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Effects of Solar Wind on Earth's Climate

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Abstract

The mechanism of climate in conventional explanations is caused by the Sun's irradiation under daily rotation of Earth. However, the effects of solar wind have been ignored. The Earth's climate depends on the wind. The daily weather moves along latitudes, spreading to the same latitude, and a wide range of weather travels in cycles of several days from west to east along longitude. In Conventional theory of heat convection of air cannot explain why the weather rotates faster than the Earth's rotation. The solar wind collides with the Earth at an angle corresponding to the state of tilted Earth's rotation axis. Although magnetic field caused by isolated moving charged particle decreases at the place far from the source, chained magnetic coupling of charged particles with solar wind exist at the surface of rotating Earth. The solar wind passing at high speeds through the east side of the Earth's atmosphere move the weather from east to west because it has a greater acceleration effect than the western deceleration effect. These facts are the evidence that the solar wind has been affecting the Earth's climate.

Keywords: *Climate change, Solar wind, Trade wind, Westerlies*

Introduction

Human-caused global warming is a current phenomenon [1]. The Holocene epoch [2], however, was superimposed on a naturally varying climate. Wind depends on the hourly atmospheric pressure arrangements. As the strike angle of solar wind depends on the tilt of the rotational axis of Earth, seasonal changes in wind not only depend on the irradiation angle of the Sun, but also on solar wind. Milankovitch cycles [3] describe the long-term effects of changes caused by Earth's movements. These cycles depend on Earth's orbital eccentricity, axial tilt, and precession. However, none had recognized the importance effects by the solar wind. In conventional terms, solar wind does not reach Earth's surface owing to the geomagnetic field; this description on the geomagnetic field induces to misunderstand as "the solar wind does not affect the climate of the Earth." Atmospheric molecules at upper boundary the Earth collide with the solar wind H^+ to ionize, and there is a locally magnetic interaction among the motioning charged particles. So, the atmosphere links with the solar wind by magnetic coupling among moving charged particles. Solar wind has an escape velocity (V_e = 617.5 km/s) characterized by anti-clockwise motion (V = 1.89 km/s) due to the rotation of the Sun. When solar wind collides head-on near the equator, the momentum of V provides a driving force in the clockwise direction based on the gear mechanism on the daytime. Thus, solar wind collides with the atmosphere during the daytime and generates trade winds that flows from the east to the west. Atmospheric flow links with the H^+ in solar wind via the magnetic coupling of moving charged particles traveling in parallel. Magnetic coupling occurs for parallel-running charged particles, but it causes a repulsive action for anti-parallel charged particles. Therefore, solar wind that passes through the eastern region of Earth accelerates atmospheric rotation. However, solar wind passing through the west side region of Earth slows atmospheric rotation. The magnetic interaction of solar wind causes a strong acceleration in parallel-running charged particles. So, solar wind drives the westerly wind. Many explanations exist based on the Coriolis effect which can be applied to the movement of rotating objects. As the Coriolis force is perpendicular to the axis of an object, it is zero at the equator. Conventional explanations did not explain the mechanism: "why does weather, characterized by a large quantity of air, rotate faster than Earth's rotation?"

The Geomagnetic Field that Expands by Magnetic Coupling of Moving Charged Particles

The density peak of hydrogen in the atmosphere of Earth is 10^{13} m^{-3}, and occurs at an altitude of approximately 80 km, while that of the oxygen atom is 10^{17} m^{-3} at an altitude of 100 km [4]. Although H^+ escapes from Earth's gravity, the peak density of H^+ exists based on a continuous supply of H^+ via solar wind.

The conventional "bow-shock" concept has frequently been mispresented as "solar wind exhibits a decreasing velocity owing to a repulsive force in the geomagnetic field." The bow-shock concept results from the collision of particles with solar wind in the upper boundary of the atmosphere. The idea that the geomagnetic field prevents solar wind is incorrect. The magnetic field is the result of line integral from the electric current in a closed circle. Isolated moving electrons in a coil always change the direction. The isolated charged particle in motion affects the local motion of other moving charged particles. According to the Aharonov–Bohm effect [5], the magnetic field (**B**) is a mathematical entity for contiguously moving electrons and the vector potential (**A**) physically influences a moving isolated electron. In other words, the A–B effect states that a moving charged particle should be described by **A** instead of **B**.

Quantum theory uses the magnetic coupling energy among charged motioning particles via **A** (**B** = rot **A**). Equation (1) indicates that **A** caused by current **j** provides energy (E_m) to another current (**i**).

$E_m = -\mathbf{A} \cdot \mathbf{i}$ (1)

Although there is horizontal magnetic coupling on parallel traveling protons (H^+), there is repulsive magnetic force between the parallel traveling H^+ and electrons (e^-). This magnetic effect maintains the plasma state of solar wind. The movement of the scalar potential (V) generates vector potential **A**. The static potential V (**E** = grad V) and vector potential **A** have an identical form of distance dependency [6]. The magnetic field decreases at a location far from the source. The H^+ in solar wind collides with an atom or a molecule in cosmic space; the ionized particles contribute to expansion of magnetic field by the chains of additions due to parallel-moving charged particles. So, the chain of coupled charged particles traveling in parallel expands the magnetosphere of the Planet (Figure 1).

As shown in Figure 1, the inner van Allen belt is located at approximately 1.6 R_e (R_e = 6,378km; Earth radius). The Outer van Allen Belt is located at approximately 4.0 R_e. There is a "gap" region between these belts at the distance of 2.2 R_e [7]. The offset mechanism related to the magnetic coupling among charged particles causes this gap region.

Effects of Solar Wind on Planetary Wind

Comparison of the Wind on Planets

The sun emits high-speed H^+ as solar wind. The rotational component of solar wind, i.e., 1.89 km/s, is perpendicular to a radiation velocity for several hundred kilometers. The charged particles emitted from the Sun travel over a long distance, eventually colliding with each other. Thus, the rotational component of the momentum of solar wind decreases owing to magnetic coupling. The charged particles of solar wind form a disk shape on a plane perpendicular to the Sun's rotation axis via the magnetic coupling of parallel currents. Comparative planetology has revealed that solar wind drives the atmosphere of a planet. Solar wind passing at high speeds through the eastern region of Earth's atmosphere pushes weather from the east to west because it has a greater acceleration effect than the western deceleration effect. Figure 2 shows the effects of solar wind on atmospheric flow on Venus, Earth, Jupiter, and Saturn. Mousis et al. describe atmospheric flow on the outer planets [8]. The wind flow on Saturn was overwritten by using illustrated data in [9].

Effects of Solar Wind on Super Rotation of Venus

Venus rotates in a direction opposite to that of other planets. The rotational period is 243 days, the orbital period is 224.7 days, and the angle of orbital inclination is 3.39°. The rotational speed of Venus's atmosphere reaches 100 m/s at an altitude of approximately 70 km. Super rotation does not occur by Venus's rotation itself, because there is little angular momentum. The clockwise rotational velocity of the atmosphere of Venus is explained caused by the collisions of solar wind with anticlockwise rotational velocity of1.89 km/s. However, the atmosphere on the nightside of Venus receives solar wind from the direction opposite to that of the dayside. A large bow-like pattern was captured by the mid-infrared camera (LIR) onboard Akatsuki, the Venus climate orbiter, in December 2015 [10], as shown in Figure 3.

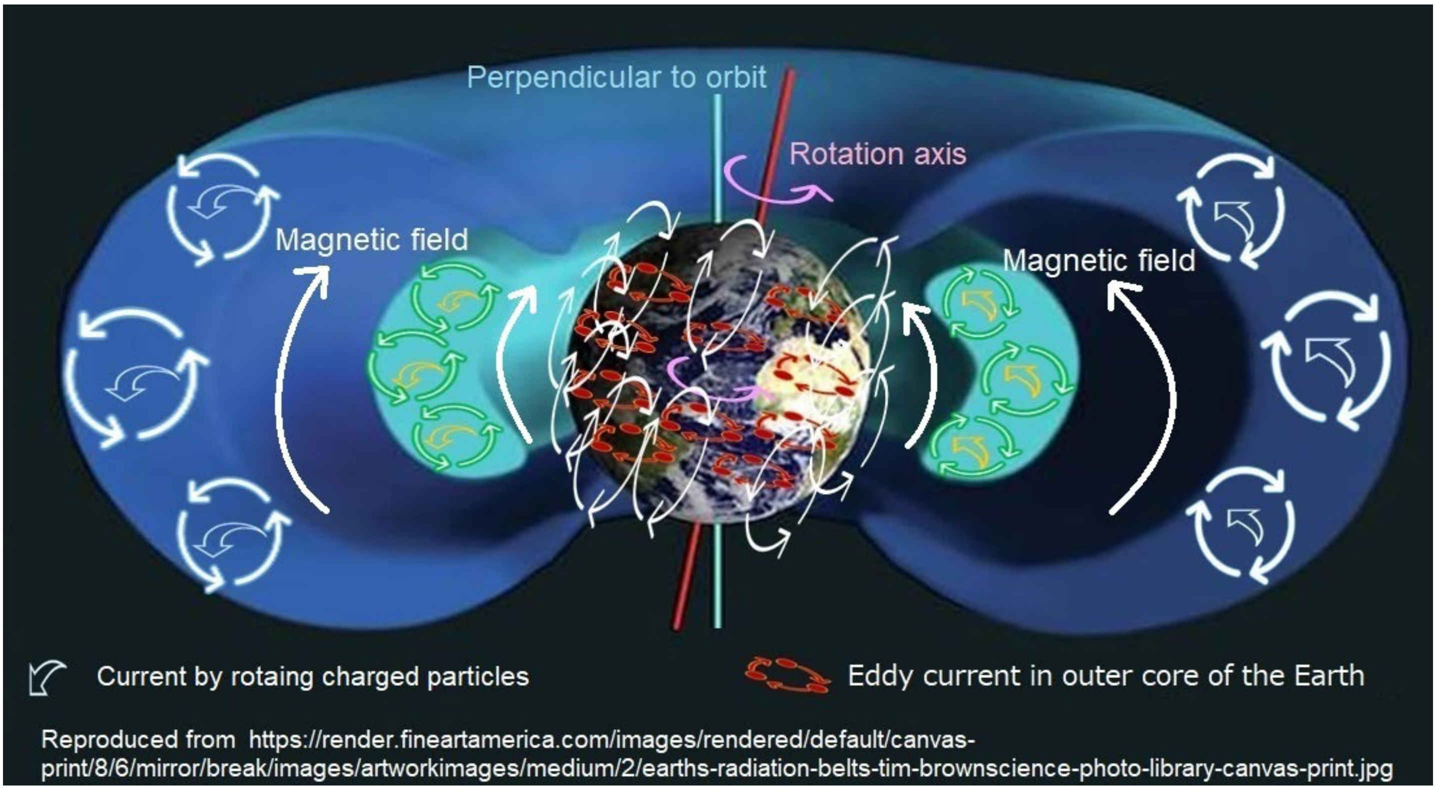
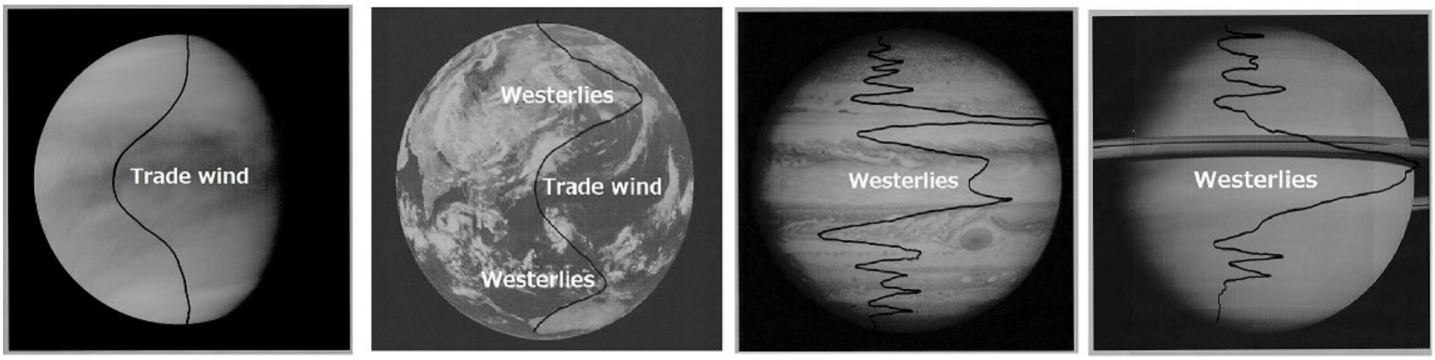


Figure 1: A model of Van Allen belt that is formed via chained magnetic coupling of moving charged particles.



a) Venus b) Earth c) Jupiter d) Saturn

Figure 2: Atmospheric flow on Venus, Earth, Jupiter, and Saturn. Original images of each planet.

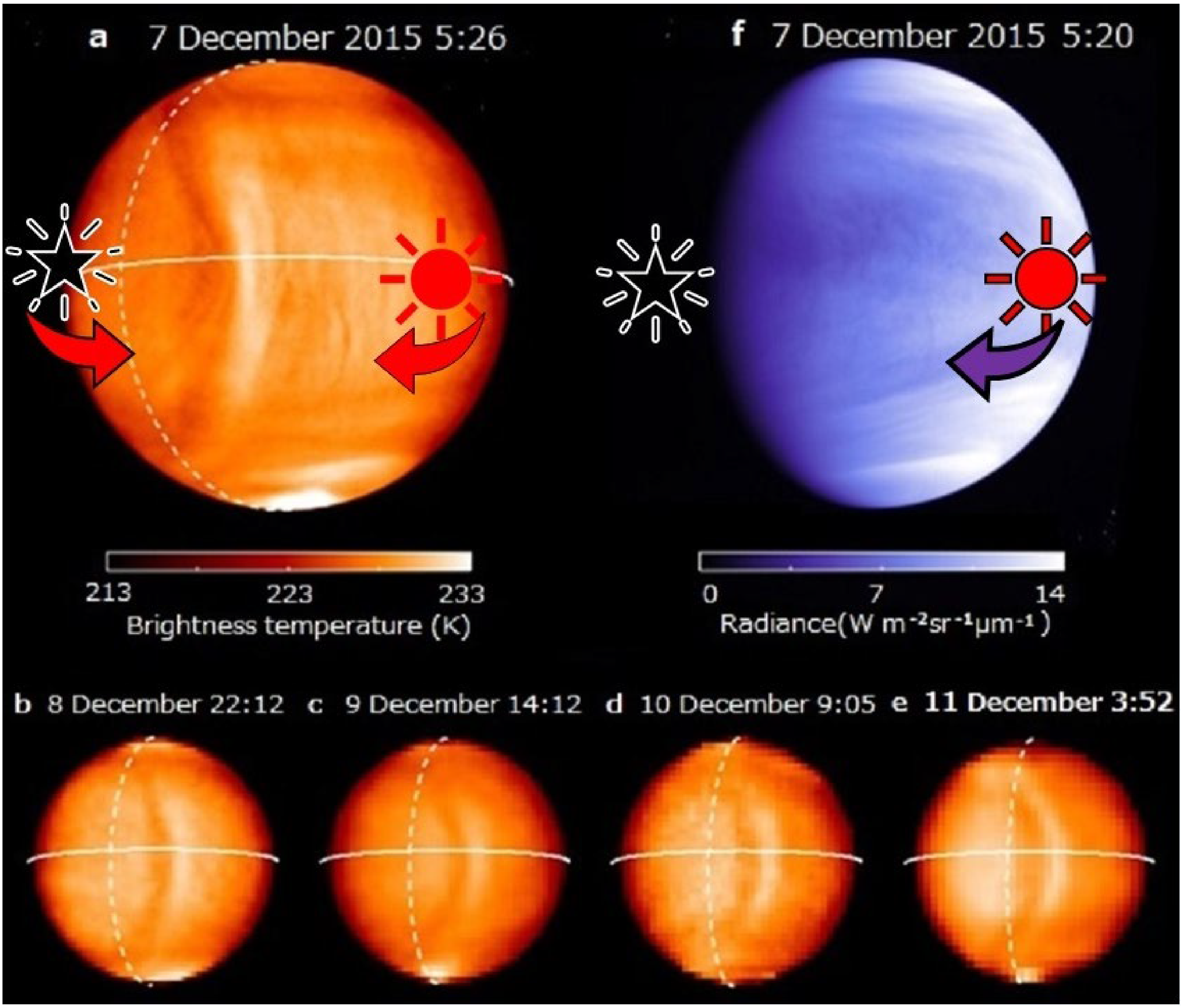


Figure 3: Hot temperature atmosphere of dayside on Venus passes through at upper layer of low temperature atmosphere on nightside at the atmospheric boundary.

This pattern remained in approximately the same place for more than four days. The dayside and nightside continued rotating for more than 100 days. So, the temperature on the dayside increased while that on the nightside decreased. Therefore, the high-temperature atmosphere of the dayside passes through the upper layer of the low-temperature atmosphere on the nightside at the boundary.

Effects of Solar Wind on Earth's Winds

Charged Particle in Earth's Upper Atmosphere

The charged particle density increases at noon owing to ultraviolet rays and light emitted by the Sun. As the mass of electrons is negligible compared with that of H^+, H^+ of solar wind moves in a counterclockwise direction, together with ions in the upper earth's sky. The magnetism caused by the rotating charged particles combines with the geomagnetism caused by the inner core. Auroras occur at a latitude of 75–80° on the daytime side. However, auroras exist at a latitude of approximately 65–70° on the nightside. The difference in the latitudes of auroras between the dayside and night side is due to irradiation from the Sun (Figure 4).

As shown in Figure 4a, the increase in aurora luminescence shifts from the west side to the east side at night, but the decrease in aurora luminescence shifts from the dayside to the nightside. Auroras observed at night are not only caused by the effects of daylight but also by the neutralization of ions by free electrons. As shown in Figure 4b, the trade winds blowing from the east to the west shift the charged particles on the daytime side. The westerlies blow at high latitudes and on the nightside.

Weather in Equatorial Area Related to Solar Wind

Daily Changes in Weather in Equatorial Areas

During the daytime in equatorial areas, where solar irradiation occurs directly from the front, wind is characterized by a clockwise flow as solar wind enters the upper atmosphere. In contrast, solar wind drives the counterclockwise flow of the atmosphere at the nightside. Therefore, rain occurs in the evening along the equator**.** Madden–Julien oscillation (MJO) is a weather phenomenon in the equatorial region generated in the western Indian Ocean, wherein alternate wet and dry areas move eastward with a slow repetitive cycle of approximately 1~2 months [11]. Th slow speed at which weather migrates east over a wide area in the tropics can be understood as an effect of solar wind. The counterclockwise flow of the atmosphere at nighttime is offset by the effect of trade winds blowing from the east to west.

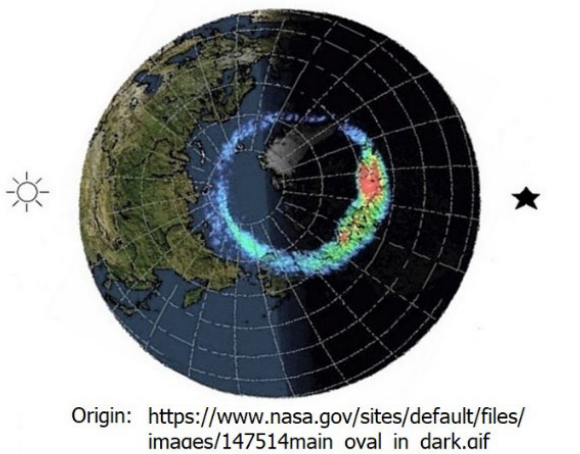
Mechanism of Typhoon

Typhoons occur in the Pacific Ocean during summer in the northern hemisphere. The most irradiated region during the summer solstice is around northern latitude of 23.4°. In this area, although trade winds blow in the daytime on end of June, westerlies of counterclockwise direction blow on both sides of the trade wind. Since the earth's axis of rotation tilts at 23.4°, the solar wind has a moving component of north direction. So, when water vapor uprises at the southern region of the trade wind blows in the summer, that is the region where westerlies wind blows, the vapor of water moves northwest with counterclockwise rotation and collides with the trade wind of clock rotation. The collision forms an anticlockwise vortex. In the vortex, water vapor condenses, and rains, causes a tropical cyclone. This tropical cyclone moves northwest in a clockwise trade wind while develops into a typhoon. Then, the typhoon collides with the westerly winds of counterclockwise rotation and travels northeast direction. Figure 5 shows an illustration of the typhoon mechanism.

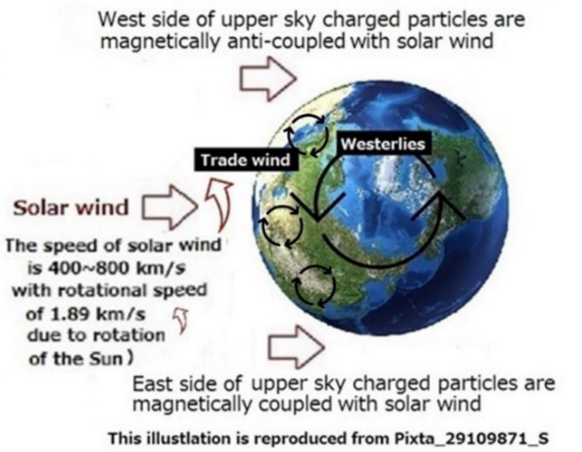
Conclusion

Weather and climate rely on the winds blowing over a wide area affected by solar wind. The tilt of Earth causes seasonal changes in the wind owing to solar wind. The flows of atmosphere are linked to solar wind via magnetic coupling among moving charged particles.

This study described effects of solar wind on the weather and the climate of Earth. This will be helpful when discussing research in a wide range of fields such as global warming.



a) Aurora



b) Effects of solar wind

Figure 4: Differences between the Sun-facing side and nightside, as observed from the North Pole.

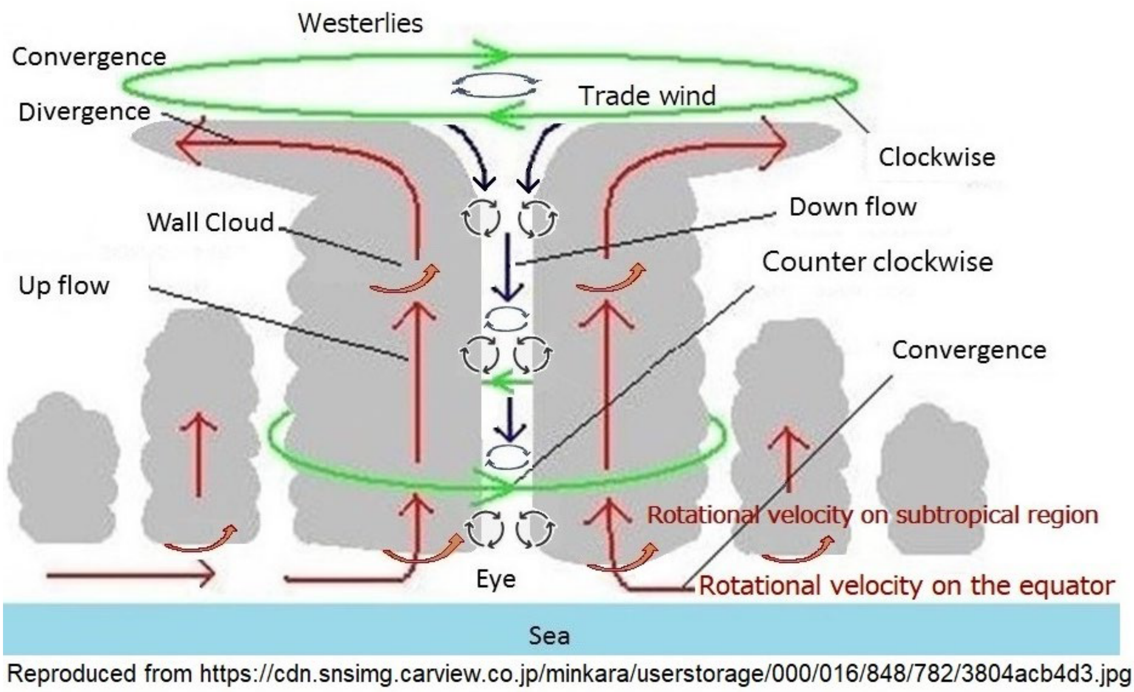


Figure 5: Typhoon mechanism in the northern hemisphere during summer.

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