

ATMOSPHERIC SCIENCES 340
WINTER QUARTER 2009
PROBLEM SET 3
DUE MONDAY FEBRUARY 9 AT 9:30 AM

- 1) A hiker starts her hike at sea-level, and sets her altimeter to the known elevation of 0 m. A few hours into her hike, she checks her altimeter – it reads 800 m. Unbeknownst to her, the sea-level pressure in the area has decreased from 1020 to 1015 hPa during her hike. Determine the error in her altimeter reading (including the sign of the error) due to the local pressure change. Assume the altimeter uses a mean temperature for the layer of 12°C. The gas constant for dry air is $287 \text{ J K}^{-1} \text{ kg}^{-1}$ and acceleration due to gravity is 9.81 m s^{-2} .
- 2) A hurricane with a central pressure of 940 hPa is surrounded by a region with a pressure of 1010 hPa. The storm is located over an ocean region. At 200 hPa the depression in the pressure field vanishes (i.e., the 200 hPa surface is perfectly flat). Estimate the average temperature difference between the center of the hurricane and its surroundings in the layer between the surface and 200 hPa. Assume that the mean temperature of this layer outside the hurricane is -3°C and ignore the virtual temperature correction.
- 3) A meteorological station is located 50 m below sea-level. The surface pressure at this station is 1020 hPa, the mean virtual temperature between the surface and sea-level is 15°C, and the mean virtual temperature for the 1000-500 hPa layer is 0°C. Compute the height of the 500 hPa pressure level above sea-level at this station. ($R = 287 \text{ J K}^{-1} \text{ kg}^{-1}$; $g = 9.81 \text{ m s}^{-2}$)
- 4) If water vapor comprises 1% of the volume of the air, what is the virtual temperature correction? ($\epsilon = 0.6219$)
- 5) An air parcel at a pressure of 700 hPa has a temperature of 10°C. What is its potential temperature? What would its temperature be if it was lifted dry adiabatically to 200 hPa? What would its temperature be if it was lowered dry adiabatically to 1000 hPa? ($R = 287 \text{ J K}^{-1} \text{ kg}^{-1}$; $c_p = 1004 \text{ J K}^{-1} \text{ kg}^{-1}$)
- 6) A *dryline* is a commonly occurring surface boundary in the southern Great Plains, separating warm dry air to the west from slightly less warm, but much more humid, air to the east. Suppose the air west of the dryline is 25°C, with a water vapor mixing ratio of 1 g kg^{-1} , and the air east of the dryline is 23°C, with a mixing ratio of 15 g kg^{-1} . Is the colder air denser, or less dense, than the warmer air? Use virtual temperature to determine the answer, and assume the pressure is equal to 1000 hPa.