6.3: Coriolis Force

Coriolis effect is an inertial force described by the French mathematician Gustave-Gaspard Coriolis. Based on Newton’s laws of motion Coriolis determined that a “mass moving in a rotating system experiences a force acting perpendicular to the direction of motion and to the axis of rotation”\(^1\). This principle has a visible effect on the movement water in the oceans and air and objects in the atmosphere.

But in order to understand the Coriolis forces’ effects on atmospheric circulation, we must first understand some basic physical premises. Firstly, The Earth is wider around at the equator compared to higher latitudes and is rotating from West to East. Because of these facts we can determine that near the equator the Earth is rotating faster in an easterly direction than it does at higher latitudes. These facts coupled with Newton’s first law that objects in motion tend to stay in motion, explain the effect on how objects move throughout the atmosphere. If you were to launch a missile from the Equator to the North Pole, the initial high velocity of rotation at the Equator is maintained in the system and the missile carries this initial speed from rotation due to Newton’s first law. This is visualized as an object launched into the atmosphere moving from west to east as it is launched from the equator to the pole in the northern hemisphere. (opposite in the southern hemisphere). A little tougher to understand are objects moving from east to west. In order to understand this we need to apply the principle of centripetal acceleration, which is defined as the acceleration needed to keep an object moving in a circle at a particular radius\(^2\). Basically if you go faster than you are allowed you will increase your radius, and if you slow down you will decrease your radius. So as objects move eastward in the northern hemisphere they want to push out to space because of their increased speed relative to the earth, but the constraint of gravity stops it from moving outward and instead moves it south in order to increase its radius. Objects and air moving west want to fall towards Earth’s axis, but are restrained by the surface, and thus are pushed north where the radius of circulation is smaller.
Now that we understand how the Coriolis force effects atmospheric motion we can apply it to our knowledge other atmospheric and oceanic phenomena. Every aspect of atmospheric circulation from the presence of jet streams to Hadley cells to oceanic gyres, is indicative of this phenomena, and prove that the Coriolis force, while not incredibly strong, (10 microns per second squared) still plays a major role in the movement of water and air on earth. One of the most extreme examples of how the Coriolis effects weather is in Hurricane systems. The low pressure center of the system attracts high pressure air from all directions. Because of the large difference in pressure gradient the speed of the air is more rapid than normal, but because of the Coriolis effect the air regardless of which direction it came from, will be directed to its’ right. The circular motion of the high pressure air around the low pressure center, creates the eye of the storm that is indicative of a Tropical storm or hurricane.

