Paper code: GGY HC – 2026

Part- I

Group- A: Climatology

Topic: Forces Affecting Winds

Wind has been defined as the horizontal movement of air that is caused by differences in pressure. Since pressure differences are mainly caused by unequal heating of the earth's surface, solar radiation may be called the ultimate driving force of the wind. 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.

a) **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, and it operates from the high-pressure area to a low-pressure area. 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.

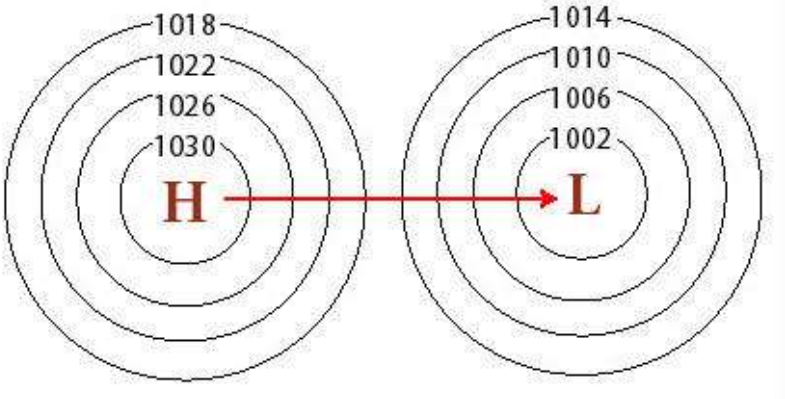

Fig: Flow of air produced by the pressure gradient force

b) 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 Farrel'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.

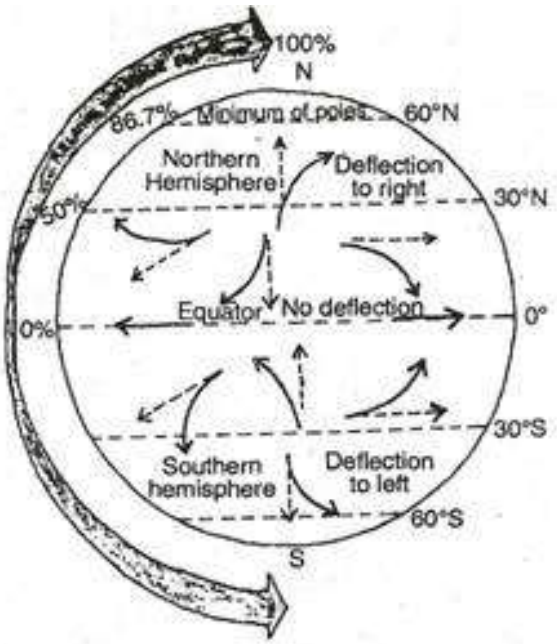

Fig. 2.16 A graphic demonstration of the effect of Coriolis force on wind direction over the earth's surface.

c) 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. This force determines the angle at which air

will flow across the isobars, as well as the speed at which it will move. It may also alter wind direction. 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.

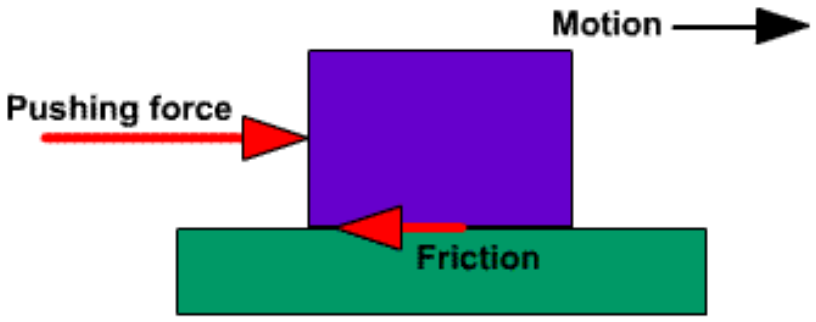

Fig.: A

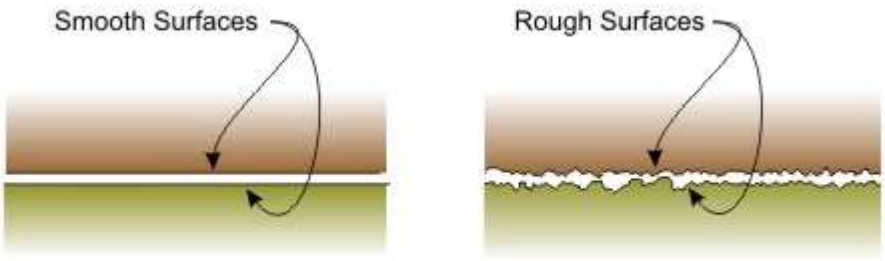

Fig.: B

d) **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. In fact, this imbalance is necessary to provide the change in the direction needed for curved flow.

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.

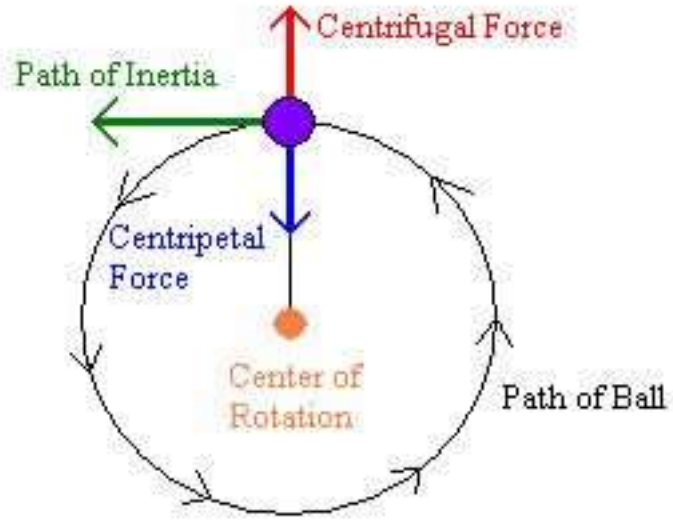

Fig.: Centrifugal force

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