

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 3**

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 3 Problem 1**

An aircraft flying a heading of  $60^\circ$  (i.e.  $60^\circ$  to the east of north) at air speed  $200 \text{ m s}^{-1}$  moves relative to the ground due east ( $90^\circ$ ) at  $225 \text{ m s}^{-1}$ . If the plane is flying at constant pressure, what is the rate of change in altitude (in meters per kilometer horizontal distance) assuming a steady pressure field, geostrophic winds, and  $f = 10^{-4} \text{ s}^{-1}$ ?

**Chapter 3 Problem 2**

The actual wind is directed  $30^\circ$  to the right of the geostrophic wind. If the geostrophic wind is  $20 \text{ m s}^{-1}$ , what is the rate of change of wind speed? Let  $f = 10^{-4} \text{ s}^{-1}$ .

**Chapter 3 Problem 4**

Calculate the geostrophic wind speed in metres per second for a pressure gradient of  $1 \text{ kPa}/10^3 \text{ km}$  and compare with all possible wind speeds for the same pressure gradient and a radius of curvature of  $\pm 500 \text{ km}$ . Let  $\rho = 1 \text{ kg m}^{-3}$  and  $f = 10^{-4} \text{ s}^{-1}$ .

**Chapter 3 Problem 7**

Determine the radii of curvature for the trajectories of air parcels located  $500 \text{ km}$  to the east, north, south, and west of the center of a circular low-pressure system, respectively. The system is moving eastward at  $15 \text{ m s}^{-1}$ . Assume geostrophic flow with a uniform tangential wind speed of  $15 \text{ m s}^{-1}$ .

**Chapter 3 Problem 10**

The mean temperature in the layer between  $75$  and  $50 \text{ kPa}$  decreases eastward by  $3^\circ\text{C}$  per  $100 \text{ km}$ . If the  $75\text{-kPa}$  geostrophic wind is from the southeast at  $20 \text{ m s}^{-1}$ , what is the geostrophic wind speed and direction at  $50 \text{ kPa}$ ? Let  $f = 10^{-4} \text{ s}^{-1}$ .