Unit 4 Applications Physical Hydrometeorology

Solve the problems assigned at your class level and to all students. Scan the solutions and send them to me by email prior to Thursday 2359 AST.

All students:

1. **All students:** Estimates of the current number of precipitation gauges range from 150000 to 250000. The standard NWS rain gauge was developed at the start of the 20^{th} century. It consists of a funnel emptying into a graduated cylinder, 4 cm in diameter, which fits inside a container of 20 cm in diameter and 50 cm tall. While various national weather agencies use their own standards, they all have to have at least one WMO reference gauge that is side-by-side to their own gauges for comparison and homogenization of the measurements. For simplicity assume all precipitation gauge worldwide had the same size of opening. Calculate the surface area of the Earth assumed as a sphere of 6371 km in radius, and that covered by the upper and lower estimate. Give the percentage of the Earth that is approximately covered by precipitation gauges. Discuss what your findings mean for the uncertainty of your analysis and conclusions of your research. Be prepared to share your findings with your class mates, i.e. prepare tables, graphs, plots, whatever is appropriate.

2. **ATM425 students:** A NWS radar provided the following reflectivity 20, 30, 40, 35 and 50 dzB at 1, 2, 3, 4, and 5 km height. The Z-R-relationship for that site is $Z=200R^{1.6}$. Calculate the vertical profile of rain. Here R is rain in mm/hr.

3. **ATM625 students:** A small atmospheric sampling volume (1 m^3) contains raindrops with a constant drop diameter. Assume a monodisperse droplet distribution in this volume of 8000, 1000, 1000, and 8 drops of 0.5, 1, 2, and 5 mm in diameter, respectively. The radar reflectivity factor may be computed by summing the sixth-powers of the diameters of all the drops contained in a unit volume of space for a given drop-size distribution of the rain sample. Assume that the drops are spheres in all cases and all fall out within an hour. Determine the radar reflectivity factor (Z) in mm^6/m^3, and the radar-estimated rainfall rates in mm/hr for these four cases. Assume a Marshall-Palmer Z-R-relationship, $Z=aR^b$ where a=200 and b=1.6. Then assume an Austin Z-R-relationship with a=230, and b=1.4. What are the units of a and b in the case of the Marshal-Palmer and Austin Z-R-relationship, respectively? Hint for the rest of the problem: You will have to calculate the real amount of water in the volume first. Discuss your results. What errors do you make with your sphere assumption?