

**Department of Applied Physics and Applied Mathematics
Columbia University**

**APPH E4210. Geophysical Fluid Dynamics
Spring 2005**

- **1/20/05** Review of basic equations of fluid dynamics on a rotating planet (conservation of mass and momentum)
- **1/27/05** Linear wave kinematics: plane wave solutions, dispersion and group velocity, slowly-varying waves and the WKB approximation (eikonal and transport equations), ray tracing, example of sound wave propagation in the ocean
- **2/3/05** Linearization of equations of motion waves in a homogeneous fluid: gravity waves, short and longwave limits, equivalence of longwave limit and hydrostatic approximation, shallow water equations; waves in a stratified fluid (nonrotating): internal gravity waves, Boussinesq approximation, dispersion relation, boundary conditions, WKB approximation for eigenvalues and eigenfunctions
- **2/10/05** Large scale motions of the ocean and atmosphere: linearized equations on the f-plane, hydrostatic approximation and separation of variables, Sturm-Liouville eigen problem, shallow water equations, barotropic and baroclinic modes; gravitational adjustment in a rotating fluid (shallow water equations on the f-plane): dispersion, Poincare waves, equation for PV conservation, geostrophic balance, the forced Klein-Gordon equation, the Rossby adjustment problem (simple example)
- **2/17/05** Rossby adjustment problem (cont'd): energetics of Rossby adjustment, conservation of PV, Taylor-Proudman theorem, Kelvin circulation theorem
- **2/24/05** Waves in the presence of boundaries (Kelvin waves); Rossby waves: the beta plane approximation, dispersion relation (qualitative, graphical solution) of the shallow water equations on the midlatitude beta plane, equivalence of bottom topography and planetary beta, Rossby wave dispersion relation, phase and group velocity
- **3/3/05** Rossby waves (cont'd): conservation of PV and physical mechanism for Rossby waves; shallow water QGPVE: scaling of the equations, Rossby number, asymptotic expansion
- **3/10/05** Midterm
- **3/24/05** QGPVE (cont'd); derivation of QGPVE for a stratified fluid
- **3/31/05** Stratified QG (cont'd): nondimensional numbers (Rossby, Burger's, etc), boundary conditions; vertically propagating planetary waves in a resting fluid; vertically propagating planetary waves in the presence of a background flow: Charney-Drazin theory, refractive index
- **4/7/05** Barotropic instability theory (shear instability)

- **4/14/05** Baroclinic instability theory: free waves in the presence of a mean flow, edge waves and the effect of boundaries, heat flux and APE, the Eady problem
- **4/21/05** Baroclinic instability (cont'd): dispersion relation and eigenfunctions in the Eady problem, energetics of baroclinic instability, general criteria for instability