Unit 7 ATM401, ATM601 and CHEM601

Application, analysis, and evaluation

Preamble: In real live, research, and on the job, you have to solve ill-formulated problems most of the time. Ill-formulated problems are, for instance, questions/tasks where you have to make assumptions, where you have to synthesize knowledge from different fields, and/or reformulate the problem into a well formulated one. The exercises in this class are formulated on purpose this way so you learn the skills to address the curve balls that your professional live will throw at you. Remember you already proved that you can solve well defined problems.

Hint: Always make a sketch of the situation to get your head around the problem. It helps you to think about how to address the question. Underline the keywords and reflect about what they mean and how they are expessed by formulas. Always transfer units to SI units.

1. Graduate students: Potential instability is important for generating severe weather and arises when dry air overlies a warm, humid layer. Assume the following situation: the air layer in the lowest 2 km is saturated at ground level with a temperature of 20^oC, but is much drier and has a temperature of 8^oC at its top. Calculate the stability and lapse rate of this air column. Assume the entire layer is forced upward by $2km$ and the top of the layer remains unsaturated during ascent. Determine the new stability and lapse rate of this air column, assuming a saturated adiabatic lapse rate of $5^oC/100m$. Hint: This task is best solved coding the equations in an excel spread sheet.

2. Graduate students: A dry adiabatic decrease of pressure goes along with a decrease in temperature which in accord with the Poisson equation reduces the saturation water-vapor pressure. Examine for an adiabatic process whether the net result means a decrease or increase in the saturation water-vapor mixing ratio and discuss your results.

3. Graduate students: Determine the change in air pressure if air temperature decreases by 5%, and entropy decreases by $50J/(kgK)$.

4. ATM601 students: Psychrometer measurements showed 15.8^oC and 25.8^oC at the wet and dry thermometers. Determine the relative humidity and specific humidity assuming an air pressure of $995hPa$.

5. All students: An air parcel with an air and dew point temperature of 15^oC and 9^oC, respectively, ascends from $500\,m$ and flows over the Brooks Range at a height of $5000m$. The wet adiabatic lapse rate is $6.3^oC/km$. Determine the height of the LCL, the air and dew point temperature at the LCL, at the top of the Brooks Range, and on the leeward side at $500\,m$ as well as the relative humidity at the surface in the upwind and downwind of the Brooks Range.

6. Undergraduate students: An air parcel of $1\,m^3$ at sea-level pressure at 20^oC contains $7\,g$ of water vapor. Calculate the vapor pressure, absolute and relative humidity, specific humidity, mixing ratio, and dewpoint temperature.

7. Undergraduate students: Assume there is a place where water vapor pressure is constant at $7hPa$ over 24 hours. Starting at 0000UT the following air temperature is measured each hour in degree Celsius: 6, 5.5, 5, 4.5, 4, 3.8, 3.6, 4, 4.3, 4.9, 5.4, 6, 6.7, 8, 8.5, 8, 7.5, 7, 6.7, 6.5, 6.2, 6, 5.8, 5.7, and 5.5. Calculate relative humidity and make a graphic of the diurnal course of relative humidity, temperature and dewpoint temperature. Hint: This problem is best to solve using excel. Discuss your results. Based on your results what would you expect under constant water vapor condition for the duirnal course of a site in the dessert?