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A2 3 Ice to Melt You: Ice Cube Solutions to Global Warming

T. Dyer, D. Lewis, C. Scrivener,

Department of Physics and Astronomy, University of Leicester, Leicester, LE1 7RH

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Abstract

We set out to determine the amount of ice needed to cool the oceans to pre-Industrial Revolution levels from the perspective of Earth in 2100, where oceans have warmed by 1.2 °C, using the method outlined in the Futurama episode *"Crimes of the Hot"*. We determined it would require 5.366×10^{17} kg of ice to cool the oceans, approximately 2% of the Antarctic Ice Sheet. This ice melting would cool the oceans, but also raise sea levels by 1.5 metres, flooding many low-lying cities, proving catastrophic for humanity.

Introduction

In the Futurama episode *"Crimes of the Hot"*, the crew are faced with the rising temperature of the Earth. Although previous papers have discussed their ultimate solution to the warming climate with moving the orbit of the Earth, there is not much scientific analysis about their original solution, where Earth sources a large ice cube from Halley's comet, every now and then, in order to cool the oceans [1].

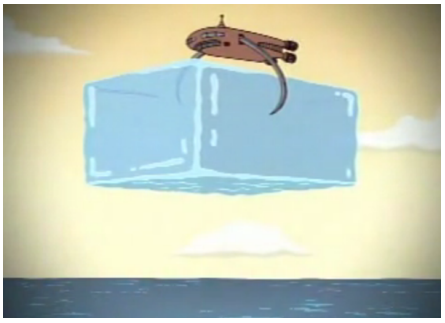

Figure 1: A visual aid to picture the size of Ice Cube required to cool the Earth. [1]

In this paper, we investigate the application of this method to cool our world's surface oceans back to its pre-Industrial Revolution levels.

From a report commissioned by the Government Office for Science, we are given the prediction that the global sea surface temperature will rise by 1.2°C by 2100. This more modest prediction still paints a stark future for the whole of mankind, particularly as warmer water holds less oxygen, leading to a decline in populations of marine life [2]. This increase in ocean temperature can be offset through the melting of ice, cooling the Earth's oceans. This is because ice absorbs energy from its surroundings in an endothermic reaction. The energy ice can absorb before it melts is called the latent heat.

Investigation

Firstly, we determined the volume of the surface ocean, with the surface ocean being the top 100m of ocean depth [3]. We know that the ocean covers 70% of the Earth's surface [4]. So, from these two determinations we can calculate the volume of the surface ocean (V_{SO}) to be:

$$V_{SO} = 0.7(V_{Earth} - V_{Earthsub100m}) \quad (1)$$

where the volume is $4/3\pi r^3$. We also know that the radius of the Earth is 6380 km. This gives us a volume of 3.58×10^{16} m^3. This can be converted to mass by using the density of water (998 kg m^{-3}) to achieve a value of 3.57×10^{19} kg.

Following this, we need to determine the amount of energy needed to be removed from the oceans, so that it cools by 1.2 °C. This can be found by multiplying the Specific Heat Capacity of water (approximately 4200 J $kg^{-1}C^{-1}$) by the mass, which is found to be 1.79×10^{23} J.

Since we know that the latent heat of ice is 334 kJ kg^{-1} [5], we can determine that to completely reverse warming of the oceans, we would require 5.366×10^{17} kg of ice. This equates to approximately to 5.852×10^{14} m^3 [6].

Analysis

Regarding this plan two major problems occur. Firstly, the feasibility of acquisition of such a large amount of ice. The amount of ice would be equivalent to 585000 km^3 of ice, which is approximately 2% of the Antarctic Ice Sheet [7]. This means that this solution would require, as the episode suggests, deep space material exploitation. This is because the on earth solution of using 2% of the Antarctic Ice Sheet would significantly change the circulation patterns on which our current physics is based on. This does not discuss the mass amount of ecological damage to wildlife that reside on the Antarctic Ice Sheet. An alternative solution that could be suggested is to freeze large amounts of water on Earth to create this ice, but the concept talks about bringing ice from Halleys comet.

Another problem that occurs from this is an increase in water volume that would come about from importing such an extraterrestrial ice block into our oceans. The melting of this amount of ice would add 5.85×10^{14} cubic metres to the oceans, leading to an increase in sea levels of approximately 1.483 metres [6]. This would in turn flood not only famously low cities like Amsterdam, but would also include capital cities like Bangkok, Tunis, Algiers and Baku.

Conclusion

In conclusion, we have investigated the feasibility of using a large ice cube to cool the Earth's oceans, and determined it would take 5.366×10^{17} kg of ice. We have also calculated that as well as cooling the ocean, the ramifications of increased sea levels by 1.5 metres would be catastrophic for human life, and therefore cannot be recommended as a valid solution to help solve climate change.

Future possible investigations into this topic could include the feasibility of sourcing such ice from Halley's Comet or other methods.

References

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