

Re: That global warming thingy

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- *From:* don@xxxxxxxxxxxxxxxx (Don Klipstein)
 - *Date:* Mon, 12 Mar 2007 21:49:44 +0000 (UTC)
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In article <45F59B47.C7C1B3B2@xxxxxxxxxxxx>, Eeyore wrote:

Don Klipstein wrote:

In article <45F519A9.8E085283@xxxxxxxxxxxx>, Eeyore wrote:

Don Klipstein wrote:

(stuff about ocean depth and my figuring that the oceans may rise a meter from thermal expansion)

How long would it take the oceans to rise in temp by 2 degrees ?

Let me try an estimate for that...

The first graph in the Wiki article on global warming looks to me like rising at a rate of about .035 degree C per year after 1979. Suppose this rate gets sustained.

I somehow remember doing a calculation in the past for thermal time constant of the ocean mass, and came up with a century or somewhat more.

Feed a .035 degree per year slope starting from 1979 into a first order lowpass filter with a time constant of a century, and I come up with a guess of 130 years, or 2109. And half this warmup of the ocean mass would occur in roughly the last 50 years of this 130 year period. And with the thermal expansion coefficient being non-constant and increasing, the halfway point of the sea level rise of this 130 year period will be even farther into it.

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Let me take a new stab at thermal time constant of the ocean mass...

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Solar constant at sea level with sun at zenith and really clear air is 1100 watts per square meter if I remember correctly. It could be closer to 1,000. Ratio of a sphere's surface area to cross section is 4, so divide 1100 by 4 to get 275 watts per square meter. Half this for average extent and opacity of cloud cover, for average insolation of 137.5 watts per square meter. Multiply by .96 for water being about 4% reflective, for 132 watts per square meter.

Average Earth surface temperature is nearly enough 288 K. So I will use 132 watts per square meter and 288 K.

Let's suppose the radiation absorbed takes a 1% jump from 132 to 133.32 watts per square meter. In a first order of approximation, a 1% increase in incoming radiation will increase the surface temperature by .25%. This is neglecting interaction of spectral shift of outgoing radiation with ability to radiate it changing with wavelength, and this neglects feedback mechanisms such as change of the Earth's ability to absorb radiation.

So that extra 1.32 watt per square meter in a first order approximation is expected to warm things up by .72 degree K.

Water has a specific heat of 4.19 joules per gram per degree K, maybe a bit less for salt water. I would guess 4.15.

A 1 square meter column of average depth sea water 3.71 km deep has a mass of close enough to 3.75×10^9 grams. Multiply this by 4.15 and .72, and it looks like about 1.12×10^{10} joules is needed to warm a square meter of ocean all the way down by .72 degree.

Divide that by 1.32 watts, and I get a thermal time constant of about 8.5×10^9 seconds, or about 270 years.

With a thermal time constant of 270 years and planet surface temperature rising .035 degree per year, I would expect the average ocean mass temperature to be 2 degrees warmer than it was in 1979 sometime around 2150–2170.

At the surface perhaps.

This is for raising the entire mass of the oceans by an average of 2 degrees. It assumes that the surface temperature will maintain a .035 degree C per year rise after 1979 and that the thermal mass of the oceans forms a first order lowpass filter with a time constant of 270 years as calculated or "calculated" above.

I did not actually calculate but only estimated the time needed for the output of a first order 270-year-time-constant filter to increase by 2 units after the start of a .035 unit per year ramp signal. Now I tried a simple computer model for this, and get 197 years – the year 2176.

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Now for another scenario:

<http://www.windows.ucar.edu/tour/link=/earth/Water/temp.html>

shows the ocean being divided into 3 main layers – the surface layer, the thermocline and the deep ocean.

The deep ocean largely has a temperature really close to that of maximum density of water. I suspect this may be largely regulated, by being fed water from whatever locations of the upper layers that have this temperature.

If the temperature of the deep ocean is regulated, then ocean warming will be largely confined to the upper layers. As an oversimplification, I will take the depth of the region that warms to be the surface layer and half the thermocline – 600 meters.

Using a 600 meter depth instead of a 3710 meter depth, the thermal time constant shortens from 270 years to 44 years. With input signal of a .035 degree per year ramp starting in 1979, my simple computer model projects a 2 degree rise 97 years from 1979, or in 2075.

The above page says that the average temperature of the surface layer is 17 degrees C. The volume thermal expansion coefficient of water is about .00017 per degree C. The average over the range of temperatures of ocean water appears to me a bit less, maybe .00015 per degree C. So when the top 600 meters has warmed up by 2 degrees C, it would expand by about .03%, or .18 meter.

– Don Klipstein (don@xxxxxxxxxx)

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