ISCCP DEFINITION OF CLOUD TYPES

Cloud Parameter Definitions And Measurement Methods

- **Cloud cover fraction**

This parameter represents the fractional area covered by clouds as observed from above by satellites. It is estimated by counting the number of satellite fields-of-view (called pixels, about 5 km across for ISCCP) that are determined to be cloudy and dividing by the total number of pixels in a region about 280 km across. Cloud amount for lower-level clouds is only that fraction of the area actually observed to be covered by clouds at that level. This way of determining cloud amount assumes that each cloudy pixel is covered completely by clouds.

- **Cloud top pressure**

This parameter represents the location of the "radiating" top of the clouds; if there is a very tenuous upper portion, this value may be below where the first cloud particles are found. Cloud top pressure is determined from cloud top temperature, which the satellite measures more directly, using a profile of atmospheric temperature with pressure. It can be considered as equivalent to cloud top height above mean sea level.

- **Cloud top temperature and its mesoscale variability**

The satellite measures the infrared radiation emitted by the cloudy scene, which is assumed to be covered completely by clouds at one level. If the cloud is optically thick, it radiates like a blackbody so that the observed emission is equivalent to the actual temperature at the top (if the upper portion of the cloud is tenuous, then the radiating level will be within the cloud). If the cloud is optically thin, then the emission will appear to be larger than that for the cloud top temperature because additional radiation is transmitted from the warmer atmosphere and surface below. The ISCCP parameter has been corrected for this effect using the measured optical thickness to determine the transmission (daytime only). The actual emission from a larger area, about 280 km across, is produced by a mixture of clouds at different levels; the deviation of this emission from that by a single cloud layer with the average temperature increases as the mesoscale variations of temperature increase. The mesoscale variability of cloud top temperature is represented by the time-averaged, spatial standard deviation.

- **Cloud optical thickness and its mesoscale variability**

This parameter represents the optical thickness of clouds at visible wavelengths (approximately 0.6 microns). It is determined from the satellite-measured visible solar reflectivity of cloudy scenes, assuming that the pixel is uniformly covered by clouds. The retrieval depends on an assumed particle size and shape. The standard ISCCP products assume that clouds warmer than 260 K are liquid clouds composed of spherical droplets with an effective radius of 10 microns and that colder clouds are ice clouds composed of crystals with a fractal shape (aspect ratio unity) that have an effective radius of 30 microns. The albedo of a cloud covering a larger area, about 280 km across, is reduced by the mesoscale variations of optical thickness; however, the ISCCP optical thickness values are averaged so as to give the correct albedo. If the mesoscale variability is needed to correct for this variability, then we provide a parameter, epsilon, that can be used for this purpose.

- **Cloud Water Path**

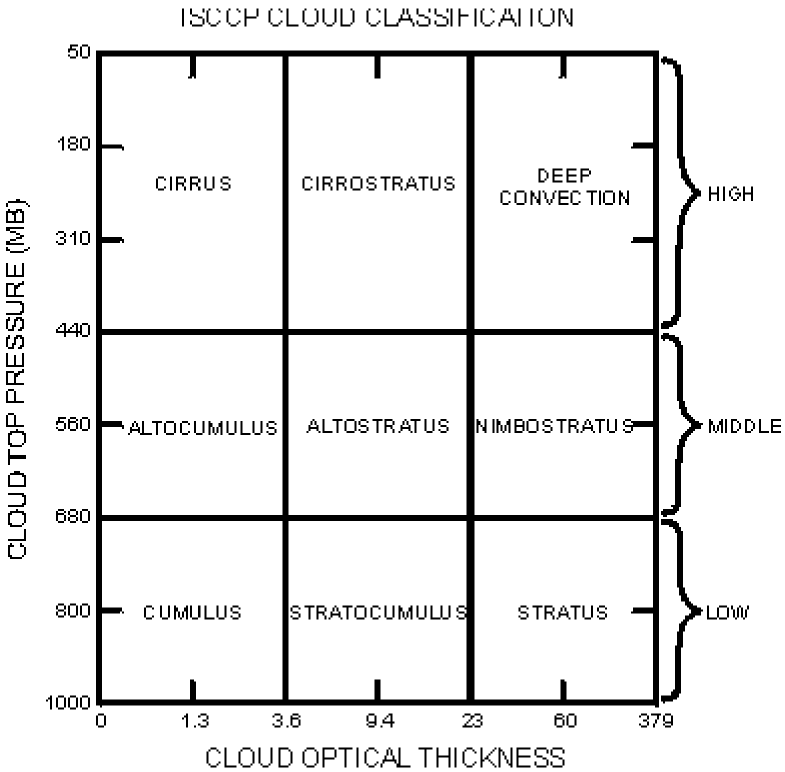
This parameter combines the measured cloud optical thickness with the assumed particle size distribution to calculate the column mass density of the cloud. The values given assume that the whole cloud layer has the same water phase and particle size as at the top.

- **Cloud Particle Size and Revised Optical Thickness**

An advanced analysis, exploiting an additional wavelength, allows for the retrieval of cloud particle size and the consistent optical thickness. Since these data are available only from the polar orbiting weather satellites and since the measurement uses reflected sunlight, we obtain only one measurement per day from each polar orbiter. We provide the climatology of cloud particle sizes and revised optical thickness values here.

- **Cloud Types**

A value of cloud top pressure and optical thickness is obtained for each cloudy pixel during the daytime. This information can be used to classify different cloud types as shown in the figure. The cloud type names here represent only an approximate climatological relationship between the satellite-measured optical parameters and the classical morphological cloud types. However, a detailed comparison of the satellite and surface-based cloud observations supports this assignment of names.



- **Cloud Layer Structure**

Satellites do not yet observe the vertical layer structure of clouds; they see only the uppermost cloud layer at each location. Likewise, surface observations of clouds see only the lowermost cloud layer at each location. However, weather balloons routine determine vertical profiles of temperature and humidity, which can be used to infer the cloudy layers by looking for height levels where the relative humidity is very high. Weather balloons do not provide good global coverage, however, being concentrated mostly in northern hemisphere land areas. A climatology of cloud layer distributions is provided here based on the weather balloon humidity profiles. Within the next few years, the first satellite cloud radar and lidars will fly that will provide more detailed measurements of cloud vertical distribution.

- **Cloud Base Pressure**

This parameter represents the average pressure at the base of the lowest cloud layer at each location. It is determined by combining the ISCCP cloud top pressure with the climatology of cloud layer thicknesses and layer structures obtained from weather balloons, where a particular vertical structure is assigned to each ISCCP cloud type shown above.

- **Cloud Base Temperature**

This parameter represents the average temperature at the cloud base of the lowest cloud at each location. It is determined from the cloud base pressure and an atmospheric profile of temperature versus pressure.