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MHD Eddy Viscosity: Testing the Concept with the Solar-Wind/Magnetosphere Coupling Data Base

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In Navier-Stokes fluids, the presence of upstream turbulence increases the viscous drag of an obstacle in a flow: this is known as the "turbulence effect." The effect is explained by an eddy viscosity that enhances the viscous coupling, with the eddy viscosity controlled by the amplitude of the upstream turbulence. From solar-wind/magnetosphere data analysis it is known that activity in the Earth's magnetosphere is driven by the solar wind (chiefly as a consequence of reconnection, but also as a consequence of unexplained "viscous effects"); the measured level of geomagnetic activity can be used as a measure of the strength of solar-wind/magnetosphere coupling. The solar wind is a turbulent flow with an MHD-turbulence amplitude that varies with time. We have statistically confirmed that there is a turbulence effect in solar-wind/magnetosphere coupling, where geomagnetic activity is observed to be greater when the solar-wind turbulence is louder. An expression for the MHD eddy viscosity of the turbulent solar wind that can be evaluated in terms of spacecraft-measured quantities is derived. Using this expression and a few decades of solar-wind measurements, cross correlations between geomagnetic activity and the eddy viscosity of the solar wind are performed. These cross correlations can yield (a) an experimental confirmation of the concept of MHD eddy viscosity and (b) a test of the validity, accuracy, and usefulness of the MHD-eddy-viscosity explanation of the turbulence effect in solar-wind/magnetosphere coupling.