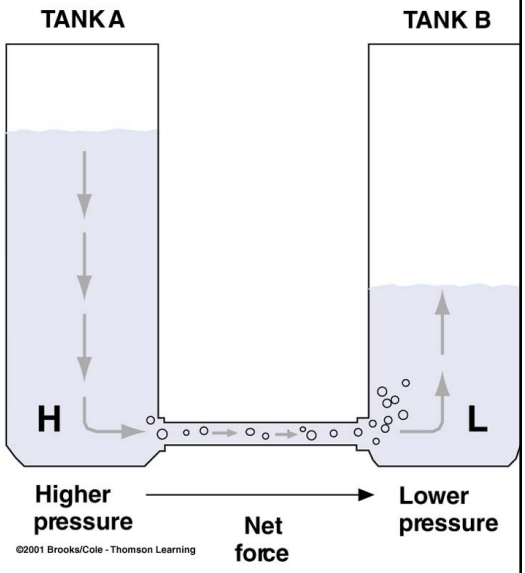
Winds

Wind is horizontal movement of the air or other word air in motion.

Forces affecting winds

1. Pressure gradient force
   a. High pressure flows to low pressure
   b. Pressure gradient = difference in pressure / distance

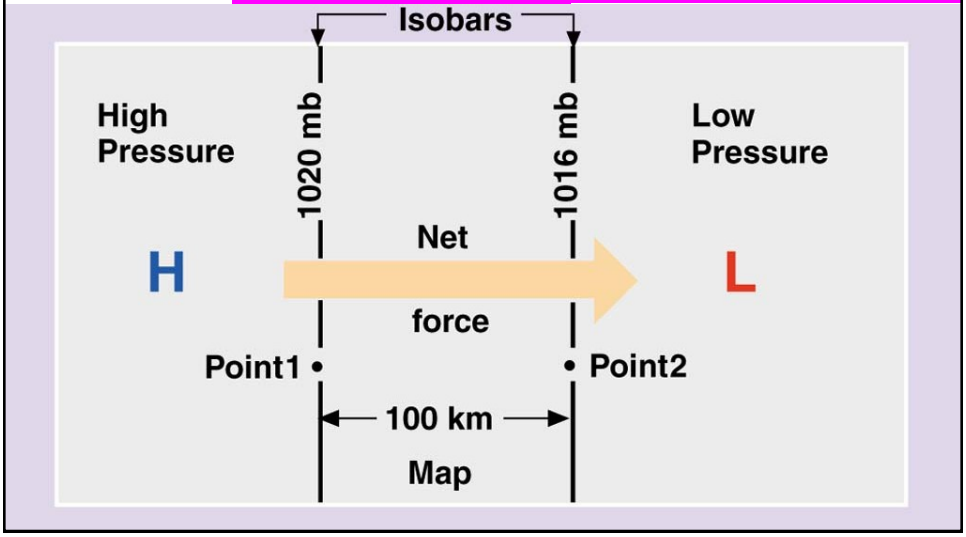


Factors Affecting Winds (PGF)

Pressure Gradient

$$PGF = -\frac{1}{\rho} * \frac{\Delta P}{\Delta X}$$

PGF= Pressure Gradient Force
ΔP= Change in Pressure
Δx= Change in Distance



Factors Affecting Winds (CF)

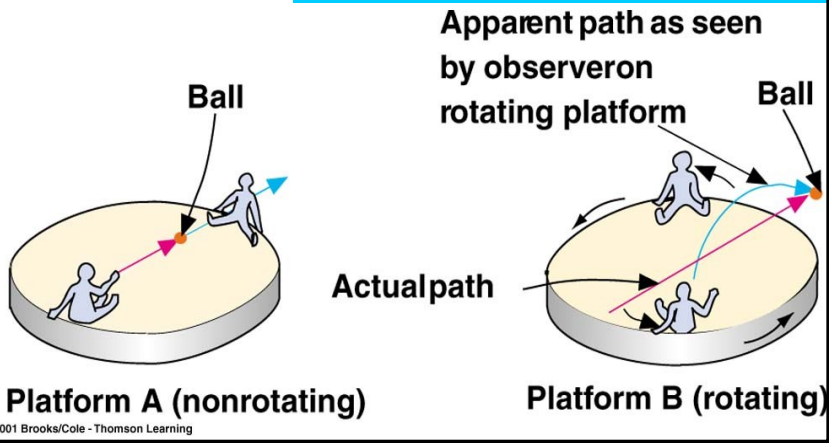
2. Coriolis force

$$CF = (2\omega \sin\theta)V$$

a. **Rotation of Earth**
b. **Latitude**
c. **Object's speed**

ω= angular velocity of spin (degree/hour)
θ= Latitude of the region
V= velocity of mass

$$\omega = \frac{360}{24} = 15^0\, ha^{-1} or \frac{2\pi}{24} = 0.26 rad/ha = 7.28x10^{-5} rad/\sec$$



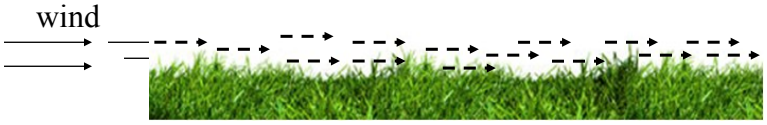
Factors Affecting Winds (FF)

3. Friction – Frictional force is the effect in fluids due the molecular property called *viscosity*. The surface layer of earth surface is not smooth and exert some resistance on the moving body (fluids like liquids or air) up to 1 km above surface

Surface Winds

A. Friction layer slows winds
B. Reduces Coriolis effect

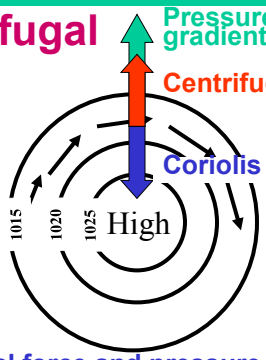
Frictional force is equal to shearing stress and can be calculated as
$\tau = \eta du/dz$



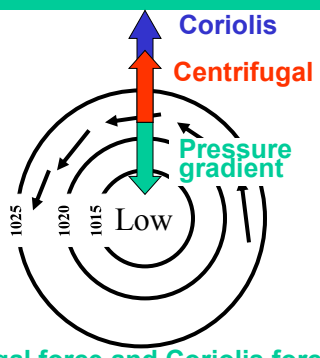
Frictional effect on object moving over rough surface

Factors Affecting Winds (CFF)

Centrifugal Force



Centrifugal force and pressure gradient force is balanced with Coriolis force



Centrifugal force and Coriolis force is balanced with pressure gradient force

4. Centrifugal Force: Moving object in curved path develop Centrifugal force which is equal to Centripetal acceleration (force). In high pressure system centripetal component is generated by the coriolis force, while in the low pressure system pressure gradient force act as centripetal force.

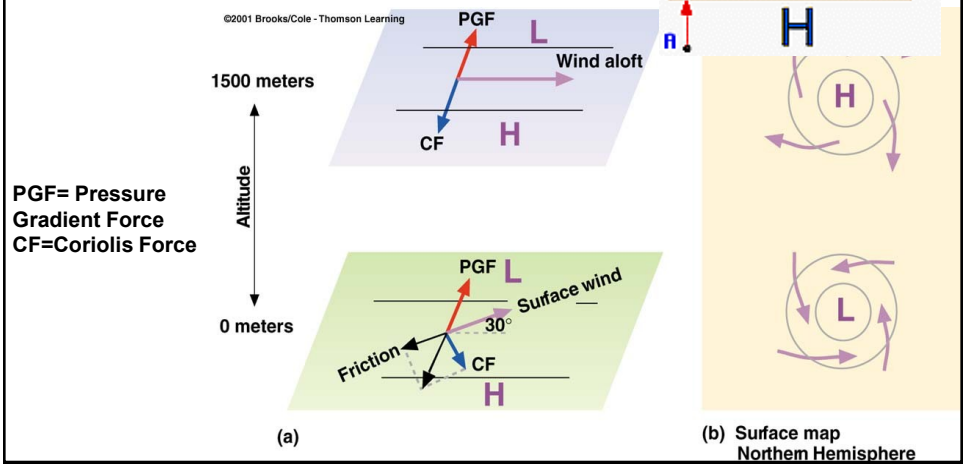
Type of winds

1. **Geostrophic wind:** When isobars are straight and parallel and there is balance between coriolis force and pressure gradient force. The wind blow parallel to isobars with low pressure on the left and high pressure on the right if you stand with your back to the wind in the northern hemisphere. It would be just reverse in southern hemisphere.
2. **Gradient wind:** When there is balance of three forces viz pressure gradient, Coriolis and Centifugal Force occur around a low pressure centre. The wind that results from a balance of three forces is known as the gradient wind.
3. **Surface wind:** The surface wind represents a balance between the pressure gradient force and friction parallel to the air motion and between the pressure gradient and the Coriolis force perpendicular to the air motion.

Wind in Northern Hemisphere

Northern hemisphere

1. Counterclockwise into low
2. Clockwise out of high



Beaufort Scale

Beaufort number	Wind Speed (mph)	Seaman's term		Effects on Land
0	Under 1	Calm		Calm; smoke rises vertically.
1	1-3	Light Air		Smoke drift indicates wind direction; vanes do not move.
2	4-7	Light Breeze		Wind felt on face; leaves rustle; vanes begin to move.
3	8-12	Gentle Breeze		Leaves, small twigs in constant motion; light flags extended.
4	13-18	Moderate Breeze		Dust, leaves and loose paper raised up; small branches move.
5	19-24	Fresh Breeze		Small trees begin to sway.
6	25-31	Strong Breeze		Large branches of trees in motion; whistling heard in wires.
7	32-38	Moderate Gale		Whole trees in motion; resistance felt in walking against the wind.
8	39-46	Fresh Gale		Twigs and small branches broken off trees.
9	47-54	Strong Gale		Slight structural damage occurs; slate blown from roofs.
10	55-63	Whole Gale		Seldom experienced on land; trees broken; structural damage occurs.
11	64-72	Storm		Very rarely experienced on land; usually with widespread damage.
12	73 or higher	Hurricane Force		Violence and destruction.

The scale was devised in 1805 by Francis Beaufort (later Rear Admiral Sir Francis Beaufort), an Irish Royal Navy officer,

Beaufort Scale

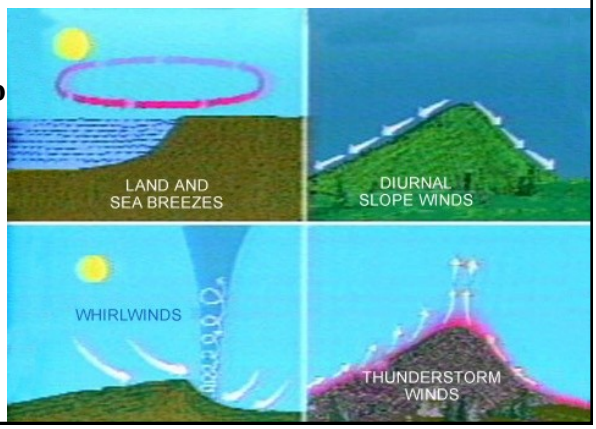
BEAUFORT NUMBER	WIND	SYMBOL	WIND SPEED (MPH)
0	calm		less than 1
1	light air		1-3
2	slight breeze		4-7
3	gentle breeze		8-12
4	moderate breeze		13-18
5	fresh breeze		19-24
6	strong breeze		25-31
7	moderate gale		32-38
8	fresh gale		39-46
9	strong gale		47-54
10	whole gale		55-63
11	storm		64-75
12	hurricane		more than 75

Local Winds

Local winds are small scale convective winds of local origin caused by temperature differences. Local terrain has a very strong influence on local winds, and the more varied the terrain, the greater the influence. **Convective winds** are all winds - up, down, or horizontal - that develop as a result of local temperature differences.

Why Local Winds Develop

- Convection from daytime heating.
- Unequal heating and cooling of the surface.
- Gravity, including downdrafts



Local winds

Land and Sea Breezes

Land surfaces becomes warmer than water surfaces during the daytime due to heat capacity that causes local-scale temperature and pressure difference, a sea breeze begins to flow inland from over the water, forcing the warm air over the land to rise and to cool adiabatically. This air flows seaward aloft and completes the circulation cell. The surface sea breeze begins around midmorning, strengthens during the day, and ends around sunset.

The land breeze at night is the reverse of the daytime sea breeze circulation. At night, land surfaces cool more quickly than water surfaces. Air in contact with the land becomes cooler than air over adjacent water. Again, a difference in air pressure develops over the land and the water causing air to flow from the land to the water. The air must be replaced, but return flow aloft is likely to be weak and diffuse and is diminished in the prevailing general winds. The land breeze begins 2 to 3 hours after sunset and usually ends shortly after sunrise

Local winds

Slope winds are local diurnal winds present on all sloping surfaces. They flow upslope during the day as the result of surface heating, and downslope at night because of surface cooling and gravity. Slope winds are produced by the local pressure gradient caused by the difference in temperature between air near the slope and air at the same elevation away from the slope. The layer of warm air is-turbulent, increasing in depth as it progresses up the slope. This process continues as long as the slope is receiving solar radiation. When the slope becomes shaded or night comes, the process is reversed. A short transition period occurs as a slope goes into shadow: the upslope winds die, there is a period of relative calm, and then a gentle, smooth downslope flow begins. Downslope winds are very shallow. The cooled denser air is stable, and the downslope flow tends to be quite smooth and slower than upslope winds. The principal force here is gravity. Downslope winds usually continue throughout the night until morning. Up valley and down valley or mountain and valley winds are also example of temperature difference

Monsoon

Monsoon is traditionally defined as a seasonal reversing wind accompanied by corresponding changes in precipitation, but is now used to describe seasonal changes in atmospheric circulation and precipitation associated with the asymmetric heating of land and sea. The monsoon of South Asia is among several geographically distributed global monsoons. It affects the Indian subcontinent, where it is one of the oldest and most anticipated weather phenomena and an economically important pattern every year from June through September. Yet it is only partly understood and notoriously difficult to predict. Several theories have been proposed to explain the origin, process, strength, variability, distribution, and general vagaries of the monsoon, but understanding and predictability are still evolving.

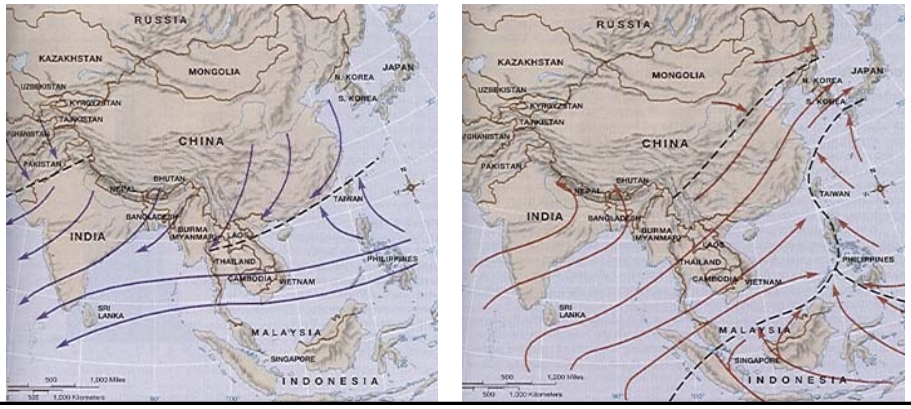
The unique geographical features of the Indian subcontinent, along with associated atmospheric, oceanic, and geophysical factors, influence the behavior of the monsoon. Because of its effect on agriculture, on flora and fauna, and on the climates of nations such as Nepal, India, Bangladesh, Bhutan, Pakistan, and Sri Lanka — among other economic, social, and environmental effects — the monsoon is one of the most anticipated, tracked, and studied weather phenomena in the region. It has a significant effect on the overall well-being of residents and has even been dubbed the "real finance minister of India

Monsoons

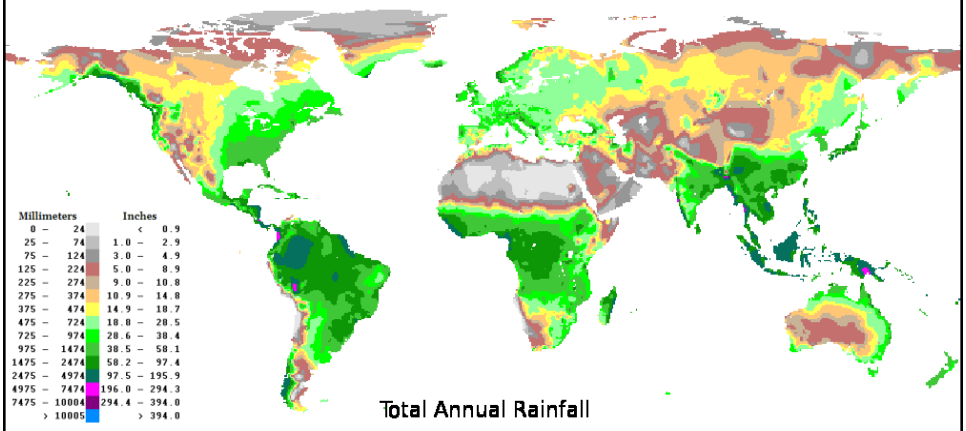
The monsoon of Asia, the seasonal reversal of winds that is dry in the winter and extremely wet in the summer.

Winter - Subtropical Jet Stream Maintains Offshore Air Flow
Hot, Dry on Continent

Summer - Heating of Continent Reverses Air Flow
Warm, Moist, Unstable Air From Indian Ocean
Large Amount of Precipitation Help by Orographic Lifting



World map


Millimeters
Inches
0 – 24 < 0.9
25 – 74 1.0 – 2.9
75 – 124 3.0 – 4.9
125 – 224 5.0 – 8.9
225 – 274 9.0 – 10.8
275 – 374 10.9 – 14.8
375 – 474 14.9 – 18.7
475 – 724 18.8 – 28.5
725 – 974 28.6 – 38.4
975 – 1474 38.5 – 58.1
1475 – 2474 58.2 – 97.4
2475 – 4974 97.5 – 195.9
4975 – 7474 196.0 – 294.3
7475 – 10004 294.4 – 394.0
> 10005 > 394.0
Total Annual Rainfall