Meteorology 101

(Some) Fundamentals of Weather

The Weather Channel

Meteorology 101

Weather & Air Quality:
Keys: **Air motion**, **clouds**, and **precipitation**.

Horizontal: Wind
Vertical: Vertical Motions, mixing

- Wind, mixing disperse Pollutants!!
- Clouds reduce sunlight and slow production of some pollutants.
- Precipitation cleanses the atmosphere.

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Questions to Answer

- How, why, when, where does the wind blow?
- What controls vertical motions?
- When and where do clouds and precipitation form?

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Geographical Terminology…

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Some Fundamentals

- Earth is heated unevenly: Tropics are warmer than the Polar Regions.
- Nature tries to try to even out temperature differences.
- Uneven heating sets atmosphere in motion and is the fundamental cause of all weather.

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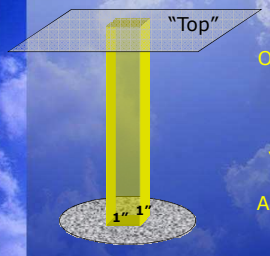
Air Pressure



On average, air weighs about 14.7 lb/in^2

14.7 lb/in^2 =29.92 "inches of mercury"

Air Pressure varies over the globe

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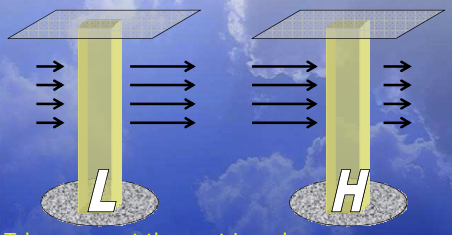
Changing Pressure - Winds



Take more out than put in – decrease pressure
Put more in than take out – increase pressure

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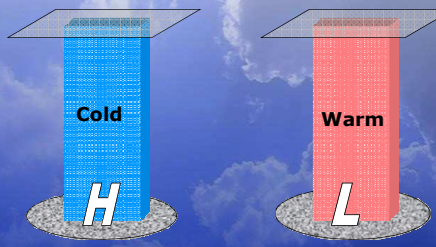
Changing Pressure - Temperature



Coldest column = highest pressure **
Warmest column = lowest pressure **

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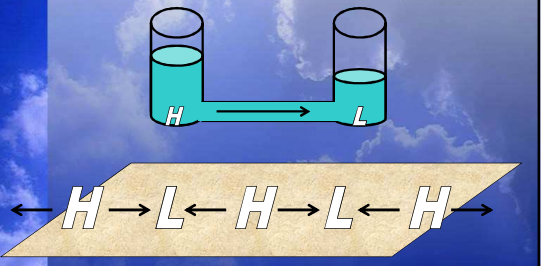
Pressure Differences Create Wind



Air moves from higher toward lower pressure

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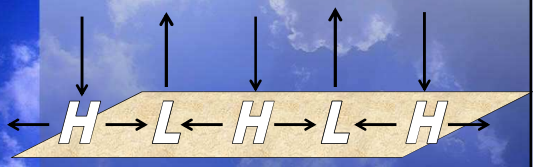
Vertical motions also occur



Air "converges" at lows, and rises.

Air "diverges" at highs, and sinks.

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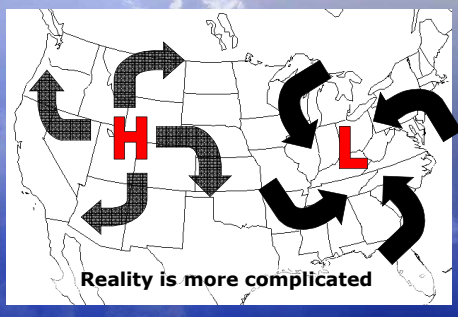

Actual winds around highs and lows

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Rising Air near Lows

- Rising air cools; water vapor in the air condenses to form clouds/precipitation
- Lows tend to bring cloudy, wet weather

Sinking air near Highs

- Sinking air warms and dries out.
- Highs tend to bring fair, dry weather.

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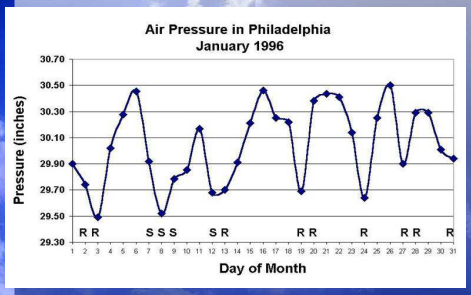

Low or lowering pressure = "Lousy" weather

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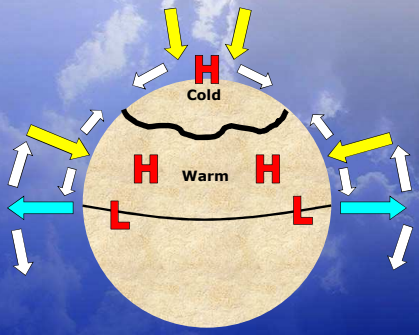

General Circulation

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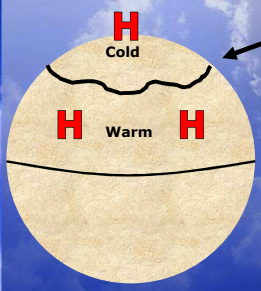

Front = Battleground of Air Masses

- Temperature differences concentrated
- Zone of lower pressure where lows (storms) often form

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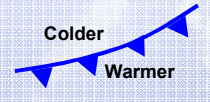
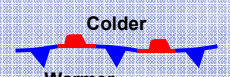


Cold Front

Cold air advances

Warm Front

Warm air advances*



Stationary Front

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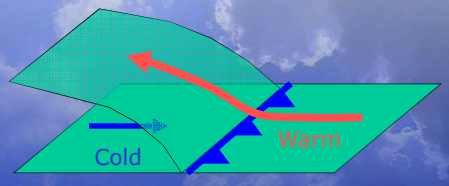
What happens when air masses meet at fronts?



Cold air lifts the warmer air.

Clouds and precipitation form.

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Upper-Level Features

Westerlies - High-Altitude winds blow generally west-to-east 3-6 miles above mid-latitudes.

Jet Stream – River of fastest-moving air within the westerlies.

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Reality is messier …

Still, highs and Lows move with the westerlies and the jet stream.

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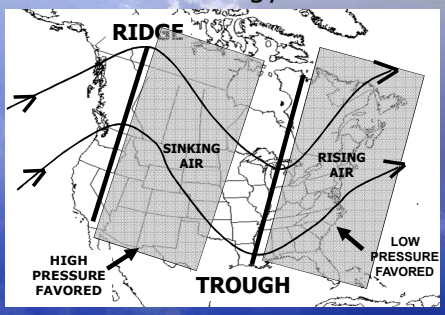

Highs and Lows form and dissipate in synch with ridges and troughs in the westerlies.

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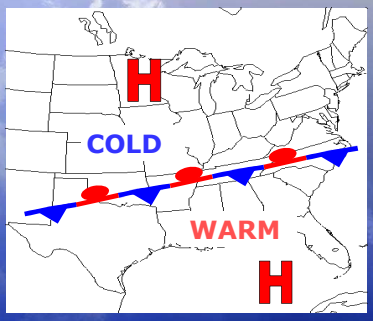
LOW This is your life!



Stationary Front separates air masses

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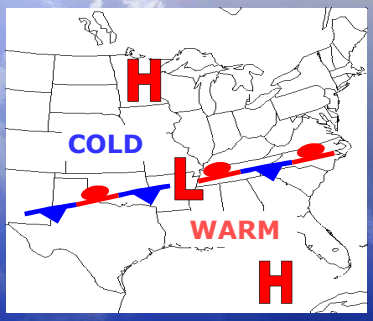
LOW This is your life!



Area of low pressure develops along front

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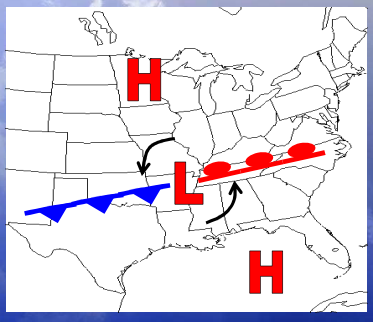
LOW This is your life!



Circulation around low sends cold air and warm air advancing

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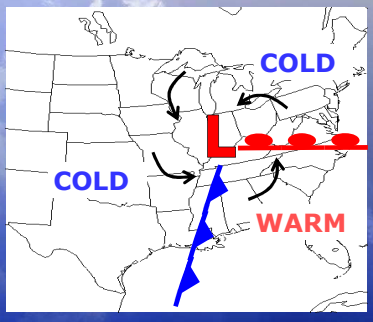
LOW This is your life!



Low and fronts move with the upper-air westerlies while circulating low-level air

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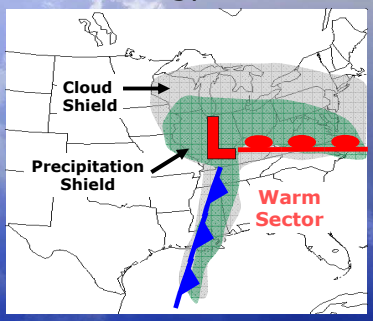
LOW

This is your life!



Typical cloud and precipitation shield of a low-pressure system and fronts

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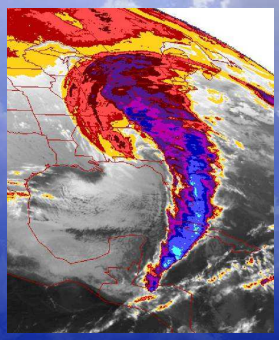

Intense lows often take on a "comma-cloud" shape when viewed from space.

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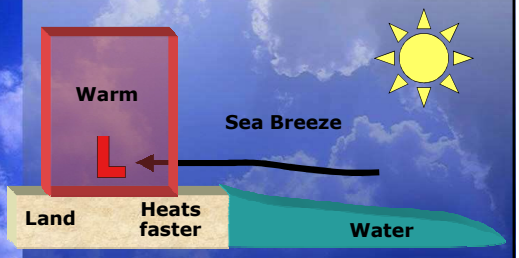
Local Winds



Uneven heating working on a smaller scale

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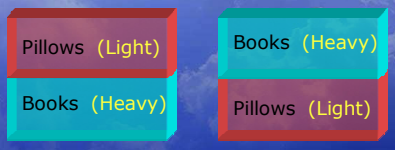
Another control on vertical motions

Vertical temperature structure of the atmosphere



STABLE

Inhibits Overturning

More likely to overturn

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In the Atmosphere…

- Typically, temperature decreases with altitude, so the lighter stuff (warmer air) is below the heavier stuff (colder air).
- Typically supports some overturning, especially in the boundary layer.

Cumulus clouds

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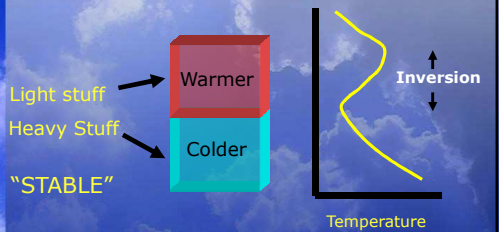
But Sometimes …



"STABLE"

Inversion – A layer of the atmosphere in which temperature increases with height.

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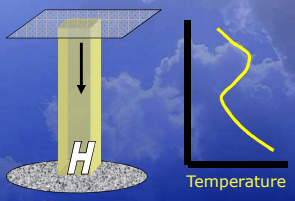
Inversions inhibit vertical mixing.

Can trap pollutants in the lower atmosphere.

Air sinks and warms near high pressure.

Creates an inversion 1000s of feet above the ground.



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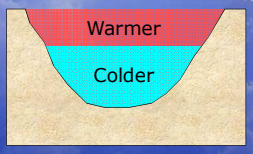

Colder, heavier air trapped in valleys.

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Key Ideas

- Wind and rising air disperse pollutants.
- When air rises, clouds/precipitation can form.
- Clouds reduce sunlight, which slows production of some pollutants; precipitation cleanses the air.
- Air rises, and winds are strongest, in the vicinity of low pressure and fronts.
- Air sinks, and winds tend to be light, in the vicinity of high pressure.

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Weather Forecasting

- **Knowledge** of how atmosphere works (e.g., high and low pressure, fronts, etc)
- **Observations, observations, observations** (surface, upper-air, satellite, radar, etc)
- **Computer guidance** (the "models")
- **Personal experience** ("I've seen that before")

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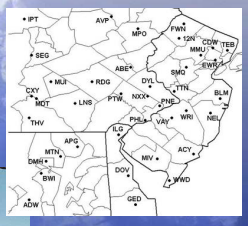

Surface observations

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Upper-air observations