1.3 CORIOLIS FORCE

In the Earth-based frame, there are two inertial forces, one directed away from the center of earth, and the other pointed in the plane perpendicular to the axis of rotation. The centrifugal force subtracts from the centrally directed force of gravitation, and is absorbed in the value for the acceleration due to gravity g. Therefore, the inertial force that leads to unexpected effects in the Earth-based frame is the Coriolis force $\vec{F}_{cor}$.

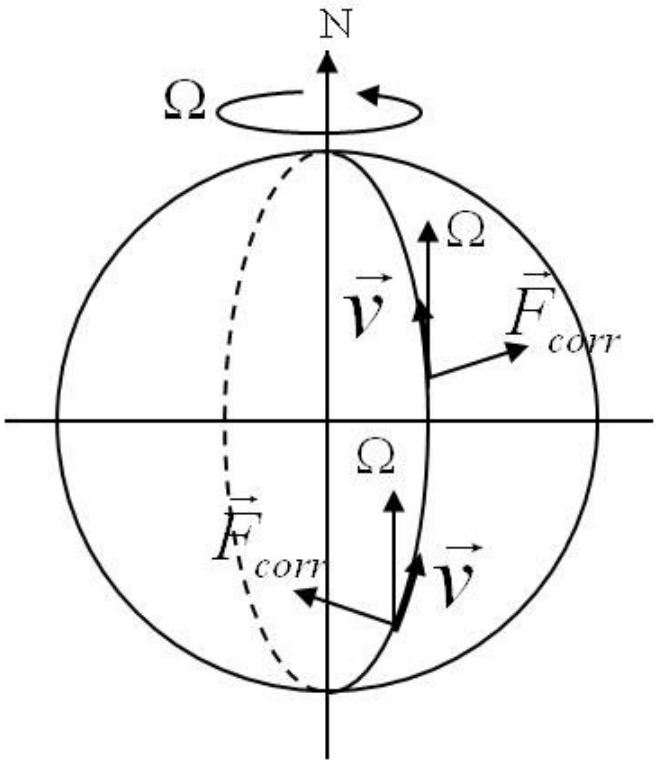

Figure 1.11: Coriolis force in northern and southern hemisphere.

$$\boxed{\vec{F}_{cor} = -2m\vec{\Omega} \times \vec{v}.} \tag{1.31}$$

Note that the Coriolis force is perpendicular to the direction of velocity of the particle, as evident from the cross product. Therefore, a moving particle is deflected perpendicular to its direction of motion by the Coriolis force. As a result, northward moving particles in the northern hemisphere are deflected to the East while northward moving particles in the southern hemisphere are deflected to the West as illustrated in Fig. 1.11.

The atmosphere of Earth is usually modeled as particles in motion. The forces on particles of atmosphere are from gravity and pressure differences. If there is a pressure gradient, then there is a

force from high pressure region towards the low pressure region. Due to the Coriolis force, when a particle has nonzero velocity towards the lower pressure region, the path of the particle is changed towards the perpendicular direction. As a result the winds circulates differently in the northern and souther hemispheres, being in the counterclockwise sense in the northern hemisphere and in the clockwise sense in the southern hemisphere as shown in Figs. 1.12 and 1.13 respectively.

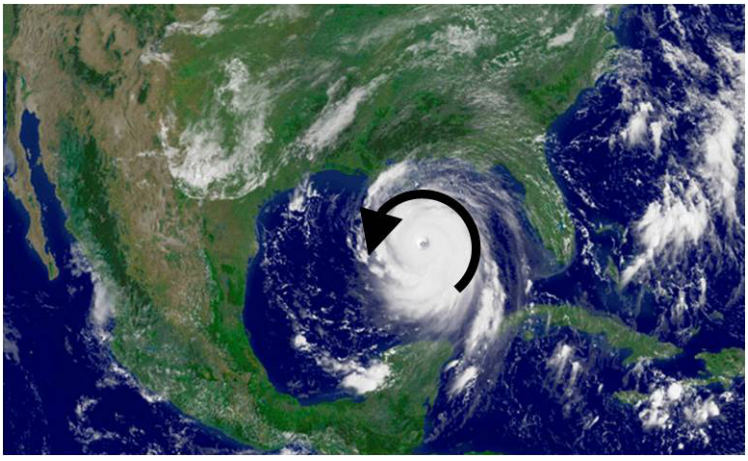

Figure 1.12: Hurricane Katrina in the Gulf of Mexico rotating counterclockwise on August 28, 2005. Hurricane Katrina later devastated the city of New Orleans in the state of Louisiana causing massive flooding. Credit: National Oceanic and Atmospheric Administration, USA.

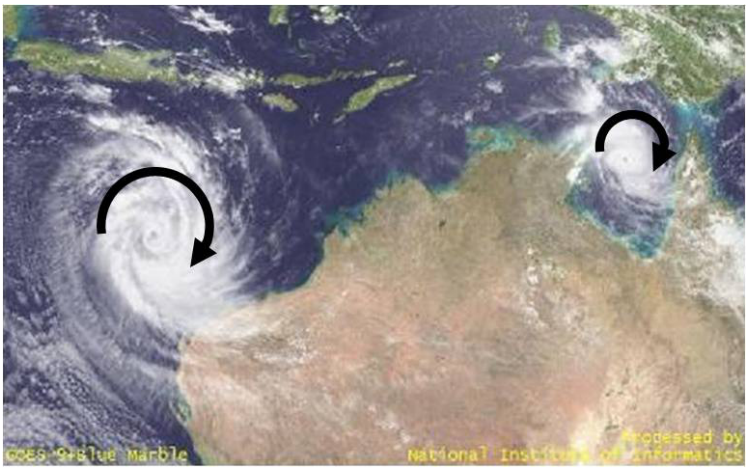

Figure 1.13: Rotation of winds in southern hemisphere. Cyclones Willy (left) and Ingrid (right) off the northern coast of Australia on 11th March 2005. (Credits: National Institute of Informatics, Japan).