The reasons that cause changing of Earth daytime by increasing and decreasing velocity of rotation around its self

Mahmood Salem Dhabaa

Geology department, faculty of science, Gharyan University

الملخص

سرعة دوران الأرض حول نفسها تتغير بسبب العديد من الأسباب والتي تؤدي الي تغيير في طول زمن اليوم. الأسباب التي تعمل على تغيير في سرعة دوران الأرض يمكن تقسيمها الي عاملان رئيسيين هما: تغيرات داخلية لا يمكن ملاحظة لأنها تحدث تحت القشرة الأرضية، بالإضافة الي العامل الاخر الذي يعرف بالتغيرات الخارجية وهي عبارة عن تحولات طبيعية تكون فوق سطح الأرض. كلا العاملين السابقين يعمل علي زيادة او خفض طول الزمن اليومي الأرضي. بالنسبة للعامل الأول يتمثل في عوامل طبيعية مثل الزلازل وحركة الصهارة وتكثفها داخل منطقة الوشاح (**mantle**) والنواة وغيرها، اما التغيرات الخارجية فتتجلى في ظواهر طبيعية مثل المد والجز البحري وذوبان الجليد القطبي وغيرها. أخيرا، زمن تغير طول اليوم الأرضي لا يتعدى سوي بعض الثواني من سنة الي اخري، ولكن يمكن ان تكون لها قيمة كبيرة على فترات زمنية طويلة.

Abstract:

Earth velocity changes under many reasons. They cause variations in the length of daytime. These reasons are; interior changes, which usually occur during events that tend to speed up Earth's rotation slightly but noticeably, and Outward changes, where material that was typically at one point at a higher elevation on Earth surface falls down to be at a lower point. The first reason may show in several figures like earthquake and condensing core of earth. On the other hand, tide, melting glacier poles, and changing weather they cause the other reason. The amount of time that increasing or decreasing in a day until now do not exceed few seconds, but on the massive scale of time as the age of earth it becomes important value.

Introduction:

Earth is unique known planet. It has a plenty of water. Our world has a moon, atmospheres, ice, and even oceans. Additionally, Earth has the right combination to sustain life. Earth's oceans cover about 70 percent of the

planet's surface with an average depth of 4 kilometers. Fresh water exists in liquid form in lakes and rivers and as water vapor in the atmosphere, which causes changing on the weather of the Earth in atmospheric layers. Earth has multiple layers. These layers are crust, mantle, and core **[3],[9]**.

The upper layer is crust. It is divided into group of huge plates that float on fluid material of mantle that placed under this layer. The plates are continually in motion. Earthquakes occur when these plates friction or collide against each other. Mountains form when the plates collide and deep trenches form when one plate slides opposite another plate. Plate tectonics is the theory explaining the motion of these plates. The mantle under the crust is about 2,890 km deep. It is composed mostly of silicate rocks rich in magnesium and iron. Intense heat causes the rocks to rise. They then cool and sink back down to the core. This convection steams is thought to be what causes the tectonic plates to move. When the mantle pushes through the crust, volcanoes erupt. At the center of the Earth is the core, which has two parts. The solid, inner core of iron has a radius of about 1,220 km. It is surrounded by a fluid outer core composed of a nickel-iron mixture. The outer core is about 2,180 km thick. The inner core revolves at a different speed than the rest of the planet. This creates Earth's magnetic field **[5],[12]**.

Scientists who assess the planet's weather see convinced evidence that Earth has been getting warmer, in some cases quickly. Most of them believe that human activity, in particular the burning of fossil fuels causes increasing the greenhouse gases in the atmosphere. Consequently, the global warming has been started. In the past decade, scientists started recording high average annual surface temperatures roughly every year. They have been observing other signs of change all over the planet: in the distribution of ice, and in the salinity, levels, and temperatures of the oceans **[2],[8]**.

Issac Newton’s laws of motion describe how winds and air pressure quantities are related to the Earth's rotation rate. This leads to a change in the length of day. It is named also as polar motion, or Earth wobble).

To understand the concept of angular momentum, imagine the Earth spinning in space. Given Earth’s overall mass and its rotation, it contains a certain amount of angular momentum. When an additional force acting at a distance from the Earth's rotational axis occurs, referred to as a torque, such as changes in surface winds, or the distribution of high and low pressure patterns, especially near mountains, it can act to modify the rate of the Earth’s spin or even the direction of the revolving axis.

Because of the law of "conservation of angular momentum," small but detectable changes in the Earth's rotation and those in the rotation of the atmosphere are linked. The conservation of angular momentum is a law of physics that states the total angular momentum of a rotating object with no outside force remains constant regardless of changes within the system. An example of this principle occurs when a skater pulls his or her arms inward during a spin. This changing in the mass distribution of one nearer the rotation axis is reducing the "moment of inertia," and speeds up (increasing the skater's spin); because the moment of inertia goes down, the spin rate must increase to keep the total angular momentum of the system unchanged. "The key is that the sum of the angular momentum (push) of the solid Earth plus atmosphere system must stay constant unless an outside force (torque) is applied," Salstein said. "So if the atmosphere speeds up (stronger westerly winds) then the solid Earth must slow down (length-of-day increases).Also if more atmosphere moves to a lower latitude (further from the axis of rotation), and atmospheric pressure increases, it also gains angular momentum and the Earth would slow down as well." Other motions of the atmosphere such as larger mass in one hemisphere than the other can lead to a wobble (like a washing machine with clothes off-balance) and the poles move, in accordance to the law of the conservation of angular momentum **[7],[13]**.

Methodology:

Earth velocity alterations have two main reasons that work to change it constantly. These reasons have named as inner and outer causes.

The inner effects have many shapes. Firstly, magma is condensing in the outer core layer that leading the inner core become bigger. The magma losing temperature since it has been created until now. This conduces altering magma from liquid to solid state. The solid magma combines with the inner core. Changing size of the inner core works to cause alteration in the rotational velocity of Earth. The solid core formed only between 1 and 1.5 billion years ago, and continues to grow, as the portion of the outer core solidifies over time. Then, the center of Earth is becoming more dense and stable, as more and more of the mass gets concentrated towards inner core. This is a big deal for rotation of the Earth. Consequently, the rotational speed increases to compensate for changing in the inner and outer core mass. Secondly, the convections steams in the mantle coat do varying the rotation speed of Earth. This magma steams are changing their paths and intense. Movement of plates depend on variation in magma flow. Thus, directions and

strength of magma currents are major reason that control of stronger or weaker earthquakes, and govern of number occurring earthquakes. Strongest earthquakes that have intense more than seven on Richter scale are increasing daily velocity rotation of Earth. When big earthquake happen, massive mass of mantle change distribution that cause shorting in the length of Earth day **[1],[9]**.

The outer effect also has many shapes. These reasons occur upper the Earth crust in ocean and atmosphere. Firstly, increasing and decreasing levels of ocean do variation in the rotation speed of Earth planet. Levels of oceans changing undergo moving the surrounding luminaries. The secular change in the planet's rotation is a classical topic in geophysics. It goes back some 300 years to when Sir Edmond Halley. Most of Halley's lunar acceleration was only apparent. It was actually the earth's rotation slowing down. The larger effect is the earth's rotational braking. This braking is caused by tidal friction. Throughout the earth's history, tidal braking has played, and it will continue to play, a dominant role in the rotation. Currently the secular change in the rotation rate increases the length of day by some 2.3 milliseconds per day per century. The other way, caused by the continual movements of the tides about the planet, produces very small but very rapid changes in rotation. These rapid changing occur at exactly the same periods as the tides themselves half-daily and daily. There are two ways that the ocean tides can cause such rapid variations. (1) As the tides move water around the globe, the moment of inertia of the earth changes by conserving the angular momentum. Therefore, the solid earth changes its rotation rate accordingly. (2) As the tidal currents slow down or speed up, they exchange angular momentum with the solid earth, which is established in the rotation rate **[4],[11]**. Furthermore, melting glacier of poles are changing levels of oceans that causes altering of daytime. When global warming has been started, temperature has raised and pole ice diminished. The melted pole ice is going to oceans and it is increasing the amount of water to new levels. This alteration in the level of oceans are effecting on the tidal movement. Then, tidal works to change velocity rotation of Earth as have been explain above. Also, "Changes in the atmosphere, specifically atmospheric pressure around the world, and the motions of the winds that may be related to such climate signals as El Niño are strong enough that their effect is observed in the Earth’s rotation signal," David A. Salstein, an atmospheric scientist from Atmospheric and Environmental Research, said in 2003. El Niño is a periodic natural warming of the tropical

Pacific Ocean, while La Niña, which was observed toward the end of 2020, is a natural cooling of the same part of the Pacific **[10],[14]**. According to NOAA (National Oceanic and Atmospheric Administration), while El Niño results in a decrease in the earth's rotation rate, La Niña tends to have the opposite effect. The recent acceleration in Earth's spin has scientists talking for the first time about a negative leap second, LiveScience said. Instead of adding a leap second, which has been done several times before to make up for a slowing of the Earth's rotation, they might need to subtract one as shown in figure (1)**[6]**.

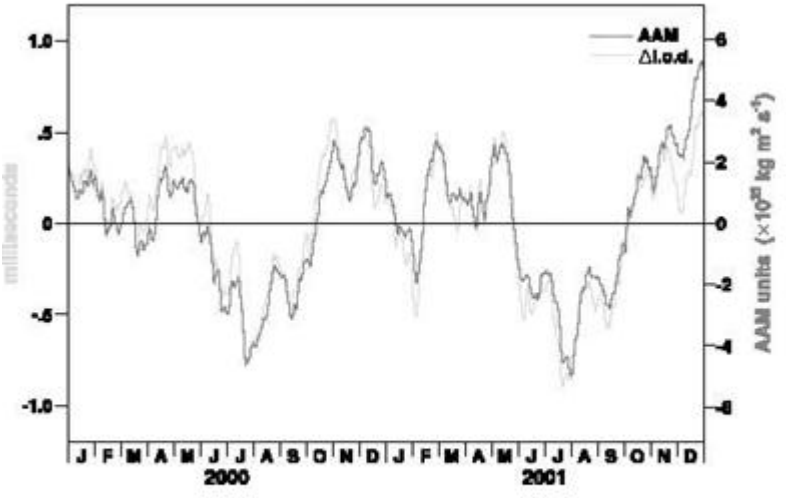

Figure (1): changing in the length of the daytime caused by El Niño and La Niña phenomena

Because of the earth's inconsistent speed, scientists in the 1950s created an atomic clock to keep precise track of time. However, as the Earth's rotation can vary, the atomic clock continued steadily ahead and the two time indicators grew farther apart. To fix that inconsistency, scientists then created UTC (Coordinated Universal Time) to help bridge the gap between Earth time and the atomic clock. However, the atomic clock continued to race ahead, so at least once every 10 years scientists added an extra leap second to

the UTC to keep them closer together. It is particularly important for things like GPS (Global Positioning System) navigation **[10].**

Conclusion:

Length of daytime is changing because many factors that have explained above. This alteration have divided to two main aspects. They are aspects increasing daytime long and they are aspects decreasing daytime long. The reasons that cause increasing daytime long are changing size of the inner core, convections steams in the mantle coat, and continual movements of the tides about the planet. On the other hand, the reasons that cause decreasing daytime long are increasing and decreasing levels of ocean and melting pole ice.

References:

[1] Alfred E. Ringwood, Origin of the Earth and Moon, Springer Science & Business Media, Germany Berlin/Heidelberg, 2012.
[2] Al Gore and Melcher Media, An Inconvenient Truth: The Planetary Emergency of Global Warming and What We Can Do About It, Rodale, USA New York 2006
[3] David Bercovici, the Origins of Everything in 100 Pages, Published by Yale University Press 2016.
[4] https://core2.gsfc.nasa.gov/ggfc/tides/intro.html
[5] https://manoa.hawaii.edu/exploringourfluidearth/node/1348
[6] https://www.livescience.com/earth-spinning-faster-negative-leap-second.html
[7] https://www.nasa.gov/centers/goddard/news/topstory/2003/0210rotation.html
[8] https://www.nationalgeographic.com/environment/article/big-thaw
[9] https://www.nationalgeographic.org/encyclopedia/core/
[10] https://www.usatoday.com/story/news/nation/2021/01/08/earth-spinning-faster-than-has-decades/6581600002/
[11] Kurt Lambeck, the Earth's Variable Rotation: Geophysical Causes and Consequences, Cambridge University Press, USA New York 2005.
[12] Pankaj Agrawal And Manish Shrikhande, Earthquake Resistant Design Of Structures, PHI Learning Pvt. Ltd, India new Delhi 2006.
[13] Richard S. Gross, The effect of ocean tides on the Earth's rotation as predicted by the results of an ocean tide model, issue 4, the American Geophysical Union, USA 1993.

[14] S. Fred Singer, Unstoppable Global Warming: Every 1,500 Years, Rowman & Littlefield, USA New York 2006.