GFD-2 Geophysical Fluid Dynamics - Principal dynamical phenomena at large and medium scales

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3 ECTS

This course is shared with other OACOS specialities

The course treats dynamical phenomena in geophysical fluid dynamics (GFD) beyond the traditional approximation of (geostrophically) balanced models valid for large -scale (called synoptic in the atmosphere and mesoscale in the ocean) slow motions in the atmosphere and the ocean. Sub-synoptic (meso-) and submeso-scales are thus primarily aimed, incorporated in the large-scale dynamics, or by themselves. The main topics are instabilities and transition to turbulence, wave-wave and wave-mean flow interactions, and frontogenesis. After recalling general notions on linear and nonlinear instability, typical instabilities of the rotating stratified flows and their nonlinear saturation are treated in the hierarchy of GFD models, namely the barotropic and the baroclinic instabilities, instabilities of density currents (including coastal currents) shear and Kelvin-Helmholtz instabilities, and inertial (centrifugal) instability of jets (vortices). Formation of coherent structures and/or transition to turbulence at the stage of nonlinear saturation of each instability is explained. Necessary notions from the turbulence theory (statistical description, Reynolds equations, closures, energy cascade and spectra) are given. Nonlinear wave interactions are explained on the examples of Rossby and gravity waves, with application to observed spectra of oceanic waves. Basic notions of wave-mean flow interactions are introduced and illustrated with the Rossby wave-mean (larger scale) and the gravity wave-mean (smaller scale) cases. Frontogenesis at large at small scales is explained with the help of simplified conceptual models.

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