Dynamics of the Oceans and Atmosphere
11:670:324
Spring 2011

The final exam will be comprehensive, including the following material:

1) Expansion of total derivatives in height and pressure coordinates
2) Evaluating sign of derivatives and wind components
3) Decomposition of vectors into components
4) Vector operations, especially uses of del operator (curl, divergence, gradient)
5) Advection: mathematical representation and interpretation
6) Effects of rotating reference frame (i.e., terms introduced into momentum equation via rotation effects)
7) The fundamental forces: description, name, and mathematical representation of each
8) Definition of effective gravity
9) Identification of terms in unscaled momentum equations
10) How to scale an equation, scaling values for large-scale motions, how to simplify an equation after scaling
11) Geostrophic motion: meaning, mathematical representation, force diagrams, importance of Rossby number
12) How to write the scaled momentum equations in (x,y,z) and (x,y,p) coordinates.
13) Continuity equation: physical principles, meaning of individual terms, mathematical representation in (x,y,z) and (x,y,p) coordinates, scaling
14) Energy equation: relationship to first law of thermodynamics, entropy form, types of diabatic heating, adiabatic processes
15) Temperature tendency equation
16) Primitive equations: what they are and how to write them mathematically
17) Implications of chaos for numerical weather prediction
18) Hydrostatic balance; hypsometric equation
19) Thickness: meaning, implications
20) Natural coordinates: how they are defined, mathematical representation of horizontal momentum equations
21) Special types of balanced flow: geostrophic, inertial, cyclostrophic and gradient, including force diagrams for each
22) Thickness: meaning, derivation, implications
23) Thermal wind: meaning, derivation, determination of type of thermal advection
24) Barotropic versus baroclinic: differences, seasonal/geographical variations
25) Horizontal divergence: physical meaning, representation in natural coordinates, finite difference form
26) Vertical velocity: relationship to horizontal divergence (i.e., kinematic method), how to calculate, relationship between w and \( \omega \)
27) Mathematical representation of relative and absolute vorticity (vector and Cartesian)
28) Vorticity in natural coordinates; shear and curvature vorticity
29) Identifying vorticity maxima and minima on a weather map
30) Potential vorticity; conservation of potential vorticity
31) Vorticity equation (z- and p-coordinates); physical interpretation of terms in vorticity equation
32) Scaling the vorticity equation