AIR PRESSURE

-Air has weight. Air has a mixture of several gases.

Air pressure- Definition- It is the force exerted in all directions due to the weight of the air present above.

-Example to understand the Air Pressure- If a gas is kept in a closed vessel, its movement is restricted by the walls of the container, where it is kept and the gas dashes the walls of the container. Like this, our atmosphere can be considered as a container bounded by land and sea, where the air is not allowed to escape due to gravity. This creates Air Pressure.

-The amount of Air pressure in a place is determined by- **Temperature and Density.**

-The relation between Air, temperature and pressure is shown in the formula, called "**Gas Law**". Pressure= Density* Temperature*Constant. It means, the increase in density or temperature will affect air pressure, and the other factor remains constant.

-

AIR PRESSURE

-The air exerts a pressure of 1034 grams per square cm at the sea level.

-The air pressure is exerted on animals, rocks, plants etc… but man does not feel the weight of the atmosphere because, the air inside our body exerts the pressure that equals the outside pressure.

-Air pressure decreases with increasing altitude. So, in higher altitudes, the air pressure created in a man is disturbed, that results in dizziness, nausea, nose and ear bleeding.

-If the altitude increases, the atmosphere becomes thinner, molecules are more diffused, the inter molecular space increases, so the air pressure decreases.

Measurement of AIR PRESSURE

- -The Air pressure is measured by Mercurial Barometer, invented by Evangelista Torricelli in 1643.

-The standard sea level pressure is 1013.25 millibars at a temperature of 15^0C at a latitude of 45^0.

-The corrections applied to the actual pressure recorded in a particular station are- Elevation correction, Temperature correction, Latitude correction, Gravity correction, Instrumental correction.

-Air pressure recording instruments-

Aneroid Barometer,

Altimeter,

Barograph,

Micro barograph,

Micro barovario graph

PRESSURE GRADIENT

-Definition- The decrease of pressure between two points along a line perpendicular to the isobars divided by the distance between the points.

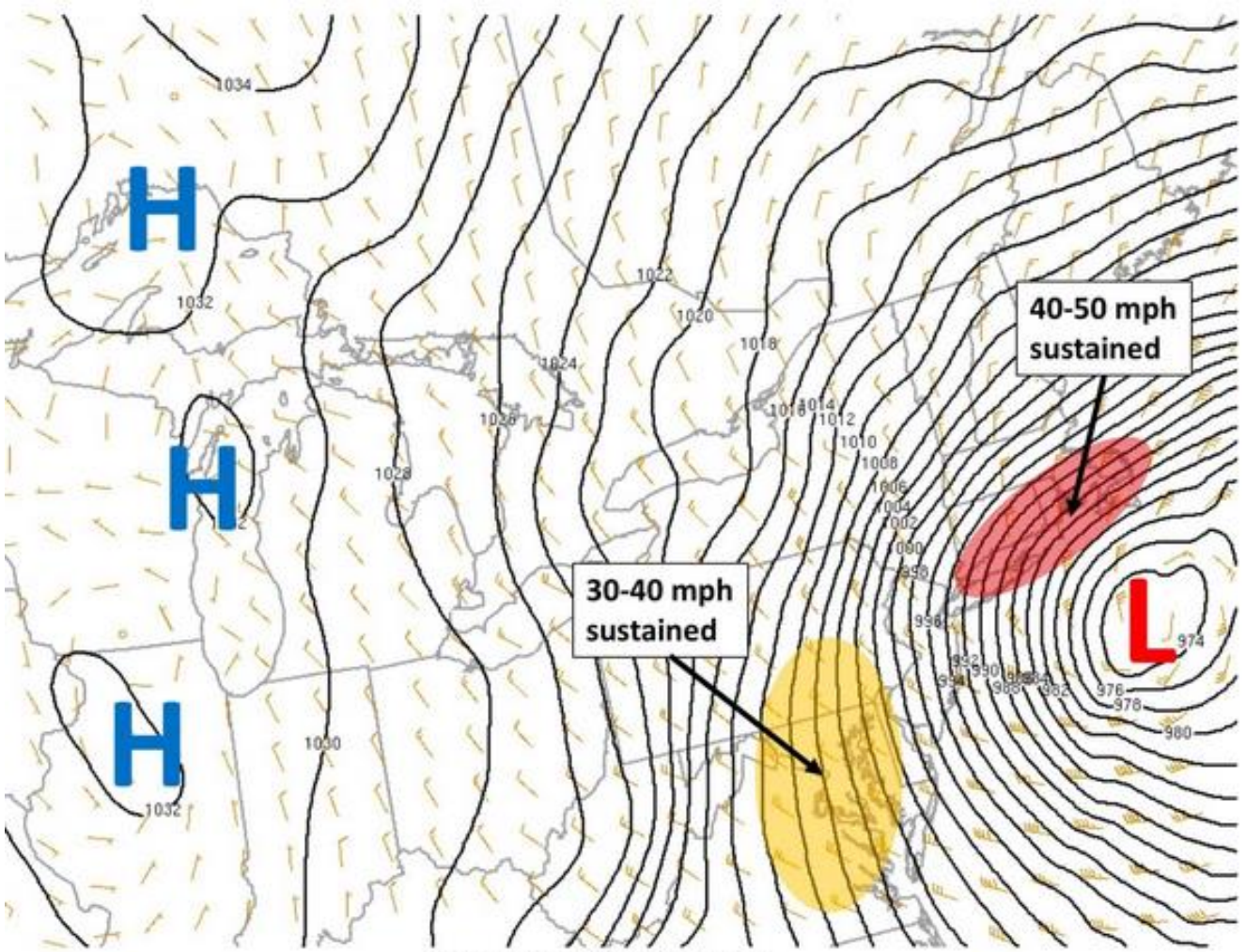
-Another definition- It is the rate of change of pressure per unit horizontal distance.

-Barometric Slope- Definition- The rate and the direction of change in air pressure. It is expressed in millibars per hundred kilometers.

-Isobars drawn closer shows a steep/ strong pressure gradient. It indicates a high velocity winds

-Isobars drawn far from each other shows a weak/light pressure gradient. It indicates a low velocity wind.

PRESSURE GRADIENT



180302/2000 MSL Pressure and surface wind

PRESSURE GRADIENT

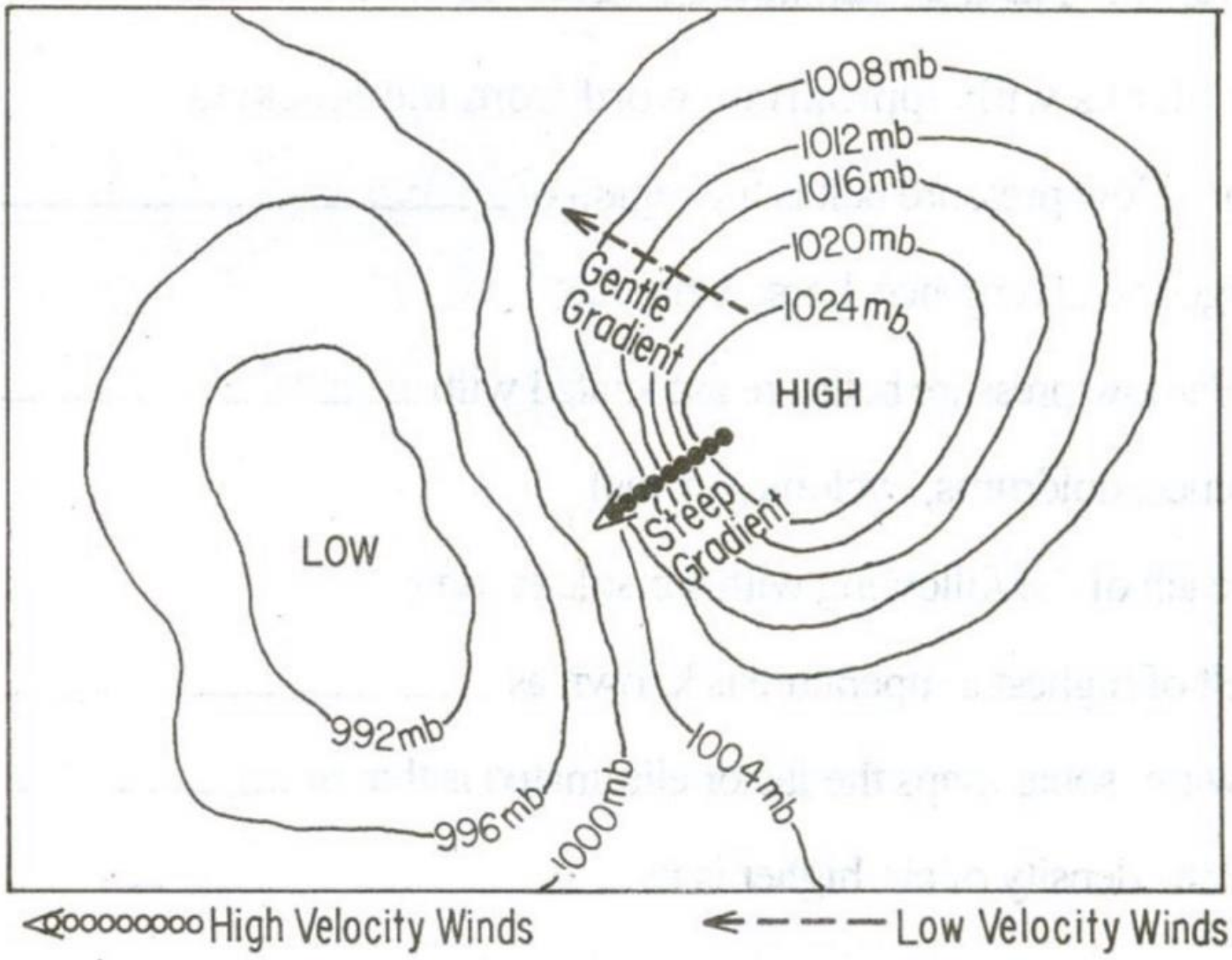


Fig. Relationship between Pressure Gradient and Winds

PRESSURE GRADIENT

Watch the video 1 – Instruments used to measure Air Pressure

https://www.youtube.com/watch?v=IWgs_TZKFfM

PRESSURE GRADIENT

Watch the video 2 – Instruments used to measure Air Pressure

https://www.youtube.com/watch?v=PGH0pN346dw

Seasonal Variations in Pressure Belts

The pressure belts vary in January and July. Let’s learn the variations in detail below:

Pressure Belt Variations in January

During January, the equatorial low-pressure belt shifts a little south of the mean equatorial position due to the apparent southward movement of the sun. As a result, all the other pressure belts shift southward.

The sub-polar low-pressure belt in the southern hemisphere does not develop any cells. In contrast, the sub-polar low-pressure belt in the northern hemisphere develops two cells called Iceland low and Aleutian low over the North Atlantic and North Pacific oceans, respectively.

Pressure Belt Variations in July

During July, the equatorial low-pressure belt shifts a little north of the mean equatorial position due to the apparent northward movement of the sun. As a result, all the other pressure belts shift northward.

The low cells (Iceland low and Aleutian low) developed over the oceans disappear; now, the landmasses develop low cells.

The sub-tropical high-pressure belt in the southern hemisphere becomes continuous, whereas the one in the northern hemisphere becomes discontinuous.

Factors affecting Wind Motion

Watch https://www.youtube.com/watch?v=WSG-3Umbqh8

•Pressure Gradient

The direction and magnitude of the pressure gradient determines wind direction and its velocity

The wind moves from high-pressure area to a low-pressure area

A closely spaced gradient implies a steep pressure change with strong wind speed and vice versa

The pressure gradient is weak where the isobars are distant and strong where the isobars are close by to each other.

The wind direction follows the direction of change of pressure, i.e. perpendicular to the isobars

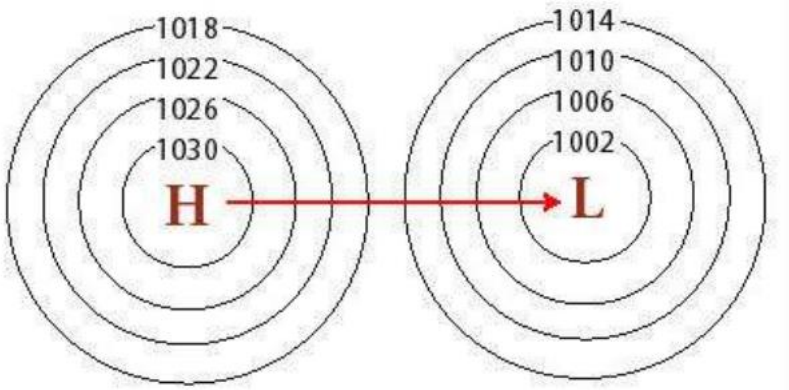


Fig: Flow of air produced by the pressure gradient force

Frictional forces

•slow down the wind movement and

•change the wind direction.

Over the ocean surface, the friction is minimum, so the air moves at low angles to the isobars and at a greater speed.

Over uneven terrain, there is high friction, air moves in high angles to the isobars and the speed gets retarded.

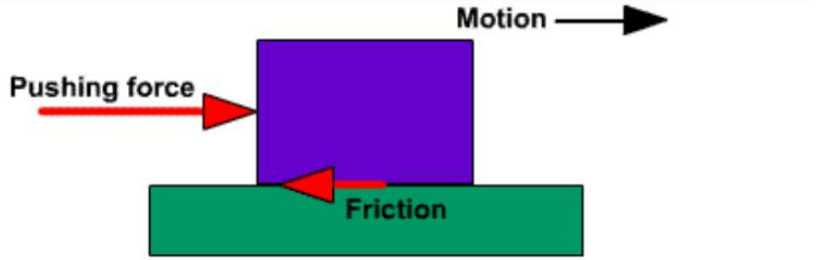
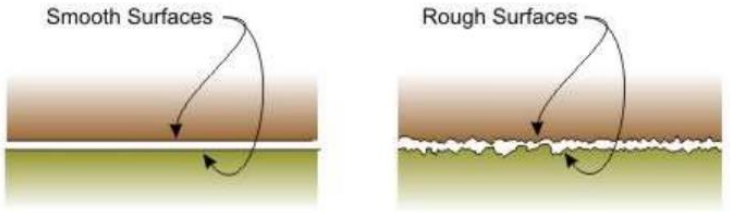


Fig.: A



Friction Force is affected by the smoothness of the surfaces

Fig.: B

- **Coriolis Force**

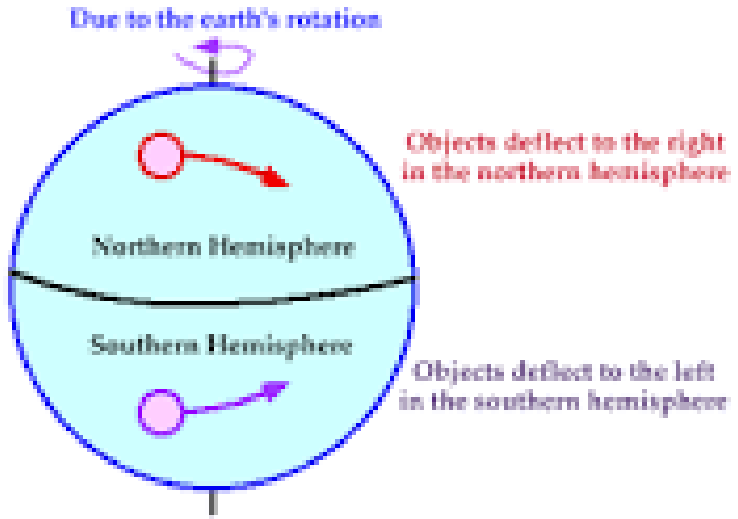
The rotation of the earth about its axis affects the direction of the wind and this force is called the Coriolis force.

It is directly proportional to the angle of latitude.

It deflects (bounce or turning other side) the wind to the left direction in the southern hemisphere and the right direction in the northern hemisphere

The deflection is more when the wind velocity is high.

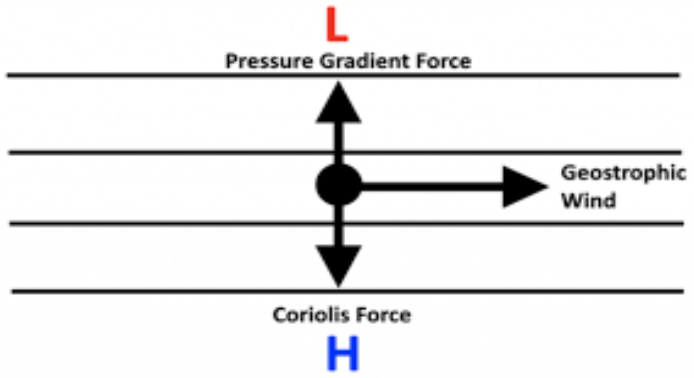
The Coriolis force is maximum at the poles and is absent at the equator.



What is Geostrophic Wind?

Geostrophic wind is the wind that is caused by two important effects in the earth's atmosphere. One of these, the **pressure gradient force**, is the force that occurs when air moves from areas of high pressure to areas of low pressure. The other, the **Coriolis effect**, is the diversion of the air in the Northern Hemisphere of the earth. The movement due to pressure, in a combination with this diversion, is called the geostrophic wind. This wind is also called the geostrophic flow. Both the Coriolis effect and the pressure gradient force will be discussed in more detail below.

While many researchers examine geostrophic winds as an actual phenomenon, many persist in believing that geostrophic winds are theoretical rather than real. The strength of geostrophic winds is affected by the Coriolis force. The direction of geostrophic winds is determined by the balance created by the pressure gradient force



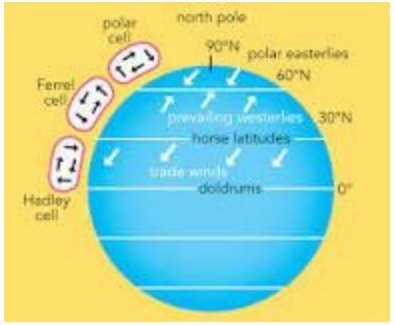
General circulation of Atmosphere
Surface wind
What is a surface wind?
Surface wind is the wind blowing near the Earth's surface. It is measured by an anemometer (speed) or wind vane (wind direction) at a standard height of 10 m above ground .

What are the three types of surface winds?

In other terms, they are also called primary winds or prevailing winds. They blow in the direction from high pressure to low pressure. The planetary wind is of three types namely, - the trade wind, the westerlies and the polar wind.

What are surface winds called?

Prevailing winds are the predominant surface winds in an area. Prevailing winds move in one direction. Winds that we feel and that interact with oceans are Earth's surface winds.



Winds are created by air molecules moving from areas of high pressure to low pressure. Surface winds are the ones that exist close to the Earth's surface and are measured at a height of 10 meters above the Earth's surface.

Why are surface winds important?
Surface winds drive the exchange of momentum between the atmosphere and ocean, producing ocean waves and provides a key forcing of the ocean circulation responsible for the global transport of important amounts of heat and carbon.

2. Latitudinal Shifting of Winds Belts

1.Due to the inclination of the earth's axis (23'/2°) and its annual revolution around the sun the sun's rays are sometimes vertical to the Tropic of Cancer, and sometimes to the Tropic of Capricorn.
2.When the sun shines vertically above the Tropic of Cancer, it is then summer solstice, and when it is vertical above the Tropic of Capricorn, it is winter solstice.
3.This results in the north-south displacement of temperature belts.
4. In different parts of the earth, the magnitude of the displacement of wind belts is not the same.
5.Over the oceans the amount of displacement is relatively smaller than over the continents.
6.The migration of wind belts is always one or two months behind the sun. This is called the time lang, which is more over the oceans than over the land.
7. The first region lying between latitudes **5° to 15°** experiences two types of climatic conditions during a year. In summer, of this region lies in the equatorial trough of low pressure and the intertropical convergence zone with abundant precipitation.
But during the winter season, the region comes under the influence of dry winds.
8.In the second region in both the hemispheres lies between latitudes **30° to 40°,** during the summer, this region has calm and warm, and the skies are almost cloudless.
But in winter the region experiences the stormy cyclones and fronts which produce fairly large amount of winter precipitation.
9.The third region, **60° to 70°** This region experiences the outbursts of cold polar air in winter. And during the summer months it receives stormy westerlies.

3. Jet Stream (Boys Presentation)

4. Local Winds (Girls Presentation)

JET STREAM :
Tamil
https://www.youtube.com/watch?v=_v-uyO7Av7I

https://www.youtube.com/watch?v=3Q8tWiyRKwI

English
https://www.youtube.com/watch?v=o203JXAnSA0

https://www.youtube.com/watch?v=Lg91eowtfbw

JET STREAM :

A Japanese meteorologist named Wasaburo Oishi first discovered a jet stream in the 1920s.

An expert in meteorology, Oishi founded Japan’s first upper-air observatory and focused his research on the happenings of the upper atmosphere.

At the forefront of his field, Oishi long held suspicions of a strong and extremely fast-moving air current that flowed from east to west.

After launching numerous weather balloons near Mount Fuji, he proved his theory right; this fast-flowing river of high-altitude currents rapidly sped his balloons east.

In a book, he described it as “a strong wind in the upper air.”

Some of these balloons ended up in the United States.

During second world war, the American bomber pilots tried to fly towards Japan at an altitude of 13000 meters.

-They saw string head winds which greatly reduced their ground speed.

But, while returning back to their base in the East, they found that the speed is faster.

- These Upper level fast winds are later named as Jet Streams.
-

JET STREAM :

Definitions

-Jet streams are relatively narrow bands of strong wind in the upper levels of the atmosphere, typically occurring around 30,000 feet (9,100 meters) in elevation.

"The jet stream is a strong narrow current concentrated along a quasi-horizontal axis in the upper troposphere or in the stratosphere characterized by strong vertical and lateral wind shears and featuring one or more velocity maxima. This speed of the wind must be greater than 60 knots" (Chakraborty, 2018).

-Mostly, the jet stream blow from west to east
-But also shifts north and south when it blow between hot and cold air.
-According to Trewartha, Jet streams are narrow bands of stronger winds bounded by slow moving air

JET STREAM :

-It is an air current blowing as a tube , thousands of Kms in length, few Kms in width, and 2 or more Kms in thickness

-Westerly Jet streams occur at the elevation from 9000-12000 meters in low middle latitudes. In these latitudes, Jet streams are in WAVY pattern

-But they blow at the lower height, in the higher altitude, like 60^0

- -During Colder season, Jet stream migrates towards Equator, with higher velocity.

-In summer, its speed decreases

-The mean velocity of jet stream is 144 km per hour

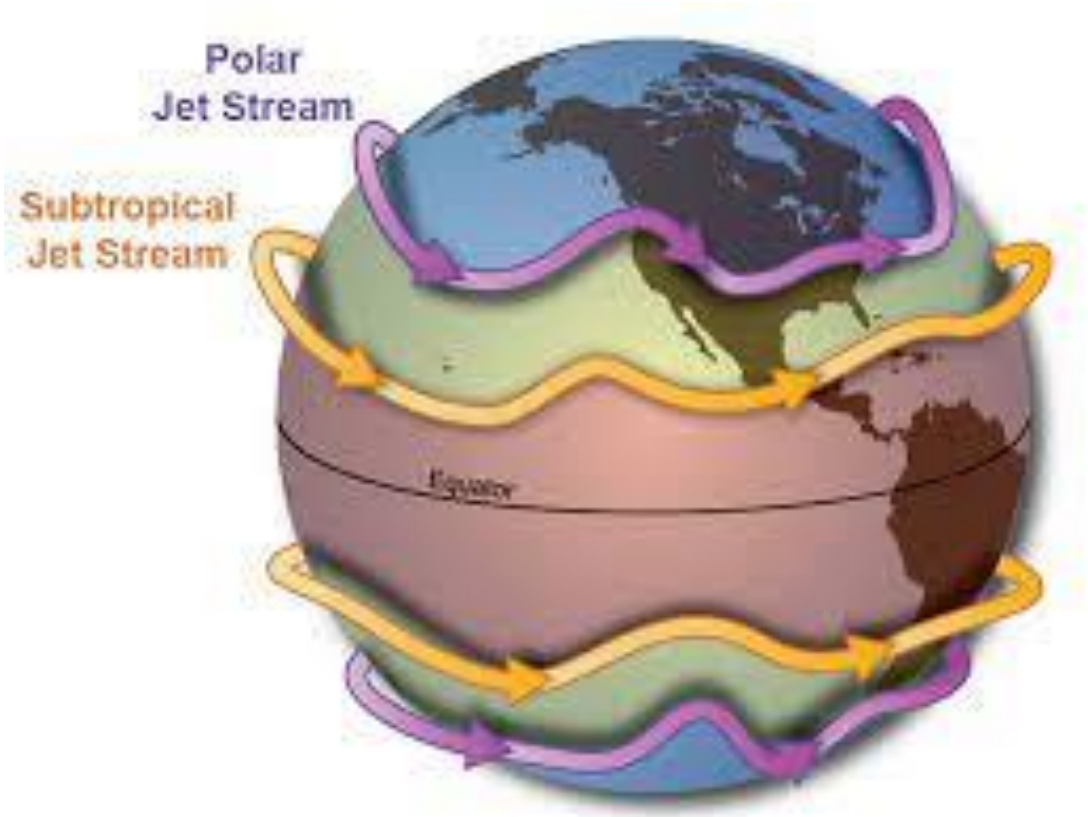
-During cold season, its speed is 160-240 km per hour

- The speed in the inner core of jet stream is 480 km per hour.

MAJOR FEATURESOF JET STREAM :

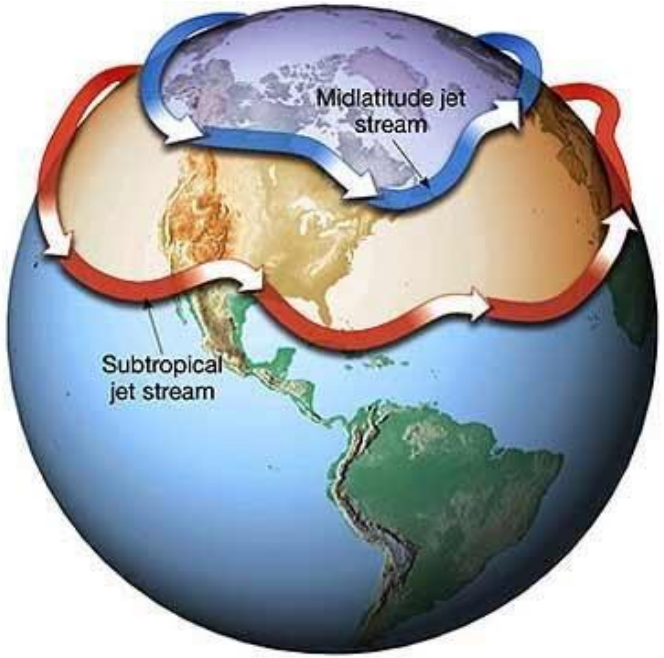
1. The circulation of the jet stream remains confined between 7.5 km to 14 km in the upper troposphere.
2. The width of the jet stream is about a few hundred kms, length of about a few thousand kms and 2-4 km of depth (Singh, 2007).
3. Jet streams can be seen between the poles and 20° latitudes in both the hemispheres. They are also called circumpolar whirl as they move around the poles in both the hemispheres (Chakraborty, 2018) (Singh, 2007).
4. The velocity of the jet stream during winter season becomes twice to that of the velocity during summer season.
5. During winter, the jet stream extends up to 20° latitudes while during summer they narrow down and remains confined to the poles.
6. The vertical shear of the jet stream is about 18-36 km/hour while the lateral wind shear is about 18 km/hr. Maximum velocity of the jet stream can be as high as 480 km/hr.

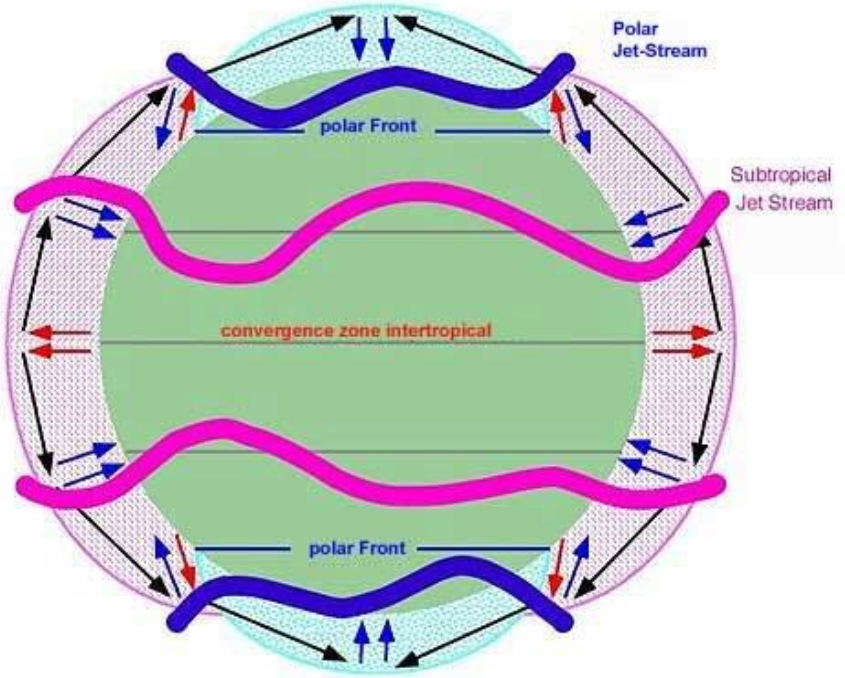
JET STREAM



- The jet stream at the higher altitude is called as **Polar-Front Jet**.
- -The jet stream at the lower altitude is called as **Subtropical Jet**.
- -These meanders share are so large, that the entire globe can be covered with 7 waves
- -Their size and extent varies in different places
- -They will become weak finally

JET STREAM


Midlatitude jet stream
Subtropical jet stream


Polar Jet-Stream
polar Front
Subtropical Jet Stream
convergence zone intertropical
polar Front

TYPES OFJET STREAM :

1. **Westerly Jet Stream-** They move from west to east and act as primary controlling factors for Indian Monsoon mechanism. They can be seen in the upper troposphere in a regular manner. Meteorologists have opined that rotation of the earth, Coriolis force and differential heating and temperature contrasts are responsible for the origin of this sub-tropical jet streams (Chakraborty, 2018).

2. **Tropical Easterly Jet stream-** These branch of jet stream blows from east to west in the upper troposphere between 5° to 20° latitudes. They are formed due to intense heating up of the Tibetan plateau and are seen established over India and Africa (Chakraborty, 2018).

3. **Polar Front jet stream-** It moves from east to west in the polar cell and is the product of temperature difference between the poles and the tropical region

TYPES OF JET STREAM

The period of transformation of the straight path of the jet stream into wavy and meandering path is called the index cycle and it is completed in four stages.

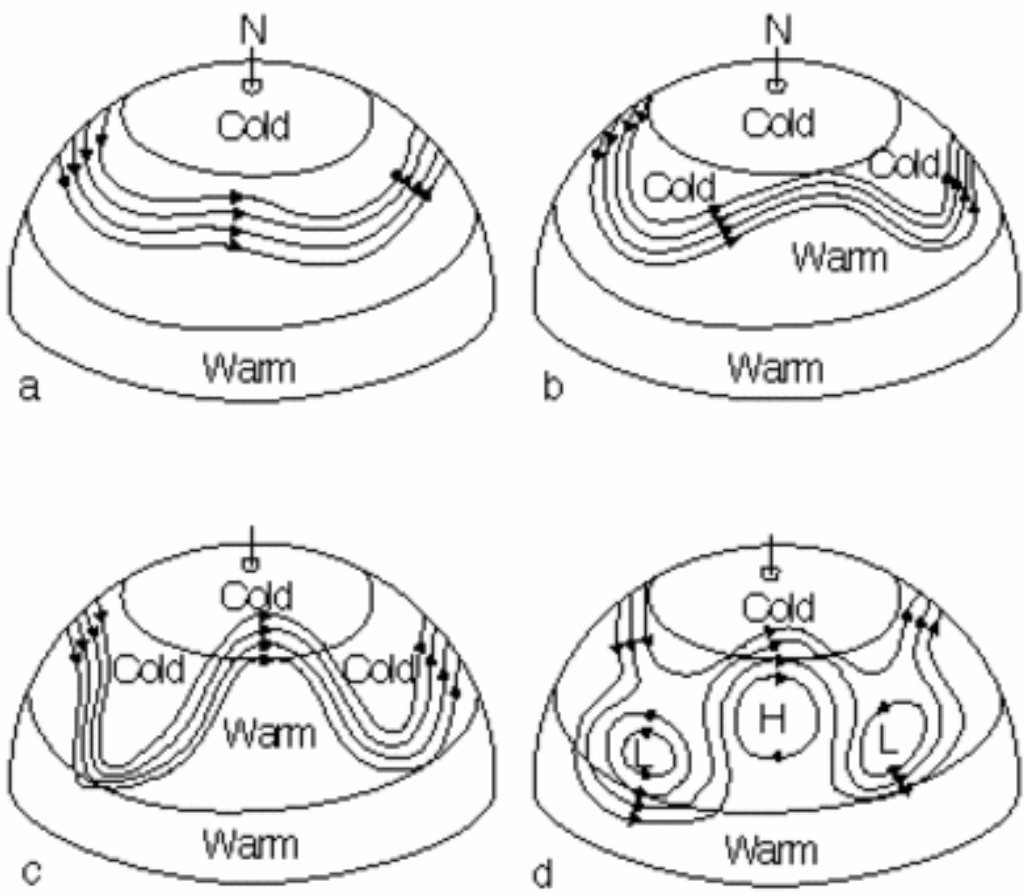
In the **First Stage** (A), the jet stream is positioned near the poles and it is bounded by polar cold air mass in the north and warm westerlies in the south. The path is straight.

In the **Second Stage** (B), the straight path gradually gets wavy and meandering leading to the formation of the Rossby Waves With the passage of time, the jet stream increases its amplitude and extend towards the equator. The pressure gradient is north-south.

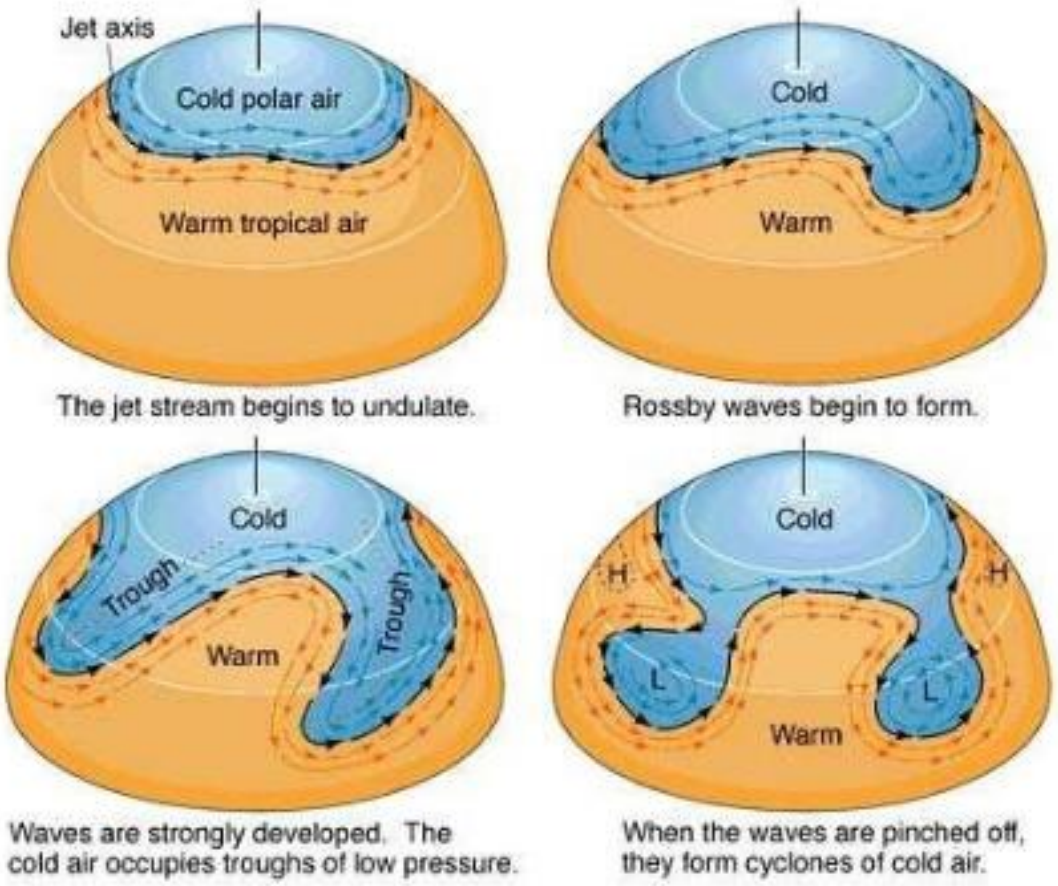
In the **Third Stage** (C), the jet stream fully becomes meandering and is positioned near the equator. Now the pressure gradient is eastwest. There is displacement of topical air mass to poles and polar air mass to tropical areas.

The **Fourth Stage** (D) is featured by cutting off of the meanders of jet stream from the main path due to very high meandering circulation and it gives rise to several cellular circulation of cyclonic and anti-cyclonic pattern

TYPES OF JET STREAM



TYPES OF JET STREAM



LOCAL WINDS

Definition- The smaller scale winds produced by changes in local climatic factors.

Facts-

-They are different from large macro scale global circulation winds.
-Their influence is limited, only in the local area.
-They influence the local weather conditions.
-Their vertical extension is only for few thousand kilometers.
-They have individual characters.
-They have different names in different places.
-

CATEGORIES OF LOCAL WINDS

Take a walk along a dry beach on a hot early afternoon.
No sooner than putting your barefoot in the sand, you start hopping and jumping and immediately run towards the sea to soak your scorching feet in the water.

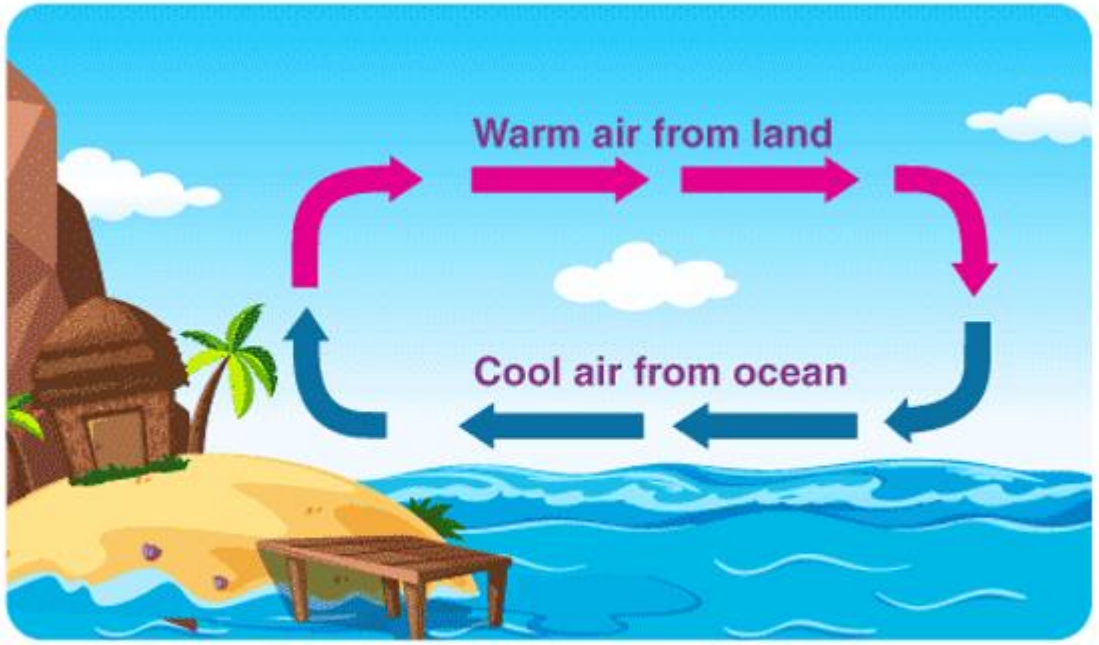
Yes, the sun heats both of them up.
However, land and water do not heat up or cool down at the same pace.
This differential heating and cooling of land and sea give rise to what are known as breezes, in the coastal areas.

CATEGORIES OF LOCAL WINDS

1. SEA BREEZE

This process takes place for the duration of the day.
Both the sea and the land surface are heated up by the sun.
The sea heats up slower than the land because it has a much higher heat capacity.
Thus, the temperature over the land surface increases, in turn, heating up the surrounding air.
Expansion occurs in the less dense warm air and an area over the land having low pressure is developed.
At the same time on the top of the sea, a high-pressure area develops.
Due to the difference in pressure, the air flows from the high pressure over the sea to the low pressure over the land.
This flow of air from the sea to the land is termed as the sea breeze.
The sea breeze is more prevalent on warm sunny days during the spring and summer.
An amazing cooling effect and a noticeable temperature drop are experienced as a consequence of it.

CATEGORIES OF LOCAL WINDS

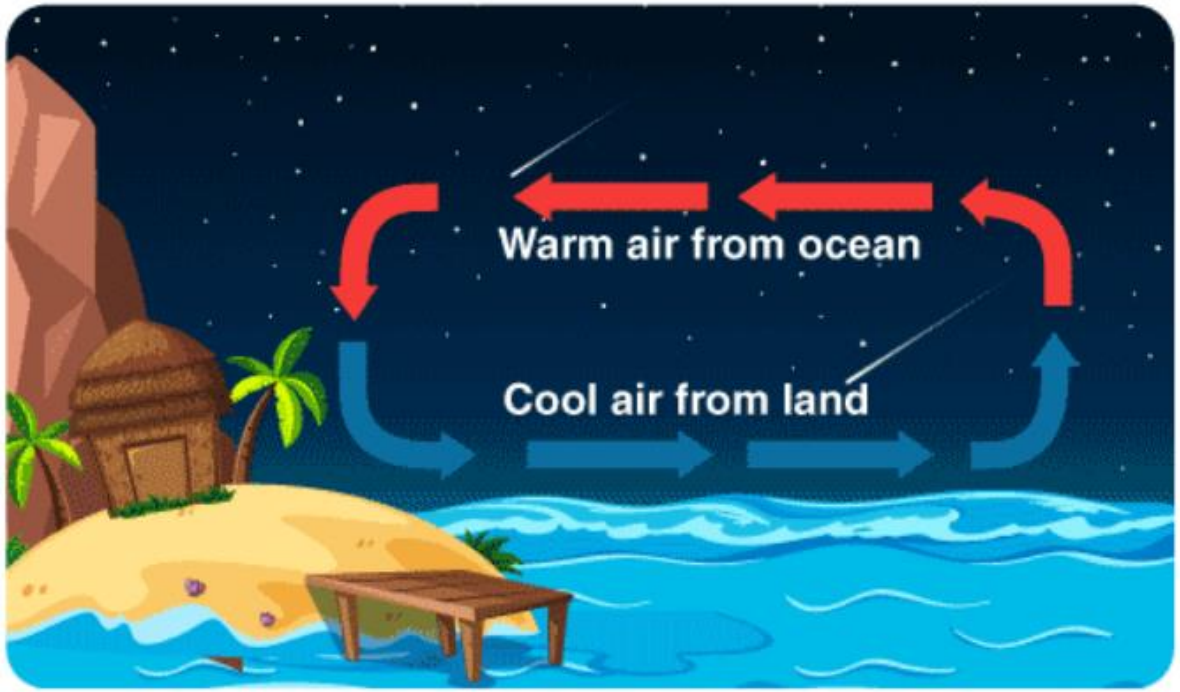


Sea Breeze

CATEGORIES OF LOCAL WINDS

- **2. LAND BREEZE**
- -a local wind system characterized by a flow from land to water late at night
- This process takes place for the duration of the night and the above-mentioned process gets reversed.
- Both the land and the sea start cooling down when the sunsets.
- As the heat capacity of the land is different from the sea it cools down quicker.
- Thus, a low-pressure situation develops over the sea as the temperature above it is higher when compared to the land.
- Due to this, the air flows from the land to the sea which is termed the land breeze.
- Land breezes can occur at any time of year but are more prevalent during the fall and winter seasons when water temperatures are still fairly warm and nights are cool.

CATEGORIES OF LOCAL WINDS



Land Breeze

•- MOUNTAIN BREEZE and VALLEY BREEZE

•On a warm sunny day the mountain slopes are heated more than the valley floor.

•Hence, the pressure is low over the slopes while it is comparatively high in the valleys below.

•As a result gentle wind begins to blow from valley towards slopes and it assumes the name of valley breeze (see fig.).

•After sunset, the rapid radiation takes place on the mountain slopes. Here, high pressure develops more rapidly than on the valley floor.

•Cold arid heavy air of mountain slopes starts moving down towards the valley floor. This is known as the mountain breeze (see fig).

•The valley and mountain breezes are also named as **anabatic and katabatic breezes respectively.**

CATEGORIES OF LOCAL WINDS

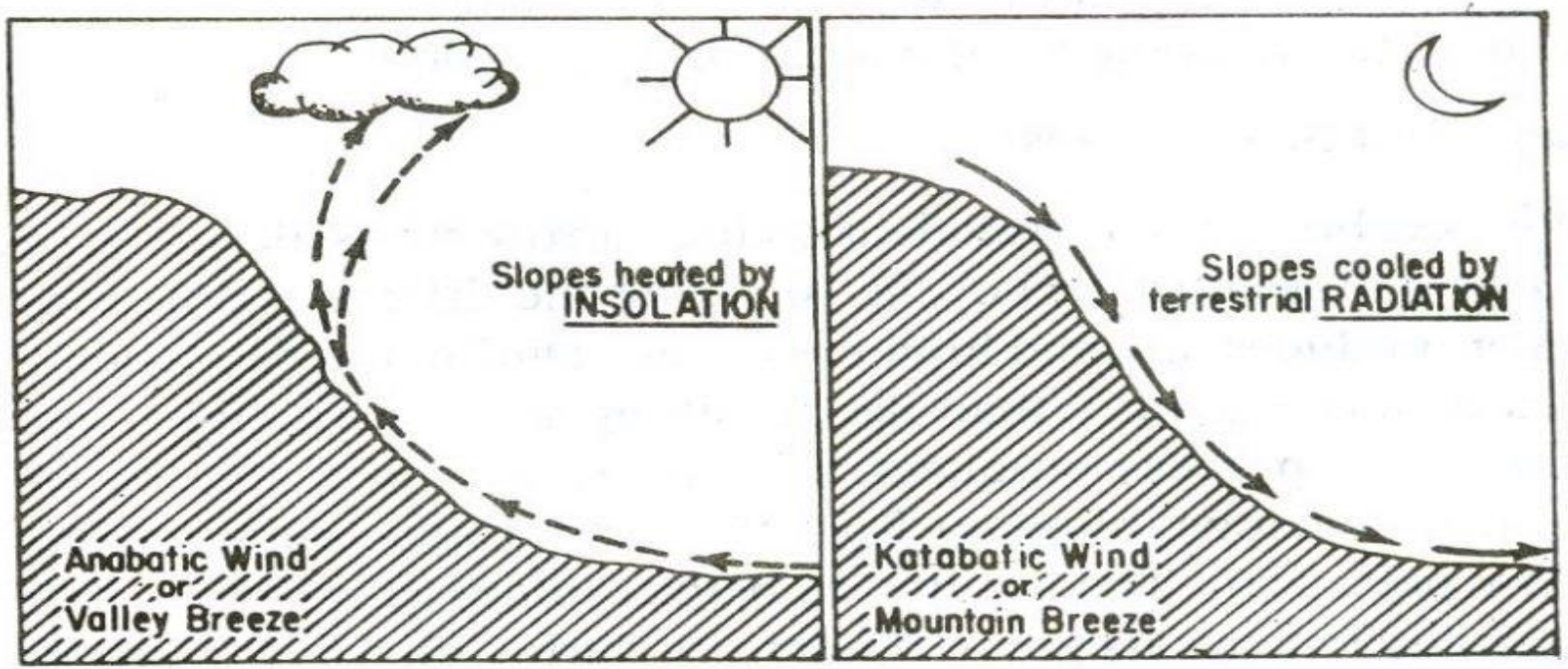


Fig. : Mountain and Valley Breezes

CATEGORIES OF LOCAL WINDSHot Local Winds

1. Loo

It is hot and dry. It blows very strongly over the northern plains of India and Pakistan in the summers. Their blow from west to east. They are usually experienced in the afternoons and the temperature varies between 45°C to 50°C.

2. Foehn

‘Foehn’ is the strong, dusty, dry and warm local wind. It develops on the leeward side of the Alps mountain ranges. It occurs due to a regional pressure gradient that forces the air to ascend and cross the barrier. This ascent sometimes causes precipitation on the windward side of the mountains.

After crossing the crest of the mountains, it starts descending on the leeward side a warm and dry wind. The temperature of the winds varies from 15°C to 20°C. This helps in the melting of snow. It makes the pasture land ready for animal grazing.

3. Chinook

‘Chinook’ is the name of a hot and dry local wind. It moves down the eastern slopes of the Rockies(the U.S.A. and Canada). The meaning of chinook is ‘snow eater’ as they help in the early melting of the snow.

Hot Local Winds

4. Sirocco

‘Sirocco’ is a hot, dry dusty wind. It originates in the Sahara desert. It is the wind of spring. After crossing the Mediterranean sea, the Sirocco is slightly cooled by the moisture from the sea. Some of its local names are- Leveche in Spain, Khamsin in Egypt, and Gharbi in the Aegean Sea area.

5. Harmattan

Harmattan is a strong dry wind that blows over northwest Africa from the northeast. It blows directly from the Sahara desert. Thus, it is hot, dry, and dusty. It provides a welcome relief from the moist heat and is beneficial to people’s health hence also known as ‘the doctor’.

CATEGORIES OF LOCAL WINDS

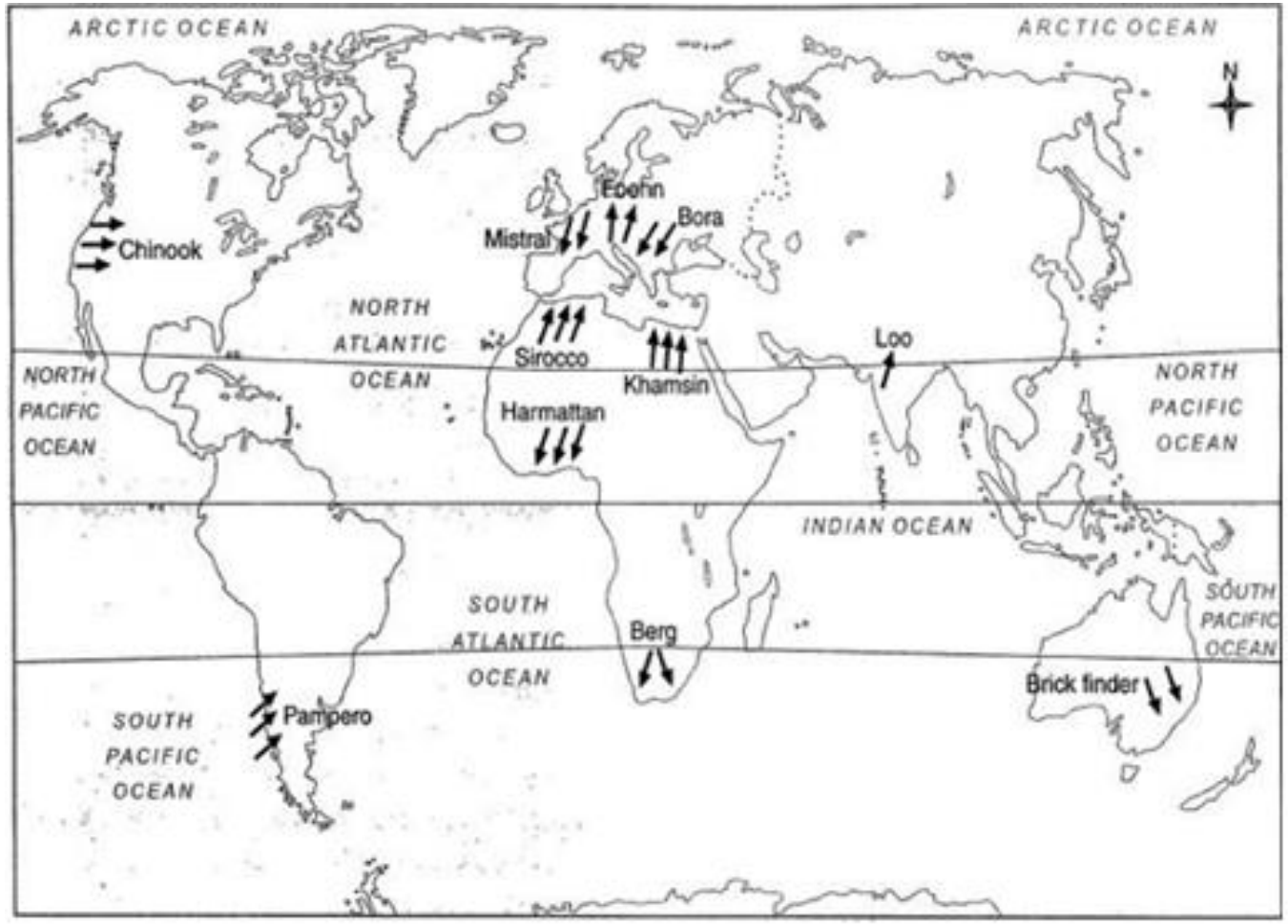
- **Cold Local Winds**

- 1. Mistral
- Mistral' is a cold wind of the Alps. It moves over France towards the Mediterranean Sea through the Rhone valley. They are cold, dry, and of high velocity. They reduce the temperature below the freezing point.

- 2. Bora
- Bora' is a cold, dry, high-speed north-easterly wind blowing down from the mountains in the Adriatic Sea region.

- 3. Blizzard
- Blizzard is a violent wind. It is freezing, wind-laden with dry snow.

CATEGORIES OF LOCAL WINDS



Name	Nature of wind	Place
Chinook (Snow eaters)	Hot, dry wind	The Rockies mountains
Foehn	Hot, dry wind	The Alps
Khamsin	Hot, dry wind	Egypt
Siroco	Hot, moist wind	Sahara to the Mediterranean Sea
Solano	Hot, moist wind	Sahara to the Iberian Peninsula
Harmattan (Guinea Doctor)	Hot, dry wind	West Africa
Bora	Cold, dry wind	Blows from Hungary to North Italy
Mistral	Cold wind	The Alps and France
Punas	Cold dry wind	The western side of Andes Mountain

Blizzard	Cold wind	Tundra region
Purga	Cold wind	Russia
Levanter	Cold wind	Spain
Norwester	Hot wind	New Zealand
Santa Ana	Hot wind	South California
Karaburun (black storm)	Hot dusty wind	Central Asia
Calima	Dust-laden dry wind	Saharan Air Layer across the Canary Islands
Elephanta	Moist wind in monsoon	Malabar coast