ATM515 **Aerosol Physics**, Fall 2025

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Homework # 1 (due date Sep. 15)

1. (25 points) Based on the following figure from Ch. 2 of 2007 IPCC report (available at https://www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-chapter2.pdf) and associated text, summary in your own words the four aerosol effects (direct, 1st indirect, 2nd indirect, and semi-direct) on radiation, cloud, and precipitation, explain briefly the physics underlying each effect and corresponding aerosol properties most important for the effect.

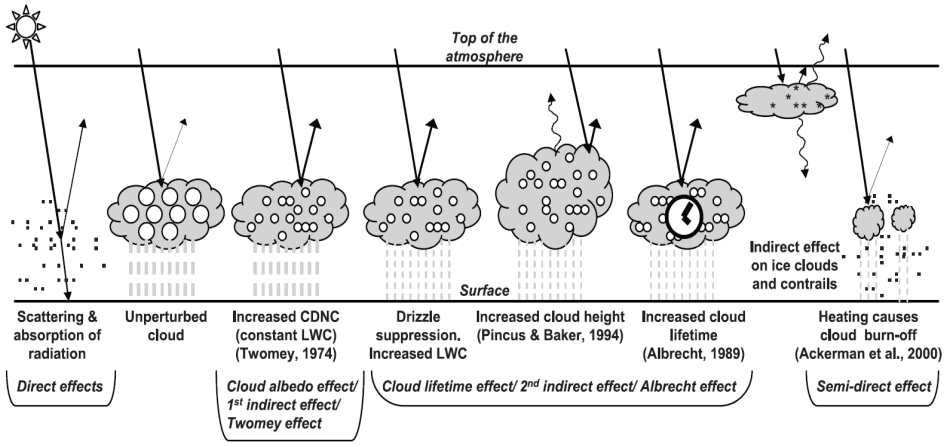

Figure 2.10. *Schematic diagram showing the various radiative mechanisms associated with cloud effects that have been identified as significant in relation to aerosols (modified from Haywood and Boucher, 2000). The small black dots represent aerosol particles; the larger open circles cloud droplets. Straight lines represent the incident and reflected solar radiation, and wavy lines represent terrestrial radiation. The filled white circles indicate cloud droplet number concentration (CDNC). The unperturbed cloud contains larger cloud drops as only natural aerosols are available as cloud condensation nuclei, while the perturbed cloud contains a greater number of smaller cloud drops as both natural and anthropogenic aerosols are available as cloud condensation nuclei (CCN). The vertical grey dashes represent rainfall, and LWC refers to the liquid water content.*

2. (25 points) Problem 8.6 in the textbook of Seinfeld and Pandis, 2006 (2nd Edition) or 2016 (3rd Edition) (also copied below). Be sure to mark units on the tables and plots.

8.6$_A$ The data given below were obtained for a lognormally distributed aerosol size distribution:

Size Interval, μm	Geometric Mean of Size Interval, μm	Number of Particles in Interval[a]
0.1–0.2	0.1414	50
0.2–0.4	0.2828	460
0.4–0.7	0.5292	1055
0.7–1.0	0.8367	980
1.0–2.0	1.414	1705
2.0–4.0	2.828	680
4.0–7.0	5.292	102
7.0–10	8.367	10
10–20	14.14	2

[a] Assume that the particles are spheres with density $\rho_p = 1.5$ g cm^{-3}.

a. Complete this table by computing the following quantities: $\Delta N_i/\Delta D_{pi}$, $\Delta N_i/N\Delta D_{pi}$, $\Delta S_i/\Delta D_{pi}$, $\Delta S_i/S\Delta D_{pi}$, $\Delta M_i/\Delta D_{pi}$, $\Delta M_i/M\Delta D_{pi}$, $\Delta N_i/\Delta \log D_{pi}$, $\Delta N_i/N\Delta \log D_{pi}$, $\Delta S_i/\Delta \log D_{pi}$, $\Delta S_i/S\Delta \log D_{pi}$, and $\Delta M_i/\Delta \log D_{pi}$, $\Delta M_i/M\,\Delta \log D_{pi}$, where M = particle mass.

b. Plot $\Delta N_i/\Delta \log D_{pi}$, $\Delta S_i/\Delta \log D_{pi}$, and $\Delta M_i/\Delta \log D_{pi}$ as histograms.

c. Determine the geometric mean diameter and geometric standard deviation of the lognormal distribution to which these data adhere and plot the continuous distributions on the three plots from part (b).