Journal of Physics Special Topics

An undergraduate physics journal

P5_2 A New Solution to Climate Change (ii)

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November 2, 2024

Abstract

This paper continues the research done in "A New Solution to Climate Change (i)" and discusses the feasibility and consequences of negating the effects of climate change via increasing the distance between the Sun and the Earth. This is accomplished by calculating the energy required to move the Earth (168×10^{30} J), the tangential velocity change of the Earth (a 1.6% decrease) and the resultant change in the period of Earth's orbit (an increase of 5% to a period of 383 days).

Introduction

As a result of the ongoing climate crisis, many ideas have been put forward to fight global warming. One such idea is proposed in the paper, "A New Solution to Climate Change (i)" [1], where the solar flux on Earth is decreased by enlarging the distance between the Sun and the Earth. This process would have significant ramifications and this paper explores these problems and comments on the viability.

Figure 1 illustrates the results from part (i) of this research. This shows by how much the Earth would have to move away from the Sun every year, in the period 2005-2100. The data from Figure 1, along with the equations given, is used throughout this paper.

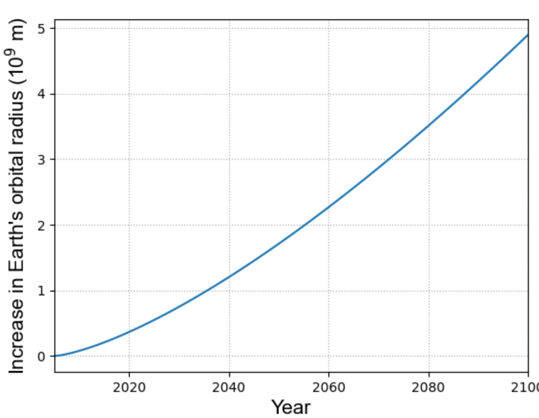

Figure 1: Proposed increase in Earth's orbital radius [1]

Analysis

For the orbit of a planetary body to remain stable, the tangential velocity and distance from the parent body is shown in the equation below [2]:

$$v_{orbit} = \sqrt{\frac{GM_{\odot}}{r}} \tag{1}$$

where 'G' is the Gravitational constant, '$M_{\odot}$' is the mass of the Sun and 'r' is the orbital radius.

Figure 2 illustrates the relationship between the tangential velocity of the Earth and the distance between the Earth and the Sun.

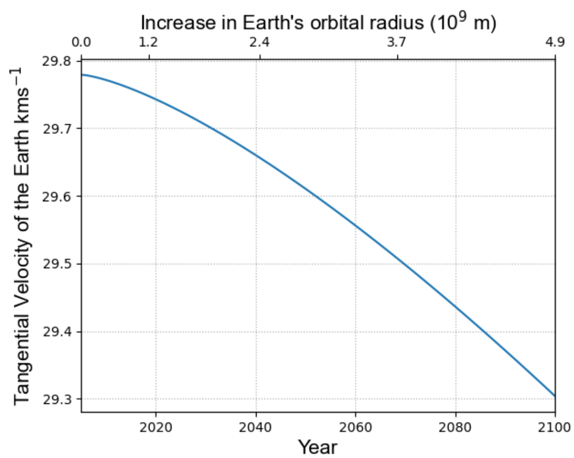

Figure 2: Tangential velocity of the Earth across its transit to a new orbit

As a result, the tangential velocity would be decreased by a total 1.6%. This would not have any noticeable effect on the Earth.

Kepler's third law, as shown below, was used with the modelled solar distance data in order to model the period of the Earth's orbit over time (Figure 3):

$$T = \sqrt{\frac{4\pi^2}{GM_\odot} \cdot a^3} \quad (2)$$

where 'T' is the orbital period and 'a' is the semi-major axis (modelled as the distance to the sun, r).

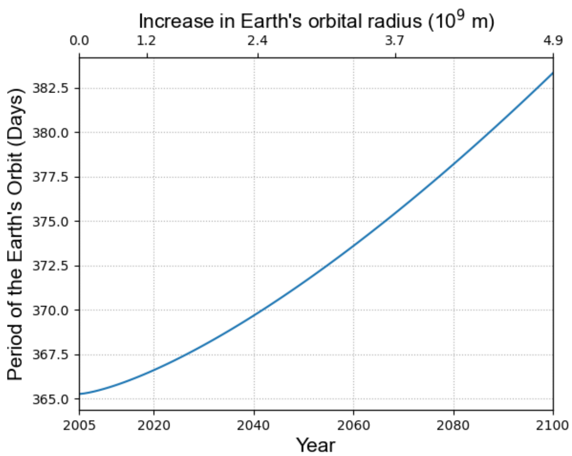

Figure 3: Period of the Earth's orbit around the sun across its transit to a new orbit

Figure 3 shows how the period of the Earth's orbit (the length of an "Earth year") changes as the Earth is moved away from the Sun. According to this model, in the year 2100, a year would equal 383 days, an almost 5% increase from the current period. This would mean that the length of the seasons would increase by approximately 5 days each.

The equation for gravitational potential energy is shown below in equation 3 [3]:

$$U = -\frac{GM_\odot m}{r} \quad (3)$$

where 'U' is the potential energy and 'm' is the mass of the Earth.

Figure 4 shows how the energy required (the change in potential energy) to increase the orbital radius varies with the orbital radius.

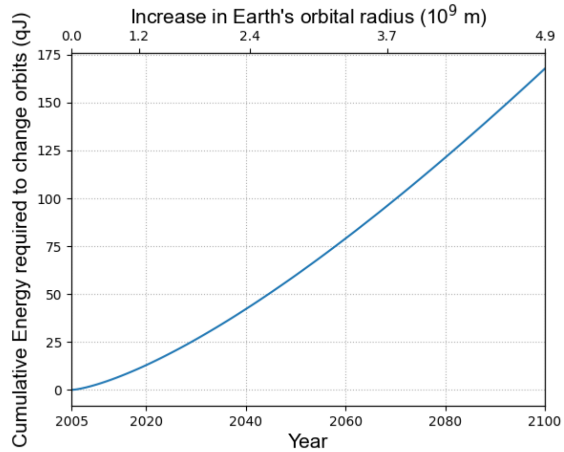

Figure 4: Energy (cumulative) to move the Earth throughout its transit to a new orbit

This energy requirement (168×10^{30} J) is colossal, 2.6 billion times the capabilities of our current output, where in 2023 the total energy produced on Earth was $\sim$ 183000 TWh [4].

Conclusion

Given the current technology, the scheme to move the Earth away from the Sun is not feasible and would likely lead to more warming due to the processes required for such a feat. It would also interfere with Earth's current satellites.

References

[1] S. Sanjeevvijay L. Munt G. Iordanidis. *P5_1 A New Solution to Climate Change (i)*. University of Leicester, Oct. 2024.

[2] *Orbital Velocity Formula: Concept, Formula, Solved Examples*. Toppr-guides, Apr. 2020. URL: https://www.toppr.com/guides/physics-formulas/orbital-velocity-formula/ (visited on 10/08/2024).

[3] HyperPhysics. *Gravitational Potential Energy*. Gsu.edu, 2019. URL: http://hyperphysics.phy-astr.gsu.edu/hbase/gpot.html.

[4] Hannah Ritchie, Max Roser, and Pablo Rosado. *Energy Production and Consumption*. Our World in Data, Jan. 2024. URL: https://ourworldindata.org/energy-production-consumption.