Exercise 4 – Microphysics of warm clouds

due 25 September 2008

1)

Consider two cloud droplets, one formed on a sodium chloride nucleus of mass 10^{-16} g, the other on an ammonium sulfate nucleus of the same mass. Calculate the critical size *r** and saturation ratio *S** for each droplet, assuming a temperature of 280 K. For any radius *r*, let $S_1(r)$ denote the equilibrium saturation ratio of the droplet formed on sodium chloride and $S_2(r)$ denote the equilibrium saturation ratio of the droplet formed on ammonium sulfate. For $r > r^*_2$, the activation size of the ammonium sulfate droplet, show that $(S_2\text{-}S_1)$ and S_2/S_1 decrease monotonically with increasing *r* to the limits 0 and 1, respectively.

2)

Imagine a cloud with droplets of different size. Consider three different drops: Drop one has a radius r_1 = 0.07 µm, drop two has a radius r_2 = 0.1 µm, and drop 3 has a radius r_3 = 1 µm. All three drops have been formed on an ammonium sulfate aerosol, a hygroscopic condensation nuclei, with a mass of 10^{-16} g. The supersaturation in the cloud is assumed to be uniform and at 0.3% (saturation ratio of 1.003). Use the Köhler curve below and explain what will happen to each of the three drops. If the drop is growing, which size (radius) can it reach? (Note: the x-axis is a logarithmic scale. Thus the increments are not equidistant.)

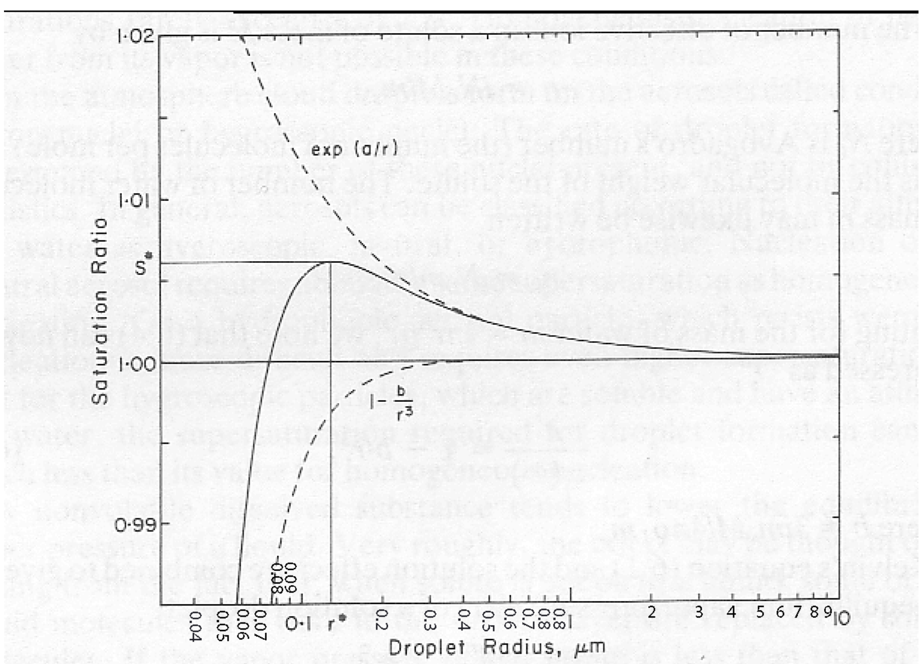

FIG. 6.2. Equilibrium saturation ratio of a solution droplet formed on an ammonium sulfate condensation nucleus of mass 10^{-16} g.