

## **Atmospheric Forces**

**Makin' the wind go 'round**

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### **Ch. 4: Atmospheric Pressure**

- **Vertical Pressure Profile**
- **Barometers**
- **Maps of Pressure Fields**
  - **Isobars**
  - **Heights of Pressure Surfaces vs. Temperature**
  - **Height Contours**

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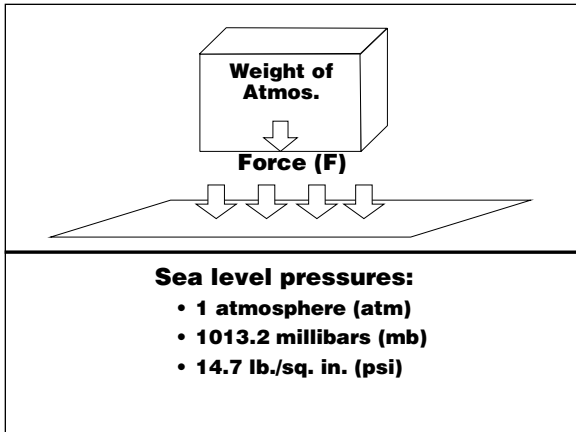
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### **Ch. 4: Forces and Wind**

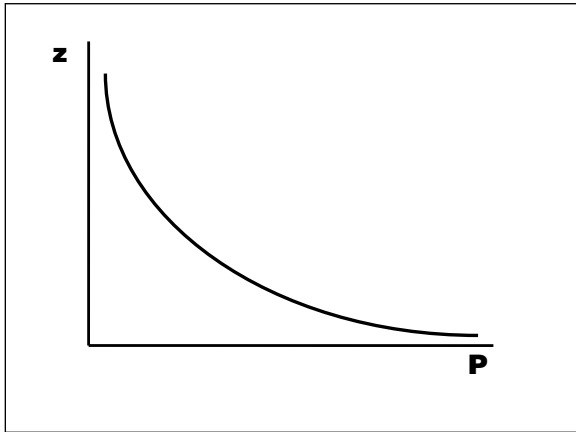
- **Atmospheric Forces**
  - **Pressure Gradient Force**
  - **Coriolis Force**
  - **Friction**
- **Winds and Balance of Forces**
  - **Hydrostatic Balance**
  - **Winds Aloft—Geostrophic Balance**
  - **Surface Winds**
- **Wind Measurement**

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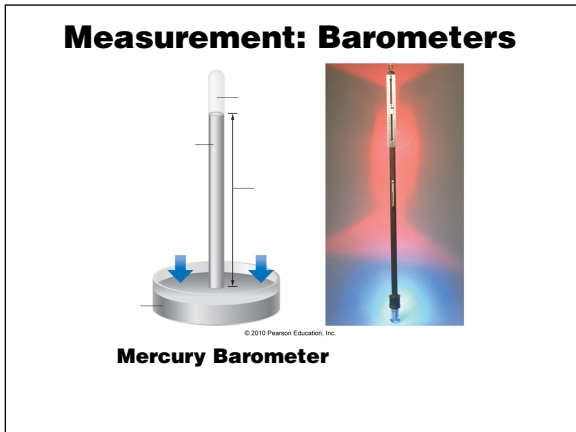
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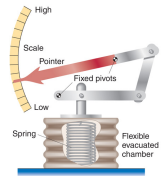
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(a)

(b)

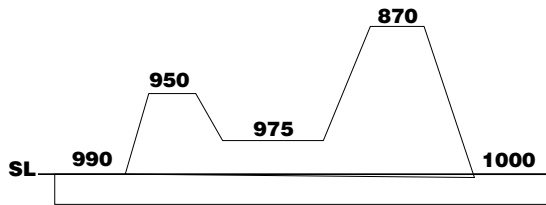
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### Aneroid Barometer

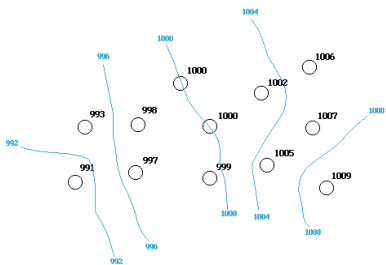
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### Reduction of Pressure to Sea Level



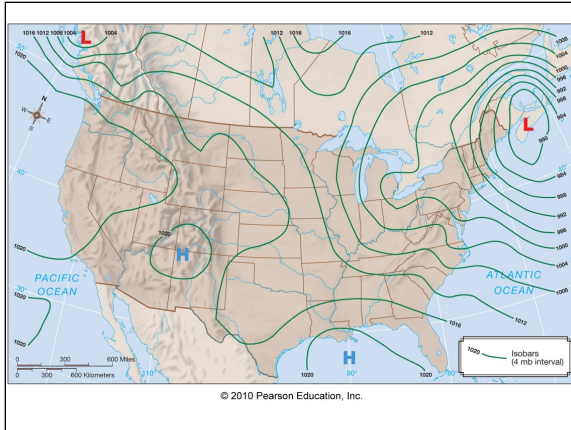
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### Charting Pressure



• **Isobars: lines connecting points of equal pressure**

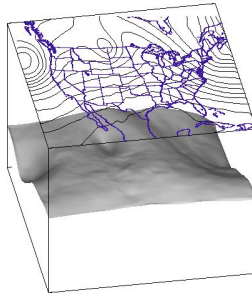
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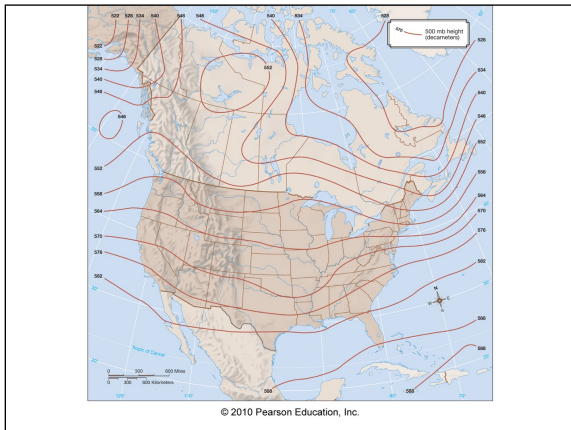
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## Heights of Pressure Surfaces

- **Pressure surface:** a surface where the atmospheric pressure is the same everywhere
- **Height contours:** lines connecting points of equal heights of some pressure surface

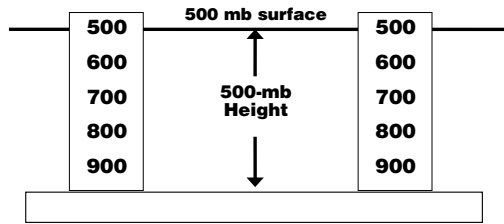


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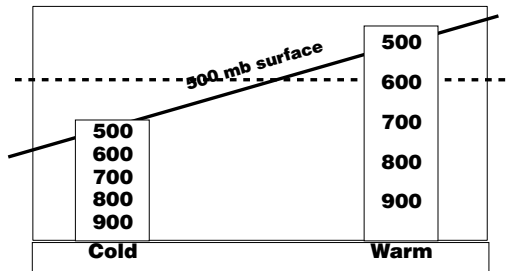
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### Pressures and Heights



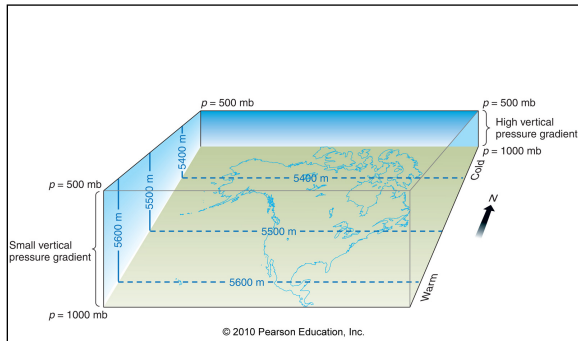
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### Pressures and Heights



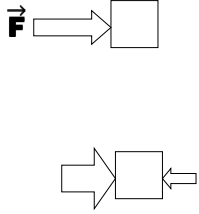
**Heights of pressure surfaces aloft are higher when the air is warmer.**

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## Forces

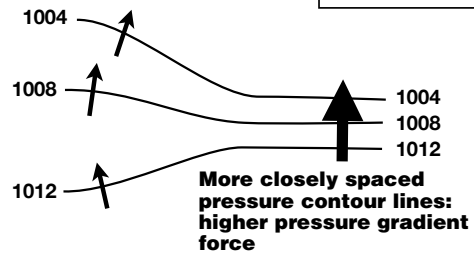


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## Pressure Gradient Force

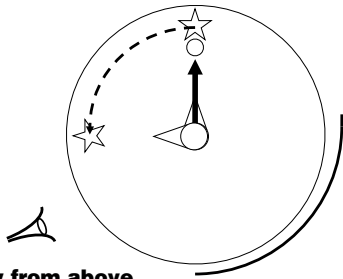
Pressure force is proportional to the difference in pressures

$$\text{PGF} \propto \frac{\Delta p}{d}$$



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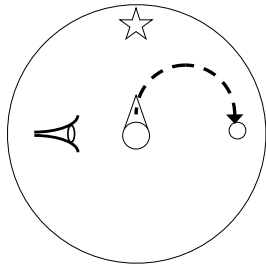
## Coriolis Force



View from above

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# Coriolis Force



View on turntable

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# Coriolis Force

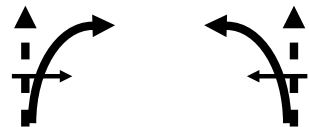
Coriolis force magnitude  $F_{cor} \propto$

Object's speed

Earth's rotation speed

Latitude

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



Northern Hemisphere

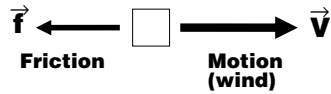


Southern Hemisphere

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## Friction

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

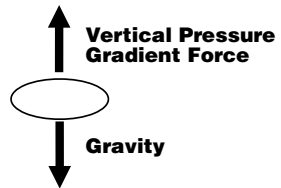


$$f \propto -V$$

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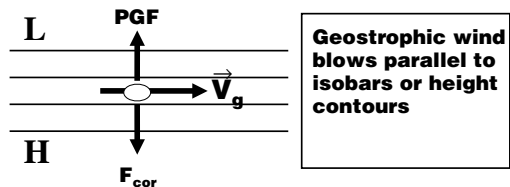
## Hydrostatic Balance

Balance of forces in the vertical direction



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## Geostrophic Balance



**Geostrophic balance: steady-state wind where the PGF is exactly balanced by the Coriolis force**

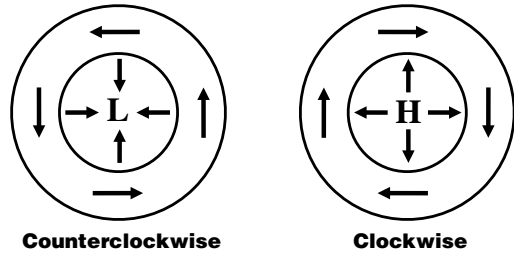
**Northern Hemisphere: lower pressure is to the left of the wind motion**

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## Circulation Around Highs and Lows

Northern Hemisphere



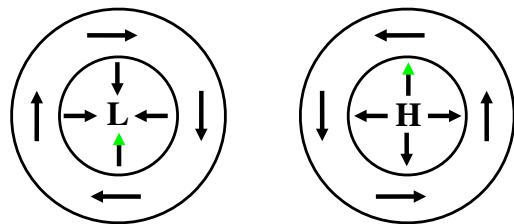
Counterclockwise

Clockwise

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## Circulation Around Highs and Lows

Southern Hemisphere



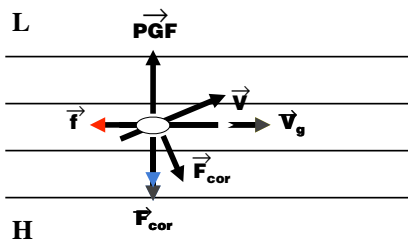
Clockwise

Counterclockwise

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## Surface Winds

—Add friction

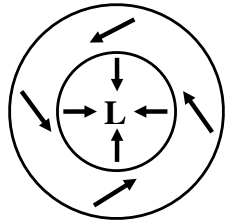


Surface winds blow at an angle to the isobars,  
turned slightly toward lower pressure

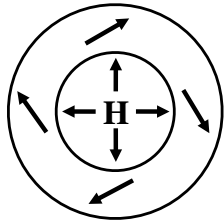
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## Circulation at the Surface

### Northern Hemisphere

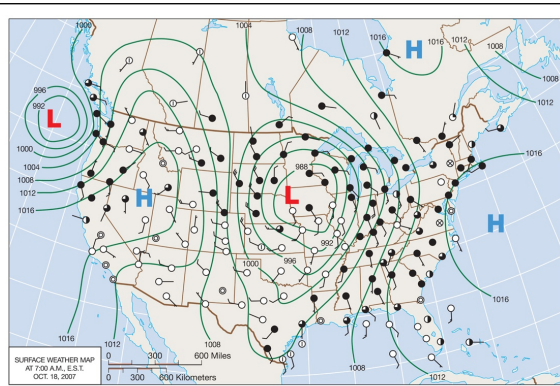


**Counterclockwise,  
spiral inward**



**Clockwise,  
spiral outward**

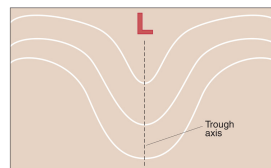
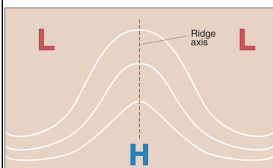
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## Ridges and Troughs

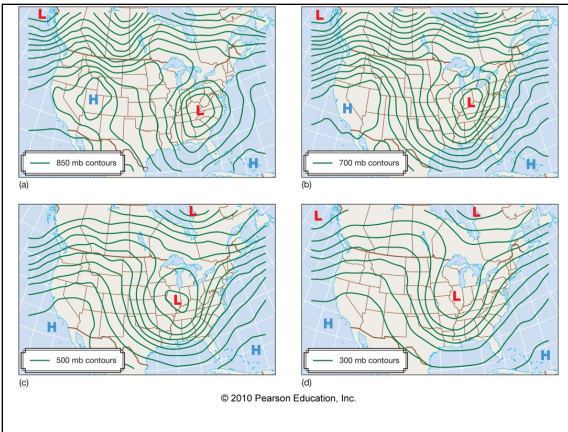


(a)

(b)

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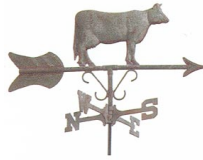
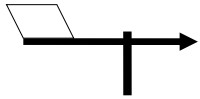
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## Wind Instruments

• **Direction: Wind Vane**



• **Speed: Anemometer**



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