

## Lecture 19    Cloud Types

Above the surface, almost all clouds form where air rises, expands and cools below its dewpoint. Nevertheless, a diverse range of cloud types exist.

Howard (1803) morphological classification scheme

- stratus ('layer') -sheetlike clouds

- cumulus ('heap') - puffy clouds

- cirrus ('strand of hair') -wispy clouds

- nimbus ('rain') - rain clouds

Height grouping (1887)

- high clouds (6 km-tropopause) -ice crystals

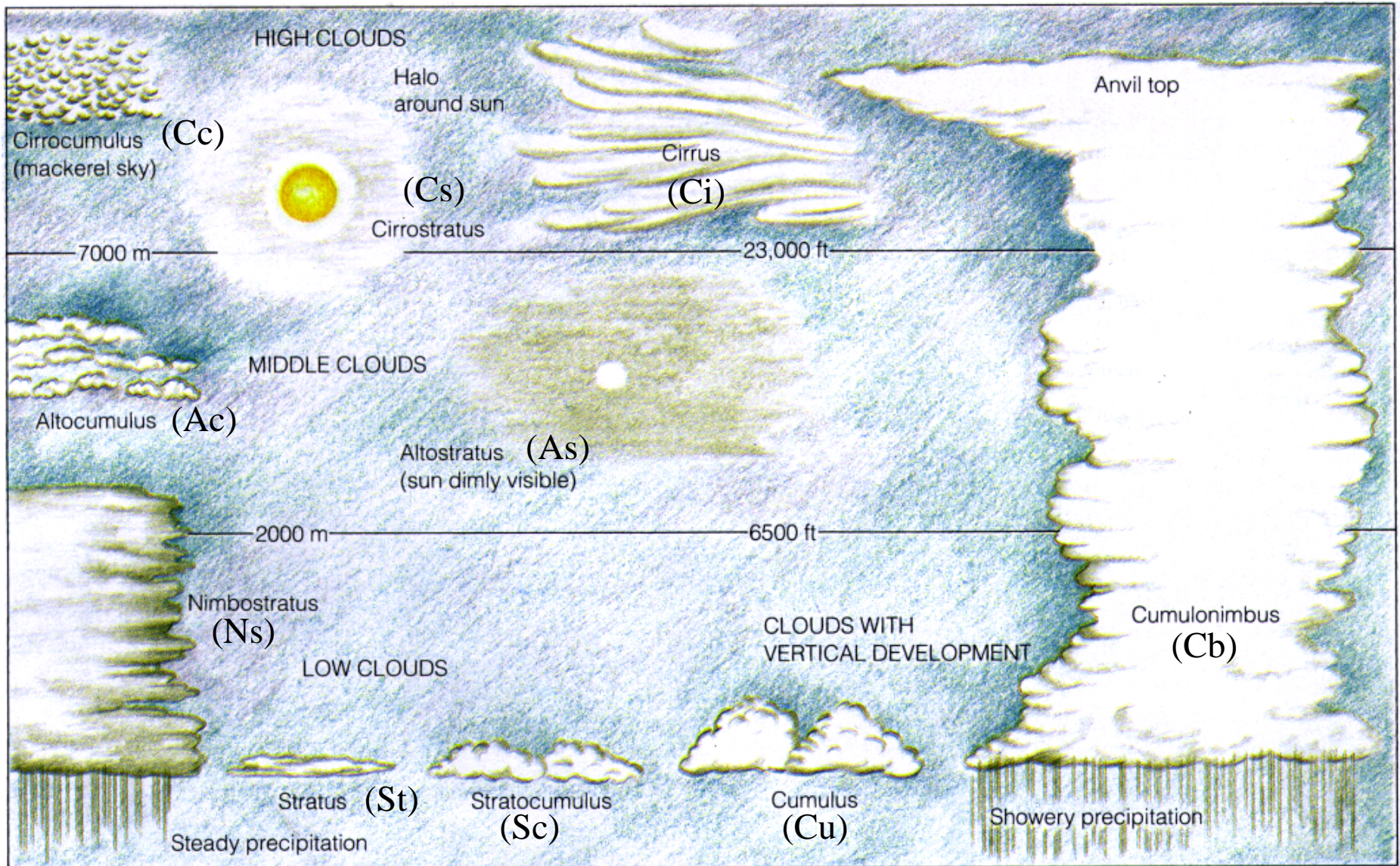
- middle clouds (2-6 km)

- low clouds (0-2 km above surface)

- clouds with vertical development

...gives 10 principal cloud forms.

# The 10 Major Cloud Types



**Figure 4.25**

A generalized illustration of basic cloud types based on height above the surface and vertical development.

## **Other cloud types**

Lenticular ('lens-shaped') - above and in lee of mountains, sometimes stacked like saucers.

Mammatus ('breast') - pendulous, rounded clouds that form at the base of cloud layers that overlie drier air, e. g. thunderstorm anvils.

Nacreous ('mother of pearl')- thin hard-to-see stratospheric clouds (30 km elevation) that can appear iridescent.

Noctilucent ('night-light') - very thin clouds in the upper mesosphere (80 km elevation), seen mainly in the polar twilight when the upper atmosphere is illuminated but the troposphere is not (see EOM fig 4.30)

Some nice cloud imagery can be found in the Cloud Atlas linked to the 101 web page.

*...Cloud slide show*

## Moist Adiabatic Lapse Rate

- Recall that dry air cools at 10 C for every km it rises (the *dry-adiabatic lapse rate*), because...

As an air parcel rises into lower ambient pressure, it expands. The energy required to expand the air parcel against the ambient pressure is taken from the energy of random motion of the molecules, so the air cools.

- Now consider moist air. While unsaturated, it also cools at the dry-adiabatic lapse rate, but when it cools below its dew point, condensation occurs.
- As the air is lifted further, it continues to expand and cool. However, as it cools, its saturation vapor pressure decreases so more water vapor condenses into cloud droplets, releasing latent heat.
- Thus, *saturated air cools more slowly as it rises* at the *moist-adiabatic lapse rate*, which is typically around 6 C per km (depends on temperature).