

Clouds & Particles

More

2. Particles

Solution Worksheet 1

1.

Factors that determine whether an aerosol can act as a cloud condensation nucleus (CCN):

- particle size,
- chemical composition and
- supersaturation.

To act as CCN, particles must be hygroscopic enough, i.e. they must contain sufficient amount of water-soluble material. That is why their chemical composition also controls the cloud droplets formation.

For example, soil dust particles, when they are just emitted, can't act as CCN, whereas sea-salt particles can (on humid days, you may find it difficult to pour salt from the shaker because water vapor has condensed on the salt crystals, sticking them together.).

2.

If the amount of aerosols in the atmosphere increases, it may change the characteristics and properties of the cloud cover. Aerosols are essential players in the cloud system, by modifying the microphysics of clouds (number and size of droplets), the precipitation potential, and the optical properties.

One of the fundamental observations is that by increasing the number of particles in the atmosphere upon which cloud droplets can form, clouds will have more, but smaller, droplets. And number and size of droplets are important in the cloud rain production and optical properties (influence of aerosols on clouds is called "indirect effect"). Therefore, as anthropogenic activities are an important source of particulate matter, humans do modify the number and characteristics of clouds.

3.

a)

Clouds form behind airplanes because the engine releases small particles (exhaust) and also water vapor. The particles act as CCNs, and droplets can form on them. This is why we see long, narrow clouds or "tracks" from the airplanes.

When we see contrails in the sky we may infer that at the altitude where the plane is flying, the air is saturated with moisture, but there are few CCNs for droplets to form on. Thus, as soon as CCNs are introduced, clouds form.

b)

The gap forms because the air and vapor just behind the airplane is very hot; thus, it takes some time before the air is sufficiently cooled for condensation to take place. During this time interval, the airplane has moved on, and we see a gap between the plane and the contrails.