The True Force Compelling a Cyclone to Spin

—*Coriolis Force* is a wrong candidate

Abstract: Coriolis force has long been named as the perpetrator causing the cyclones to spin. One obvious observation about cyclones is that they all have converging movement while spinning about an eye, but Coriolis force is a diverging force. Convergence and divergence are two opposite concepts. That diverging force has caused and maintained a converging movement is apparently illogical. The conventional explanation why cyclones spin must be reexamined for the true physics to be discovered.

Further, when someone proposes to explain the spinning of cyclones based on a particle's curved loci resulted by Coriolis force, he should be aware of that the record of such loci is a historical statement (Fig A), but the image of the curving "tentacles" of a cyclone is an instantaneous statement (Fig B).

Key Words Cyclones, equator, air pressure, disk, walling effect

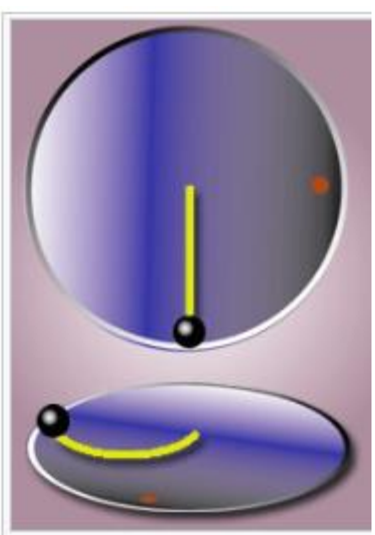


Fig. A

Source credit: https://en.wikipedia.org/wiki/Coriolis_force

Fig. B

Credit Source:

https://en.wikipedia.org/wiki/Cyclone

Clouds [1] in sky may contain various physical forms of water: vapor, mist, water droplets, rain drops, or even ice droplets. Suspending in high air with near zero restriction in horizontal movement, they may collect each other under the influence of mutual gravitational force among them. Sooner or later, some of them may organize the appearance of a prominent mass across a big area in the sky. We will call it a disk of cloud. It is natural that prominent mass has a prominent mass center.

Our Earth keeps incessantly self-spinning. Its spinning drags the atmosphere to move over its surface, and the clouds, being "hijacked" by the atmosphere, must also move over the surface of the Earth. It is so natural that the spherical shape of the Earth would introduce speed difference between some clouds moving near the equator and others but closer to the Earth's pole, with those near the equator moving faster. If these two groups of clouds happen to belong to one big disk of cloud, the south part and the north part of the same disk must move out of pace with respect to the ground. For clarity in explanation, let's focus on a cloud disk appearing in the north hemisphere. For this cloud disk, its south edge would have the highest speed toward the east, while the north edges the lowest. If the highest speed is called V_1 and the lowest speed is called V_3, we can easily figure out that the speed, called V_2, of the mass center of this disk should fit in this relationship: $V_1 > V_2 > V_3$. If a person stays at the mass center and faces the equator, relative movement may lead him to conclude that the edge of the disk in front of him is moving from his right to left, but the edge in his back from his left to right.

The centrifugal force produced by the Earth's spinning forces everything on it to have a tendency to be swung away toward the outer space (f_1 in Fig 1). This centrifugal force is parallel to the equatorial plane and be determined by $f_1 = m\omega^2 r$, where m is the mass under the influence of the centrifugal force, ω is the angular spinning speed of the Earth and r is the perpendicular distance between the mass in concern and the spinning axis of the Earth. According to this equation, the south edge of the disk of clouds, with a bigger distance from the Earth's axis, should have a higher elevation than the mass center with respect to the surface of the Earth (assuming a perfect sphere). Therefore, the south edge may produce certain fluid pressure due to gravity toward the mass center.

The pressure difference between the south edge and the mass center of the disk of clouds may be further escalated due to another force. Everything suspended in air tends to be herded toward the Equator by a force indicated as f_2 in Fig 1. Force f_2 has the maximum value at $\Phi=45^o$ and zero at $\Phi = 0^o$ or 90^o. So, the mass center, located more northern than the south edge, would have a tendency ducking under the south edge. Meanwhile, being more northern than the mass center, the north edge would push itself toward the mass center, resulting in a wall towering over the mass center. The overall result is that the mass center has a tendency to sink itself lower than both the north edge and south edge and subsequently has the highest

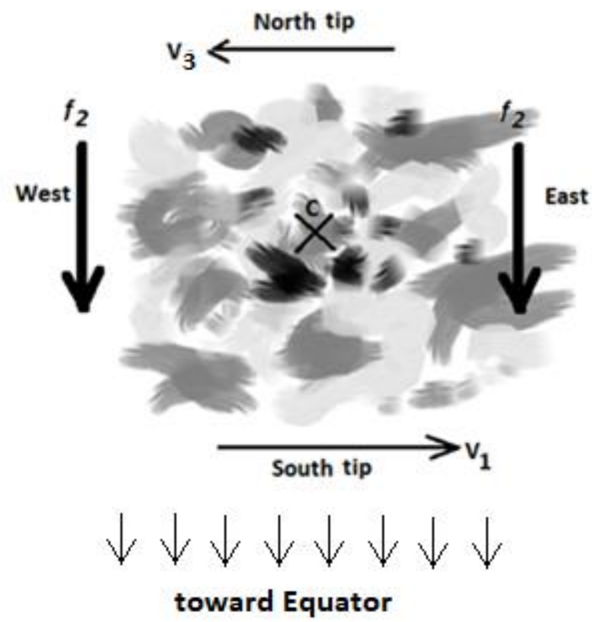


Fig 2 **V_1, V_2 and both f_2 work together motivating the cloud gathering into a spinning disk**

(Viewer is at rest with respect to the mass center c)

force f_2

mass density among the three. We call this effect brought out by both edges but suffered by the mass center the walling effect.

Now, in Fig 2, both f_2 in the east and west should statistically have the same magnitude pointing toward the south, or the Equator. However, since the entire disk of clouds is a fluid body, f_2 in the west is beefed up by the momentum carried by the moving mass traveling at speed V_3 on the north edge. Meanwhile, f_2 in the east is crippled by the momentum carried by the moving mass in south traveling at V_1. Consequentially, due to V_1>V3, f_2 in the west ends up being modified into a stronger force than the f_2 in the east. Then, with respect to the mass center of the disk, f_2 in the west produces a stronger torque; torque usually ends up forcing a free body to rotate. The moving style so presented and the reason causing it are applicable to any material loop of any radius encircling the mass center of the cloud disk.

When a large cloud disk gets in a rotation state, what we call a cyclone[2] appears. With the information presented in Fig 2, a counterclockwise rotation is easily visualized out of it. Symmetrically, a clockwise rotating cyclone can also be visualized as shown in Fig 3 if the cyclone appears in the south hemisphere.

In both Fig 2 and Fig 3, had speed V_1 and V_3 been nearly equal in magnitude, f_2 in the east and west would have no chance to be modified into an unequal pair, and would have always stayed nearly equal. Then this pair of force would most likely push the entire cloud disk coherently toward the Equator. Some local dimples may be made into spinning because of the friction agitated by V_1 and V_3, which are moving in opposite direction (seen from the mass center), but the entire disk would hardly get into spinning.

When the entire disk gets into a spinning state, at the beginning, the clouds at distance further away from the mass center have higher linear speed than those nearer the center. The air pressure below the outer edge of the disk therefore drops more than that is closer to the center. This is a common fluid phenomenon—at where an object travels at higher speed, the

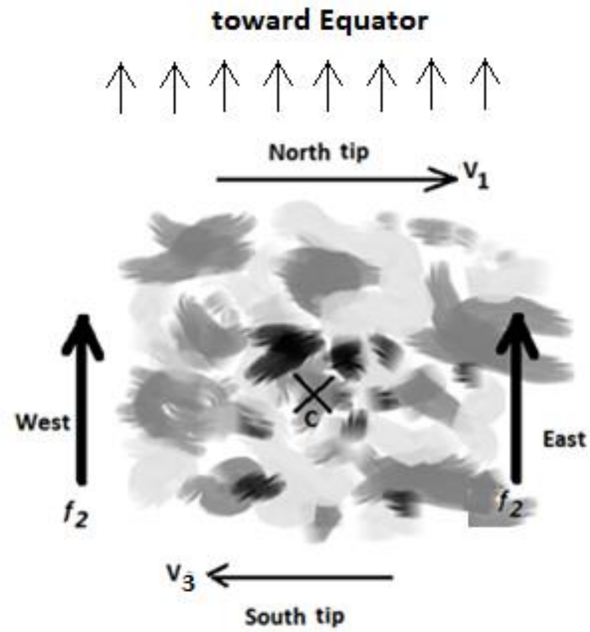


Fig 3 A clockwise spinnning cyclone in the south hemisphere is in the making

(Viewer is at rest with respect to the mass center c)

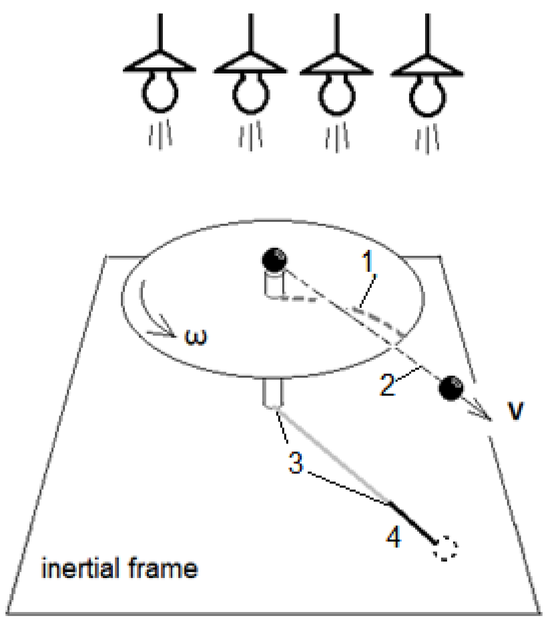
pressure of the ambient fluid drops more. To establish balance, the pressure below the center of the disk also correspondingly lowers itself, causing the central part of the disk, which has the highest mass density in the disk, further to sink lower.

The further sinking of the center creates chance for the neighboring clouds at bigger distance to roll in because of the pressure difference so enhanced. As the distance shortened toward the center, the rolling in neighbors, due to momentum conservation, will circle about the center at higher speed, further reducing the air pressure below the cloud disk. It won't take long for the clouds closer to the center to travel at higher speed than those at the outer edge. This means that an area of the lowest air pressure below the entire disk begins to build up about the center, and the central clouds cannot help but only to keep sinking. If the cloud quantity of the disk is large enough, and if the original air pressure below the disk was already low enough at the start, the aforementioned neighboring-mass-rolling-in will continue with ever escalated intensity. This may lead to at some point that the clouds located in the central region center, being the densest portion, are totally sucked away toward the ground. A hole, or called the eye of the cyclone, is created.

When the eye is brought into shape, dramatic mechanical phenomena appear. Being the spot of the lowest pressure in the disk, the eye becomes a bottomless abyss keeping sucking materials from the adjacent area in the cloud disk. As materials rush to the eye, they must move at higher and higher speed, both linear and angular. With higher linear speed, the materials flying near the eye further cause the air pressure there to maximally drop. Higher angular speed, on the other hand, must produce stronger centrifugal force, forbidding the flying materials from truly approaching the dead center. Then, next to the eye, a circular wall of air current is formed. Within this wall, two forces fiercely compete and balance each other: (1) the centrifugal force, and (2) the sucking force of the eye. The higher the linear speed mentioned in (1), the lower the air pressure is in the eye.

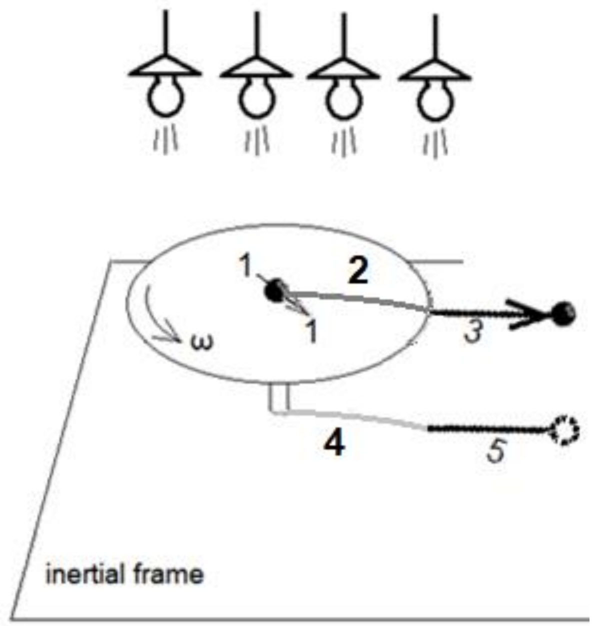
The fierce turbulence of a cyclone must end itself because the disk must carry only a limited quantity of clouds, no matter how big it was at the beginning. After more clouds have been sucked toward the eye and dispersed at lower elevation, the disk gradually shrinks. Without continuous material carrying enough momentum to sustain the eye's sucking power, the cyclone must end up being self-extinct.

From formation to disappearance, the material movement within a cyclone is dominated by a converging movement; hardly any diverging movement is seen involved. However, it seems to this author all contemporarily popular explanations on the reason why cyclones appear spinning are based on the so called Coriolis effect or Coriolis force [3]. Either Coriolis effect or Coriolis force is about diverging movement. As a matter of fact, some Coriolis effect we detect may have nothing to do with the supposed Coriolis force (Fig 4). Instead of



1. Loci of ball projected and recorded on turn table
2. Actual historical path of the ball
3. Path 2 projected and recorded directly below the turn table
4. Path 2 projected and recorded outside the turn table

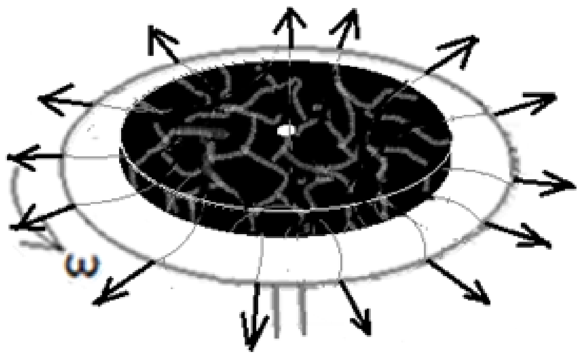
Fig 4. Illusory Coriolis Effect



1-1 The ball's initial moving direction

2. The curved loci of the ball's movement printed on the turn table
3. Speed and direction the ball carries at the time it leaves the turn table
4. Loci 2 projected on the inertial frame
5. Loci 3 projected on the inertial frame

Fig 5 The movement of a ball under the influence of Coriolis Force



All arrows represent the velocity of all torn pieces from the cloud collection on the turn table when leavng the turn table.

The fine curved lines represent the loci they traced and left on the turn table

Fig 6 Coriolis effect on a cloud collection as a candidate of a cyclone

having any force involved, the Coriolis effect may sometimes just be some visual effect, whose appearance is not a result of any dynamic consequence other than kinematic consequence. In Fig 4, the ball's actual traveling path has nothing to do with the turning table; therefore no Coriolis force or any kind of force appears during its movement, regardless.

If a physical influence is called force, it must have the quality of producing acceleration on some mass. Coriolis force should have no exception. In Fig 5, the ball has direct contact with the turn table. When it is propelled leaving the center of the turn table, the turn table would inevitably exert influence on the ball's movement, no matter whether the movement is in the form of rolling or sliding over the table. It can be easily deduced that it is an accelerated movement, in which the ball must also move on a new radial line in every next instant of its movement. When it finally leaves the turn table, it would have obtained the maximum speed and would continue its movement at this speed and in a direction different from its initial velocity. The bigger the turn table is, the more this new direction would point at the center of the turn table with this final speed.

In comparison to the above analysis, we can regard the cloud collection portraying as a cyclone to be a collection of black balls in Fig 5 placed on a turn table (See Fig 6).

It is potentially possible that when a cloud gathering has become large enough and a spinning cyclone is on the way to flex its muscle, the Coriolis force loses no time to step up a process of tearing the cloud into pieces and throw them away from the edge of the gathering. For the tearing to be successful, the Coriolis force must overcome three forces: (1) the overall mutual gravitational force produced by the entire gathering, (2) the force caused by the walling effect on both the north and south edge of the cloud gathering, (3) the sucking power pointing toward the eye.

If the Coriolis force wins, the spinning cyclone mass would be disintegrated—the cloud gathering had been large enough to start a cyclone but not large enough to resist the destructive power of the Coriolis force and therefore unable to sustain the cyclone to live on. It is not some rare events that time to time certain expected cyclone said in the way to be spawned in meteorology report eventually vanishes itself.

Of course, if the Coriolis force fails, the three forces mentioned above would soon push up the appearance of a madly spinning cyclone. However, it does not mean the Coriolis force is willing to recede from the scene. When enough amounts of materials have been sucked by the eye and dispersed toward the ground, the cloud disk prominently reduces its diameter. Although the shrunk disk continues to spin about the eye with the high speed it has been "trained" to accomplish with, the angular momentum must reduce with the disk's diminishing material stock. Eventually it must come to a point that all three forces working together cannot resist the Coriolis force, which keeps increasing in correspondence with the escalated spinning of the cloud disk. Being torn apart becomes an inescapable fate of the disk. Once adequately dispersed, the madly flying power of each cloud piece is braked by the adjacent air in its next movement. The cyclone ceases.

Nevertheless, now we can see that the essential nature of Coriolis force is of a centrifugal force with two imperative characteristics: (1) its magnitude continues increasing, (2) with respect to a spinning reference frame that enables the Coriolis fore to grow in magnitude, this force must continuously change its radial line on this frame in every instant of its existence.

[1] Cloud, https://en.wikipedia.org/wiki/Cloud

[2] Cyclones, https://en.wikipedia.org/wiki/Cyclone

[3] Coriolis force, https://en.wikipedia.org/wiki/Coriolis_force