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Nonlinear Coupling between Zonal Modes and Damped Modes
KIRIT MAKWANA, JUHYUNG KIM, PAUL TERRY, DAVID HATCH, University of Wisconsin-Madison — A simple fluid ITG model is simulated to study nonlinear coupling between zonal modes (ky=0, zero frequency modes) and damped modes. It is observed that the cross correlation terms dominate the energy dynamics, with the unstable modes supplying all the energy and the damped modes removing a significant portion of it. The remainder is removed by high "k" dissipation. However, even the dissipation has significant damped mode effects. Phase mixing analysis shows that transfer of energy from the unstable to damped modes via the zonal modes is more efficient compared to direct transfer of energy from unstable to damped modes. This is confirmed in simulations, which show that when zonal flows are included in the dynamics, 1) there is significantly more energy in the ky = 0 fluctuation component, and 2) the energy transfer channel from unstable modes to zonal modes to damped modes captures almost all of the energy injected by the instability. When zonal flows are not included, damped modes still saturate the instability but the transfer from the unstable modes is less efficient and requires a larger fluctuation level.

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