IDENTIFYING AND UNDERSTANDING CLOUDS

An 8 hour course for the Senior Learning Institute - Feb. 5, 7, 12, 14 - from 10 until noon.

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COURSE DESCRIPTION

This course will begin with a discussion of a dozen fundamental cloud types within their formal zones of classification. The phase changes and dynamics behind cloud development will come next. Rising air will be addressed; in such conditions most clouds develop. Tips for identifying and interpreting clouds and cloud patterns will be provided along with interesting facts about them. *For example, it takes about a million cloud droplets to make one rain drop! That is no exaggeration. Another: Certain cloud droplets can be as cold as 40 degrees below zero and yet remain liquid.* Expect a relaxed, "no pressure" environment with opportunities to ask questions, make observations, and exchange ideas. For support, please go to the science tab here: http://ztechzone.net/slinstitute/

HOW THIS 8-HOUR COURSE CAME TO BE OFFERED

In April, 2007, I taught a 12 hour course, ***Clouds and How They Form***. It was one of 11 courses I presented for the Senior Learning Institute from July, 2006 through May, 2009. If you were involved in that course, please note that this one will not be as detailed and in your case might best be described as a refresher. After a hiatus from the Senior Learning Institute I presented a course in August, 2012, ***Lower Atmospheric Winds that Influence Weather and Climate.*** Shortly before that I was asked to propose a course for this term and I recalled the number of requests to offer "clouds" again. It seemed that interest levels were favorable.

IF YOU INITIALLY HAVE TROUBLE IDENTIFYING CLOUDS OUTSIDE please don't worry; Sometimes I can't make a positive identification in spite of the training and practice. Through the years I have observed that people who learn the clouds from two-dimensional images sometimes have difficulty making the transition to the real clouds. On the other hand, people who learn outside (e.g. farmers, sailors) generally have no difficulty with two-dimensional images. There will be times when what you observe outside will look nothing like what you will have seen in this classroom. **Here is why**: 1) the projected images and photos limit you to two-dimensional viewing; your depth perception is used when looking at real clouds (if both of your eyes are working) and that provides a decidedly different perspective, 2) clouds have developmental stages and the ones you see in class will be mostly mature stage examples; in real-time observations you might be looking at youthful stage or dissipating (old) stage clouds or, 3) you could be observing one cloud type in transition toward becoming another cloud type, 4) in class you will be looking at clouds as though you were wearing racehorse blinders – focusing upon only what is in front of you. Outside, you may look in all directions and angles, 5) in class the clouds you see projected will be frozen in time but outside things are ever changing. You will take your eyes away from a certain cloud and moments later when you look at it again it can look quite different.

Seriously - for safety reasons please avoid preoccupation with the clouds while you are driving or doing any other activity demanding your full attention.

Here are the cloud types that you will be coached to identify (sketch on page 3):

h=high family. **m**=middle family. **l**=low family. **v**=family of vertical development.

cirrus (h)	**altostratus (m)**	**cumulus humilis (v)**
cirrocumulus (h)	**nimbostratus (l/m)**	**cumulus mediocris (v)**
cirrostratus (h)	**stratocumulus (l)**	**cumulus congestus (v)**
altocumulus (m)	**stratus (l)**	**cumulonimbus (v)**

And then there is **fog**, which, in most cases, is stratus at or within a few feet of the surface.

ABOUT THIS OUTLINE: It is my **guide** and yours; it is not uniformly weighted. Some entries will merely be mentioned, some appear mainly to provide definitions, others are there as reminders to me, and even others will be covered relatively thoroughly. Topics overlap and the order may not be exact. My favored presentation-style is to allow for spontaneity and your input.

A. A description of the International cloud classification
1. Latin nomenclature
2. high family
3. middle family
4. low family
5. family of vertical development
6. fog

B. The 6 phase changes and their thermal properties
1. **condensation** (developer of cloud droplets and dew) – yields heat
2. **evaporation** – absorbs heat – an important cooling process
3. **freezing** (creates sleet and hail)–yields heat (including the "supercooled" case)
4. **melting** – absorbs heat – an important cooling process
5. **deposition** (developer of ice crystals in clouds and frost) – yields heat
6. **sublimation** – absorbs heat

C. The hydrologic cycle with emphasis upon the atmosphere
1. cycling via the phase changes
2. transpiration
3. precipitation
4. surface and subsurface runoff
5. infiltration
6. magmatic & extraterrestrial sources

D. Expressions of the humidity of air
1. absolute humidity - weight of water vapor in a given volume of air.
2. specific humidity - weight of water vapor in a given weight of air.
3. relative humidity - percentage expression of amount of water vapor in air compared to its capacity for moisture at that particular temperature.
4. dew point – the temperature of saturation – or, the temperature to which air must be cooled in order for it to be saturated with water vapor.
5. vapor pressure – that portion of the air pressure caused by the water vapor molecule.

E. Factors which influence air's density and pressure
1. temperature
2. water vapor content (humidity)
3. compression (happens most often when air is sinking)
4. expansion (happens most often when air is rising)

F. Divergent/convergent airflow patterns
(Clouds are more likely with surface or near surface convergence).
1. radial and rotational
2. straight-line unidirectional
3. head-on convergence
4. constrictive and outlet
5. cape and embayment type
6. acceleration and deceleration

G. Factors which help to make air rise and, with enough moisture, generate clouds:
1. near surface convergence
2. divergence aloft
3. convection
4. orographic uplift
5. frontal uplift
6. the chimney effect

H. Fundamental cloud formation
1. air rising and cooling to its dew point temperature and then cooling further.
2. cooling from below to the dew point and further (as in radiation fogs)
3. mixing along a boundary between two layers of moist air

I. Adiabatics defined and described along with "ideal" lapse rates
1. the "dry" & moist adiabatic rates
2. the dew point lapse rate
3. the environmental lapse rate (E_L)
4. the "normal" lapse rate

J. Absolute stability, absolute instability, and conditional instability

1. When E_L is less than the saturated (moist) adiabatic lapse rate
2. When E_L is greater than the unsaturated (dry) lapse rate
3. When E_L is between the saturated and unsaturated adiabatic lapse rates

K. Factors causing the environmental lapse rate (E_L) to change – e.g. heating from below.

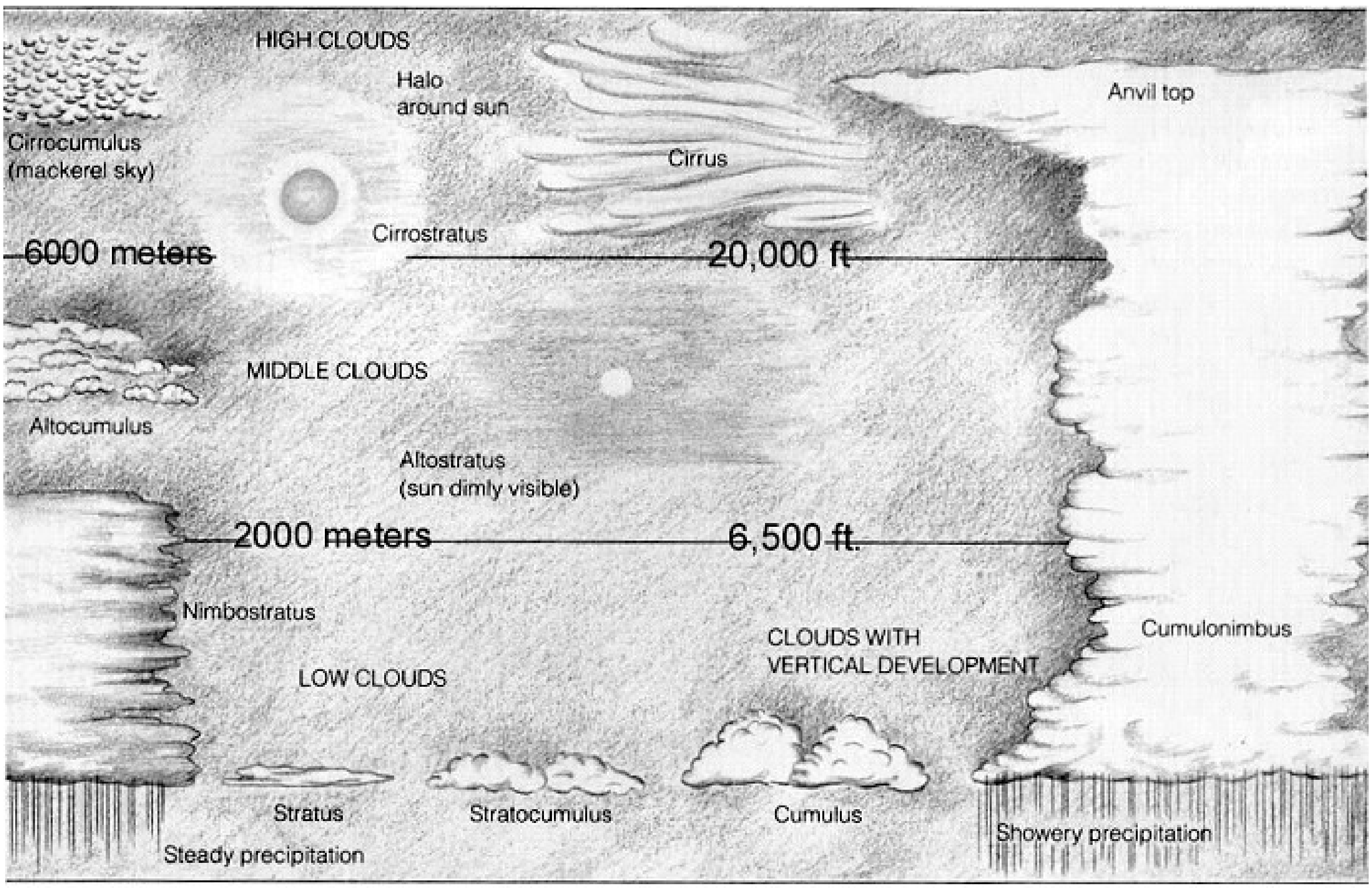
L. Cumulonimbus – circumstances of development

1. youthful stage
2. mature stage
3. dissipating stage
4. steady state
5. phenomena exclusive to the cloud

M. Cloud patterns (if time allows)

1. with tropical types of cyclones
2. with extratropical types of cyclones
3. with heterogeneous surfaces
4. with mountains
5. warm ocean currents
6. island chains

N. If ample time remains we will review the 12 fundamental cloud types.

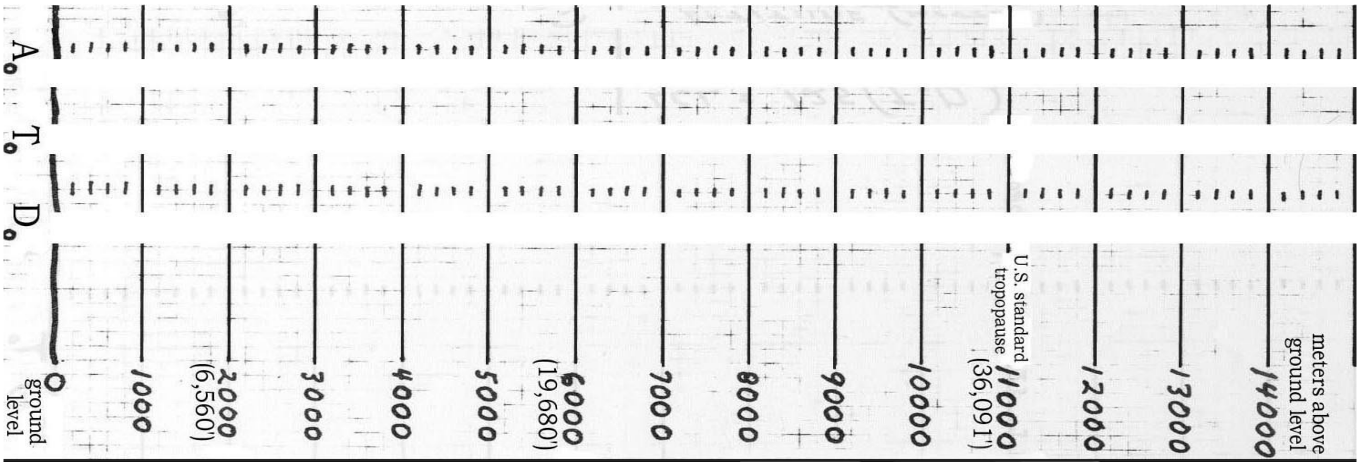


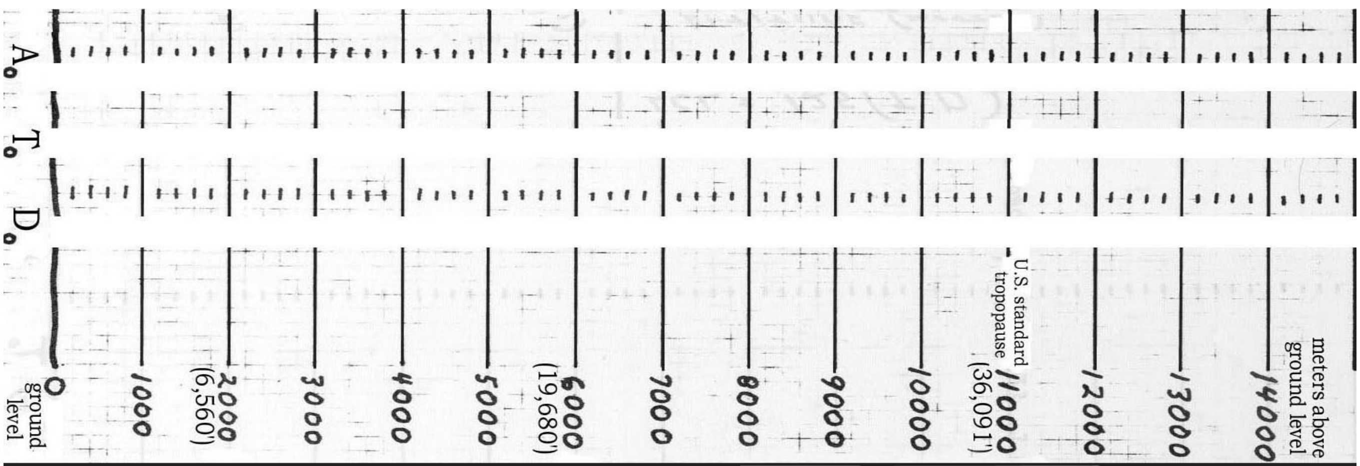
cloud diagram courtesy of C. Don Ahrens – modifications by T. Ansel Toney

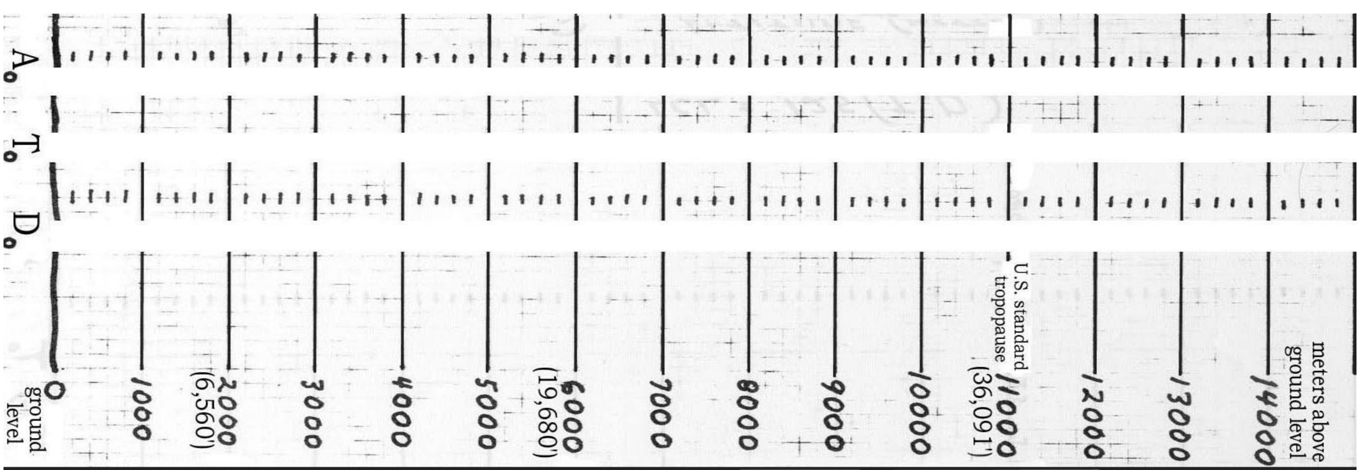
Two **cumulus humilis** clouds are illustrated here - (individual cells, each wider than they are tall).

Cumulus mediocris (not illustrated) is taller than it is wide, thus beginning to “tower” a bit.

Cumulus congestus (not illustrated) is much larger and consists of merged cumulus mediocris cells. The largest resembles youthful stage cumulonimbus and, in fact, becomes that once the cloud top reaches about 6000 meters.







T = air temperature (in the column under examination).
D = dew point (in the column under examination).
A = ambient (or environmental) air – that is – the air around the column under examination.

Unsaturated adiabatic lapse rate ≈ 1.0° Celsius per 100 meters.
Saturated adiabatic lapse rate ≈ 0.6° Celsius per 100 meters (the common mean for calculating).
Dew point lapse rate ≈ 0.2° Celsius per 100 meters.
Ambient lapse rate (A_L) is the most variable of all and determines an air column's stability or instability. Ambient air temperatures and rates are NOT adiabatically determined.