

Air Quality 2025: Size Distributions Assignment

Question 1: Cloud Size Distributions

Write a python code to that is well documented. The liquid water content (LWC) for a given volume of air may be determined through mass integration of the cloud droplet distribution.

$$LWC = \rho_w * \left(\frac{\pi}{6}\right) * \sum_{i=1}^m N_i * (d_i^3)$$

Where ρ_w is the density of water (1,000 kg/m³ or 1e6 g/m³), π has a value of approximately 3.14, N_i is the concentration of droplets in size channel i , d_i is the droplet diameter in size channel i , and m is the total number of channels. Calculate the LWC base on measurements given below. Perform unit conversions and provide your calculated value of LWC in units of g/m³. Assume the density of water is constant and is know exactly. Use the channel measurements provide in Table 1 for determining your answer.

Table 1: Measurements of cloud droplets obtain with an instrument such as a Cloud Droplet Probe (CDP).

Channel Number	Minimum Diameter	Maximum Diameter	Concentration
1	2 µm	4 µm	0 #/cm ³
2	4 µm	6 µm	0 #/cm ³
3	6 µm	10 µm	69 #/cm ³
4	10 µm	15 µm	100 #/cm ³
5	15 µm	20 µm	300 #/cm ³
6	20 µm	25 µm	69 #/cm ³
7	25 µm	30 µm	9 #/cm ³

Number Concentration Plot

Include in your python program the creation of a plot of the number concentration in terms of $dN/d \log D_p$ [cm⁻³] using the channel measurements provide in Table 1. Include the total number concentration on the plot. Save the plot to a png formatted file.

Area Plot

Include in your python program the creation of a plot of the area distribution in terms of $dA/d \log D_p$ [µm² cm⁻³] using the channel measurements provide in Table 1. Include the total particle area on the plot. Save the plot to a png formatted file.

Volume Plot

Include in your python program the creation of a plot of the volume distribution in terms of $dV/d \log D_p$ [µm³ cm⁻³] using the channel measurements provide in Table 1. Include the liquid water content on the plot. Save the plot to a png formatted file.

Question 2: Aerosol Size Distributions

Write a python code to that is well documented. Create plots similar to Question 1 expect use data in Table 2. Assume all particles are ammonia sulfate, which has a density of 1.769 g/cm^3 . Provide the $\text{PM}_{2.5}$ mass in units of ug/m^3 .

Table 2: Measurements of aerosols obtain with an a Passive Cavity Aerosol Spectrometer Probe (PCASP) at frequency of 1 Hz and sample volume of 1.0 cubic cm.

Channel Number	Minimum Diameter	Maximum Diameter	Concentration
1	0.105 μm	0.129 μm	382.6376
2	0.129 μm	0.152 μm	225.6267
3	0.152 μm	0.186 μm	118.4703
4	0.186 μm	0.220 μm	93.9911
5	0.220 μm	0.269 μm	69.8000
6	0.269 μm	0.332 μm	26.6178
7	0.332 μm	0.549 μm	4.2485
8	0.549 μm	0.709 μm	0.9822
9	0.709 μm	1.164 μm	1.3772
10	1.164 μm	1.496 μm	0.8287
11	1.496 μm	2.317 μm	0.4208
12	2.317 μm	2.569 μm	0.1683
13	2.569 μm	2.921 μm	0.2079
14	2.921 μm	3.716 μm	0.2099
15	3.716 μm	4.505	0.1386

15_07_28_15_31_07.counts.pcasped.raw.gz (Time: 55970.208 to 56980.133)

