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Evidence from large scale numerical simulations and observations for a relationship between magnetic reconnection, current sheets and intermittent turbulence in the solar wind

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Turbulence is ubiquitous in space plasmas and leads to the emergence of coherent structures. These display signatures of intermittency in the form of rare large amplitude fluctuations that produce highly non-Gaussian heavy tailed probability distribution functions, and have properties consistent with dynamical generation by strong plasma turbulence. Therefore, coherent structures embedded in the solar wind should reflect the non-linear dynamics that give rise to intermittency, such as random magnetic reconnection between adjoining flux tubes.

We present evidence from large scale numerical simulations and observations of a relationship between magnetic reconnection, current sheets and intermittent turbulence in the solar wind for the first time using in-situ measurements from the Wind spacecraft at 1 AU. Reconnection exhausts and current sheets are concentrated in spatially non-uniform intermittent structures, such that 87-92% and $\sim$9% respectively are associated with the most non-Gaussian 1% of fluctuations. The likelihood that an identified current sheet will also correspond to an active reconnection site increases dramatically as the least intermittent fluctuations are removed. Hence, the turbulent solar wind contains a hierarchy of intermittent structures that are increasingly linked to current sheets, which in turn are more likely to correspond to sites of active magnetic reconnection.

These results could have far reaching implications for laboratory and astrophysical plasmas where turbulence and magnetic reconnection are ubiquitous.