Clouds

SOEE1400: Lecture 3

Cloud Classification

Four latin terms form the basis for the naming of clouds:

- **Cirrus** : fibrous or hair-like
- **Cumulus** : a heap or pile
- **Stratus** : a horizontal sheet or layer
- **Nimbus** : rain-bearing

The prefix **Alto** is used to indicate medium altitude clouds.

Terms, and basic classifications first proposed by Luke Howard in 1803.

http://ww2010.atmos.uiuc.edu/(Gh)/guides/mtr/cld/cldtyp/home.rxml - good online guide

Precipitation

- Cloud droplets require a **condensation nucleus (CCN)** on which to form; growth then occurs by deposition of water molecules from vapour. CCN are abundant.
- Cloud droplets are typically 10 to 30 μm in diameter. Growth/evaporation can occur within a few 10s of seconds.
- Rain drops are typically 0.5 to 5 mm in diameter, growth from the vapour would take several hours – longer than the lifetime of typical convective clouds.

- Ice nuclei (IN) are not abundant – in many cases ice will not form spontaneously unless the temperature is down to about -40°C
  - The air is commonly supersaturated relative to ice
  - Commonly there are just a few ice crystals, which then grow very fast, “stealing” all the available water, and falling out of the cloud as they grow large.
- Ice crystals provide a more efficient process of forming rain
  - Saturation vapour pressure over ice is less than that over water $\Rightarrow$ ice crystals grow at expense of water droplets
  - If ice crystal touches a cold droplet, the droplet freezes
  - Once large enough, ice crystals – or clumps of crystals – fall past droplets and collect them. Rapid growth of soft hail pellet (graupel) by *riming*.
  - Graupel falls from cloud, melting before reaching the surface as rain

High Level: (*cirro-*)

- Cloud base above 6000m
- Are all forms of cirrus (ice clouds)

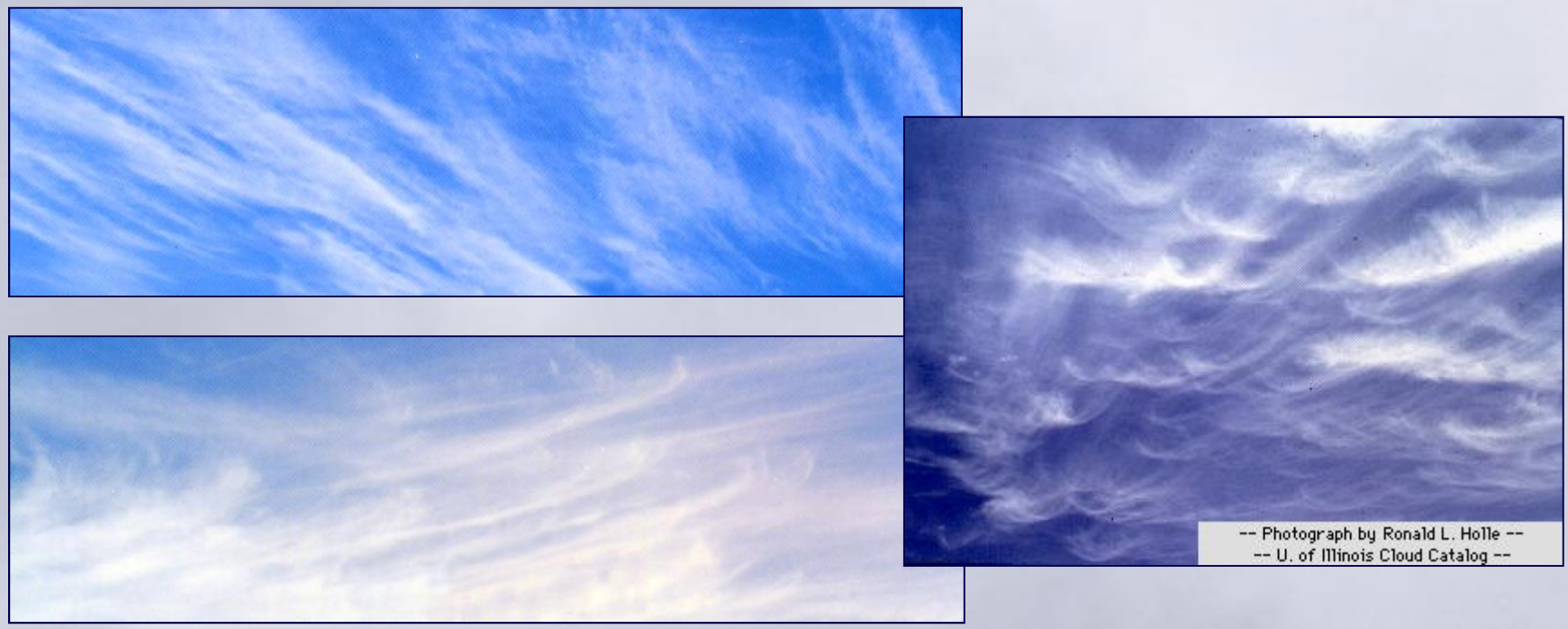
Medium Level: (*alto-*)

- Cloud base 2000-6000m

Low level:

- Cloud base below 2000m (within boundary layer)

High-Level Clouds



Cirrus (Ci): White, delicate, fibrous in appearance. Forms in patches or narrow bands. May for comma-shaped streaks or “mare’s tails” (cirrus uncinus)

Cirrus clouds are formed entirely of ice crystals. These grow and evaporate slowly, leading to soft edges to clouds.

Cirrostratus (Cs): Thin, transparent sheet or veil; sun clearly visible & casting shadows at surface. A halo may be seen around the sun (or moon). Sheets of cirrostratus may cover entire sky, and be up to several 1000m deep.

Cirrocumulus (Cc): Thin white patch or sheet of cloud; appears dappled or rippled. Dappling results from convective overturning within the cloud, ripples from gravity waves.

Aircraft contrails: condensation from aircraft exhaust. May dissipate quickly, or be very long-lived depending on conditions.

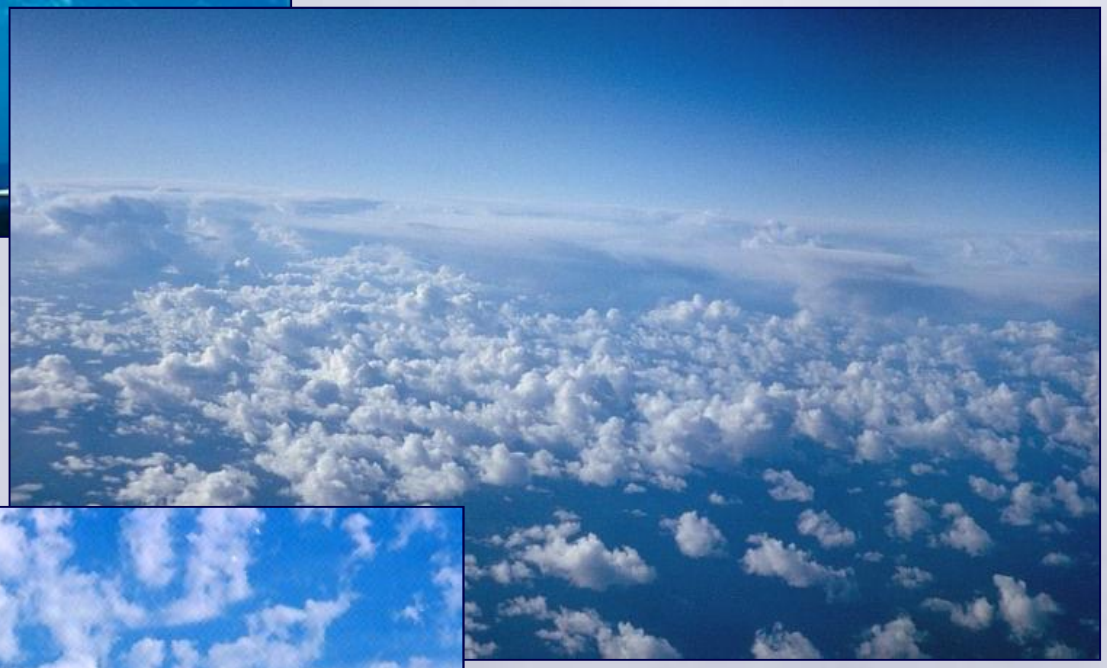
Medium-Level Clouds

Altostratus (As): A greyish sheet of cloud, may be fibrous or uniform in appearance. Thin enough in parts to make out the sun, but no halo.

Altocumulus (Ac): white or grey patches arranged in sheets. Shape and texture are variable.

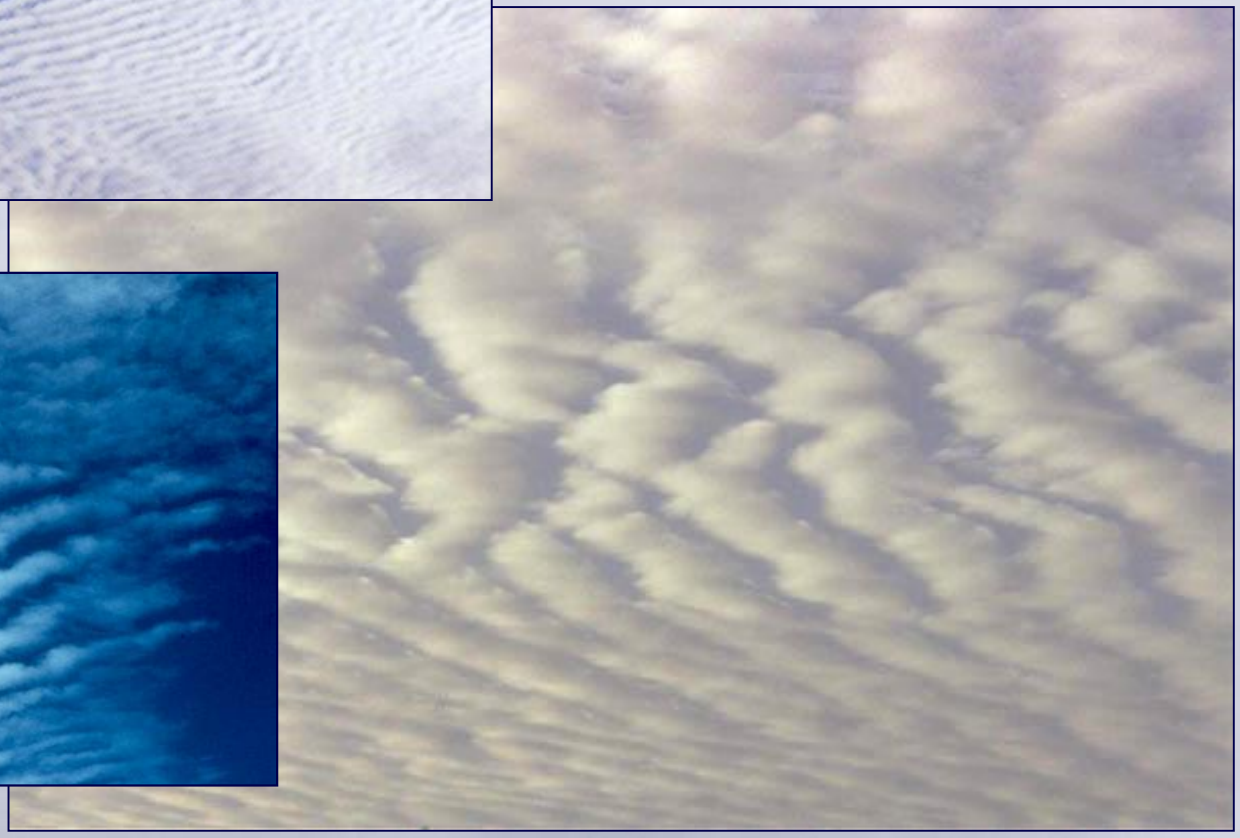
There are several distinct sub-classes of altocumulus

Altocumulus lenticularis (Ac len): white or grey lenticular (lens shaped) clouds formed by the lifting of air over a topographic barrier.



Altocumulus castellanus (Ac cas): white or grey, broken cumulus-like clouds; upper part appearing castle-like. Sometimes arranged in lines.

Altocumulus undulatus (Ac und): white or grey patches or sheets of cloud with an undulating or rippled appearance.



Low-Level Clouds

Cumulus (Cu): Brilliant white to grey, dense detached clouds. Forms clumped or heaped (cauliflower-like) shapes, usually with sharp outlines and flat base. Field of Cu often have bases all at same (lifting condensation) level.

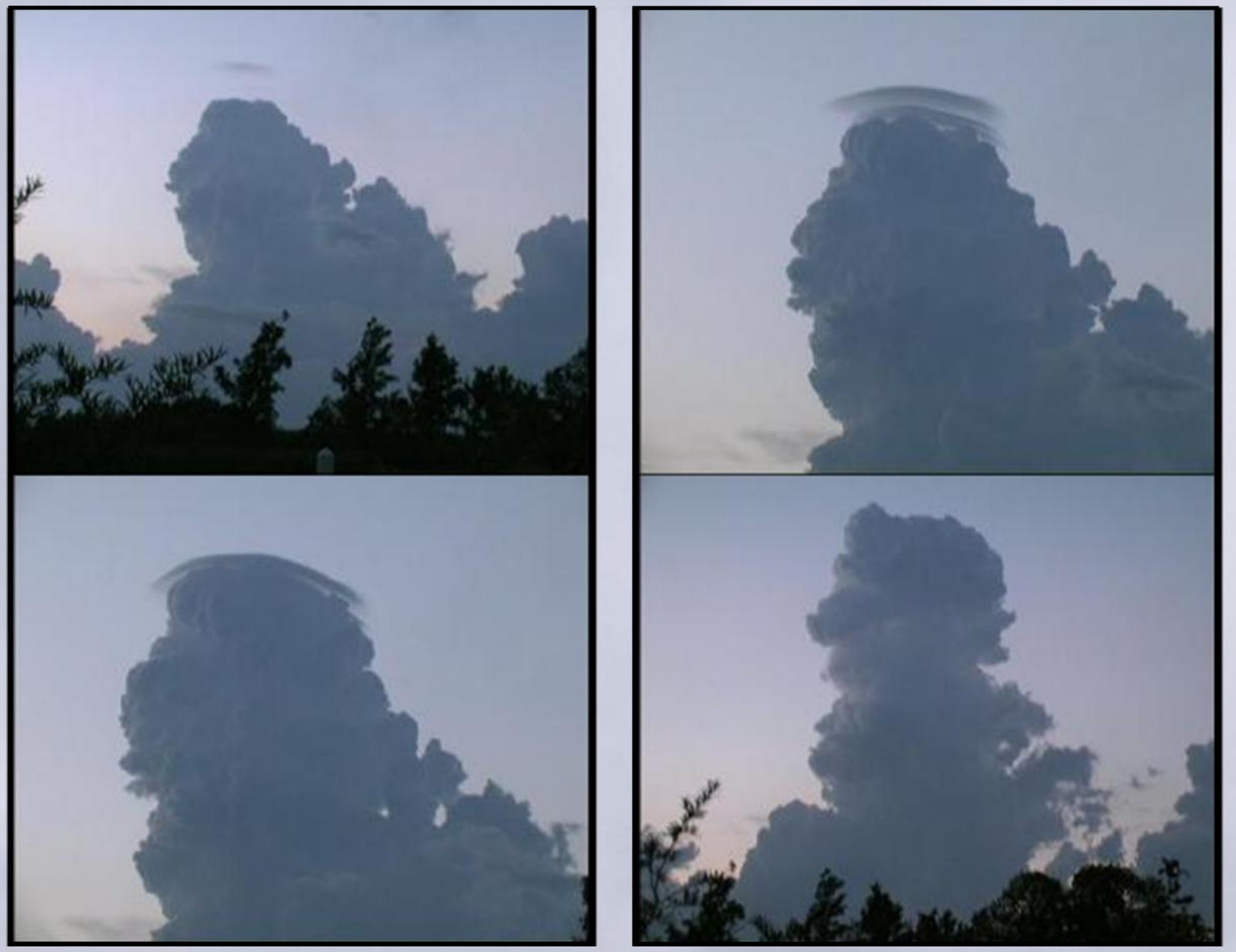
Cumulus humilis (Cu hum): small cumulus, of limited vertical extent, may have a flattened appearance. Also called fair-weather cumulus

Cumulus mediocris : cumulus, of moderate vertical extent.

Cumulus congestus: crowded (congested) field of cumulus or greater vertical extent. May produce rain.

Congestus over Benin, 17 August 2006

Pileus : cap clouds that form above large cumulus as the upward motion of the convective cloud distorts the layer of air above (pileus is latin for skull-cap)



Pileus over Benin, 17 Aug 2006

Cumulonimbus (Cb) : huge towering cloud, dark base and white sides. Associated with heavy rain, thunderstorms, and hail. Frequently has an anvil shaped top.

More Cb

mammatus : smooth, rounded shapes sometimes formed on the underside of cumulonimbus; they result from downdrafts within the cloud.

Arcus cloud (over Lincolnshire). This cloud appears at the head of the “cold pool” of low level air which is produced by the rainfall in a cumulonimbus storm. It indicates the location of the “gust front”.

Arcus cloud (over Benin, August 2006). This cloud appears at the head of the “cold pool” of low level air which is produced by the rainfall in a cumulonimbus storm. It indicates the location of the “gust front”. Here we can see rainfall behind the gust front.

Stratocumulus (Sc) : white or grey sheet of cloud, usually formed in mounds or rolls.

Stratocumulus with *virga* – hair-like strands of falling rain, which evaporate below cloud before reaching the surface.

Stratus (St) : grey featureless layer of cloud with a uniform base. Often associated with drizzle or snow.

Nimbostratus (Ns) : Dark grey, featureless, thick layer of cloud. Associated with prolonged precipitation. Commonly forms in frontal systems

Homework, 30 January – 3 February 2012

- For the same time each day, make a note (and a photo, if possible) of the cloud types and nearest-in-time satellite image (from the Dundee site).
- Put these into a word document, less than 2 Mb.
- Email the document to me before 6 February.