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Storm tracks near marginal stability

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The variance of atmospheric storm tracks is characterised by intermittent bursts of activity interspersed with relatively quiescent periods. Most of the poleward heat transport by storm tracks is due to a limited number of strong heat flux events, which occur in a quasi-periodic fashion. This behaviour is in contradiction with the usual conceptual model of the storm tracks, which relies on high growth rate background flows which then spawn weather systems that grow in an exponential or non-normal fashion.

Here we present a different conceptual model of the atmospheric storm tracks which is built on the observation that, when including diabatic and other dissipative effects, the storm track region is in fact most of the time marginally stable. The ensuing model is a nonlinear oscillator, very similar to Volterra-Lotka predator–prey models. We demonstrate the extensions of this model to a stochastically driven nonlinear oscillator. The model produces quasi-periodic behaviour dominated by intermittent heat flux events.

Perhaps most surprisingly, we will show strong evidence from re-analysis data for our conceptual model: the re-analysis data produces a phase-space plot that is very similar indeed to the phase-space plot for our nonlinear oscillator model.