

Introduction to Clouds, 12.340x, Global Warming Science. Historically, clouds have been classified on a Linnean system in Latin. This system is based on cloud appearance. There are 10 categories, or genera, which can then be broken down into subspecies.

The genera are appearance-based. For example, the three main cloud types are cumulus, which stands for "heap," which denotes the morphology; stratus, which means "spread," as in a layer; and cirrus, which means "curl," as in a lock of hair. The genera can be preceded by a qualifier to denote precipitation. For example, a nimbostratus is a precipitating layer cloud.

The subspecies are also based on appearance. One set of qualifiers denote height. Cumulus for low, mediocris for average, and alto for high. An altostratus would be a high, layered cloud. Other appearance qualifiers are also listed here.

The majority of clouds exist only in the lowest layer of the atmosphere, called the troposphere. Cumulus and stratus typically exist at the lowest altitudes, below about three kilometers. Altocumulus and altostratus exist from about three to six kilometers. Cirrus exist above six kilometers all the way to the tropopause, the layer which sets the top of the troposphere and delineates it from the stratosphere. Deep thunderstorms, known as "cumulonimbus," can span from the surface to the tropopause.

Although this was not the reason for the naming convention, it is interesting to note that cloud phase is incorporated into the genera. Cumulus and stratus are normally warm clouds. That is to say, they are composed of droplets, but not ice crystals. Altocumulus and stratus often also contain ice crystals and are therefore called mixed in phase. Cirrus types are completely ice. Cumulonimbus vary in phase, with the lowest parts composed only of droplets, the mid parts ice crystals as well as droplets, and the upper parts of ice.

Two cloud types exist above the tropopause. Nacreous clouds are found in the polar stratosphere and are also called polar stratospheric clouds or PSCs. Noctilucent clouds are found in the polar mesosphere and are also called "polar mesospheric clouds" or PMCs. Both PSCs and PMCs are composed entirely of ice.

An important aspect of cloud formation is the relationship of particles to clouds. Cloud droplets and ice

crystals do not nucleate directly from the vapor phase. Laboratory experiments show that relative humidities of 400% or more are required for direct nucleation of droplets and ice from the vapor, a level that is never realized in the Earth's atmosphere. Instead, small particles act as the condensation sites on which droplets and ice crystals form. Above about minus 20 degrees C, droplets form on particles at relative humidities just above water saturation. The particles are called cloud condensation nuclei, which nucleate the droplets.

Below 0 degrees C, special particles, termed "ice nuclei," can act as sites of nucleation. There are several modes of so-called heterogeneous ice nucleation. These include the direct deposition of water vapor to the ice nucleus surface; contact freezing, when an ice nucleus comes in contact with a pre-existing droplet; and condensation or immersion freezing, when an ice nucleus nucleates ice from within a droplet phase. Below minus 40 degrees C, small atmospheric droplets can spontaneously freeze -- an ice nucleus is not required to stabilize the new phase of ice. And these droplets are therefore termed "homogeneous freezing nuclei."

Example images of the major cloud types follow. Stratus clouds. Cirrus clouds. Cumulus clouds. Cirrocumulus. A cirrostratus cloud that also has a halo. A cumulonimbus cloud, where the top is creating an anvil cirrus cloud. These images show examples of virga, precipitation which evaporates before it reaches the ground, and the fall streaks of ice crystals precipitating out of cirrus clouds.