Clouds and More Clouds
AOSC 200

Tim Canty

Class Web Site: http://www.atmos.umd.edu/~tcanty/aosc200

Topics for today:

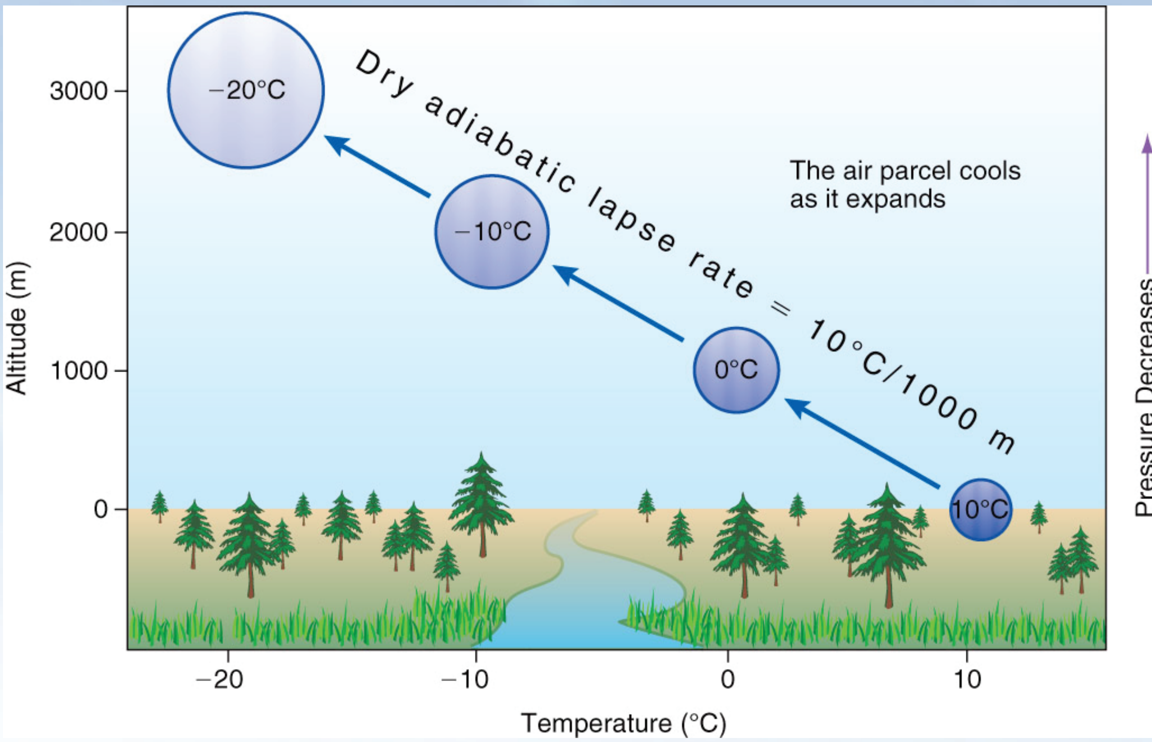
How to make clouds pt 1.

Lecture 12
Oct 3 2019

Hot air rises!

What happens then?

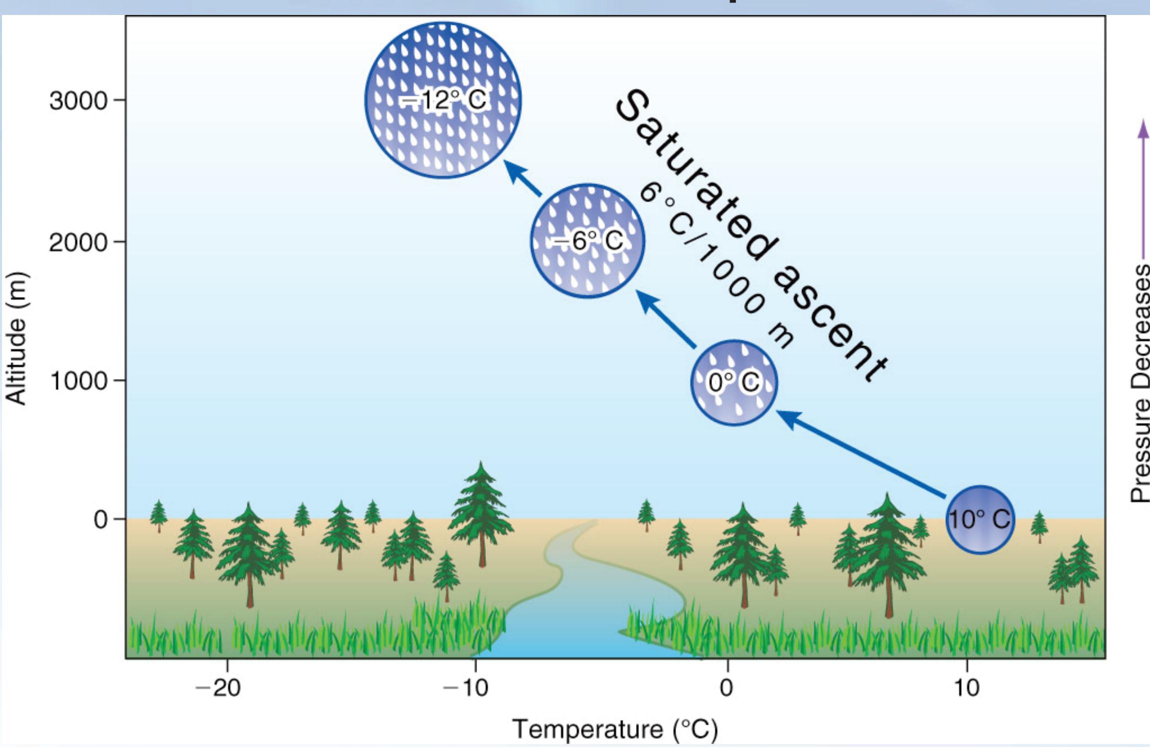
Lapse Rate



Dry adiabatic lapse rate: if no cloud forms, air will cool at 10°C per kilometer.

Fig 3-19 *Meteorology: Understanding the Atmosphere*

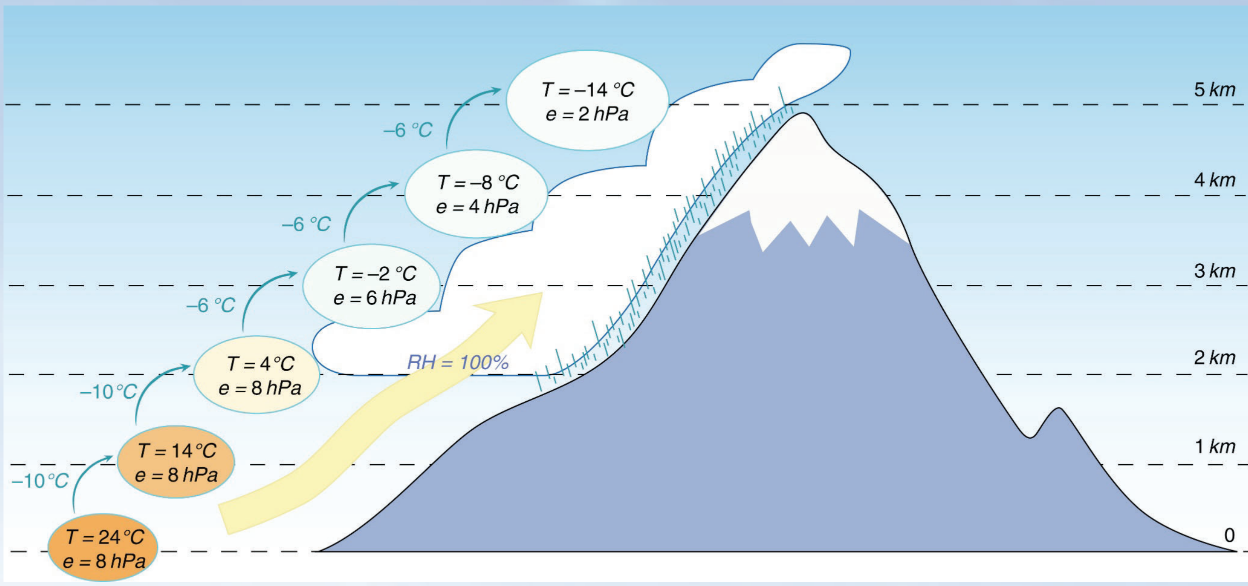
Saturated Adiabatic Lapse Rate



Once water begins to condense, latent heat is released. The air parcel cools at a slower rate than if the air parcel was dry

Fig 4-14 *Meteorology: Understanding the Atmosphere*

Real World Example

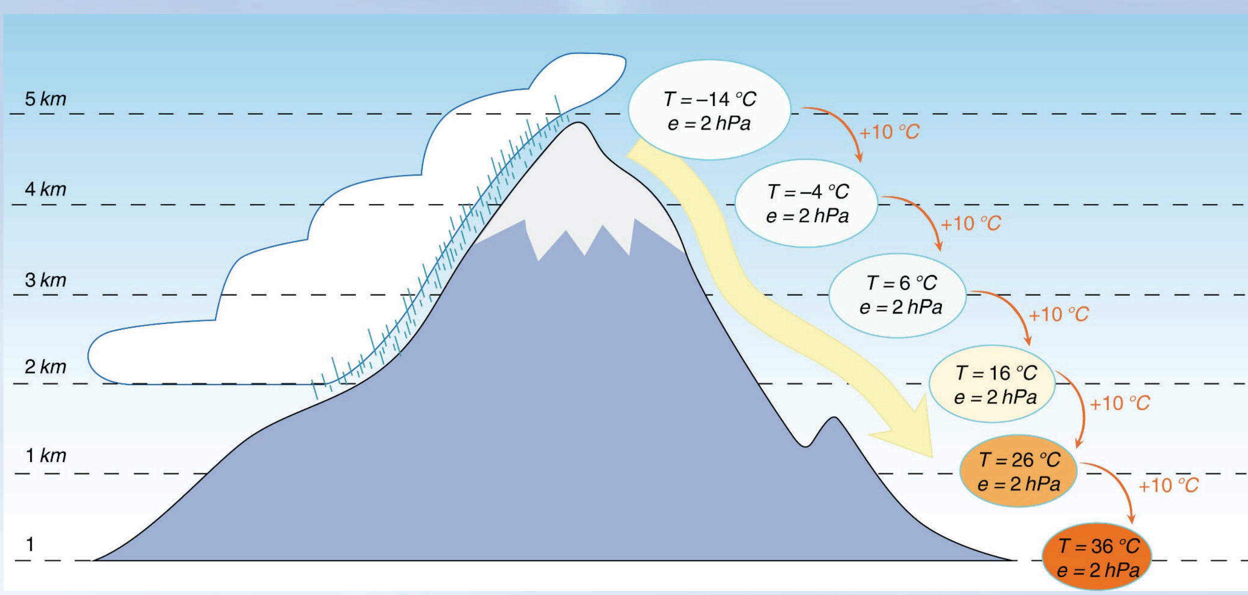


As air rises up a mountain side, it cools at the dry adiabatic lapse rate

Once it reaches saturation, it cools at the saturated lapse rate. Also, precipitation (rain or snow) falls out of the cloud and the vapor pressure decreases

Fig 6.7 *Weather: A Concise Introduction*

Real World Example



The air parcel has lost a lot of water. As it sinks down the mountain side, the air in the parcel warms and dries out the cloud.

The parcel warms only at the dry lapse rate.

When the parcel reaches the ground, it's warmer than when it started

Fig 6.8 *Weather: A Concise Introduction*

Real World Example

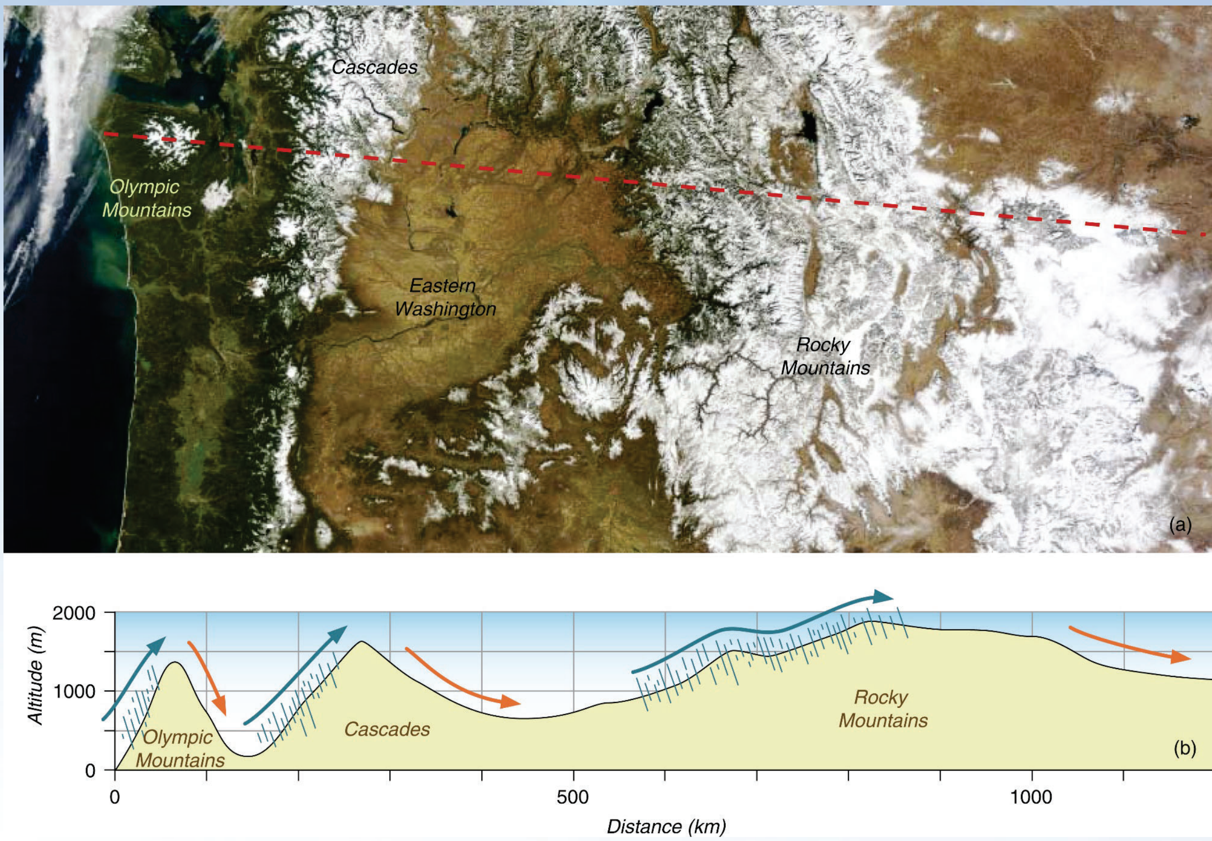


Fig 6.9 *Weather: A Concise Introduction*

"Rain Shadow"

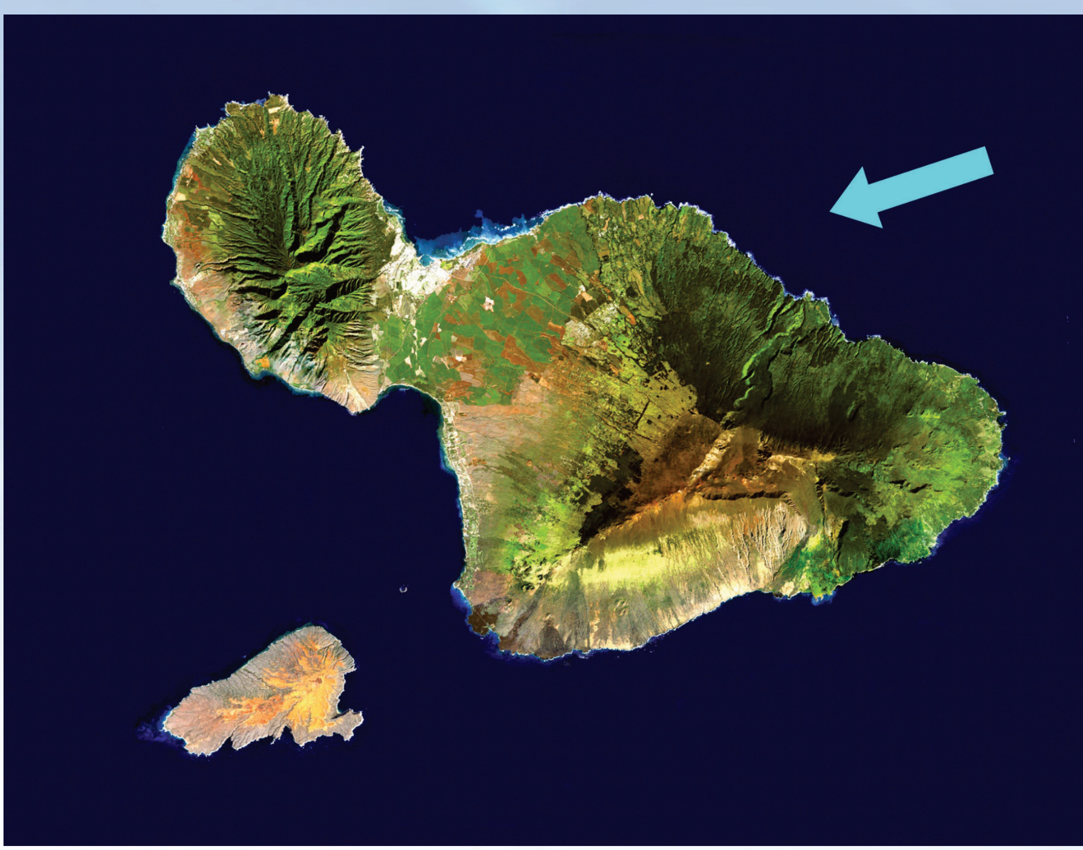
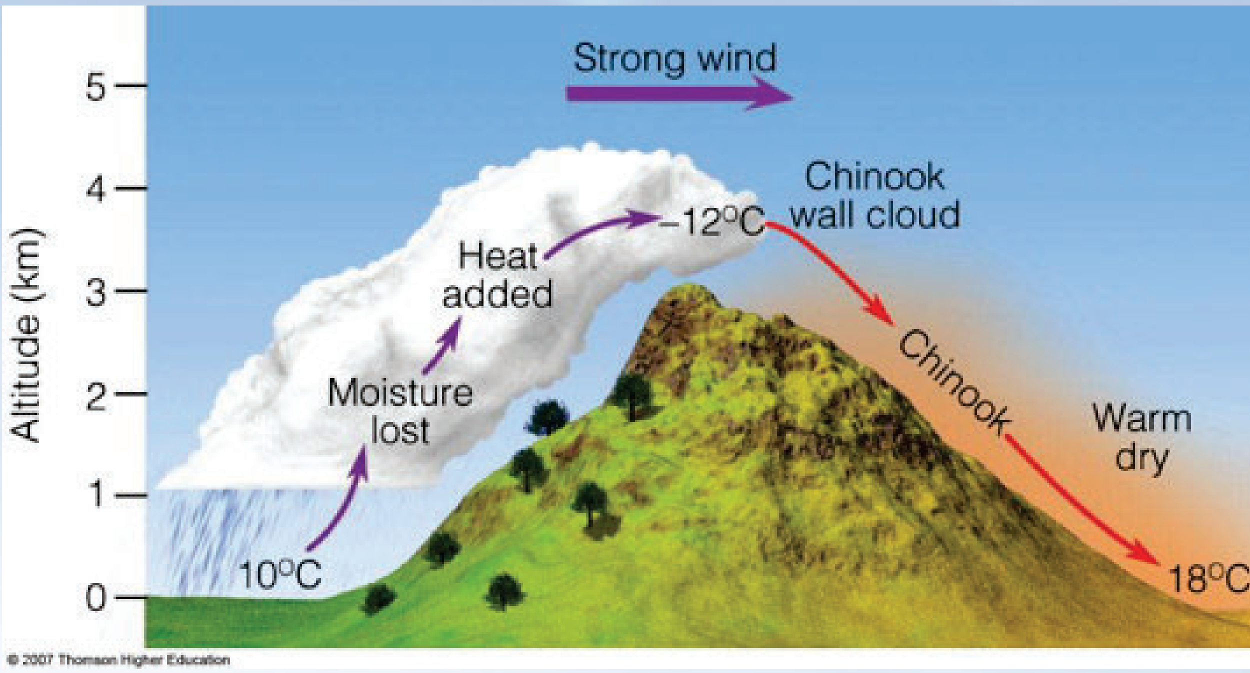


Fig 6.10 *Weather: A Concise Introduction*

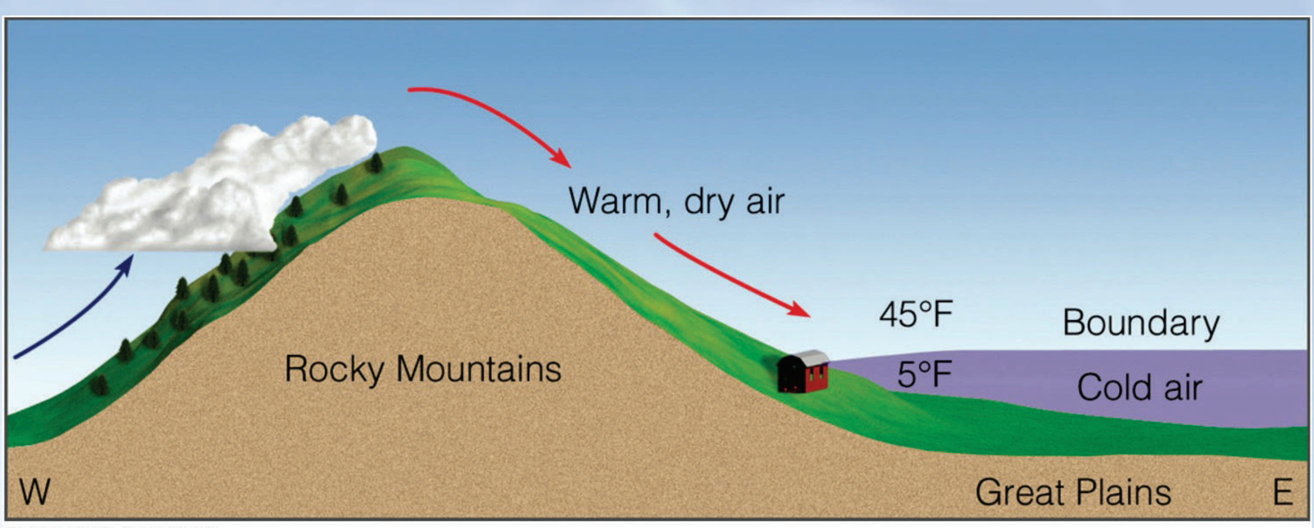
Chinook (a type of Foehn wind)



Air rushing down the downwind side of the mountain warms and dries as it sinks (compressional heating) leading to warm surface winds

Fig 7.11: ***Essentials of Meteorology***

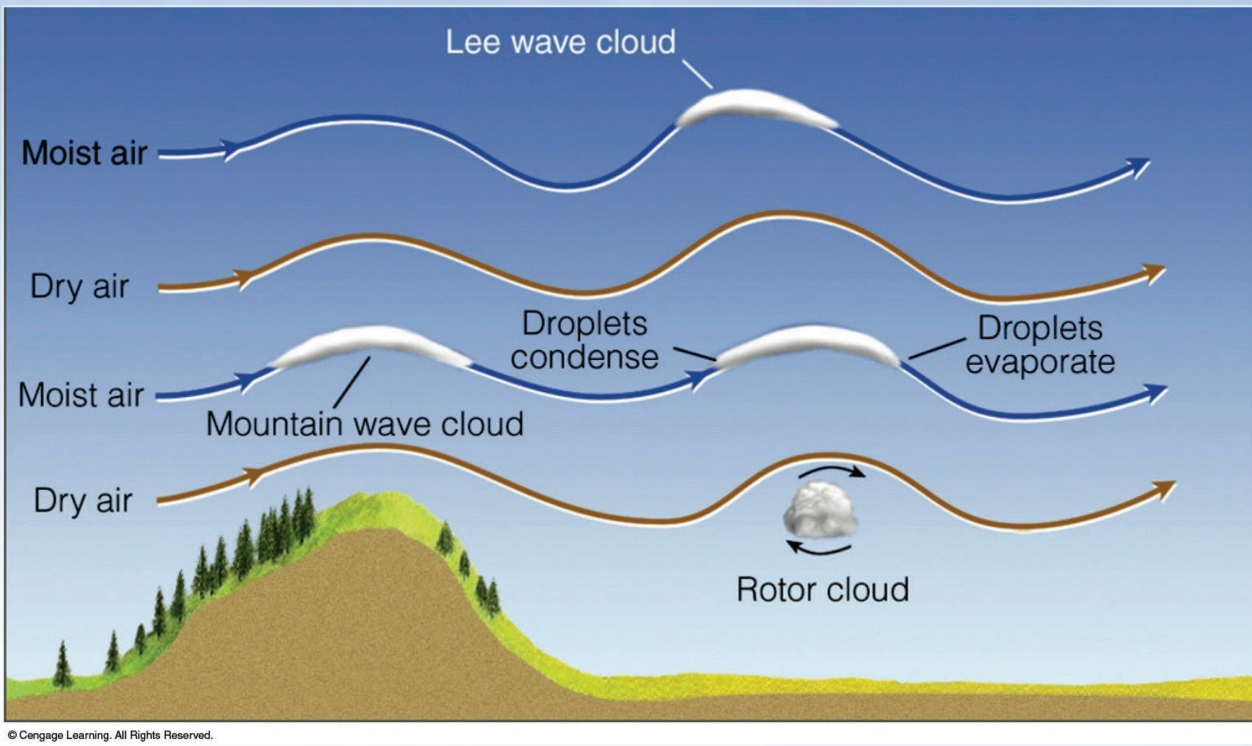
Snow Eater



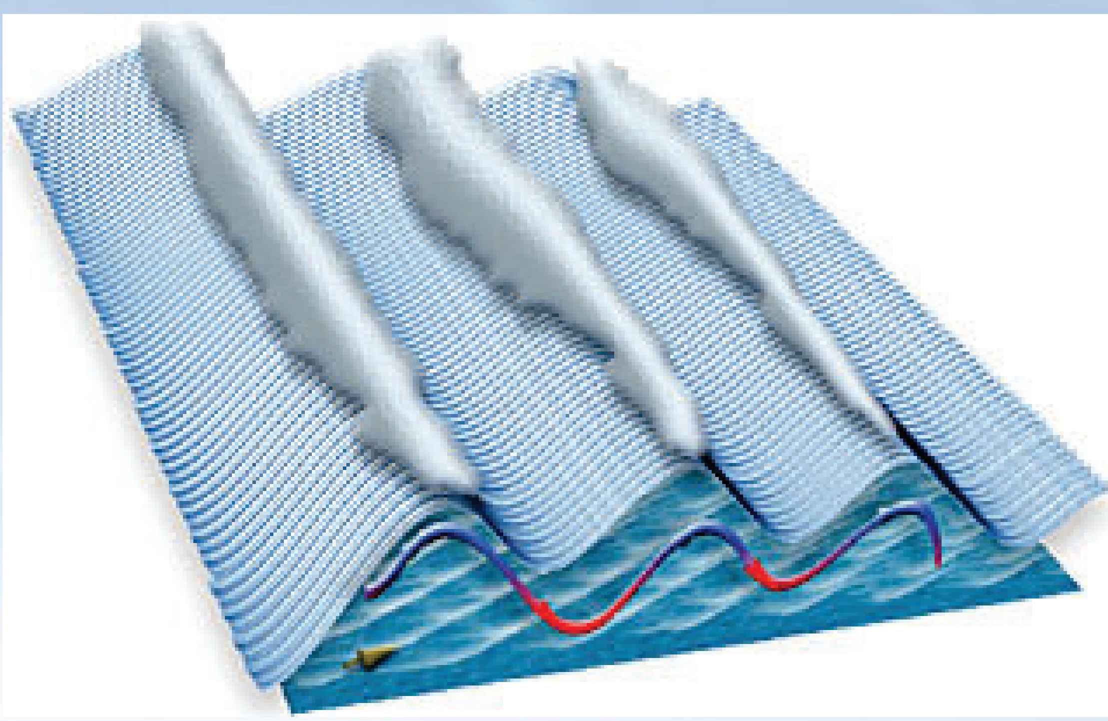
The boundary between warm and cold air can move quickly and "slosh" back and forth

Fig 7.u3: ***Essentials of Meteorology***

Gravity Waves



Gravity Waves

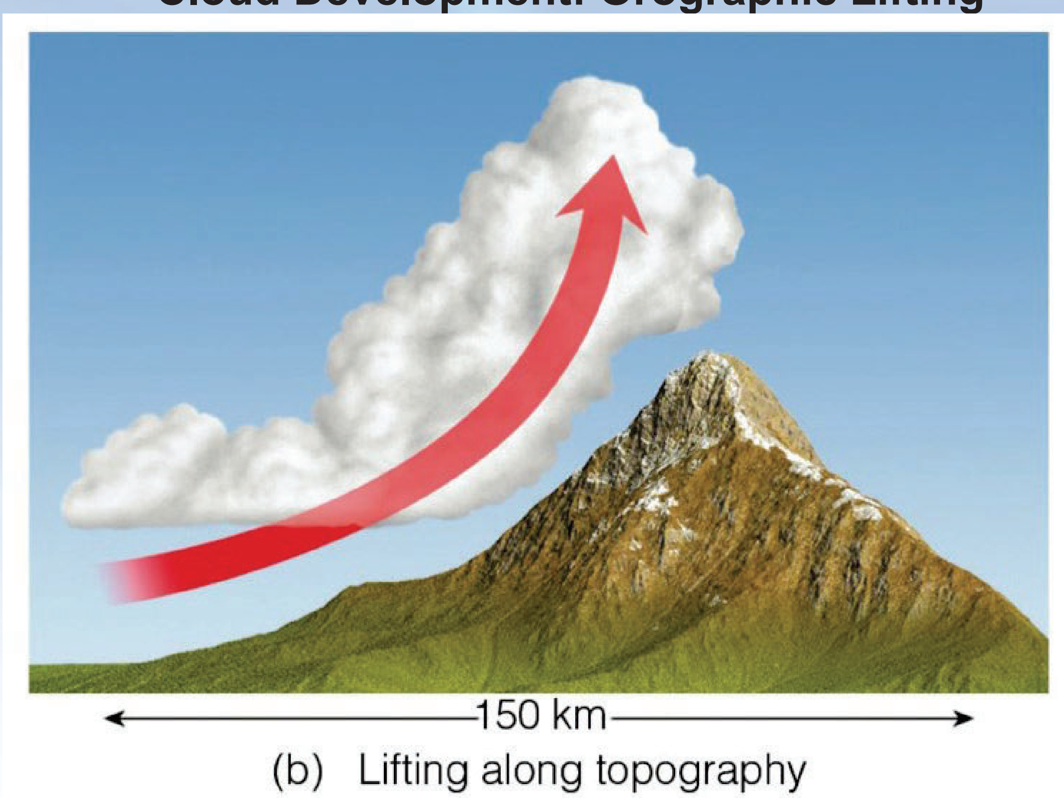


Similar to ocean waves, "crests" form clouds

http://www.brockmann-consult.de/CloudStructures/gravity-waves-cloud-description.htm

Lenticular Clouds

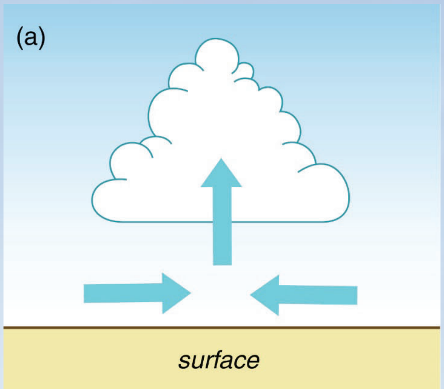
Cloud Development: Orographic Lifting



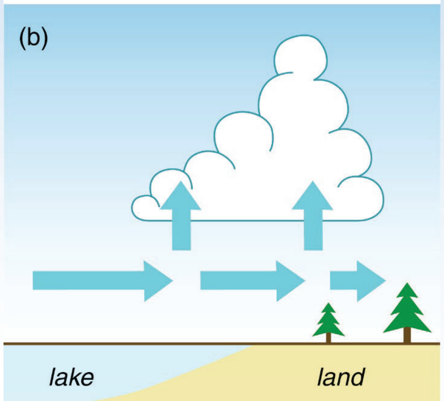
Air is forced up the side of a mountain and cools as it rises

Fig 5.10: *Essentials of Meteorology*

Cloud Development: Convergence



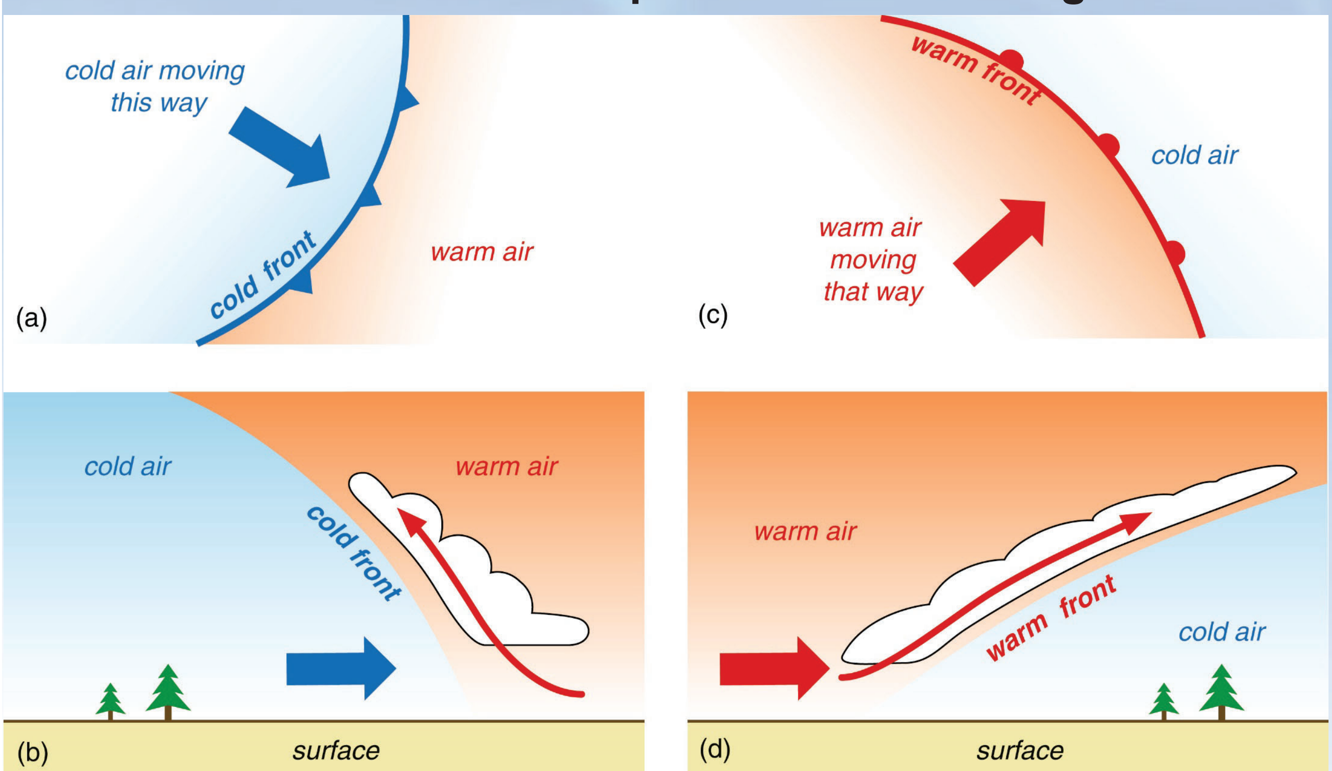
When wind meets from different directions, the air in between has no place to go but up



When the leading edge of the wind slows down, the wind behind "piles up"

Fig 6.11 *Weather: A Concise Introduction*

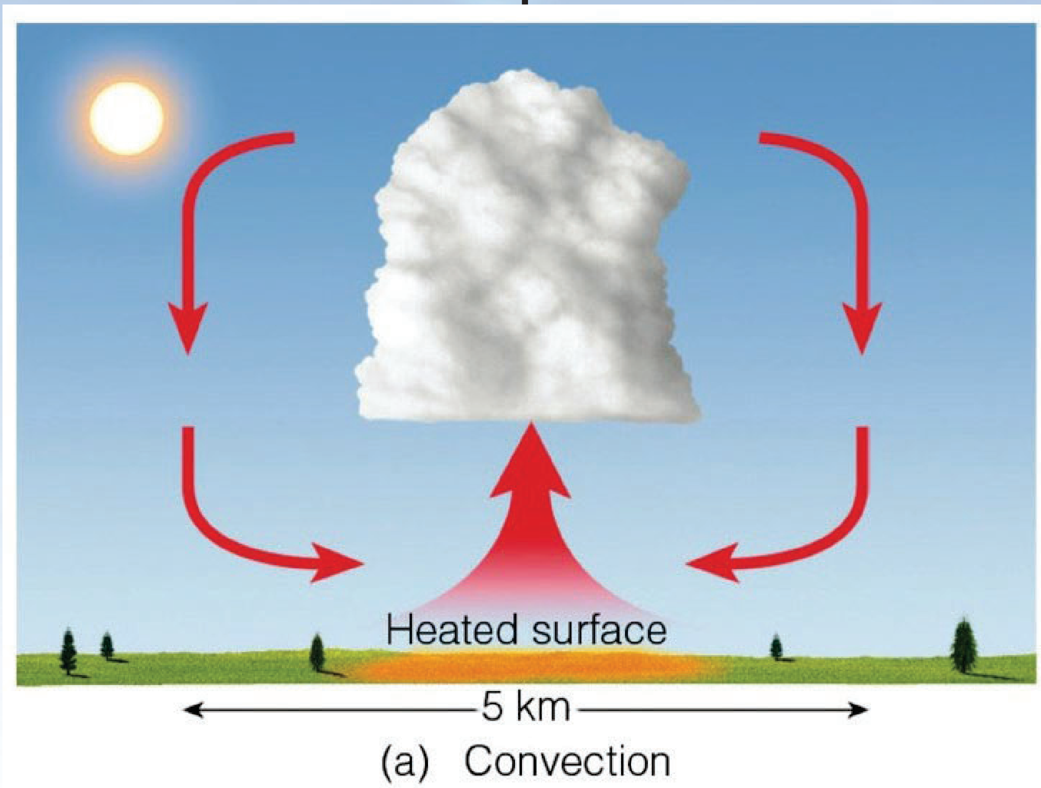
Cloud Development: Frontal Lifting



Warm air will ride up over cold air

Fig 6.12 *Weather: A Concise Introduction*

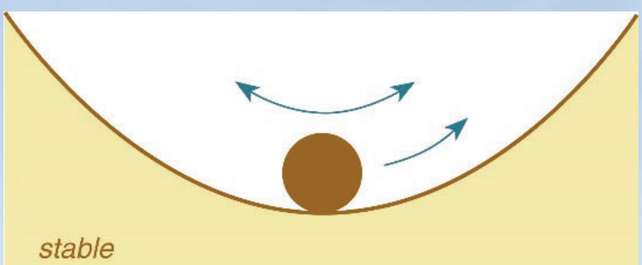
Cloud Development: Convection



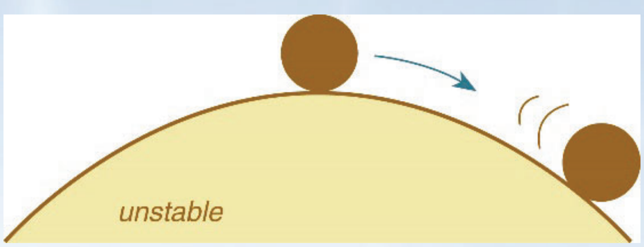
As surface air is warmed by the sun, it becomes less dense and rises

Fig 5.10: *Essentials of Meteorology*

Stability vs. Instability



In a stable atmosphere, air won't rise unless something forces it up

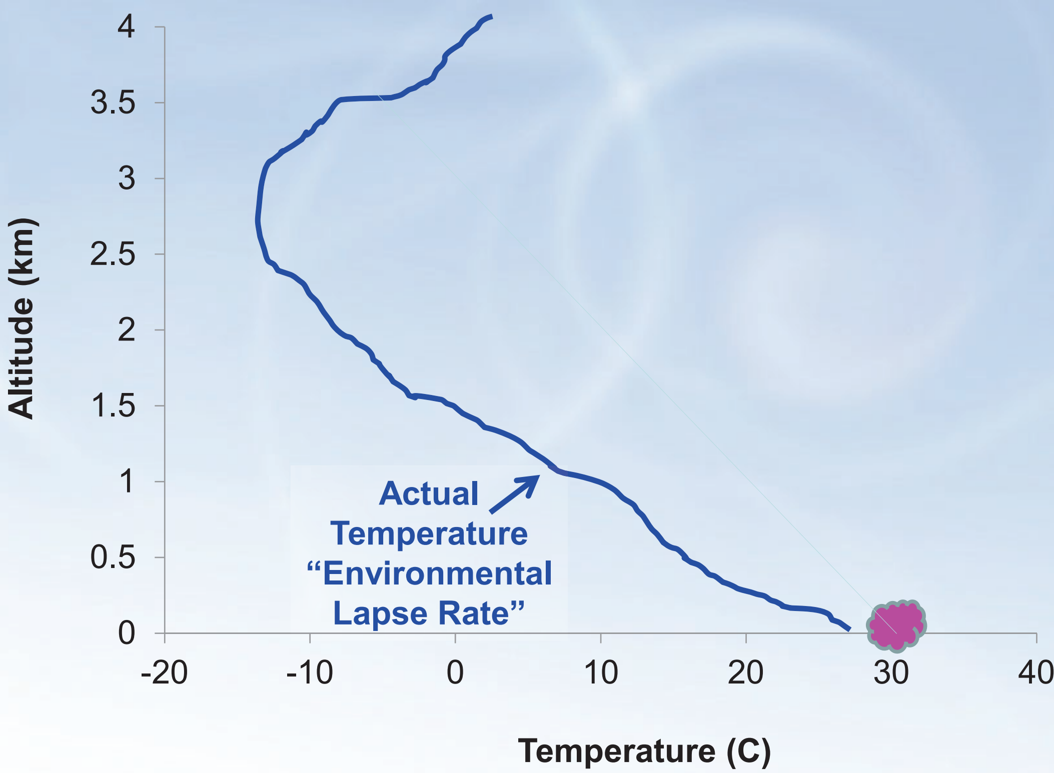


In an unstable atmosphere, air can rise on its own through convection

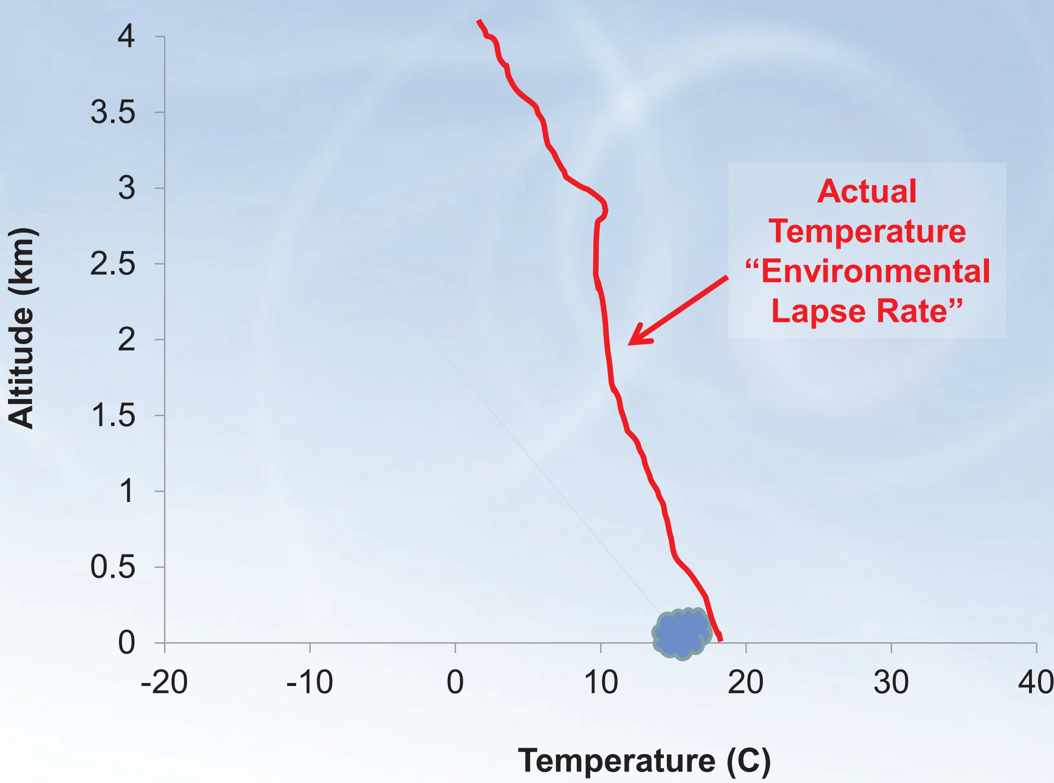
In an conditionally unstable atmosphere the air will rise on its own but it needs a push first.

Fig 6.5.1-4 *Weather: A Concise Introduction*

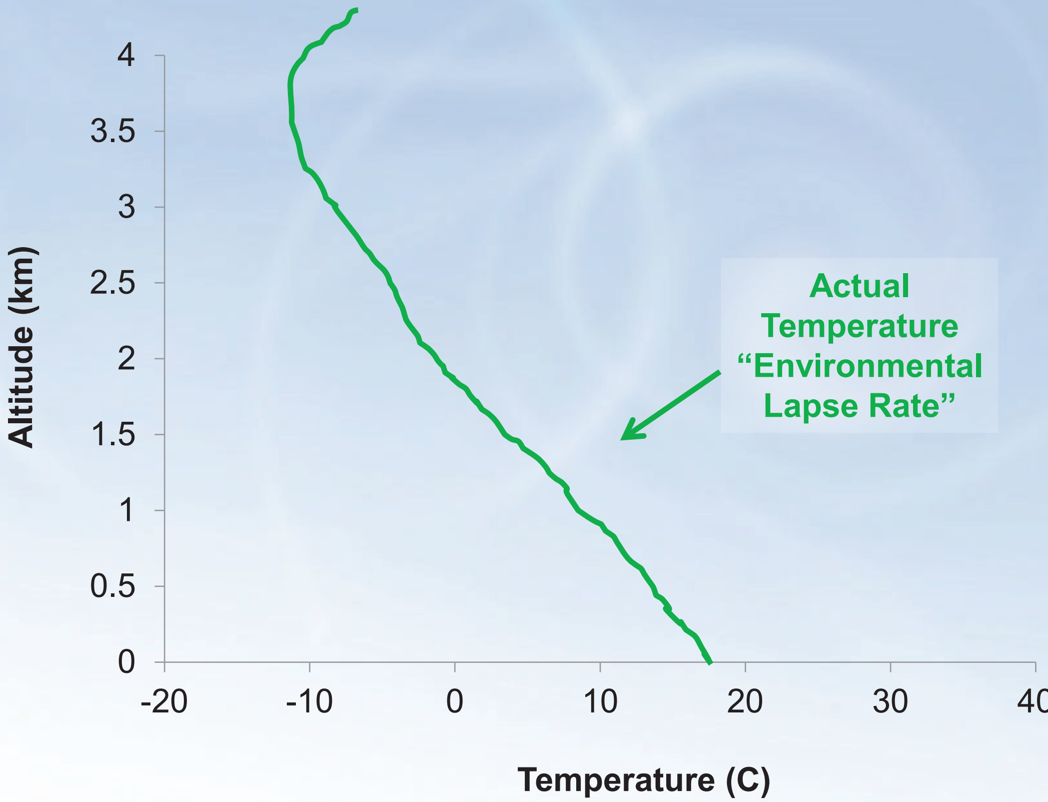
Lapse Rate: Unstable Atmosphere



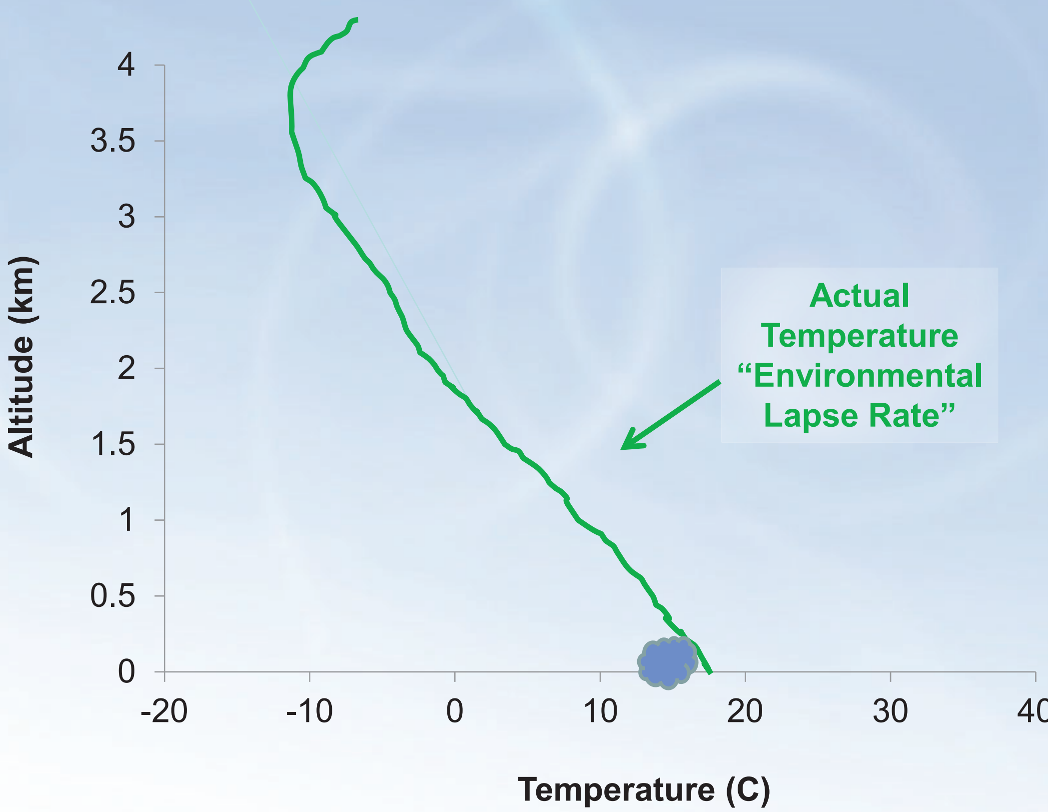
Lapse Rate: Stable Atmosphere



Lapse Rate: Conditionally Unstable Atmosphere



Lapse Rate: Conditionally Unstable Atmosphere



Putting it all together

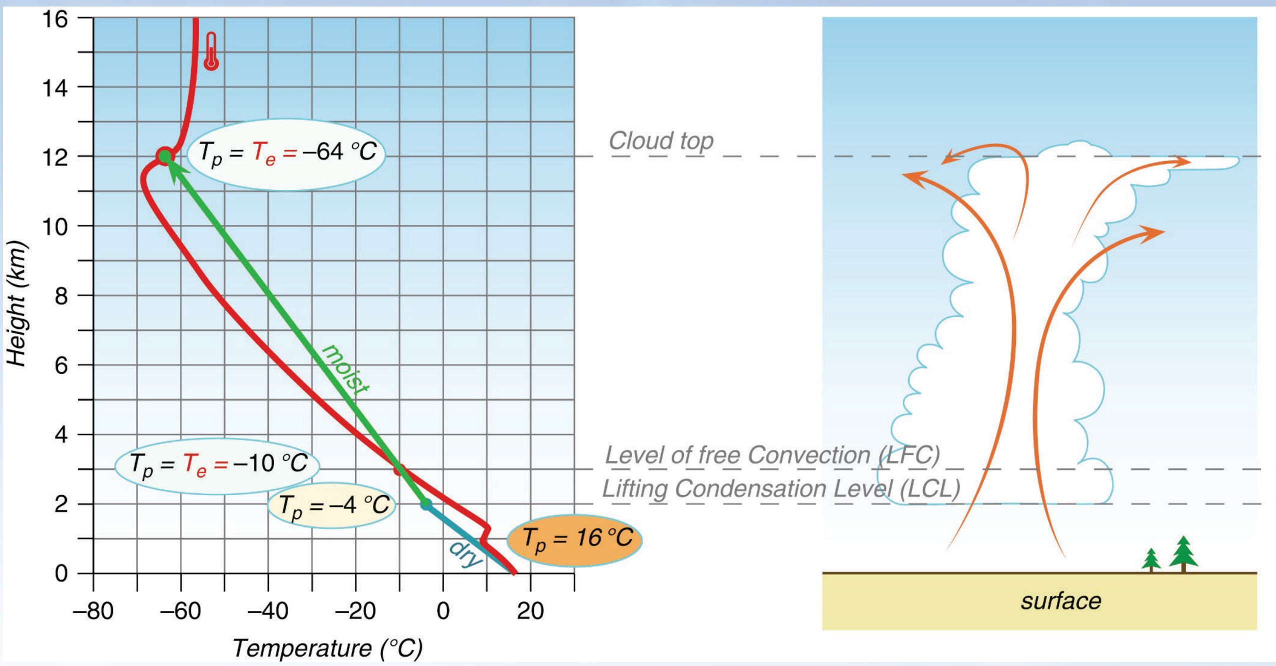


Fig 6.22 Weather: *A Concise Introduction*

Clouds!!!

Stratus – Layer
Cumulus – heap or pile
Nimbus – rain
Alto – high
Cirrus – ringlet or curling

TABLE 4.2 Approximate Height of Cloud Bases Above the Surface for Various Locations

CLOUD GROUP	TROPICAL REGION	MIDDLE-LATITUDE REGION	POLAR REGION
High Ci, Cs, Cc	20,000 to 60,000 ft (6000 to 18,000 m)	16,000 to 43,000 ft (5000 to 13,000 m)	10,000 to 26,000 ft (3000 to 8000 m)
Middle As, Ac	6500 to 26,000 ft (2000 to 8000 m)	6500 to 23,000 ft (2000 to 7000 m)	6500 to 13,000 ft (2000 to 4000 m)
Low St, Sc, Ns	surface to 6500 ft (0 to 2000 m)	surface to 6500 ft (0 to 2000 m)	surface to 6500 ft (0 to 2000 m)

Clouds come in three altitude categories…

Table 4.2: ***Essentials of Meteorology***

Clouds!!!

TABLE 4.1 The Four Major Cloud Groups and Their Types

1. High clouds Cirrus (Ci) Cirrostratus (Cs) Cirrocumulus (Cc)	**3.** Low clouds Stratus (St) Stratocumulus (Sc) Nimbostratus (Ns)
2. Middle clouds Altostratus (As) Altocumulus (Ac)	**4.** Clouds with vertical development Cumulus (Cu) Cumulonimbus (Cb)

…but there are 4 major cloud groups in total

Table 4.1: ***Essentials of Meteorology***

Clouds!!!

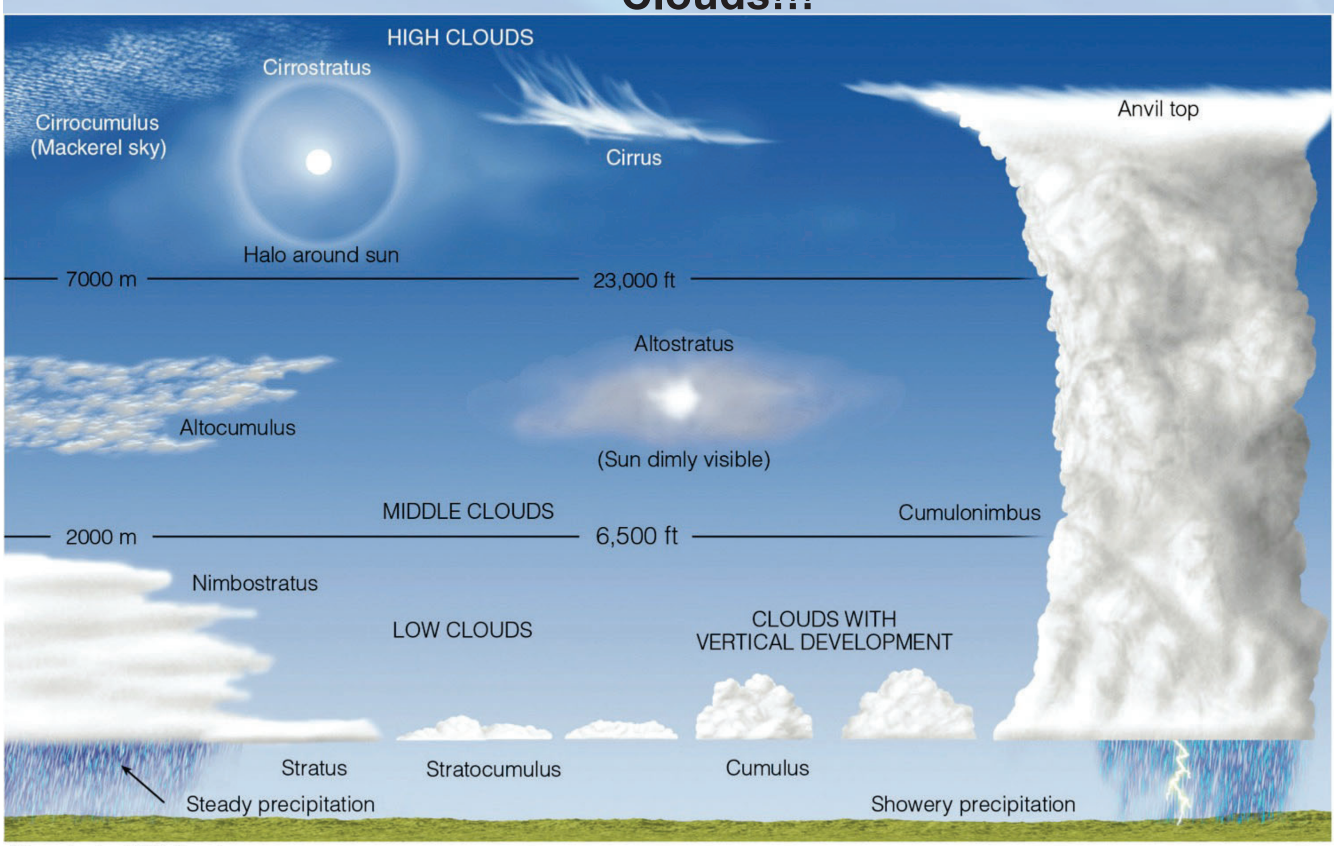


Fig 4.36: ***Essentials of Meteorology***

Clouds!!!

TABLE 4.3 Common Terms Used in Identifying Clouds

TERM	LATIN ROOT AND MEANING	DESCRIPTION
Lenticularis	(*lens, lenticula,* lentil)	Clouds having the shape of a lens; often elongated and usually with well-defined outlines. This term applies mainly to cirrocumulus, altocumulus, and stratocumulus
Fractus	(*frangere,* to break or fracture)	Clouds that have a ragged or torn appearance; applies only to stratus and cumulus
Humilis	(*humilis,* of small size)	Cumulus clouds with generally flattened bases and slight vertical growth
Congestus	(*congerere,* to bring together; to pile up)	Cumulus clouds of great vertical extent that, from a distance, may resemble a head of cauliflower
Undulatus	(*unda,* wave; having waves)	Clouds in patches, sheets, or layers showing undulations
Translucidus	(*translucere,* to shine through; transparent)	Clouds that cover a large part of the sky and are sufficiently translucent to reveal the position of the sun or moon
Mammatus	(*mamma,* mammary)	Baglike clouds that hang like a cow's udder on the underside of a cloud; may occur with cirrus, altocumulus, altostratus, stratocumulus, and cumulonimbus
Pileus	(*pileus,* cap)	A cloud in the form of a cap or hood above or attached to the upper part of a cumuliform cloud, particularly during its developing stage
Castellanus	(*castellum,* a castle)	Clouds that show vertical development and produce towerlike extensions, often in the shape of small castles

Table 4.3: ***Essentials of Meteorology***