14 Clouds Lift Mechanisms

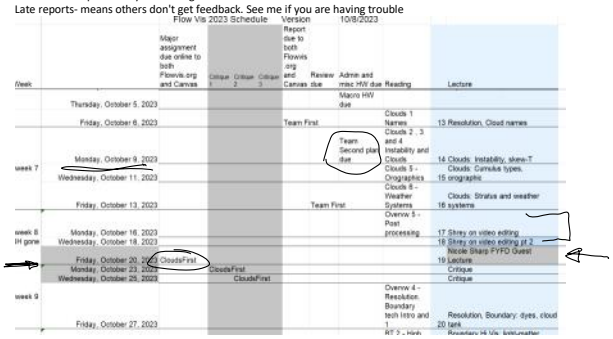
Wednesday, October 5, 2022 3:26 PM

Skew T worksheet
Available on class page

Today: Clouds - Instability lift mechanism

Admin:

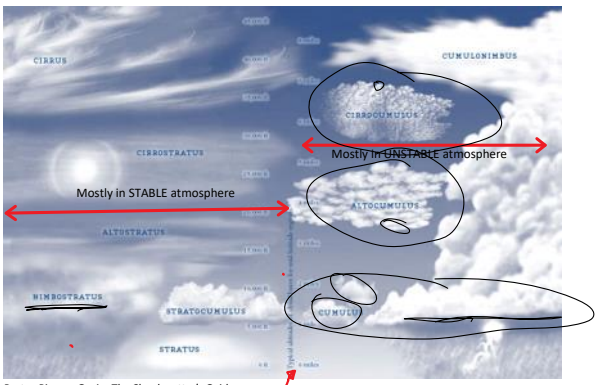
Reading assignment.
Up through Clouds 1, 2 3 and 4.
Clouds First post: Edit your post date and time = your cloud image date and time
Several clicker polls today. Please log in.
Late reports- means others don't get feedback. See me if you are having trouble



M,W afternoon = BEST

I will be gone next Friday afternoon Oct 13 until Monday Oct 23. No equipment checkout during that time
Shrey will give video tutorial on Davinci Resolve Oct 16 and 18. Regular attendance OK.
Guest Lecture October 20: Nicole Sharp, author of FYFD. Attendance required.

Following info partially adapted from Mike Baker, local NOAA Weather Service forecaster.



Pretor-Pinney, Gavin. *The Cloudspotter's Guide.* Perigee/Penguin, 2006.

Quick Cloud ID tricks:

Hold out three fingers at arm's length. Can you cover a cloud element (clump) with three fingers? No then it's a low cloud, cumulus variety
If it's between one and three fingers in width, then it's a mid level, alto- type
Smaller than one finger = cirro- level, high cloud.
No cloud elements, just smooth layers = stratus types.
If there is visible darkening on the bottom, then it's a low level or alto level layer.
If it's all bright, then it's cirrostratus.

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

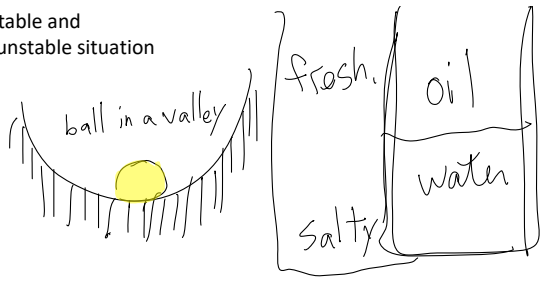
Is most complicated but most relevant for our summer clouds. Start with background physics.

What is instability? In groups, give example of
1) a stable and
2) an unstable situation

2) fresh oil

Stable = System returns to original state after a perturbation.

1) a stable and
2) an unstable situation



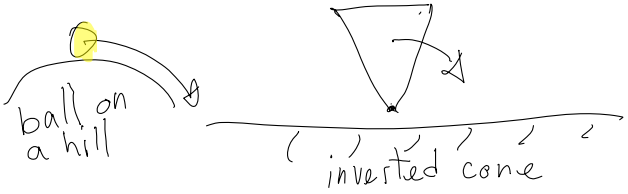
Stable = System returns to original state after a perturbation.

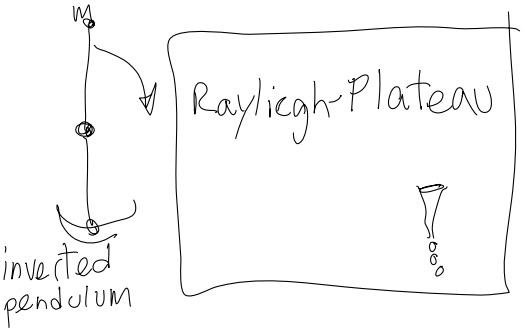
stable

unstable

fluids

Unstable = System does not return to original state after a perturbation





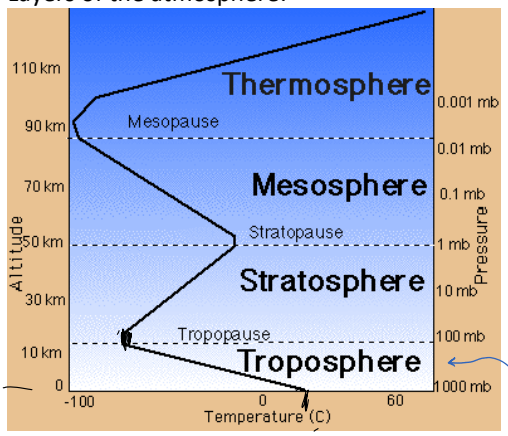
Results: some simple, some complex.

Stable — to perturbation

Unstable — metastable

https://en.wikipedia.org/wiki/List_of_hydrodynamic_instabilities_named_after_people

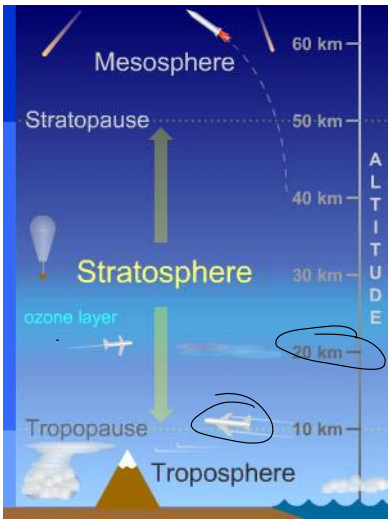
Layers of the atmosphere:



http://www.aerospaceweb.org/question/atmosphere/atmosphere/layers.gif

Stably stratified

All weather happens in troposphere.
Driven by what happens at 500 mb level.



http://www.windows2universe.org/earth/Atmosphere/stratosphere.html

O_3 absorbs sunlight, heats stratosphere
Warm over cold
Less dense over more dense = STABLE. Hold that thought.

Weather data comes as a mix of English and metric systems.
Back to SCALES; how big….
How big is this? Well, OK, how wide is your screen?

Do you estimate in metric or in English units?
A) Metric 23%
B) English 32%
C) I can do both! 41%
D) I can't do either. 0

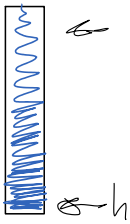
	2022	2023
Metric	13%	23%
English	33%	32%
I can do both!	58%	41%
I can't do either.		0%

< Minute paper: In your head, 10 km = X miles, = Y thousand feet.
Be approximate, 1 sig fig.

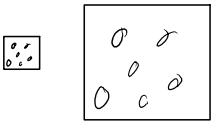
6 miles ~30,000 feet

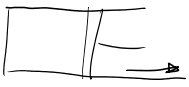
Temperature change with altitude in troposphere:
Minute paper in groups: *Why* is it colder on top of a mountain than at the foot? Hint: it's not the ideal gas law.

Start with pressure profile in atmospheric column: highest at surface, decreases going up.
Comes from hydrostatics; gravity balanced by pressure.



Consider a parcel of air (imaginary little cube, 1 inch to 10 feet^3). Same temperature as its neighbors.
Reduce its pressure (surface forces), while allowing no heat transfer.
It expands = *adiabatic* expansion
In expanding, it *does work* on its neighbors
Loses internal energy; cools.
= Conservation of Energy, 1st Law of Thermo.
NOT the Ideal Gas Law





Piston/cylinder

Rising parcels expand, *do work,* lose energy and therefore cool.

Vice versa is true too; descending parcels get compressed (work is done on them) and warm up.