14.Clouds3

Friday, October 7, 2022 3:26 PM

Today: Clouds - Instability lift mechanism

Admin:

Reading assignment.

Up through Clouds 1, 2 and 3.

Clouds First post: Edit your post date and time = your cloud image date and time

Several clicker polls today. Please log in.

- Cloud image submission: Include

1) your edited image
2) your original (unedited) image — Canvas
3) the appropriate Skew-T diagram. Also put in your report.
4) a short statement of cloud type and stable or unstable atm. Also put in your report.
5) Post on Flowvis.org. Edit your post date to match your cloud date and time.
6) Later, add your report to your post and in Canvas.

Clouds = droplets or ice MOVING UPWARDS

Lift mechanisms determine appearance:

1. Instability. Yes, basically Rayleigh-Taylor. Denser air sinks etc.
2. Orographics: terrain, mountains
3. Synoptic scale weather systems. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences

1. Instability

Is most complicated but most relevant for our summer clouds. Start with background physics.

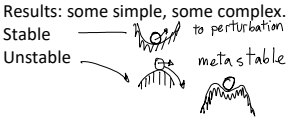
What is instability? In groups, give example of

1) a stable and
2) an unstable situation

Results: some simple, some complex.

Stable — to perturbation

Unstable — metastable



Sounding Data

Modern radiosondes measure or calculate the following variables:

- Pressure
- Altitude
- Geographical position (Latitude/Longitude)
- Temperature
- Relative humidity
- Wind (both wind speed and wind direction)
- Cosmic ray readings at high altitude

Pasted from <http://en.wikipedia.org/wiki/Radiosonde>

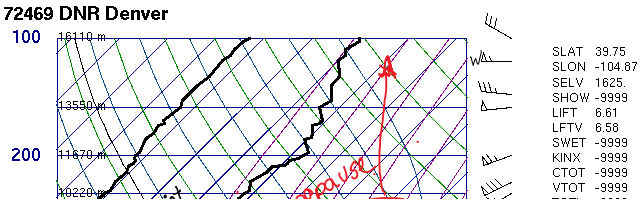
Here's what it looks like: SKEW-T

http://weather.uwyo.edu/upperair/sounding.html

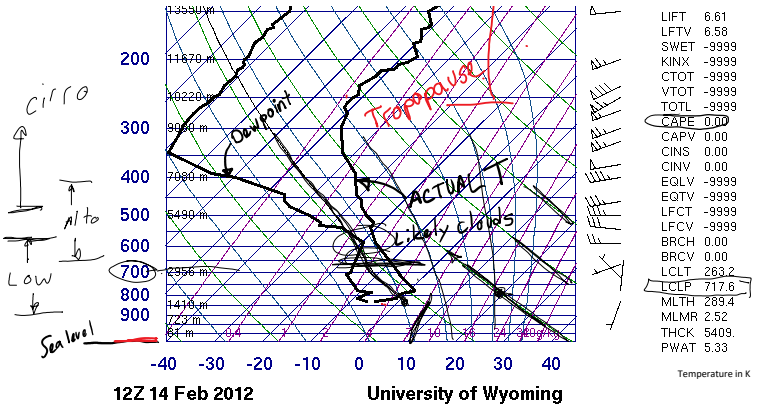
YOU will do this for the date of your image

Open the skew T worksheet, so you can take notes on it.

Pressure in millibars



Definitions



Definitions

http://weather.uwyo.edu/upperair/indices.html#CAPE

Where are clouds? Where temperature is close to dew point, i.e. where the two heavy black lines come together.
Also, kink CW towards more steep in T line suggests clouds at that level.
Condensation = warming (opposite of evaporation = cooling on your skin)

Can also get **local cloud height** from ATOC CU Boulder observation:
http://skywatch.colorado.edu/ or Flowvis.org>Links>Weather

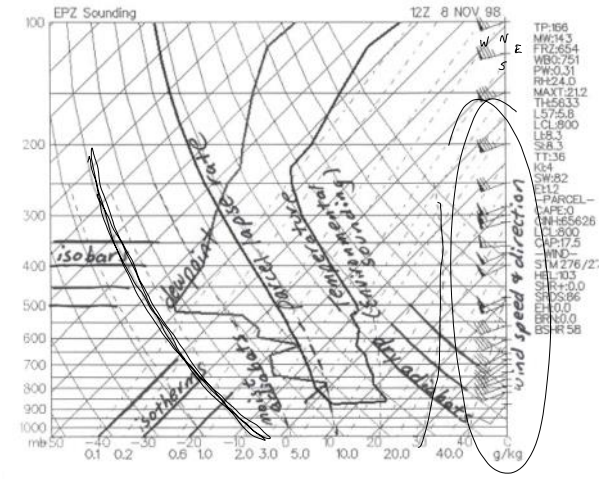
Can get current and predicted cloud heights plus winds and other weather from Windy phone app and http://Windy.com . A bit tricky to navigate, though.
Choose location, then Meteogram tab at bottom.

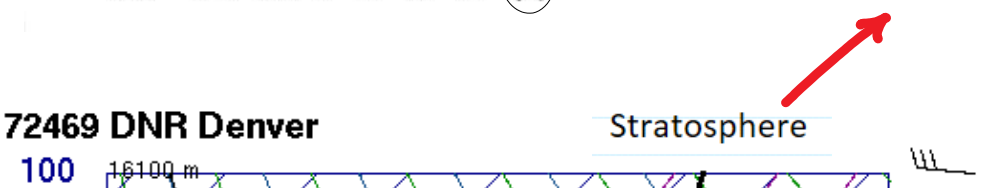
NO VERTICAL GRID?

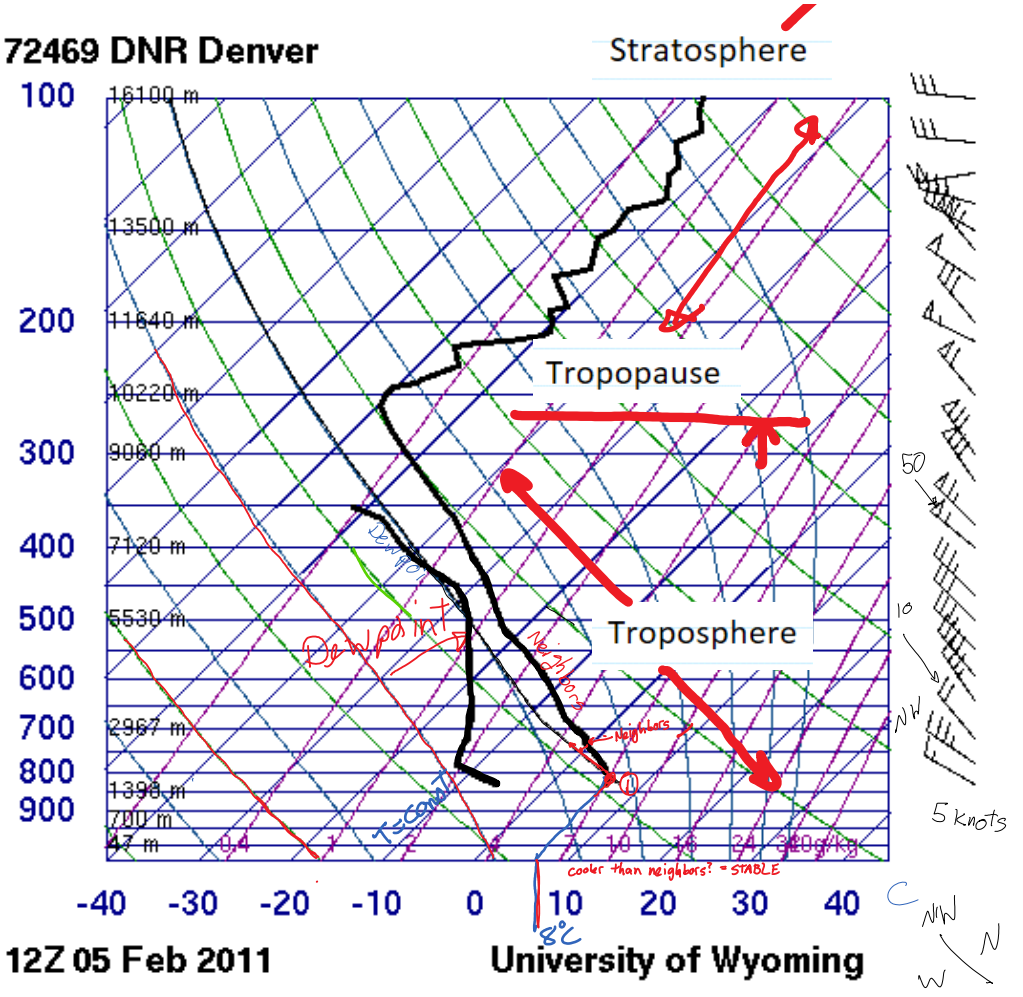
So many lines! How many kinds?

Horizontal blue	Constant pressure isobar
Angled blue	Constant temperature; isotherm. Angle / SKEW T
Angle/curve green	Dry adiabat. A dry parcel will follow this temperature line if cooled adiabatically
Angle/curve blue	Moist, saturated adiabatic lapse rate. Rising parcel will follow this through a cloud.
Purple	Lines of constant mixing ratio; absolute humidity for saturation.
Heavy black	Right line is temperature profile. Left line is dew point
Light black	Adiabat starting at the top of the boundary layer

Basics: http://www.theweatherprediction.com/thermo/skewt/
Skew T Mastery: Free online course from UCAR.
https://www.meted.ucar.edu/lesson/225/login







= STABLE
if CAPE > 0 UNSTABLE

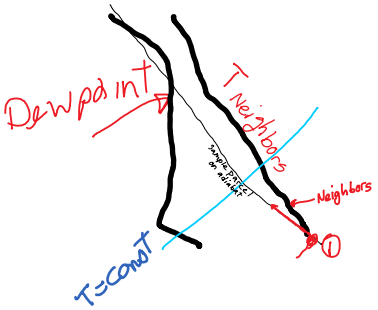
① Starting parcel

② Raise it, cool it adiabatically (move up along the adiabat), perturb the system
Check it, is my parcel warmer or cooler than the actual neighboring parcels?

S → T i. Cooler; more dense, wants to sink again, go back to origin STABLE

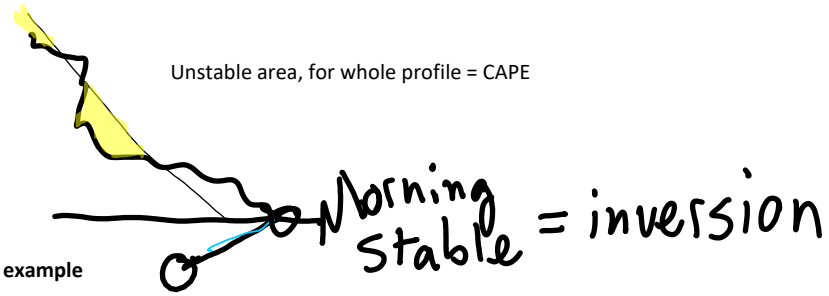
T → S ii. Warmer; less dense, wants to keep going up! UNSTABLE

Can start at any point on the actual temperature line. Go parallel to the adiabats. Choose dry adiabat (green) if below likely cloud level or wet (blue, saturated) if in a cloud.

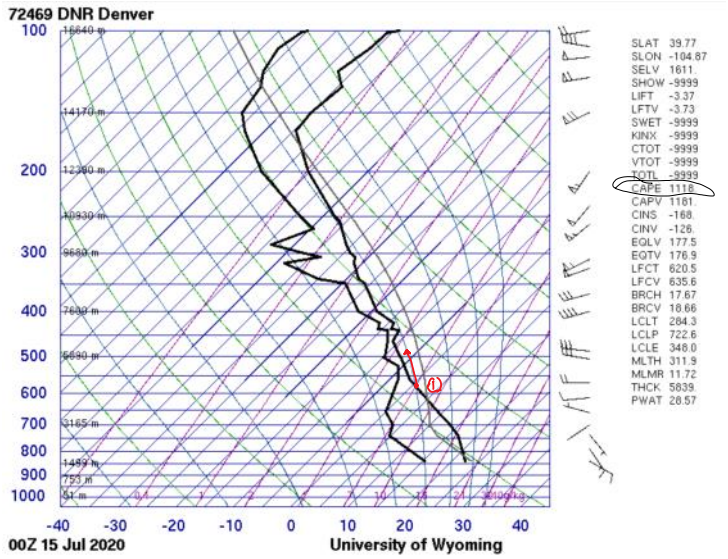


Stable clouds = flat STRATUS type
Unstable clouds = puffy CUMULUS family

Atmosphere is all **stable if CAPE = 0** Convective Available Potential Energy
Has unstable layers if CAPE > 0. Thunderstorms if CAPE > 500 or so.



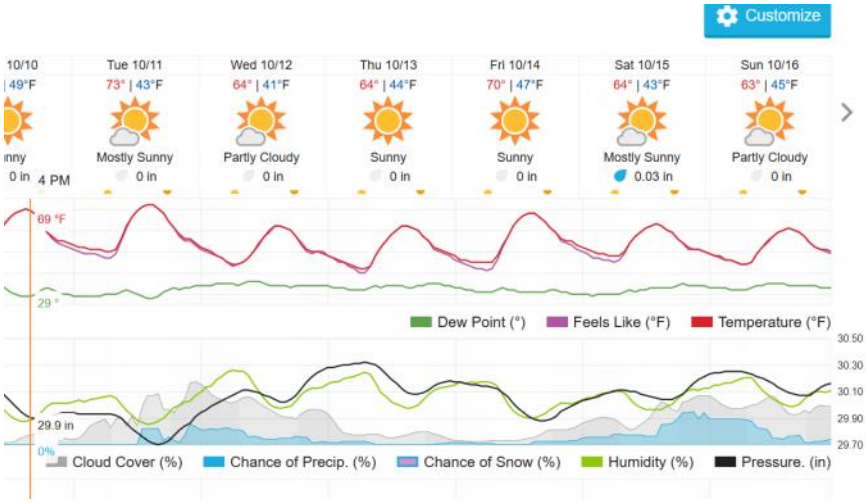
Unstable Skew-T example



From 1 follow moist adiabat; is probably in a cloud (above LCLP at 722 mbar). Stays warmer than neighbors: UNSTABLE

What was the surface weather on a given day?
https://www.wunderground.com/history

Dew point: Temperature a parcel would have to be cooled to in order to get condensation (dew). ~ Absolute humidity.
Relative humidity: How much water the air currently holds compared to how much it could hold at this temperature. For a given absolute water vapor concentration, RH is high for low temperatures (close to dew point) and low for high temperatures. So T and RH time plots move opposite.



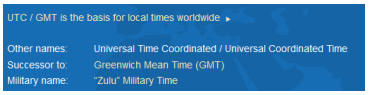
https://www.wunderground.com/forecast/us/co/boulder/40.02,-105.27

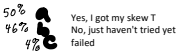
Other info on Skew-T: wind indicators. LCL = lifting condensation level, cumulus have flat bottoms at this altitude.

OK, now look at skew-T for your date:

http://weather.uwyo.edu/upperair/sounding.html

Skew-T download tips: Skew-T Times:





Z indicates Zulu time = UTC = GMT = Greenwich Mean Time = Time at date line in England.

12Z, Feb 14 = ~6 am Feb 14 here. Sunrise.
00Z, Feb 1**5** = ~6 **p**m Feb 14 here. Sunset.

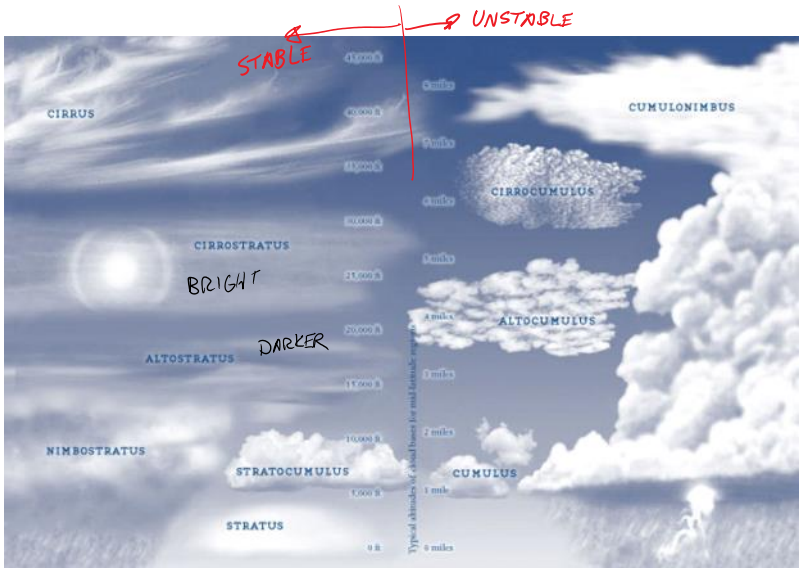
1. Choose closest location and date/time. 12z month/day X is the 6 am sounding, 00z X+1 is the 6 pm sounding for date X
2. Choose plot, not text
3. Will open in next browser tab

e.g. our date → our tomorrow

Clouds = droplets or ice MOVING UPWARDS

Lift mechanisms:

1. Instability
2. Orographics: terrain, mountains
3. Synoptic scale weather systems. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences



Clouds classified by

A. **Structure**: stratus = flat layers, cumulus = clumps
B. **Base height**: (2 km)
   a. low: up to 6500 ft (above ground, not from sea level) and vertically developed (includes cumulonimbus)
   b. middle: 6500 to 23,000 ft (2 - 7 km)
   c. high: 16,000 to 45,000 OVERLAP (4.9 - 14 km)
      Cirrostratus: bright, no observable thickness, thin, uniform veil
      Altostratus: darker, may have noticeable thicker regions

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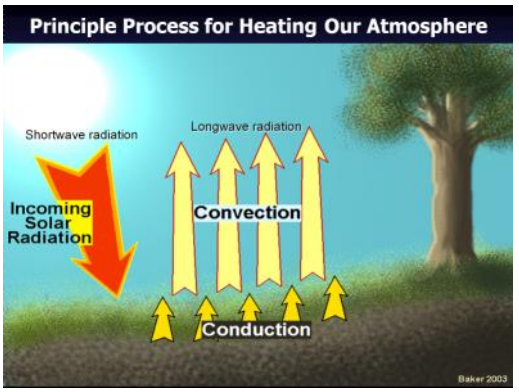
Clouds = droplets or ice MOVING UPWARDS

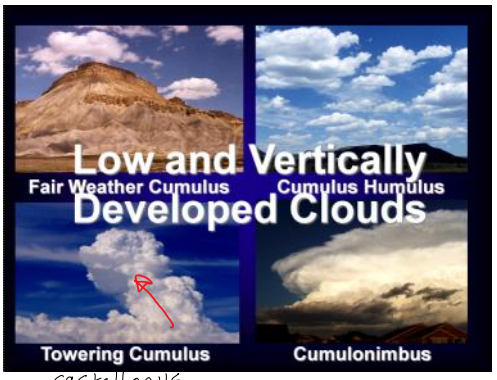
Lift mechanisms:

1. Instability: creates Cumulus clouds
2. Orographics: terrain, mountains
3. Synoptic scale weather systems; local instability. Both at warm and cold fronts; cold air pushes under in a cold front, warm air overruns in a warm front.
4. Convergence: shoreline temperature differences and cyclonic uplift

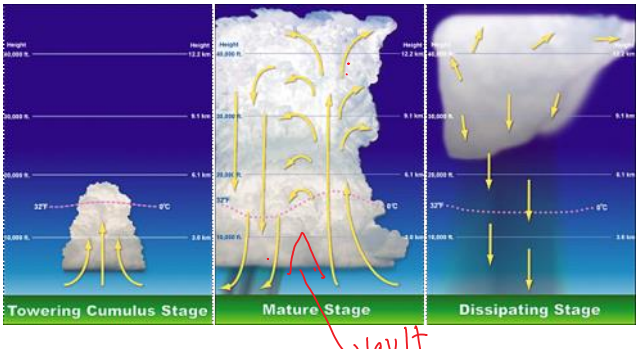
1. Instability driven clouds



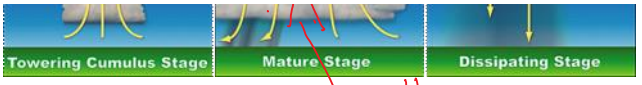
If atmosphere is UNSTABLE, the heated air will continue to go up!



castellanus



vault



Vault

http://www.k3jae.com/wxstormdevelopment.php

Dark ground (plowed field etc.) can create local hot spot, starting a thermal. Mountain uplift can also trigger start of cycle.

Thunderstorm anatomy, visible in Mike Olbinski's time lapse *Monsoon IV*: https://vimeo.com/239593389?ref=fb-share&1 or his *Pursuit*: https://vimeo.com/226958858
Pyrocumulus = cloud formed at the top of a wildland fire smoke plume.

2: Orographic clouds, caused by topography, i.e. mountains

Orography (from the Greek όρος, hill, γραφία, to write) [Wikipedia]

Most common interesting cloud in winter and spring is the

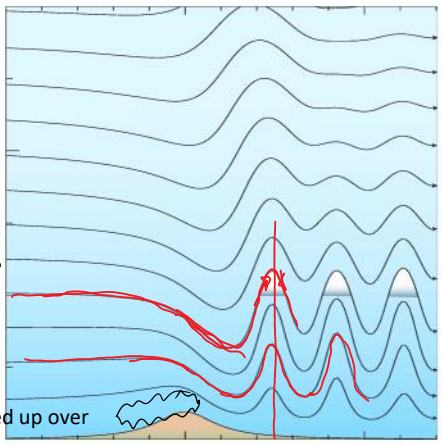
Altocumulus lenticularis (higher than 6500 ft above local ground level) (standing)
or
Stratocumulus lenticularis (lower)
or
Mountain Wave Cloud, trapped or lee

ACSL

requires STABLE atmosphere: note exception to unstable/cumulus pairing

STANDING WAVE

Clouds Produced by Vertically ***Trapped*** Mountain Waves



Thomas Carney et al., *AC 00-57 Hazardous Mountain Winds and Their Visual Indicators* (Federal Aviation Administration, 1997), http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/780437D88CBDAFD086256A94006FD5B8?OpenDocument.

West

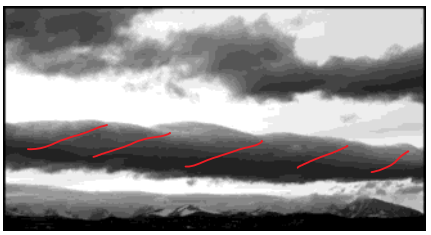
East

Clouds that sit right on the Divide = FOEHN cloud wall. From air being forced up over the mountains

Foyne

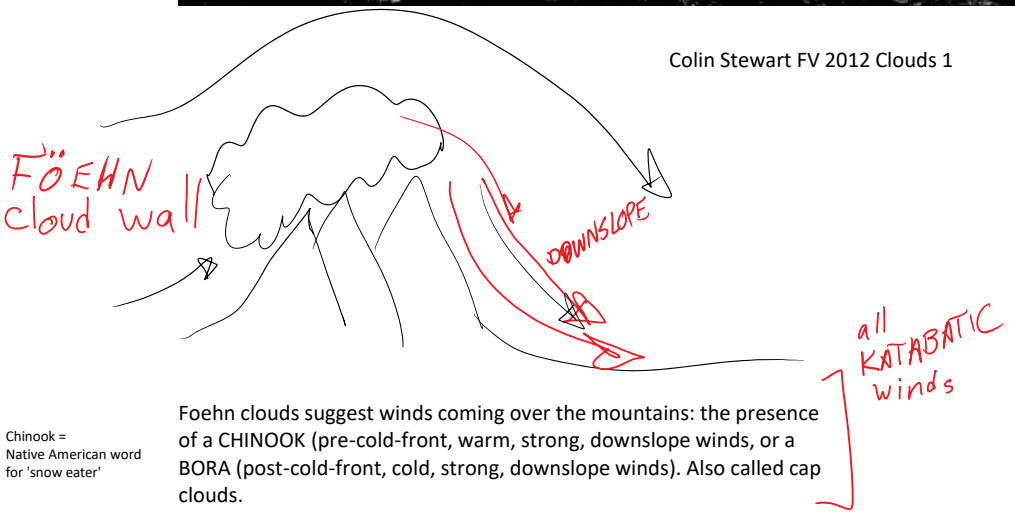
Altocumulus lenticularis. Typically 1 to 5 wave crests.

Clouds stay stationary, but may move off and reform periodically



Ben Britton, FV 2010

Colin Stewart FV 2012 Clouds 1



Chinook =
Native American word
for 'snow eater'

Foehn clouds suggest winds coming over the mountains: the presence of a CHINOOK (pre-cold-front, warm, strong, downslope winds, or a BORA (post-cold-front, cold, strong, downslope winds). Also called cap clouds.