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Two-dimensional turbulence: energy balance and variational constraints

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Statistically equilibrated geophysical turbulence is characterized by a power integral expressing the balance between the production of mechanical energy by forcing and dissipation. The most realistic dissipative mechanism is bottom drag, acting equally effectively on eddies of all scales. And the rate of energy injection is not an external parameter. These two facts pose a considerable challenge to the standard phenomenology, which posits that the energy production rate is known, and that energy is unobtrusively removed at large-scales without disturbing the local-in-wavenumber transfers of the inverse energy cascade. I'll discuss results from DNS indicating that universal scaling theories fail to explain the main features of geophysical interest. I'll discuss alternative theories, based on the dominant role of coherent structures (vortices and jets), and variational optimization of transport coefficients.