Exercise 6

23. June 2014

1. Today we will look at a simple box model to understand climate system feedbacks. Working in pairs, you will determine the effect of adding freshwater to the ocean under various climate background states. To pick an experiment, open an `R` session and run the program `expirements.R`. Make sure you are not doing the same experiment as the group next to you! Perform a spin-up for your climate state (if needed) and describe the background state in a few sentences (2 points)

2. Apply the perturbation! Describe the result and discuss (explain why) the system reacts the way it does! (3 points)

3. What would you expect if the perturbation was stronger? What if it is weaker? (1 points)

4. Theory Problem: Rosby Waves (Total 4 points) Consider the vorticity equation:

$$\frac{D}{Dt}[(\zeta + f)/h] = 0 \tag{1}$$

with $h = const, u, v$ as velocity components. Assume a mean flow with constant zonal velocity U:

$$u = U = constant > 0 \tag{2}$$

and a varying north-south component:

$$v = v(x, t) \tag{3}$$

   (a) This gives the total motion a wave-like form. Derive the vorticity equation! Use the ansatz:

$$v(x, t) = A\cos[(kx - \omega t)] \tag{4}$$

   (b) Determine the dispersion relation $\omega(k)$, the group velocity $\frac{\partial\omega}{\partial k}$, and the phase velocity $c = \frac{\omega}{k}$.

   (c) Derive the wavelength $L = \frac{2\pi}{k}$ of the stationary wave (given when $c = 0$)

   (d) A typical wavelength is 6000 km, a typical U is 15 m/s. Does this wave travel east to west or west to east?

Notes on submission form of the exercises: *Students can work together in groups of two, each group can submit one solution together. The answers to the questions shall be send to paul.gierz@awi.de.*