. We present results of the coupled solar wind-turbulence model assuming a simple tilted dipole magnetic configuration that mimics solar minimum conditions, together with several comparative intermediate cases. By considering eight possible solar wind configurations, we show that the large-scale solar wind and IMF inhomogeneity and the strength of the turbulence sources significantly affect the distribution of turbulence in the heliosphere within 5 AU. We compare the predicted turbulence distribution results from a complete solar minimum model with in situ measurements made by the Helios and Ulysses spacecraft, finding that the synthetic profiles of the turbulence intensities show reasonable agreement with observations.
We will also discuss the capability of this model and a future direction of development of a more advanced model.

Keywords: solar wind, turbulence, MHD simulation