

## Physical Geography Chapter 5: Atmospheric Pressure, Winds, Circulation Patterns

Torricelli – 1643- first Mercury barometer  
(76 cm, 29.92 in) – measures response to pressure

Pressure – millibars- 1013.2 mb, will cause Hg to rise in tube

*Unequal heating of Earth's surface is responsible for differences in pressure to!*

### Variations in Atmospheric Pressure

1. Vertical Variations – increase in elevation, less air pressure  
Mt. Everest – 8848 m (or 29, 028 ft) – 1/3 pressure
2. Horizontal Variations
  - a. Thermal (determined by T)  
Warm air is less dense – it rises away from the surface at the equator
  - b. Dynamic: Air from the tropics moves northward and then to the east due to the Coriolis Effect. It collects at this latitude, increasing pressure at the surface.

### Basic Pressure Systems

1. Low – cyclone – converging air pressure decreases
2. High – anticyclone – Diverging air pressure increases

### Wind

Isobars- line of equal pressure

Pressure Gradient - significant difference in pressure

Wind- horizontal movement of air in response to differences in pressure

- Responsible for moving heat toward poles
- 38° Lat and lower: radiation surplus

If Earth did not rotate, and if there was no friction between moving air and the Earth's surface, the air would flow in a straight line from areas of higher pressure to areas of low pressure.

Of course, this is not true, the Earth rotates and friction exists: and wind is controlled by three major factors:

- 1) PGF- Pressure is measured by barometer
- 2) Coriolis Effect
- 3) Friction

#### *1) Pressure Gradient Force (PGF)*

Pressure differences create wind, and the greater these differences, the greater the wind speed.

Differences can be seen in isobars- lines that connect places of equal air pressure (fig. 16.3)

The (PGF) is the driving force of wind, and it has both magnitude and direction.

Magnitude is determined from the spacing of the isobars.

The direction of the force is always from areas of higher pressure to areas of lower pressure and at right angles to the isobars.

Once the air starts to move, friction and Coriolis come into play. Friction and Coriolis only modify movement, and do not produce it.

2) *Coriolis Effect*: All free moving objects or fluids, including the wind are deflected to the right of their path of motion in the northern hemisphere and to the left in the southern hemisphere.

The Earth rotates @  $15^\circ$  each hour.

-A rocket will veer to the right of a target

The shift in wind direction attributed to the Coriolis Effect is:

- a) Always directed at right angles to the direction of air flow
- b) Affects only wind direction, not wind speed
- c) Is affected by wind speed (stronger the wind, the greater the deflection)
- d) Strongest at the poles and weakens equatorward, and becomes non existent at the equator.

3) *Friction with Earths surface*

- the frictional effect on wind is important only within the first few kilometers from earths surface

At upper levels in the atmosphere, friction is nonexistent and the remaining forces balance to produce the actual wind direction.

### **PGF**

These winds are called geostrophic winds. Since there is no friction they tend to travel at higher speeds than surface winds  
ex: jet streams

### **COR**

At lower levels in the atmosphere, friction plays an important part. The cause of friction is topography (terrain), the end result is:

### **PGF**

Friction lowers wind speed thereby reducing the Coriolis effect. Because the PGF is not affected by wind speed, it wins the tug of war shown here.

### **FRI**

### **COR**

## Wind Terminology

- winds are named after their source
- windward refers to the direction from which the wind blows
- Leeward – refers to the direction toward which the wind is blowing

Prevailing wind – most dominant wind direction

Cyclone

Anticyclones

## Sub-Global Surface Wind Systems

### 1. Local Winds- smallest scale

- a. Land Breeze – Sea Breeze: diurnal cycle in which the differential heating of land and water again plays a role.

- b. Mountain Breeze – Valley Breeze

- c. Drainage Winds (Also known as Katabatic Winds)

- Are local to mountainous regions and can occur only under calm clear conditions
- Cold dense air flows downward – going through passes down to the valley below

- d. Chinook – type winds (snow enters)  
(Föhn [Foehn] in the Alps)

- Originate elsewhere but must pass over a mountain range. As the winds flow down the leeward side after crossing the mountains, the air is compressed and heated at a greater rate

Santa Ana of Southern Cal

Nortorious for helping – forest fires

## 2. Medium Size (Continental): Monsoon Winds

Mausim – meaning season

Air moves away  
From SE Asia

Low develops  
air moves toward  
Low and rises

Winter

Summer

Winds often shift in the exact opposite direction

## **Global Pressure Belts**

Idealized Global pressure Belts

Equator- Low or Trough – due to temperature – causes air to rise

Horse Latitudes- 30° N/ 30°S – Subtropical High – sinking of air cells related to equatorial low

Subpolar – Lows – P decreases until in 65° Lat

Polar Highs in the Polar Region

## The Global Pattern of ATM Pressure

Landmasses disturb these idealized sequences

- Heat up at different rates, affect movement of air via topography
- Pressure belts shift with the migrations of the noon sun angle (between the tropic of cancer and Capricorn)

*Seasonal Variations*

January

High Pressures in Siberia and N.A. (Canadian Hi)  
(Land cools off)                      Polar Hi

**Fig 5.13A**

Low Pressures over water – Iceland, Aleutians

Southern Hem- 3 Hi's in the ocean  
Big Low over Antarctica

July

Hi's become lows in Asia – 2 divided by Himalayas

Hi Pressures in oceans

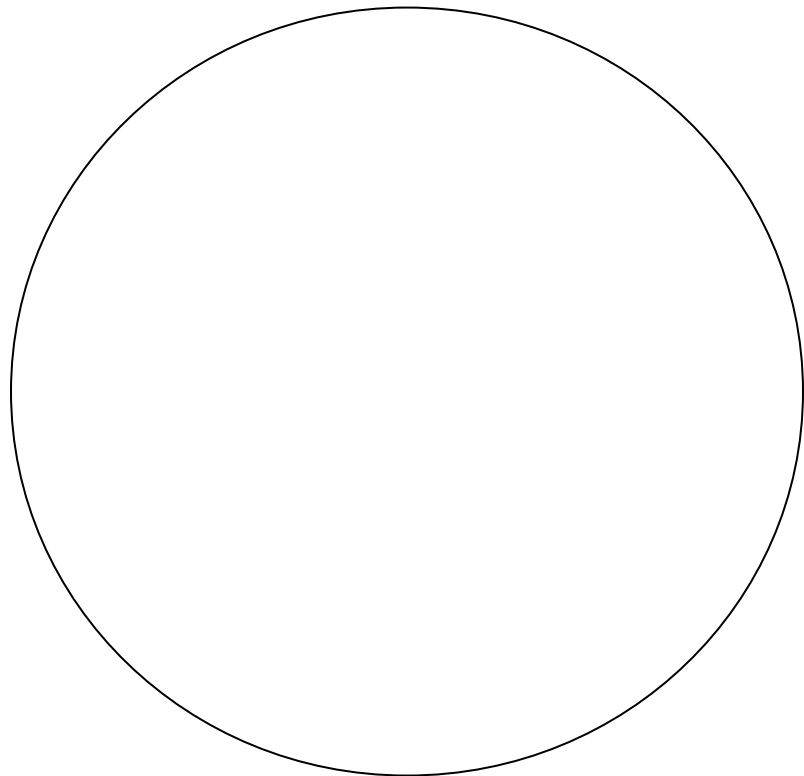
Northern Hi: One in each ocean    Pacific, Bermuda/ Azores

Southern Hi: One in all 3 Oceans

The position migrates with the noon sun angle

Global Surface Wind System

Air diverges from zones of High Pressure and converges on areas of low pressure



Tradewinds-  $5^{\circ}$  -  $25^{\circ}$  Latitude  
Also known as Tropical Easterlies  
Source is subtropical Highs

Doldrums -  $5^{\circ}$  S to  $5^{\circ}$  N  
Also called ITCZ  
Heaviest Precipitation, most cloud cover

Subtropical High -  $25^{\circ}$  to  $35^{\circ}$  N  
Horse Latitudes – eat em' or toss em'  
Strongest in eastern portion of oceans

Westerlies -  $35^{\circ}$  -  $65^{\circ}$  N/S  
Associated with stronger weather  
Stronger in Southern Hemisphere (less land)

Polar Winds – Accurate measurements are sparse  
Poles are consistently hi

Polar Front- Front (army front)  
Polar Easterlies vs Westerlies  
Very stormy

These areas migrate with the noon sun angle northward and southward

- Boundary Zones are affected most
- $5^{\circ}$  to  $15^{\circ}$  Wet vs. Dry **Fig 5.15**
- $30^{\circ}$  -  $40^{\circ}$  Sub tropical Hi vs. Westerlies] we are here windy storms

Upper Air Winds Westerlies  $15^{\circ}$  to  $20^{\circ}$  to pole  
Faster moving – especially in winter

Upper Air Easterlies  $15/20^{\circ}$  North and South

Jet Streams – very strong currents within Upper Air Westerlies  
Polar Front Jet Stream:  $50-70^{\circ}$   
Sub tropical Jet Stream:  $\sim 30^{\circ}$

Like the upper air Westerlies, both Jets are best developed in the winter

Rossby Waves – Long waves- result from cold air pushing into lower latitudes (forming troughs of Low P), while warm tropical air moves into higher latitudes forming ridges of high pressure **Fig 5.21**

Causes?: variation in ocean surface Temp (ENSO)

Jet stream Study: Good to fly in  
Can carry Pollutants – Mt. St. Helens ash

## Ocean Currents

Gyres- broad circulatory patterns

## Ocean currents

Coastal Upwelling – as with CA current

- make handout

## El Nino

- last for 2 months
- 50 years – 10 El Ninos
- Southern Oscillation ( Sir Albert Walker)
  - Hi P east, Lo P West (typical)  
Enhances flow from Hi P to Low P  
Warm water in Western Pacific
- El Nino Hi P west, Lo P east  
Warm water collects along eastern Pacific
- La Nina- strong Trade winds  
Higher P east, Lower P west  
More upwelling in cold currents (Peru/ Humboldt, CA)

## El Nino History

- >16<sup>th</sup> Century- every 6 years
- >Now – every 2 ½
- >1982-83 worse one, than 97-98

## Now North Atlantic Oscillation – NAO

Solar Radiation → Atmosphere → Hydrosphere → Back to Atmosphere

Feedback