Planetary Winds and Factors Affecting them

$$F = m \times \frac{v^2}{r}$$

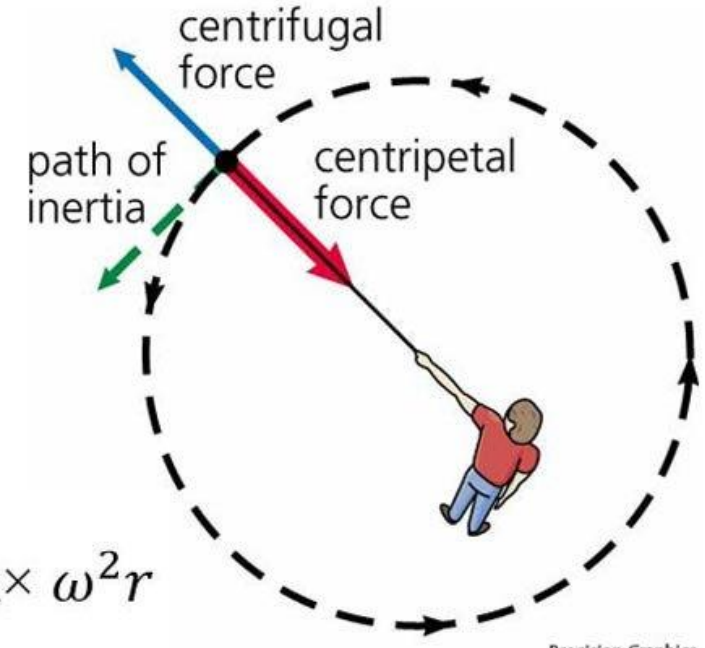
$$F = 5 \times \frac{5^2}{10}$$

$$F = 12.5 \text{ N.}$$

Centrifugal Force

$$F = m \times \frac{v^2}{r}$$

$$F = m \times \frac{(\omega r)^2}{r} \text{ or } F = m \times \omega^2 r$$



Manash Jyoti Bhuyan
Assistant Professor
P.G. Department of Geography
Nowgong Girls' College

The Concept

- The winds blowing almost in the same direction throughout the year are called **permanent winds**.
- These winds are also called as **invariable** or **planetary** winds because they involve larger areas of the globe.
- We know that, winds blow from high-pressure belts to low-pressure belts.
- These winds include **trade winds** or **tropical easterlies**, **westerlies**, and **polar** winds or **polar easterlies**.

Trade winds

- Trade winds blow in a belt lying between 5°N-30°N in the northern hemisphere and 5°S-30°S in the southern hemisphere.
- These are extremely steady winds blowing from subtropical high-pressure areas towards the equatorial low-pressure belt.
- These winds should have blown from the north to south in Northern Hemisphere and south to north in Southern Hemisphere, but, they get deflected to the right in Northern Hemisphere and to the left in Southern Hemisphere due to **Coriolis effect** and **Ferrel's law**.
- Thus, they blow as northeastern trades in Northern Hemisphere and southeastern trades in Southern Hemisphere.

- These winds are called trade winds because of the fact that they helped the sea merchants in sailing their ships as the direction of the trade winds remains more or less constant and regular.

- It may be pointed out that the zone of trade winds is called **Hadley Cell** on the basis of the convective model prepared by Hadley for the entire earth.

Westerlies

- The permanent winds blowing from the **subtropical high-pressure belts** (30°-35°) to the **sub-polar low-pressure belts** (60°-65°) in both the hemispheres are called **westerlies**.

- The general direction of the westerlies is south-west (**SW**) to north-east (**NE**) in the northern hemisphere and north-west (**NW**) to the south-east (**SE**) in the southern hemisphere.

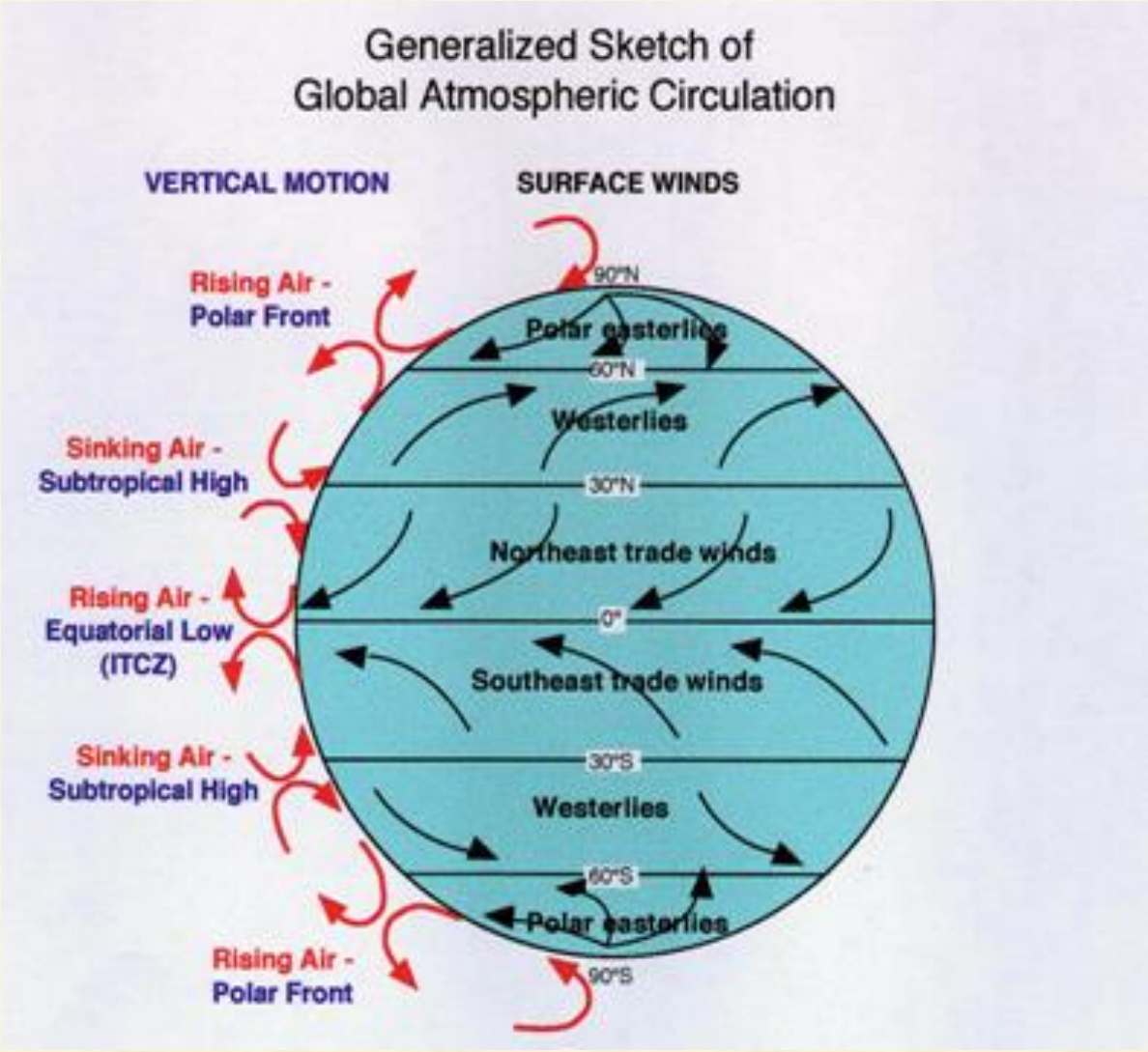


Fig: Generalised global pattern of planetary winds

- The general characteristic features of the westerlies are largely modified due to cyclones and anticyclones associated with them.

- Because of the dominance of land in the northern hemisphere, the westerlies become more complex and complicated and become less effective during summer seasons and more vigorous during winter seasons.

- These westerlies bring much precipitation in the western parts of the continents because they pick up much moisture while passing over the vast stretches of the oceans.

- The westerlies become more vigorous in the southern hemisphere because of the lack of land and dominance of the oceans. Their velocity increases southward and they become stormy.

- They are also associated with boisterous gales.
- **roaring forties** between the latitudes of 40°-50° S,
- **furious fifties** at 50° S latitude and
- **shrieking sixties** at 60° S latitude.

Polar Winds

- **Dry**, **cold** prevailing winds that blow from the high-pressure areas of the polar highs at the north and south poles towards low-pressure areas within the Westerlies at high latitudes.

- Blow within the latitudinal belt of **60°-65°** in both the hemispheres

- This outflow is then deflected westward by the **Coriolis effect**, therefore these prevailing winds **blow** from the **east** to the **west**.

- Since the winds originate in the east, they are then known as **easterlies**. Unlike the westerlies in the middle latitudes, the polar easterlies are often **weak** and **irregular**.

Forces Affecting Winds

- If the earth were stationary and had a uniform surface, air would flow directly from high-pressure areas to low-pressure areas.

- Because none of these conditions exist, the direction and speed of wind are controlled by several factors.

- These are **pressure gradient**, the **Coriolis effect**, **frictional** forces, and **centrifugal action** of wind.

1. Pressure gradient

- The force that causes wind movement results from horizontal pressure differences.
- It is the direction and magnitude of the pressure gradient which ultimately determines wind direction and its velocity.
- This is the force generated due to the differences in horizontal pressure.

- Since a closely spaced gradient implies a steep pressure change, it also indicates strong wind speed. The wind direction follows the direction of change of pressure, i.e. perpendicular to the isobars.

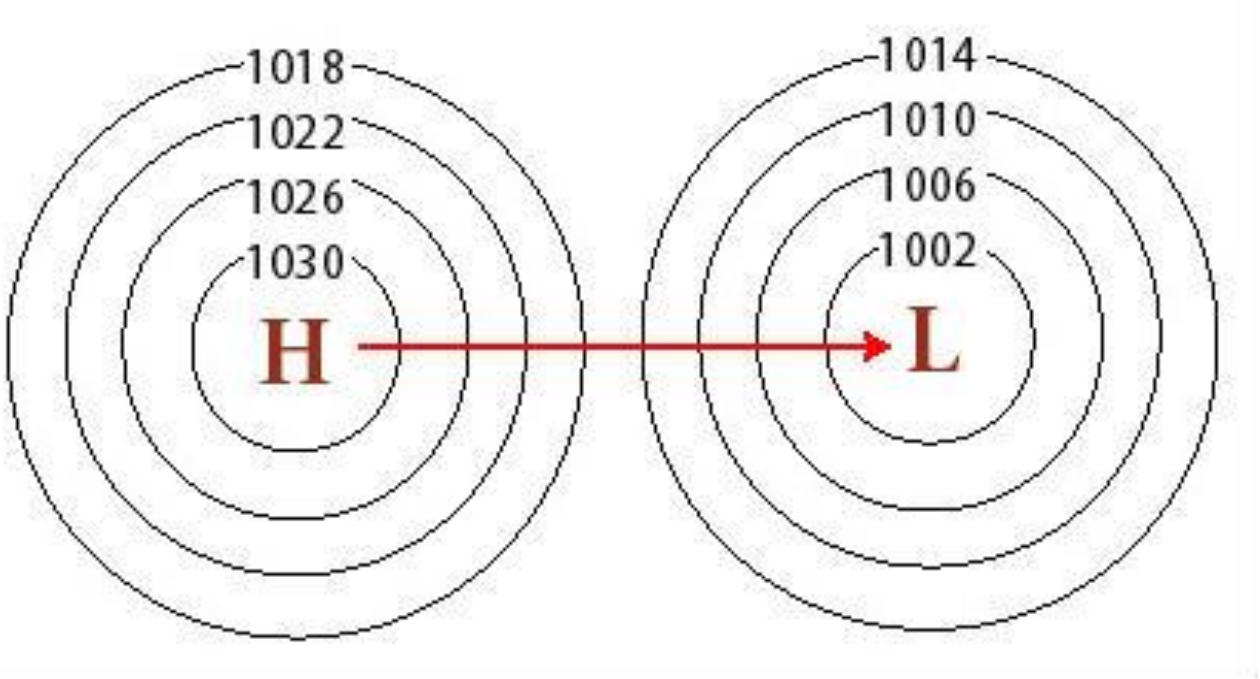


Fig: Flow of air produced by the pressure gradient force

2. The Coriolis force

- Due to the earth’s rotation, winds do not cross the isobars at right angles as the pressure gradient force directs, but get deflected from their original path.

- This deviation is the result of the earth’s rotation and is called the **Coriolis Effect** or **Coriolis force**.

- Due to this effect, winds in the northern hemisphere get deflected to the right of their path and those in the southern hemisphere to their left, following **Ferrell's Law.**

- The Coriolis force changes wind direction but not its speed. This deflection force does not seem to exist until the air is set in motion and increases with wind velocity, air mass, and an increase in latitude.

- It should be pointed out that the Coriolis force is **zero** at the **equator** and **maximum** at the **poles**.

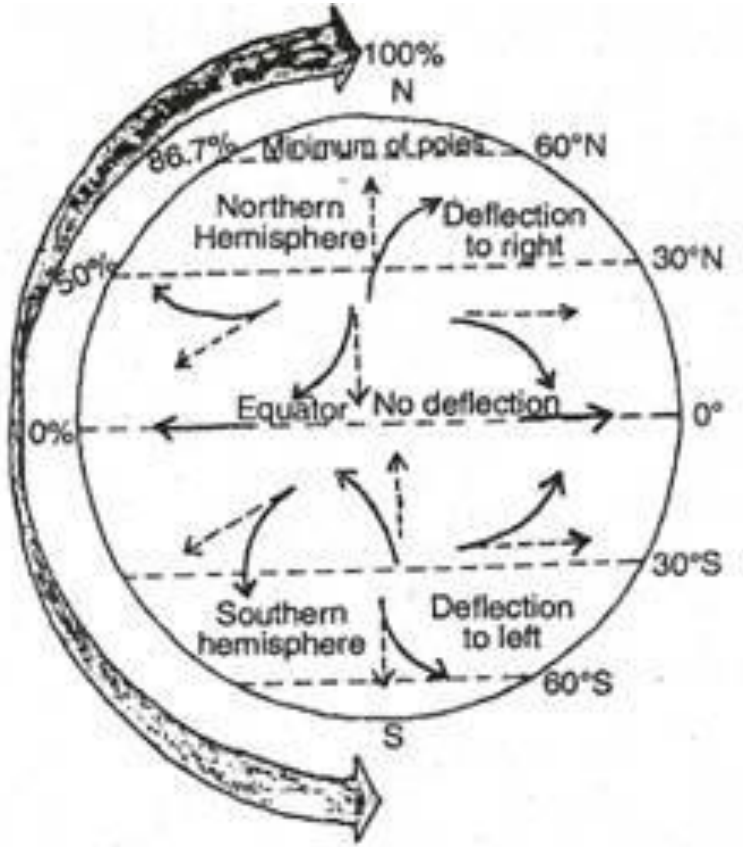
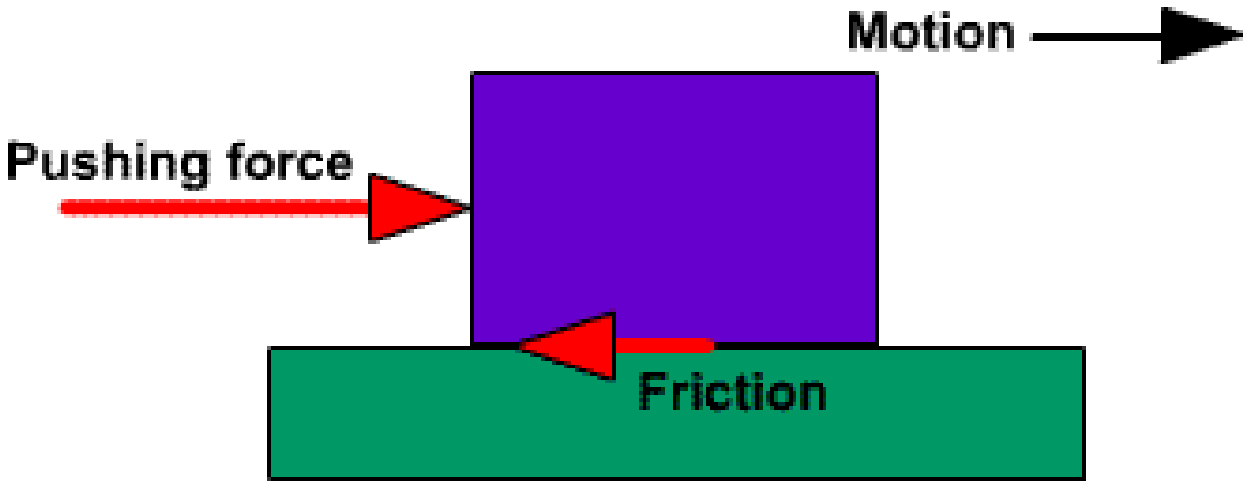


Fig. 2.16 A graphic demonstration of the effect of Coriolis force on wind direction over the earth's surface.

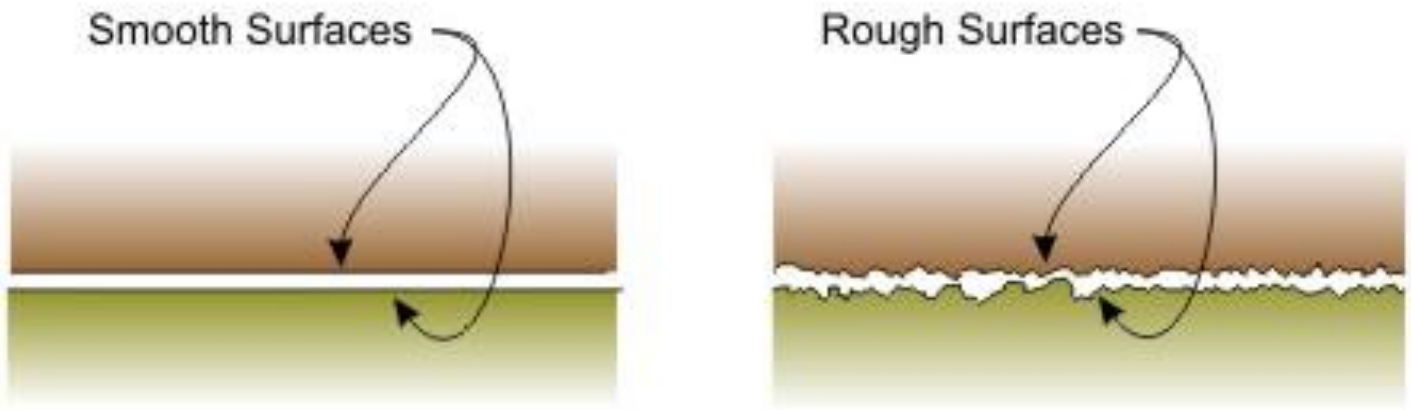
3. Frictional forces

- At or near the earth's surface, friction is an important factor affecting wind. But its effect is confined to only a few thousand meters from the surface.

- Frictional forces act not only to slow down the wind movement but also to change the wind direction.



- The irregularities of the earth’s surface offer resistance to the wind motion in the form of friction.



Friction Force is affected by the smoothness of the surfaces

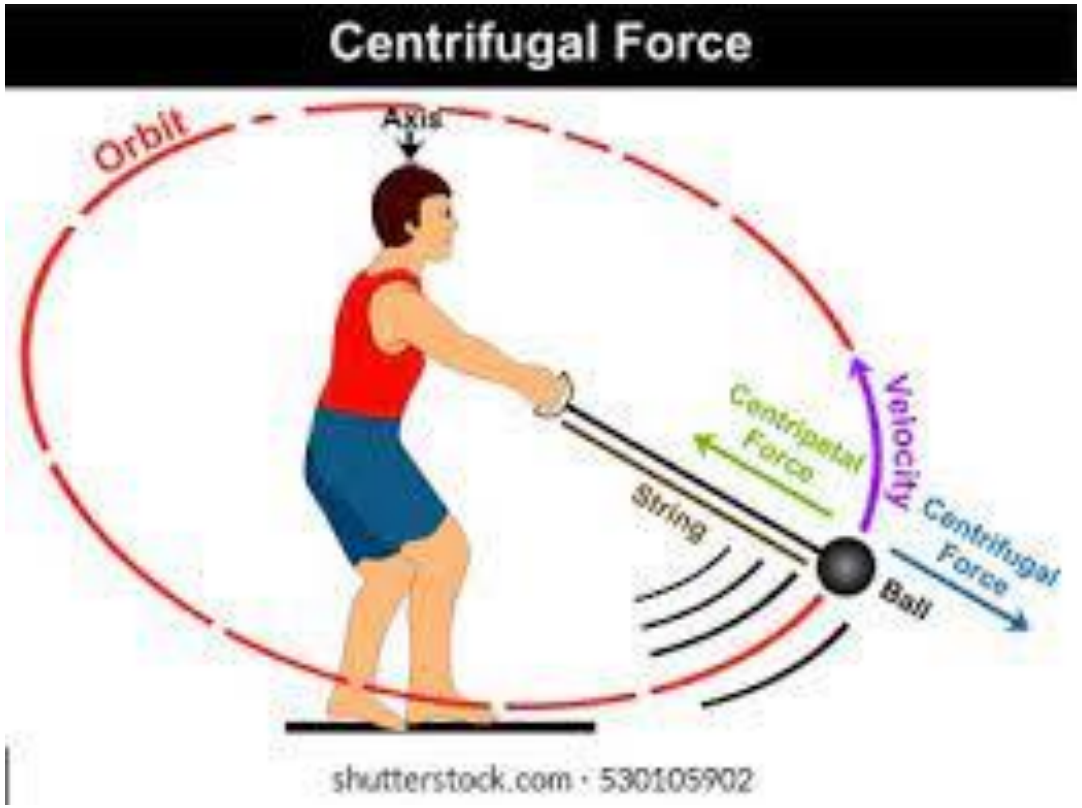
- This force determines the angle at which air will flow across the isobars, as well as the speed at which it will move.

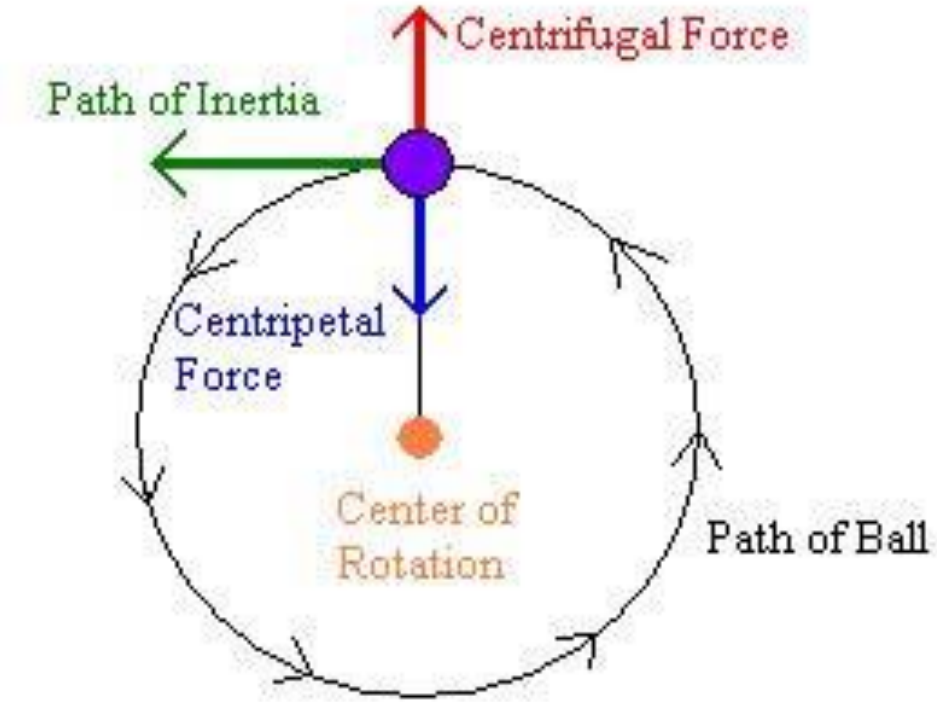
- Over the relatively smooth ocean surface, the friction is minimum, so the air moves at low angles to the isobars and at a greater speed.

- Over uneven terrain, however, due to high friction, the wind direction makes high angles with, isobars and the speed gets retarded.

4. Centrifugal action of wind

- The centrifugal force is an apparent force that includes the effects of inertia for winds moving along a curved path.





- The directionality of the centrifugal force points *outward* from the center of the curve.

- It should be noted that centrifugal force is hardly a force in the true sense of the term.

- It results from a state of imbalance existing between other forces when isobars are curved.

- The Coriolis force is a factor which operates forcefully only when there is a high velocity wind with a small radius of curvature as in small-sized violent tropical storms.

- It acts in a direction radially outward from the center of curvature of the wind's path.

Thank You