Numerical Modeling of Weather and Climate

Two sample questions for exams

(total number of questions in exam: usually 4 to 6)

Question 1

A simplified form of the shallow-water equations with background rotation can be obtained for the case $\partial/\partial y = 0$. The governing equations can then be written as

$$\frac{Du}{Dt} - fv + g^{*}\frac{\partial H}{\partial x} = 0$$

$$\frac{Dv}{Dt} + f(u - u_g) = 0$$

$$\frac{\partial H}{\partial t} + \frac{\partial (uH)}{\partial x} = 0$$

Here *f*=const denotes the Coriolis parameter, $(u_g, 0)$=const the prescribed large-scale geostrophic flow, *u(x,t)* and *v(x,t)* the horizontal velocity components, *H(x,t)* the layer depth, and

$$\frac{D}{Dt} = \frac{\partial}{\partial t} + u\frac{\partial}{\partial x}$$

the advection operator.

Task: Draft an explicit finite difference numerical integration scheme for the above set of equations using centered differencing in space and time on an unstaggered grid.

Question 2

The last term in the horizontal wind equation is the eddy flux

$$\frac{\partial U}{\partial t} + U\frac{\partial U}{\partial x} + V\frac{\partial U}{\partial y} + W\frac{\partial U}{\partial z} - fV = -\frac{1}{\rho_o}\frac{\partial P}{\partial x} - \frac{\partial}{\partial z}\overline{u'w'}$$

Discuss 3 different ways how to parameterize $\overline{u'w'}$ with its pros and cons.