VICTORIA UNIVERSITY OF WELLINGTON
School of Mathematics, Statistics and Operations Research
School of Geography, Environment and Earth Sciences

MATH 321 Applied Mathematics I
MATH 322 Applied Mathematics II
MATH 323 Mathematics for Earth Sciences

Meteorology Reading Course

2013

Assignment 4

Complete the following problems which are taken from *An introduction to dynamical meteorology*, by J. R. Holton's, 3rd edition, Academic Press, 1992. This assignment is worth 25% towards final assessment of this module.

Chapter 4 Problem 1

What is the circulation about a square of 1000 km on a side for an easterly (that is, westward–flowing) wind that decreases in magnitude toward the north at a rate of $10\,\mathrm{m\,s^{-1}}$ per 500 km? What is the mean relative vorticity in the square?

Chapter 4 Problem 3

An air parcel at 30°N moves northward conserving absolute vorticity. If its initial relative vorticity is $5 \times 10^{-5}\,\mathrm{s^{-1}}$, what is its relative vorticity upon reaching 90°N

Chapter 4 Problem 4

An air column at 60°N with $\zeta = 0$ initially stretches from the surface to a fixed tropopause at 10 km height. If the air column moves until it is over a mountain barrier 2.5 km high at 45°N, what are its absolute vorticity and relative vorticity as it passes the mountaintop, assuming that the flow satisfies the barotropic potential vorticity equation.

Chapter 4 Problem 9

Derive a formula for the dependence of depth on radius for an incompressible fluid in solid-body rotation in a cylindrical tank with a flat bottom and free surface at the upper boundary. Let H be the depth at the centre of the tank, Ω the angular velocity of rotation of the tank, and a the radius of the tank.

Chapter 4 Problem 10

By how much does the relative vorticity change for a column of fluid in a rotating cylinder if the column is moved from the centre of the tank to a distance 50 cm from the centre? The tank is rotating at the rate of 20 revolutions per minute, the depth of the fluid at the centre is 10 cm and the fluid is initially in solid–body rotation.