Large scale coherent flow structures in planetary turbulence arise from spectrally non-local interactions

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The commonly observed phenomenon of spontaneous jet formation in beta-plane turbulence is studied using Stochastic Structural Stability Theory (S3T),
which is an implementation of statistical mean state dynamics.
Jet formation is shown to result from a linear instability arising from a bifurcation in the system parameters and
leading directly to nonlinear finite amplitude jet equilibria.
Given that the S3T system does not contain the perturbation nonlinearity associated with the turbulent cascade, the close agreement in the dynamics and structure of jets arising in these S3T simulations and those arising in fully nonlinear turbulence simulations compels the conclusion that the turbulent cascade process is not required for jet formation in beta-plane turbulence.