

Colloquium Talk

Prof. David Marshall

Oxford University

Geometry and Energetics of Mesoscale Ocean Eddies and Their Rectified Impact on Climate

Wednesday, January 31, 2018

at 15:30 h

ESI, Boltzmann Lecture Hall

Abstract: The ocean is populated by a vigorous mesoscale eddy field that is unresolved by the majority of ocean circulation models used for climate prediction. A geometric framework for parameterising ocean eddy fluxes is presented that preserves the symmetries and conservation laws of the unfiltered equations. The framework involves rewriting the residual-mean eddy force as the divergence of an eddy stress tensor and solving a dynamically consistent eddy energy budget. The magnitude of the eddy stress tensor is bounded by the eddy energy, allowing its components to be rewritten in terms of the eddy energy and non-dimensional parameters describing the mean "shape" of the eddies, analogous to "eddy ellipses" used in observational oceanography. These non-dimensional geometric parameters have strong connections with classical stability theory with the eddy energy growing when the eddies tilt against the mean shear and vice-versa. The new geometric framework leads to three desirable results: 1. the correct dimensional eddy energy growth rate for the linear Eady model of baroclinic instability; 2. assuming perfect knowledge of the eddy energy, skilful predictions of inferred eddy diffusivities diagnosed from high-resolution simulations of the nonlinear Eady problem; 3. prediction and physical explanation of "eddy saturation", the remarkable insensitivity of the strength of the Antarctic Circumpolar Current to surface wind forcing in eddy-resolving calculations. Preliminary results from the application of GEOMETRIC to an ocean general circulation model will be discussed along with outstanding opportunities and challenges.

A. Constantin

January 11, 2018