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The Solar-Cycle Dependence of the Heliospheric Diffusion Tensor

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Abstract content
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Long-term cosmic-ray modulation studies using ab initio numerical modulation models require an understanding of the solar-cycle dependence of the heliospheric diffusion tensor. Such an understanding requires information as to possible solar-cycle dependences of various turbulence quantities. In this study, data for the heliospheric magnetic field is analysed using second-order structure functions constructed assuming a simple three-stage power-law frequency spectrum. This spectrum is motivated observationally and theoretically, and has an inertial, an energy-containing and a cutoff-range at small frequencies to ensure a finite energy density. Of the turbulence quantities calculated from 27-day averaged second-order structure functions, only the magnetic variance and the 14-hour spectral level appear to show a clear solar-cycle dependence. Although the energy range spectral index is solar-cycle dependent, the 20% change over a solar cycle is insignificant compared to the factor of three change of the magnetic variance over a solar cycle. The spectral index in the inertial range, as well as the turnover and cutoff scales do not appear to depend on the level of solar activity. The ratio of the variance to the square of the magnetic field also appears to be solar-cycle independent. These results suggest that the dominant change in the spectrum over several solar-cycles is its level. Comparisons of the results found in this study with relevant published observations of turbulence quantities are very favourable. Furthermore, when the magnetic variances and heliospheric magnetic magnitudes calculated in this study are used as inputs for theoretically motivated expressions for the mean free paths and turbulence-reduced drift lengthscale, solar-cycle dependencies in these quantities are seen. Values for the diffusion and drift lengthscales during the recent unusual solar minimum are found to be significantly higher than previous solar minima.

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