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Turbulence, Heating and Reconnection: what causes what?

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The relationship between turbulence, heating and reconnection is central to unlocking the secrets of space plasmas. Reconnection converts magnetic energy into kinetic energy and in that is a clear source of heating. Similarly, turbulence can transform energy into heat directly via wave-particle interaction. But the link between turbulence and reconnection complicates the story tremendously.
Reconnection can be promoted by turbulence: the presence of fluctuations can stimulate the presence of multiple reconnection sites, can produce anomalous dissipations that create the conditions for faster reconnection. Yet reconnection can also produce turbulence: the presence of strong flows produced by reconnection and the creation of strong density gradients, in the separatrix regions and in the reconnection outflows produces the onset of turbulence. Fluctuations and instabilities created by reconnection can then feed a turbulent cascade of its own.
But reconnection can also be an indirect mechanism for turbulent dissipation: current sheets and vortices can promote reconnection and reconnection can then convert energy from the turbulent cascade to heating.
We present new results based on the full kinetic model of space plasmas where turbulence and reconnection are acting together to produce heating. To reach this goal we consider a macroscopic turbulent current layer, unlike the classic homogeneous turbulent state used in previous studies but also unlike the laminar intializations of reconnection. We study the relationship of turbulence and reconnection via statistical indicators of the heating process and of the wave activity