A.3 Lecture 3 and 4

This question on seeding stratocumulus clouds can be calculated analytically, meaning I could ask you about it on the exam. If so you will be given Equation 1.33 and 1.37 There is a spreadsheet to do the calculations if you're struggling.

Example 1.3 A stratocumulus cloud, 100m thick, has a liquid water mixing ratio of 0.5 g m^{-3} and a number concentration of 50 drops cm^{-3} of air. Over a period of time you are able to increase the concentration of salt particles entering the cloud base to 500 drops cm^{-3} of air. In both cases the size distribution can be considered to be exponentially distributed. What is the change in the cloud albedo?

Answer You should be able to derive (and demonstrate the derivation in the exam) Equation 1.38 in the notes. Once you get to here it is quite straight forward.

- The third moment, M_3 can be calculated by dividing the liquid water mixing ratio by $\frac{\pi\rho_w}{6}$ so that $M_3 = \frac{0.5\times10^{-3}\times6}{\pi\times1000} \cong 9.55\times10^{-7}$ m^3 m^{-3}.
- The zeroth moment, $M_0 = 50\times10^6$ m^{-3} so the second moment from Equation 1.38 is $0.6\left(\times50\times10^6\right)^{1/3}\times\left(9.55\times10^{-7}\right)^{2/3}\cong 0.0214$.
- The albedo from Equation 1.37 is $A_c = \frac{\pi\times0.0214\times100}{\pi\times0.0214\times100+15.4} = 0.30$.
- After addition of seed aerosol, $M_0 = 500\times10^6$ m^{-3} so the second moment from Equation 1.38 is $0.6\left(\times500\times10^6\right)^{1/3}\times\left(9.55\times10^{-7}\right)^{2/3}\cong$ 0.0462.
- The albedo from Equation 1.37 is $A_c = \frac{\pi\times0.0462\times100}{\pi\times0.0462\times100+15.4} = 0.49$.
- So $\Delta A_c = 0.49 - 0.30 = 0.19$.