

MAGIC update 2012-01-20

Clouds consist of a large number of small water drops (and/or ice particles) with typical diameters twenty micrometers (about one thousandth of an inch). Each of these drops is formed around an aerosol particle, with typical diameters 200 or so times smaller. These aerosol particles may be composed of naturally formed substances such as sea salt from ocean breaking waves or dust, anthropogenically derived (i.e., from human activities) substances such as sulfates from burning coal, or a combination of the two types. Aerosol particles are ubiquitous in the atmosphere. Without them, weather as we know it would be quite different, as cloud drops would form only if the relative humidity were several hundred percent!

Cloud drops do indeed form, but what is the process by which they do so? Perhaps the simplest formation process to describe is that for cumulus clouds, the large ones common on summer days that take on a variety of shapes. A cumulus cloud forms when a parcel of air near the ground is heated through contact with the Earth and expands, becoming less dense than the air above. The parcel then rises and its temperature decreases, resulting in an increase in relative humidity. At some height the air parcel has cooled sufficiently that the relative humidity reaches 100%, and the water vapor contained in the parcel begins to condense on available surfaces. For a rising parcel of air, the only available surfaces are those of aerosol particles. An aerosol particle on which water condenses to form a cloud drop is called a cloud condensation nucleus, or CCN; whether or not a given particle acts as a CCN is determined by its size and/or composition. The collection of all of these drops scatters light from the sun, and we observe this as a white puffy cloud.

Cumulus clouds often appear in a regular pattern, a manifestation of the updrafts of the parcels from which they are formed. Also, all clouds in the pattern have rather flat bottoms at about the same height, which is the height at which the air has cooled to the temperature that the water vapor condenses, or, to state it another way, the temperature at which the relative humidity is 100%.

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Please address any questions or comments to elewis@bnl.gov.

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