If 3 Was 9

I'm an optimistic person -- hey, when you lose your eyesight and you still get to have a wonderful life with incredible good fortune when it comes to career, family, friends, and so much else, why wouldn't one come to think good things tend to happen?! But that doesn't mean I don't notice problems or have concerns. About five years ago I concluded that there were, fundamentally, four big things to worry about, in terms of the fate of the United States and its people (I won't pretend to know enough about events around the world to take a strong stand on the problems of every nation.) Those four things are:

- Artificial Intelligence
- Authoritarianism
- China
- Climate change

Two A's and two C's; easy to remember. It's my belief that if things go well regarding these four issues over the next few decades, quality of life will likely be extremely high for the typical American, and perhaps also for less-well-off Americans, even if other issues I care about don't develop as I hope. Of course, there are a million things to worry about. I do worry about many of them, but when I find myself spending hours contemplating the minimum wage or differences in candidate healthcare plans, I remind myself that these are not in the Big Four; they matter, but they are not existential or near-existential in the way, in my opinion, the B4 are. Perhaps I'll write an essay about why I think these are the most important concerns; in the meantime, if folks are sure I'm leaving something as or more important than these out, let me know! Today I'll just talk a bit about one of the items: the climate.

We've all read more about the climate than we really want to this summer, what with heat waves and fires around the globe. And given my tendency toward loquacity, I understand if folks are shuddering at the possibility of many thousands of words more. But, not to worry! I have a super-simple point to make. I won't even need more than a few hundred words to say it, and moreover, if you stop a few sentences from now, you'll get the heart of the matter. It's this:

When you read that climate scientists expect 3 degrees of warming this century, and you think that seems maybe not ideal but not like something that could matter all that much, remember this: 3 degrees is really 9 degrees. Or maybe 7 or 8 if we're lucky.

Jimi Hendrix asked what would happen if six turned out to be nine. But it's really three that's nine. That's because of two simple factors, one obvious and one less so. The obvious one is, each Fahrenheit degree equals 1.8 Celsius degrees. Scientists use the metric system and so of course speak of 3 degrees when they mean 3 degrees Celsius. But that's 3*1.8 = 5.4 degrees in the Fahrenheit scale we Americans are used to.

The second issue is that scientists talk about **global** temperature increase. But we don't live on the whole globe. In particular, we don't live in the middle of the ocean, we live on land. And the land heats up much faster than the ocean; indeed, the evidence I have found suggests almost twice as fast. ** That wouldn't matter much if the Earth was primarily land, but of course, the opposite is true, as every schoolchild knows, about three-quarters of the planet is covered by water. So, let's say the Earth has its temperature rise 1 degree. We don't know how much that means land temps are up but with some algebra, we can figure it out; let's say ocean temperatures increase T degrees and land temps rise 2T degrees. Then:

*.25*2T + .75*T = 1 degree*

= .5T + .75T = 1.25T = 1

So T = 1/1.25 =.8

Which is to say, if global temps are up 1 degree -- any kind of degree! -- then ocean temps are likely up around 0.8 degrees and land temps are up 1.6 degrees.

And so, if global temps are up 5°F as discussed above, then land temps are up 5.4*1.6 which is a little under 9.

9°F is a lot! It's the difference, approximately, between the average summer temperature in Boston and the average summer temp in Miami.

Now, we can pare this down a little. The Earth is closer to 70% water than 75%; that cuts the multiplier slightly, to perhaps 1.55 instead of 1.6. Moreover, the best data I have is from Byrne (2020) who says that average temperatures were (a few years ago when he was writing) .95C higher than the 20th-century average, with land up 1.43x and oceans up .77x. That's a 1.86 ratio; if we plug in 1.86 instead of 2.0, along with the lower ocean-coverage percentage, we get a multiplier right around 1.5. 1.5*5.4 is still between 8 and 9, but it's closer to 8; I focused on 9 above just so I could keep the Jimi reference I originally built the essay around! Finally, while 3C is a standard estimate, the latest IPCC report is slightly less pessimistic, with a 2.7C increase predicted. Applying all these gets us down to an increase of 7.3F average on land, though probably more like 9°F in Massachusetts where I live, due to warming amplification at higher latitudes.

I'm not a climate expert so I won't go on and on about all the problems that a 7+°F temp increase can create. Plenty of others will do that for you. My purpose is just this: when you read that temps could easily rise 3 degrees by 2100, and then you read about the terrible

consequences of that, and then you think "How could 3 degrees have that large an impact?"... well, now you, I hope, won't think that, because you'll realize: "Oh, wait, 3 degrees is really more than 8 of the degrees I'm used to on the surface I live on, **of course** that could have a meaningful impact!

**Why does the land heat up twice as fast as the water? The glib answer is: have you ever been to the beach?! In particular, have you ever been to Maine's Ogunquit Beach, AKA "Fire and Ice"? The sand is so hot you can't take off your flip-flops, but the ocean will have your teeth chattering. Water is famously hard to heat up; it takes considerably more heat to get a pot of water to boil than it does to get an equally heavy steel pan to the same temperature. Moreover, when you heat the surface of the ocean since water is always sloshing about as liquids do, the heat moves down into the depths more than on land, whereas it is well-known it can be very cool under just a modest layer of sand or soil.

With all that said, I can't state with confidence that just because the land heats up much faster than the water on a hot day, similarly climate change heats the land more than water. What I can say is, first, as cited above, it is empirically the case that land is heating almost twice as fast as the ocean. And if you read up on it you'll see that scientists do believe this is the natural state of affairs, predictable from the physics of the situation. And it is my guess that the factors I listed -- the high specific heat of water and the differing properties of liquids and solids -- play a role here but are not the whole story.