Atmospheric Forces

Makin' the wind go 'round

Ch. 4: Atmospheric Pressure

• Vertical Pressure Profile
• Barometers
• Maps of Pressure Fields
  → Isobars
  → Heights of Pressure Surfaces vs. Temperature
  → Height Contours

Ch. 4: Forces and Wind

• Atmospheric Forces
  → Pressure Gradient Force
  → Coriolis Force
  → Friction
• Winds and Balance of Forces
  → Hydrostatic Balance
  → Winds Aloft—Geostrophic Balance
  → Surface Winds
• Wind Measurement
Sea level pressures:
- 1 atmosphere (atm)
- 1013.2 millibars (mb)
- 14.7 lb./sq. in. (psi)

Measurement: Barometers
Mercury Barometer
Aneroid Barometer

Reduction of Pressure to Sea Level

- Isobars: lines connecting points of equal pressure
Heights of Pressure Surfaces

- Pressure surface: a surface where the atmospheric pressure is the same everywhere.

- Height contours: lines connecting points of equal heights of some pressure surface.
Heights of pressure surfaces aloft are higher when the air is warmer.
Forces

\[ \vec{F} \rightarrow \]

\[ \vec{F} \rightarrow \]

Pressure Gradient Force

Pressure force is proportional to the difference in pressures

\[ \text{PGF} \propto \frac{\Delta p}{d} \]

More closely spaced pressure contour lines: higher pressure gradient force

Coriolis Force

View from above
Coriolis Force

Coriolis force magnitude $F_{cor} \propto$
Object's speed
Earth's rotation speed
Latitude

Direction: right angle (90°) to direction of motion

Northern Hemisphere  Southern Hemisphere
Friction

- Frictional force opposes motion
- Magnitude directly proportional to object's speed

\[ \mathbf{f} \propto -\mathbf{V} \]

Hydrostatic Balance
Balance of forces in the vertical direction

Geostrophic Balance

Geostrophic wind blows parallel to isobars or height contours

Geostrophic balance: steady-state wind where the PGF is exactly balanced by the Coriolis force
Northern Hemisphere: lower pressure is to the left of the wind motion
Circulation Around Highs and Lows

Northern Hemisphere

Highs and Lows

Clockwise

Counterclockwise

Circulation Around Highs and Lows

Southern Hemisphere

Highs and Lows

Counterclockwise

Clockwise

Surface Winds

—Add friction

Surface winds blow at an angle to the isobars, turned slightly toward lower pressure
Circulation at the Surface

Northern Hemisphere

Counterclockwise, spiral inward

Clockwise, spiral outward

Ridges and Troughs

L H Ridges only

H L Troughs only

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Wind Instruments

- **Direction:** Wind Vane
- **Speed:** Anemometer