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Turbulence and Self- Organised Criticality under finite driving- how they can look the same, and how they are different.

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The paradigm of Self- Organised Criticality (SOC) has found application in understanding scaling and bursty transport in driven, dissipative plasmas such as at the earth's magnetosphere and the solar corona. Turbulence also has scaling and bursty transport as its observable signature so that the question naturally arises as to if, or how, these phenomena are related. SOC a limiting process that occurs as the ratio of driving rate to dissipation rate is taken to zero, while idealized turbulence takes this ratio to infinity. We consider the more realistic scenario of finite driving rate. We demonstrate the difficulty of distinguishing SOC and turbulence under these conditions with a simple multifractal test timeseries, the p- model- which we show both exhibits multifractal scaling in its structure functions and power law avalanche statistics. We use similarity analysis (Buckingham's Π theorem) to identify the control parameter R_A which is analogous to the Reynolds Number R_E of turbulence in that it relates to the number of excited degrees of freedom, that is, the range of spatio-temporal scales over which one finds scaling behaviour. However for avalanching systems the number of excited degrees of freedom is maximal at the zero driving rate, SOC limit, in the opposite sense to fluid turbulence. Practically, at finite R_E or R_A one observes scaling over a finite range which for turbulence, increases with R_E and for SOC, decreases with R_A, suggesting an observable trend to distinguish them. We use the BTW sandpile model to explore this idea and find that whilst avalanche distributions can, depending on the details of the driving, reflect this behaviour, power spectra are not clear discriminators of an SOC state.