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Earth's climate: Influences from extra-terrestrial bodies

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ABSTRACT

This review aims to find researches conducted, facts and figures related to the brief mentioned above i.e. how influences from other planets change Earth's climate. The report prioritizes on climate change from an interplanetary perspective apart from major terrestrial reasons and determines nature of events likely to occur if instability continues, with reference to studies accomplished on Jupiter, Saturn, Mars, and various bolide impacts.

Keywords—*Climate change, Extra-terrestrial bodies, Impact on climate, Study of Jupiter's Moon, Global change in climate*

1. INTRODUCTION

Our planet Earth is the only known galactic body to sustain life, which makes it special from among thousands of other planets and stars. But life did not originate without any substance. It is because Earth has a favorable atmosphere to maintain and help carry out biochemical activities that make living possible. Therefore, any anomalous change in a minute quantity or quality of global balance in terms of energy budget or ecological equilibrium has the potential to disturb the presence of natural living behavior. Here we discuss how the effect of extra-terrestrial masses influence our planet's climate and how by studying the atmospheres of space-bound bodies, we can predict future climate aberrations.

2. CLIMATE AND OCEANS

Regarding the climate of our planet, many drastic changes have been occurring over the past few decades and the results are quite apparent. Scientists have classified two main sinks of pollutants generated naturally or artificially i.e. through humans. One is the forest ecosystem all over the globe acting as the basis of carbon dioxide, particulate matter, dust, aerosols, and a plethora of organic and inorganic elements resulting from various reactions occurring on our planet. The other sink is the ***ocean***. Oceans cover more than half of the total planet's area and have been the first masses to arise after formation of Earth 4.6 billion years ago. These were the media that supported early organisms thus, forming an irrefutable link to life as we know it. Through variations in currents, wind directions, wave nature, and tides, oceans have helped drive atmospheric phenomena since their existence. Therefore, these provide a natural inertia to changes occurring on the planet because of their size, volume, spread and innate quality to control major vicissitudes, both in the atmosphere and biosphere. Although being the largest sink comes with its own set of problems. Accumulation of forces that would otherwise cause life-threatening incidents on Earth, the constant absorption of those have led to oceans turning into a time-bound reservoir for abrupt change which, in time, will destroy whatever lives and breathes on Earth [4].

3. CLIMATE AND COSMOS

Apart from global happenings with terrestrial origins, a number of phenomena occurring outside our protective atmosphere have the capability to alter climate. This has been projected through modeling techniques and researches on Earth's precession, obliquity, and change in orbit shape. Now, we will understand what these *planetary-scale* cycles are. All three i.e. Eccentricity, Obliquity, and Precession are collectively known as ***Milankovitch cycles***. Eccentricity is the change in shape of the Earth's orbit when it comes in the vicinity of Venus and Jupiter. It happens every 100,000 years resulting in the planet receiving a slightly varied amount of solar insolation. Obliquity is due to the rotational axis of Earth shifting from 21.5° to 24.5° every 41,000 years [5]. This phenomenon occurs due to influences from the moon and is responsible for the varied amount of solar output received during winters and summers, affecting seasons in both hemispheres. Precession arises due to the wobble of the Earth about its axis. The bulged equatorial region and slightly narrow poles induce this phenomenon, which is escalated by the gravitational pull from both the moon and the sun. The cycle repeats every 23,000 years causing fluctuations in perihelion and aphelion conditions in the North and South hemispheres [3].

These activities, as is stated above, occur over a large time period of thousands of years, nevertheless have a significant impact on modifying the planet's climate record. It is known that the glacial and inter-glacial periods that occurred in the Ice-Age phases

have been influenced by these extra-terrestrial occurrences which regulated the amount of sunlight received by our planet with respect to changing orbit positions and tilt of the rotational axis. Thus, it can be thoroughly justified that Earth is affected by episodes of extra-planetary origin.

4. CLIMATE AND INTERPLANETARY RESEARCH

Studies have continued with new and independent scientists putting forth theories to prove a planetary effect on Earth's climate system. In 1997, University of Toronto Physicist Jerry Mitrovica and Allessandro Forte of the Institut de Physique du Globe de Paris used numerical simulations to provide information connecting Earth's changing shape and the gravitational effects of massive planets, Jupiter and Saturn. The scientists predict that gravitational forces from these planets have large size changes on the Earth's climate, in terms of geological time-scale. Considering Earth at the time of its formation, when it was yet to solidify and form properly, the effects of these planets would have been much more than are seen now. Using mathematical simulations, Mitrovica found that around 20 million years ago Earth passed through a gravitational resonance phase associated with the orbits of Jupiter and Saturn, which in turn influenced the way Earth's axial tilt changed during that period. This rapidly changing tilt of young Earth would have been a result of a number of factors, external and internal, with gravitational effects from titanic planets like Jupiter one of the influential forces driving its deformation.

"To comprehend what stimulates climate change, apart from considering dynamics that thrive on our planet, it is important to take into account Earth's position in the solar system". This statement was conveyed by the leading scientists pursuing this research thus, making it one of the important studies to co-relate climate change and interplanetary interactions.

The study is financed by the Natural Sciences and Engineering Research Council (NSERC) and the Canadian Institute for Advanced Research (Earth Systems Evolution) [1].

5. CLIMATE AND METEORS

Paleoclimatological studies have found evidence relating bolide impacts and alterations in climate systems on a global scale. Mass extinctions that occurred during the Late Devonian and Cretaceous-Paleocene periods are well documented to impacts from celestial bodies like asteroids or stray meteors, with special reference to Chicxulub asteroid impact that hit and ended life in the latter period. Iridium deposits were found in sedimentary rocks all over the world which indicated the impact of this bolide. An asteroid was also one of the factors responsible for Permian extinction referred to as "The Great Dying". An extra-terrestrial body when collides with Earth results in a release of tremendous energy equal to the detonation of several million nuclear weapons with a huge area under its influence. That is the first phase of an ***impact event***. The next is release of gases such as carbon monoxide (CO), carbon dioxide (CO2), dust particles, suspended particulates of size ≥ 10 μm, and smoke and fumes that have the potential to block out solar insolation for several days to months or increase the global temperature of the Earth, thus changing climate over an extended period.

6. NEW APPROACH TO INTERPLANETARY EFFECT ON CLIMATE CHANGE

A more recent approach to climate change with respect to celestial involvement is provided by University of Houston Planetary Scientist, Liming Li, and his team. October 2017 saw climatologists and scientists from the domain of physics, environment, and planetary geology discussing interesting ideas put forth in 'Earth's Changing Global Atmospheric Energy Cycle in Response to Climate Change' by Yefeng Pan et al in the journal *Nature Communications* [2]. The research focuses on how energy capital of the Earth is intensifying, causing a drastic increase in the incidences of storms as a result of additional potential energy accumulated inside the planet's reservoir which needs immediate discharge. This excess energy is leading to kinetic storms all over the central Pacific Ocean, where earlier too, scientists had discovered intense tropical cyclones on the rise. The team has enumerated all evidence through a calculated ***Lorenz energy cycle*** after the MIT scientist Edward Lorenz gave the concept in 1955. This energy cycle is known to influence climate and weather. It is a series of complex formula procedure which related how potential energy is converted to kinetic energy in the atmosphere. By studying Titan, Saturn's biggest moon whose energy budget is balanced just like Earth's, Li observed how a giant storm on Saturn, thousands of kilometers wide, changed how the planet absorbed solar energy. The scientists working on this project are of the idea that the same planetary energy effect can be applied to Earth to know variations in climate over an extended period of time.

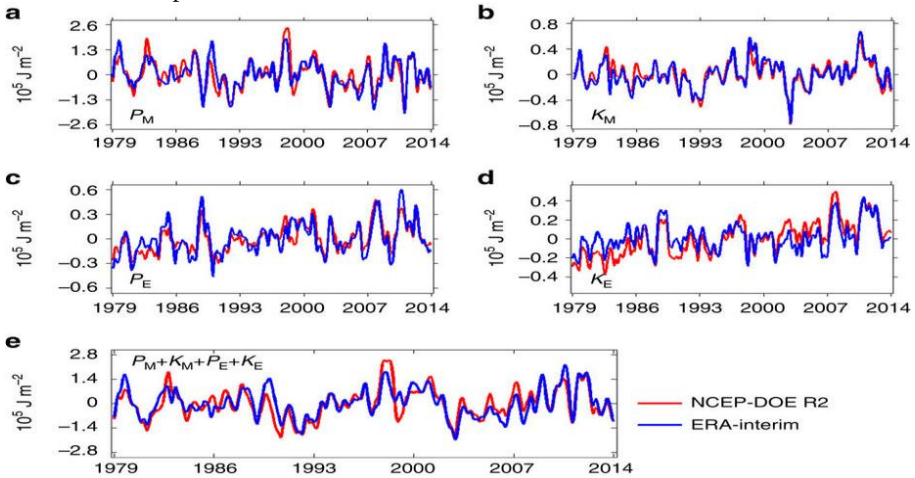

Fig. 1: (a) The mean available potential energy P_M, (b) The mean kinetic energy K_M, (c) The eddy available potential energy P_E, (d) The eddy kinetic energy K_E, (e) The total mechanical energy (that is, $P_M+K_M+P_E+K_E$)
(Source: https://www.nature.com/articles/ncomms14367)

The table above suggests, through careful analysis, that the total mechanical energy of the planet i.e. summation of mean potential and kinetic energies and eddy potential and kinetic energies, is increasing, resulting in a mass imbalance in the energy flow. This imbalance creates disproportionate low and high-pressure belts in sensitive zones around the globe, thus making those areas susceptible to variations ranging from synoptic scale events to mesoscale events within a short duration. This infers that atmospheric phenomenon usually happening at synoptic scales would increase in frequency and relate closely to the mesoscale events. Thus, a huge storm operating in a short interval is bound to be the new mutation over the affected location.

Earlier, just 10-year time scales were studied which were limited in their approach of determining future global warming impacts. But now Li and his team are researching climate change over a 35-year time period, taking into consideration the data on wind and temperature fields gathered by ground-based observatories and satellites and in particular effects of large-scale storms on celestial systems like Saturn. Till date, the results they found suggest that increasing potential energy reservoir causes a positive trend in storm occurrences over many identified hotspots globally. Another group of scientists has successfully completed the Lorenz energy budget of Mars which will help understand how it changed from a warm wet planet to the presently cold and dry world. Similar studies of other cosmic bodies are bound to reveal many facts that will help us understand climate change on Earth profoundly.

7. CONCLUSION

It is safe to conclude that the effects of extra-terrestrial bodies on Earth' climate are a fact and not a theory. Studies relating the two have been going on for some time and new approaches add-on to the existing studies, making us aware of the inter-connection between celestials. Our home is susceptible to forces that would cause abrupt climatic events even from beyond. What makes a difference now is the ability to research past and present phenomena to predict future climate variations, even if we don't possess the capability to change Earth's due progression towards annihilation in time. The only reassurance, if this is a reassurance at all, is that we would be able to discern how life on this blue planet would end.

8. REFERENCES

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