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Turbulence-driven magnetic reconnection and the magnetic correlation length in collisionless plasma turbulence

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Observations of Earth's magnetosheath from the Magnetospheric Multiscale (MMS) mission have provided an unprecedented opportunity to examine the detailed structure of the multitude of thin current sheets that are generated by plasma turbulence, revealing that a novel form of magnetic reconnection, which has come to be known as electron-only reconnection, can occur within magnetosheath turbulence. These electron-only reconnection events occur at thin electron-scale current sheets and have super-Alfvénic electron jets that can approach the electron Alfvén speed; however, they do not appear to have signatures of ion jets. It is thought that electron-only reconnection can occur when the length of the reconnecting current sheets along the outflow direction is short enough that the ions cannot fully couple to the newly reconnected magnetic field lines before they fully relax. In this work, we examine how the correlation length of the magnetic fluctuations in a turbulent plasma, which constrains the length of the current sheets that can be formed by the turbulence, impacts the nature of turbulence-driven magnetic reconnection. Using observations from MMS, we systematically examine 60 intervals of magnetosheath turbulence – identifying 256 small-scale reconnection events, both with and without ion jets. We demonstrate that the properties of the reconnection events transition to become more consistent with electron-only reconnection when the magnetic correlation length of the turbulence is below ~20 ion inertial lengths. We further discuss the implications of the results in the context of other turbulent plasmas by considering observations of turbulent fluctuations in the solar wind.