The Busy Worker's Handbook to the Apocalypse

Abstract

Climate change will cause agricultural failure and subsequent collapse of hyperfragile modern civilization, likely within 10-15 years. By 2050 total human population will likely be under 2 billion. Humans, along with most other animals, will go extinct before the end of this century. These impacts are locked in and cannot be averted. Everything in this article is supporting information for this conclusion.

Target audience is the educated but busy / swamped American worker who reads the occasional article on climate change and concludes that everything must be under control or else there would be urgent alarms going off right? That was basically me until a couple years ago when a period of unemployment gave me the opportunity to dive into the science and start evaluating the conclusions for myself.

I do not expect anyone to read this entire article from start to finish. My hope is that it can serve as a decision making aid for answering some of the critical questions that we face when trying to make major life decisions and deciding how best to prepare for the future. It is organized like a reference book to make it easy to find a relevant section when a situation arises and you need specific information.

"The most revolutionary thing one can do
is always to proclaim loudly what is happening."

- Rosa Luxemburg

Written by Sam Hall

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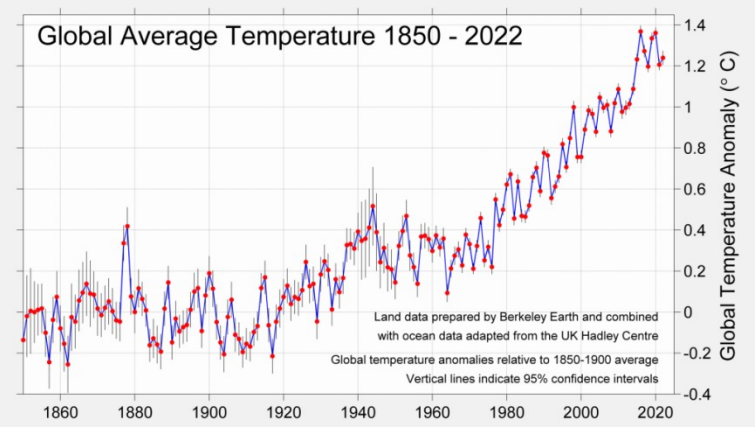
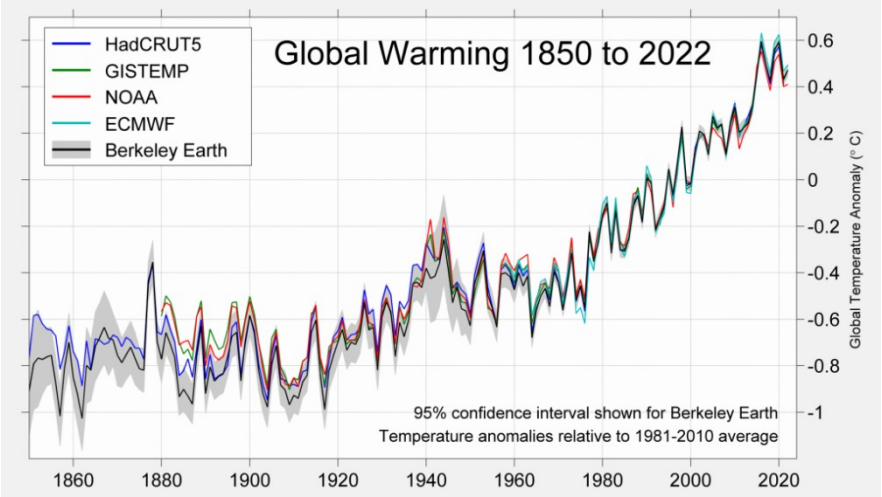
1. Current Status

2022 was 1.24°C over preindustrial, a cooler year by recent comparison thanks to La Niña. The average of the last 8 years was 1.28°C, so rounding that to 2 significant figures I will use 1.3°C as our current average warming level. 2016 was a super El Niño year and the hottest year on record at 1.37°C, which may surprise many folks to realize we have already hit 1.4°C (rounding to the nearest tenth) twice, reaching nearly the same global average temperature again in 2020 during an [ENSO neutral/negative year](#).



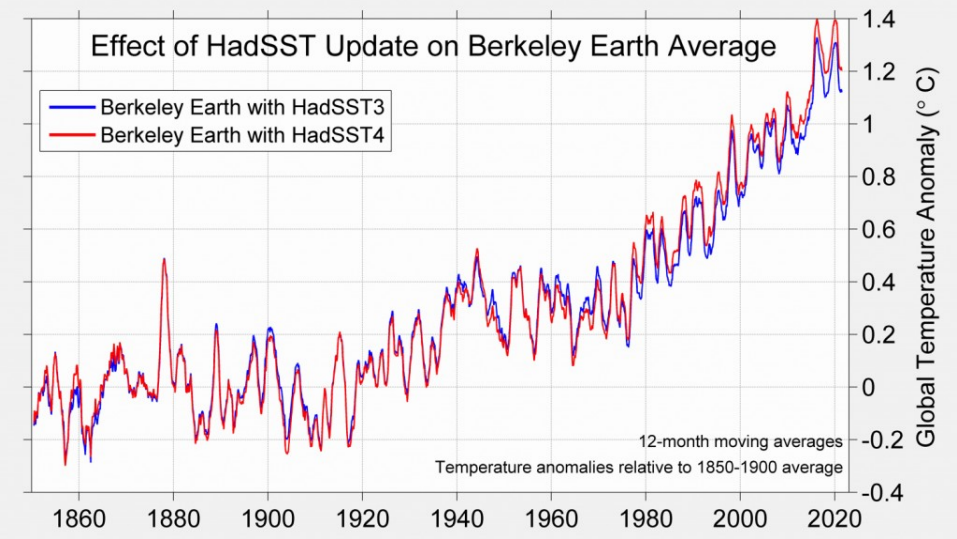
Year	Rank	Warming in °C
2022	5	1.24 ± 0.03
2021	7	1.21 ± 0.03
2020	2	1.36 ± 0.03
2019	3	1.33 ± 0.03
2018	8	1.20 ± 0.03
2017	4	1.27 ± 0.02
2016	1	1.37 ± 0.03
2015	6	1.23 ± 0.03

I use [Berkeley Earth's numbers](#) for current warming for a few reasons, but there is not a significant variation between different sources (shown in the chart below) so just choose whatever you like and adjust my numbers by a tenth as needed.



I do not use NASA's numbers (GISTEMP) because they omit polar regions, which are warming faster than the rest of the globe. This means NASA will always show a lower number for current warming. James Hansen, whose work I will reference extensively, cites NASA's numbers in all of his updates, so take that into account when comparing different data sources.

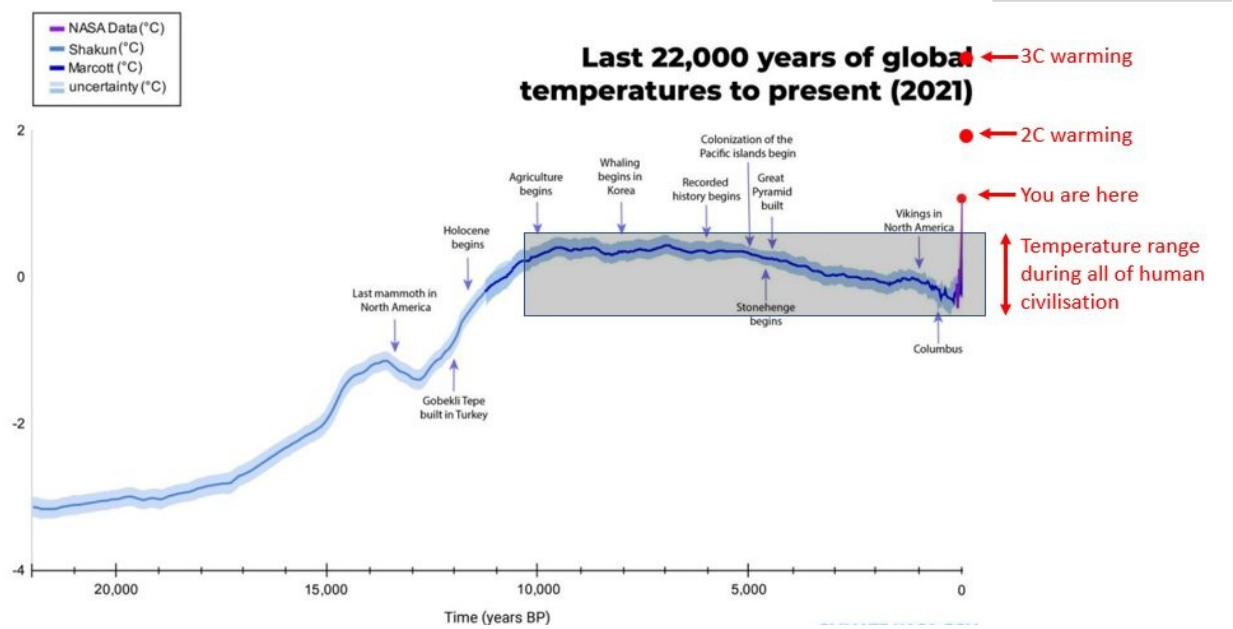
Berkeley is, to my knowledge, the only climate data source that has incorporated the latest update to Sea Surface Temperature (SST) modeling using HadSST4 data, which they began including in their 2021 global average temperature report published in Jan 2022. I think this is an important update and have not seen any justification from others for why they're not also using it. The HadSST4 update adjusted global average temperatures up by approx 0.09°C, or basically a tenth of a degree. You can read their full discussion of HadSST4 in the methodology section towards the end of the 2021 report. As you can see below there is very little difference in the two models prior to about 1975. The HadSST4 update is about capturing recent rapid ocean warming. About 90% of added heat energy from global warming goes into the oceans, and the top few meters of the ocean store as much heat as Earth's entire atmosphere.



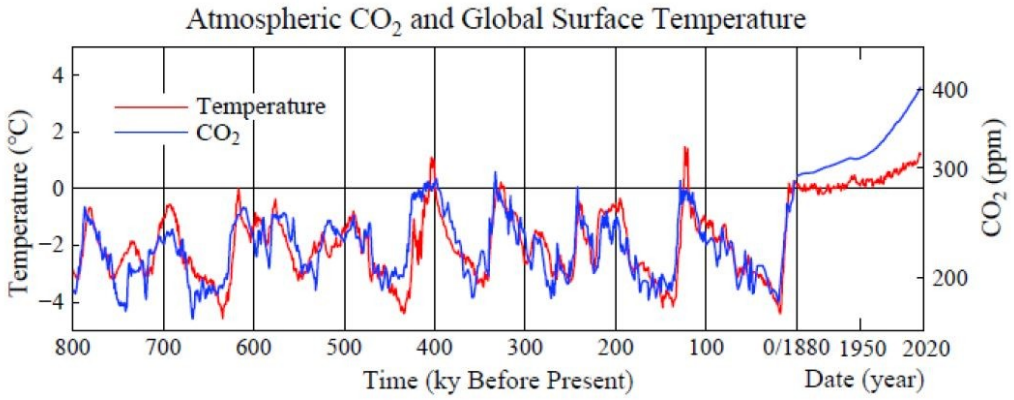
To quote directly from Berkeley's report: "This is the first year that Berkeley Earth has adopted the recently released HadSST version 4 in our report. Compared to HadSST version 3, which it replaces, version 4 uses more data and includes a reassessment of the effects of biases related to transitions in the technology used to measure sea surface temperatures. Historical measurement programs have evolved from sailing ships measuring buckets of water, to powered ships measuring engine intake water, to automated buoys, etc. Each transition in the measurement technology can introduce small inconsistencies in the reported measurements. In reassessing these issues, HadSST version 4 estimated that historical measurement biases were somewhat larger than previously believed. As a result, HadSST version 4 estimates the ocean has warmed somewhat faster than previous assessments. By extension, this results in somewhat greater total warming since the pre-industrial period in the Berkeley Earth global averages. This transition to HadSST version 4 is the main source of small upward revisions in historical averages in this report compared to Berkeley Earth's 2020 report. These revisions also imply slightly less time is available before key thresholds, such as 1.5 °C, will be reached."

The following graphics provide a longer term context for our current warming. First, a look back over the last 22,000 years highlighting the Holocene Climatic Optimum (the broad flat area), a warm period averaging 0.5°C over the preindustrial reference. Crucial elements of human expansion and

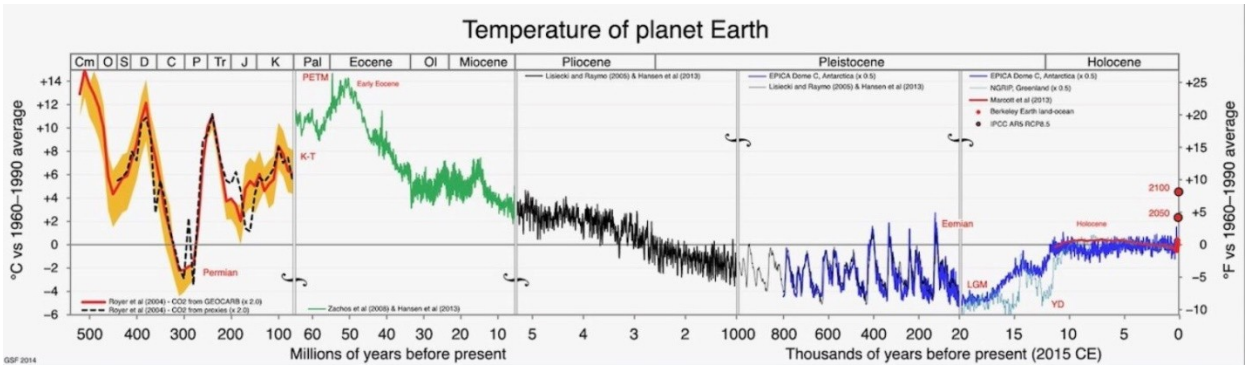
development of agriculture and civilization occurred during this period. XKCD also has a fantastic temperature timeline that I'm not going to try to fit into this post (click and you'll see why).



We can extend this view back through 800,000 years of earth cycling in and out of ice ages.

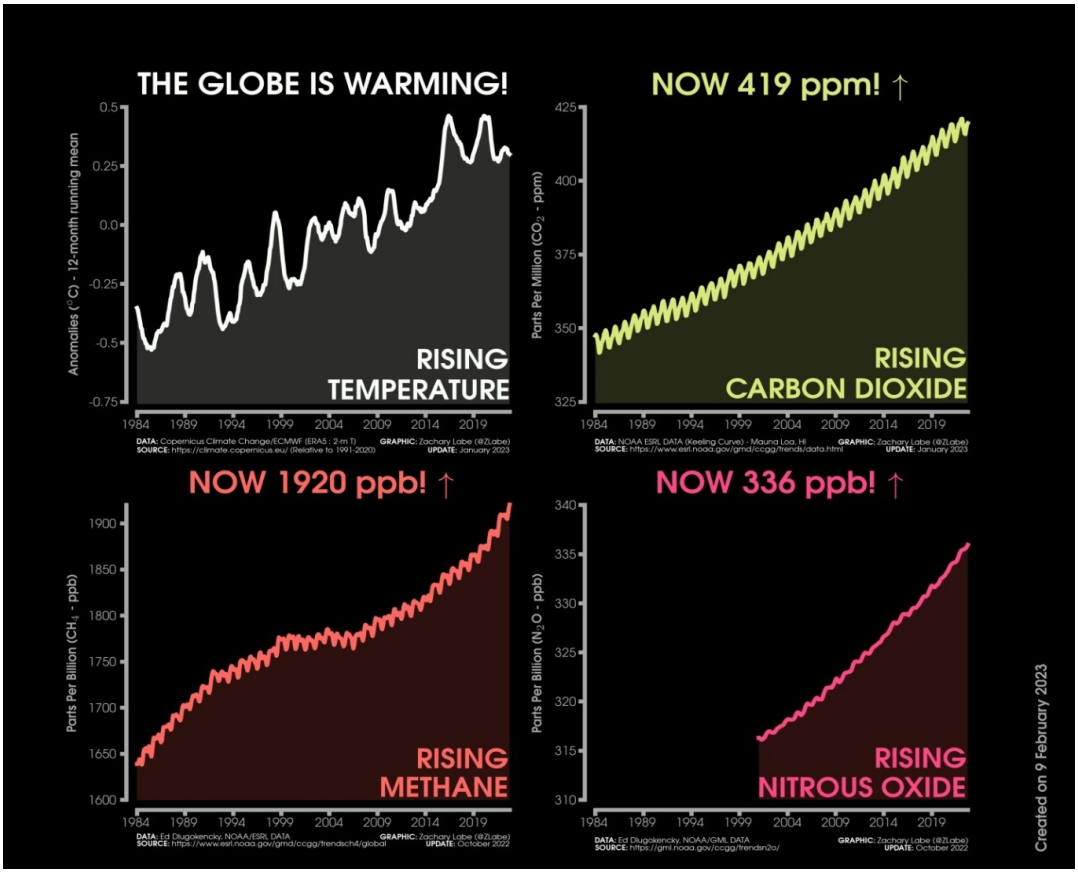


And lastly, a look back at half a billion years of earth's climate history. Within about 25 years we will be entering a temperature realm not seen since the Pliocene 3 million years ago.



2. Warming Factors

There are 3 significant greenhouse gasses warming our planet, and several natural cycles that can amplify or moderate temperature swings. The 3 main greenhouse gasses, in order of importance, are CO2 (carbon dioxide), CH4 (methane) and N2O (nitrous oxide). Monthly updated CO2 measurements from the Mona Loa, Hawaii observatory are available here. Zack Labe is a climate scientist at Princeton who regularly posts excellent updated graphics on Twitter, Mastodon, and on his personal webpage. I highly recommend following Zack and utilizing some of the outstanding graphics he produces.

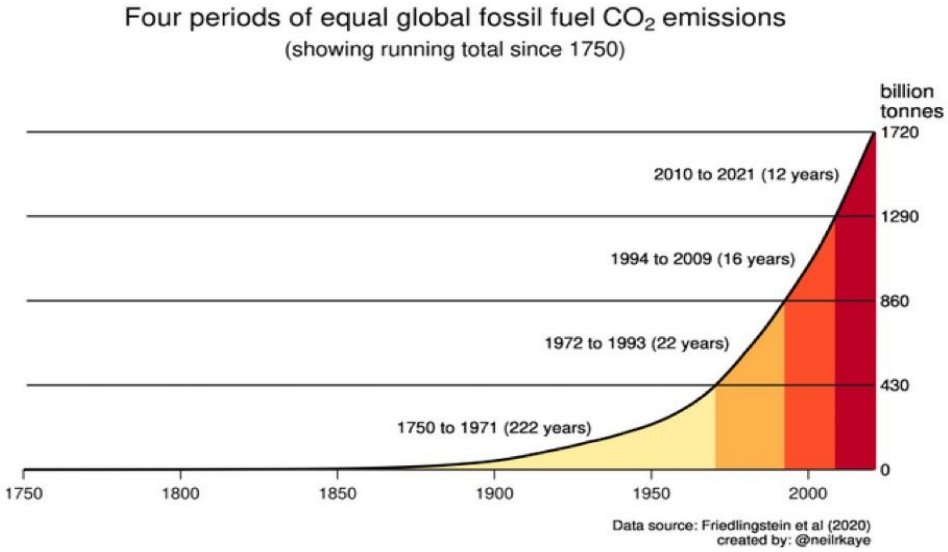


2.1 Carbon Dioxide

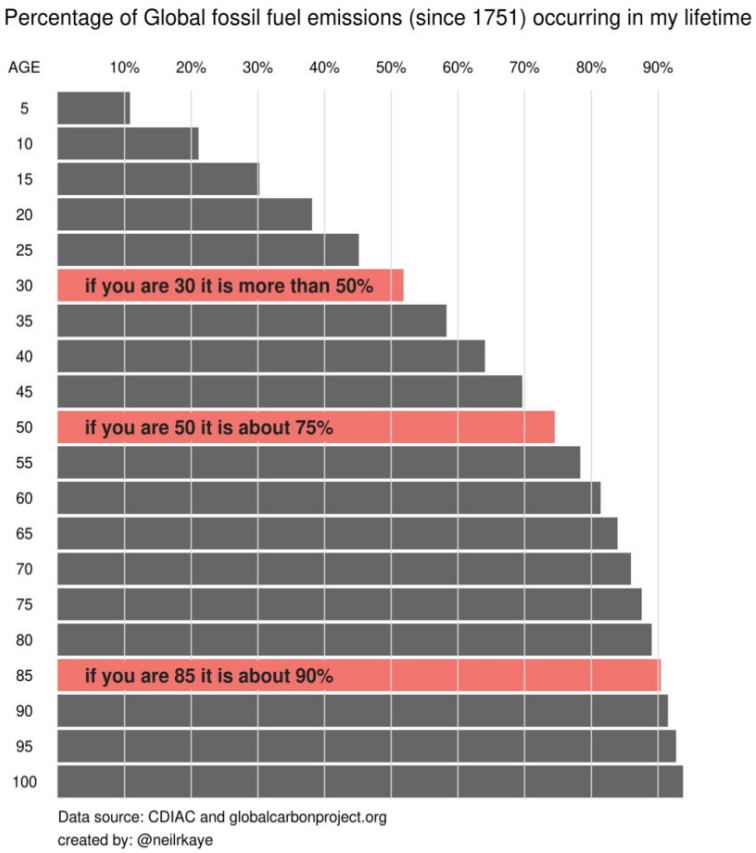
About 55% of newly emitted CO2 is absorbed into the oceans (causing ocean acidity) or by plants/soil. So the atmospheric measurements we see are the remaining 45% that mixes into the atmosphere. The carbon cycle regularly circulates CO2 out of the atmosphere, into the soil/oceans, and back into the atmosphere again, so individual CO2 molecules do not just sit long-term in the atmosphere. But the carbon cycle does not remove CO2, it simply circulates it around, so the concentration of atmospheric CO2 remains elevated for a long time, on the order of 300 to 1,000 years. For any practical concerns to living humans, we can simply treat anthropogenic CO2 as permanent. (Further reading)

CO2 emissions have been of global significance since the industrial revolution (commonly cited as beginning around 1750), but it is staggering to realize how trivial the early years actually were. The

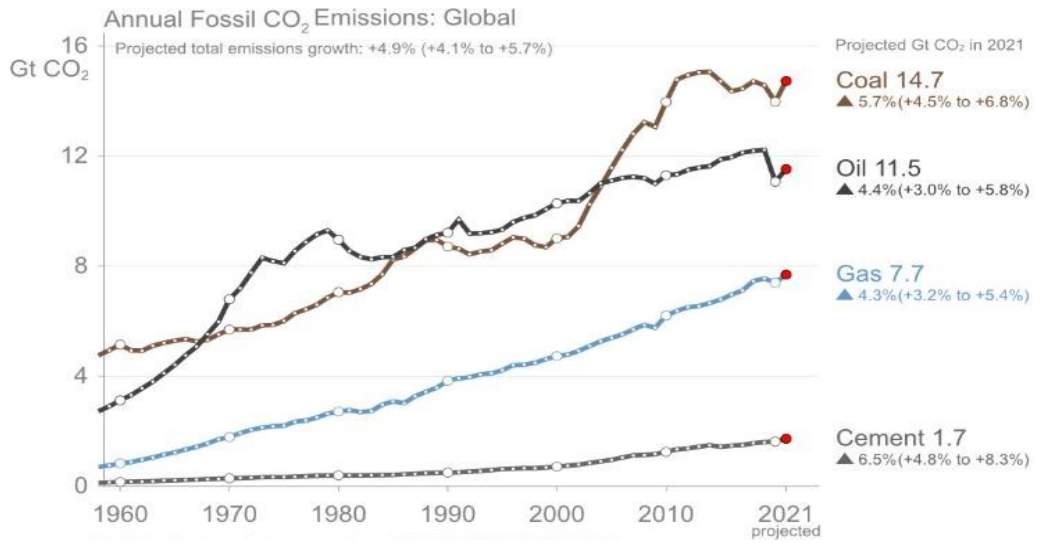
following graph divides total, cumulative fossil fuel CO2 emissions into quartiles. We see that 50% of total CO2 emissions from fossil fuels were emitted in just the last 28 years. And 75% were emitted in the last 50 years. This is the real world impact of an economy based on exponential growth.



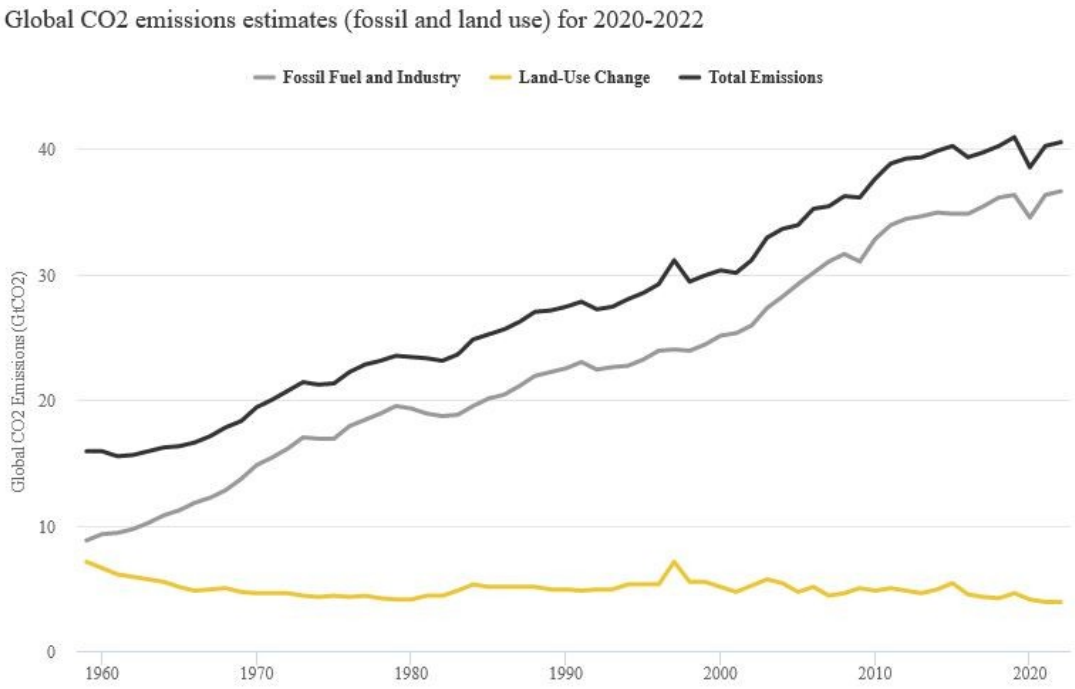
I am a millennial, and nearly 2/3 of total, cumulative CO2 emissions from human use of fossil fuels have been released within my lifetime. Charts by Neil Kaye of UK MetOffice, you can [follow him on twitter](#).



Below is a breakdown of the primary fossil fuel CO2 sources from Global Carbon Project (not updated with 2022 data).



CO2 emissions also come from other activities besides burning fossil fuels, primarily deforestation and agriculture (cement production seems to get lumped in with fossil fuels). However, fossil fuels have massively exceeded those other factors since about 1960. The chart below is from Carbon Brief, on their website it's interactive, you can mouse over the lines and it will display the values for each year.



The annual global emission rate from fossil fuels is still increasing, meaning each year we emit more CO2 than we did the year before (with a notable dip in 2020 due to initial covid responses). You'll note in the

chart above that the gray line set a record in 2022 but the black line didn't, a result of decreasing emissions from land use change (deforestation), but personally I'm wary of saying that emissions have leveled off just yet.

It is estimated that from 1850-2020 humans emitted a cumulative 2.42 trillion tons of CO2**, so 45% of that means **we've added 1.09 trillion tons of CO2 to the atmosphere where it acts as a greenhouse gas**. Our annual global emissions for 2022 was 40.5 billion tons, so 45% of that is an extra 18.2 billion tons added to the atmosphere last year. This represents a 1.7% increase to the total cumulative load. If we assume constant future emissions at 2022 levels it would increase the cumulative atmospheric load by 10% in 6 years, 15% in 9 years, 20% in 12 years, and by 25% in 15 years. The fantasy of Net Zero (see section 4) relies on not just decreasing emissions, but actually negative emissions to remove that cumulative load already present in the atmosphere.

CO2 takes time to cause warming. Hansen writes that after 100 years CO2 will have caused about 75% of the embedded warming, with the last 25% taking much longer as slow feedbacks fully play out (see Sec 6, Para 3 of this paper). This means there is a lag between increasing CO2 concentration and observed warming, much like putting on a blanket doesn't immediately warm you up. So the warming we observe today is the result of CO2 emissions from decades past, and the additional CO2 we're emitting today won't really take effect for decades to come.

** You may see other articles quoting a significantly lower figure of around 455 billion tons. The confusion here arises from whether the figure is for "carbon" or "carbon dioxide", obviously CO2 has two oxygen atoms that contribute weight. Some researchers focus exclusively on the carbon atom. The conversion factor for carbon to CO2 is x3.67. The other factor is whether the figure is for fossil fuel emissions or total anthropogenic emissions including deforestation. The two paragraphs below are excerpted from Friedlingstein et al 2021 and should clarify the difference.

3.1 Fossil CO_2 Emissions

3.1.1 Historical period 1850-2020

Cumulative fossil CO_2 emissions for 1850-2020 were 455 ± 25 GtC, including the cement carbonation sink (Fig. 3, Table 8) .

3.3 Total anthropogenic emissions

Cumulative anthropogenic CO_2 emissions for 1850-2020 totalled 660 ± 65 GtC (2420 ± 240 $GtCO_2$), of which almost 70% (455 GtC) occurred since 1960 and more than 30% (205 GtC)

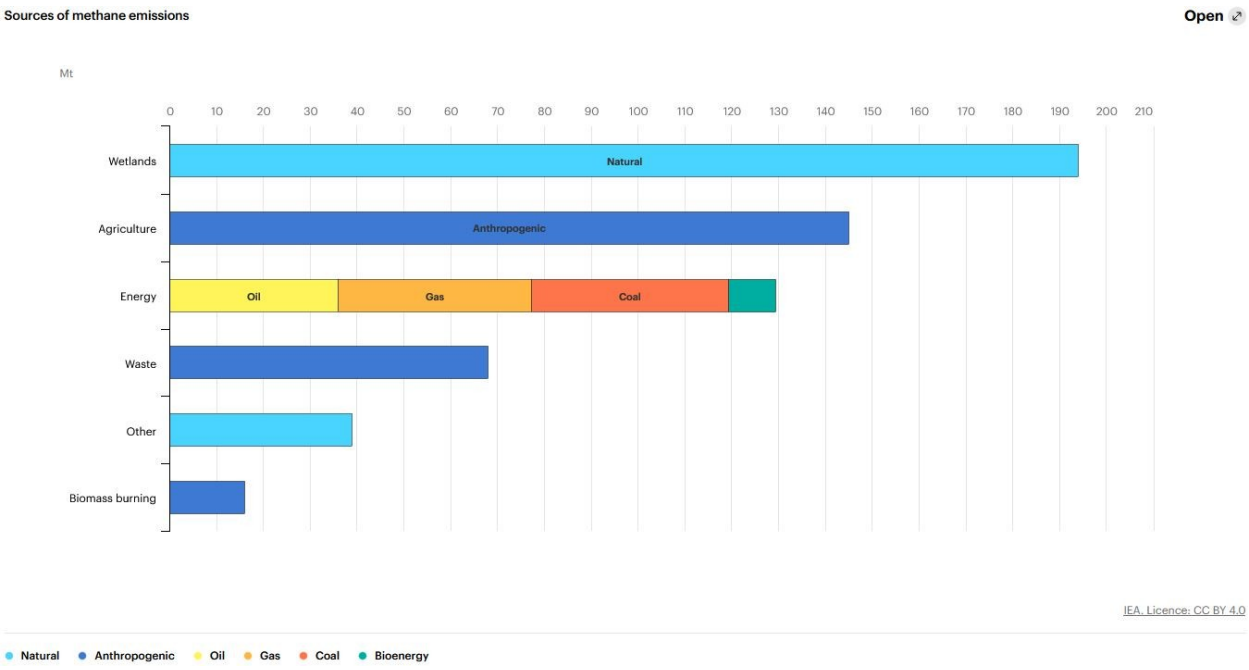
2.2 Methane and Other GHGs

Methane behaves very differently from CO2, it reacts readily with an average lifespan in the atmosphere of about 12 years. What that means is that our methane emissions are actually much higher than one might think from the graphic at the start of section 2, because maintaining a constant level of methane in the atmosphere requires a constant baseline of methane emissions, and every time we raise the level of methane in the atmosphere we have to emit even more to keep replacing the methane that is

constantly being removed. So in order to produce a steady, sustained climb like we see currently, our actual raw methane emissions have to be enormous.

One ton of methane creates about 86 times as much warming as CO2 over a 20 year period (abbreviated GWP20 for 20-year global warming potential). That impact goes down over time, with GWP100 at about 32x CO2. Because human civilization is not likely to last thru the next 20 years, I will use the GWP20 as the relevant value. You may note that methane concentrations are measured in ppb, rather than ppm like CO2, meaning there's much less methane in the atmosphere than CO2. However, we've already more than doubled this potent greenhouse gas from preindustrial. A recent study suggests that air pollution (NOx) helps knock methane out of the atmosphere, so decreasing pollution could increase methane's lifespan and thus increase its GWP even higher.

Another major difference is the emissions sources. Methane comes primarily from wetlands, and one of the biggest concerns for future emissions increases is thawing of arctic ice and permafrost which currently contain enormous amounts of frozen methane. (1) (2) (3) Measurements of fossil fuel methane emissions are also highly suspect with significant underreporting. (1) (2) (3)



Methane levels have increased from a preindustrial level of approx 750 ppb to 1,920 ppb currently. Using the GWP20 of 86x, we can convert that to an equivalent CO2 (CO2e) of about 101 ppm. This is helpful when looking at projections from climate scientists about what happens if we double CO2, we can simply add up the observed CO2 increase and the converted CO2e from methane to get our total global warming impact. Adding 101 ppm CO2e to the observed CO2 concentration of 419 ppm gives us a current total CO2e of 520 ppm.

We can do the same for other greenhouse gasses like nitrous oxide, an extremely potent GHG with a GWP100 = 298x CO2 (unlike methane, GWP20 is not significantly different). Using approx 260 ppb as the preindustrial value for N2O we get a CO2e of 23 ppm, putting our running total CO2e at 543 ppm.

Hansen writes in Global Warming in the Pipeline: "With all trace gases included, the increase of GHG effective forcing between 1750 and 2021 is 4.09 W/m2, which is equivalent to increasing the 1750 CO2 amount (278 ppm) to 561 ppm (formulae in Supporting Material). **We have already reached the GHG climate forcing level of doubled CO2**." [emphasis added]

2.3 Natural Cycles

There are several natural cycles that can enhance or moderate global warming. Leon Simons is a climate scientist who is active on twitter and regularly posts great graphics and information like the chart below (which can also be found in several of Hansen's updates).

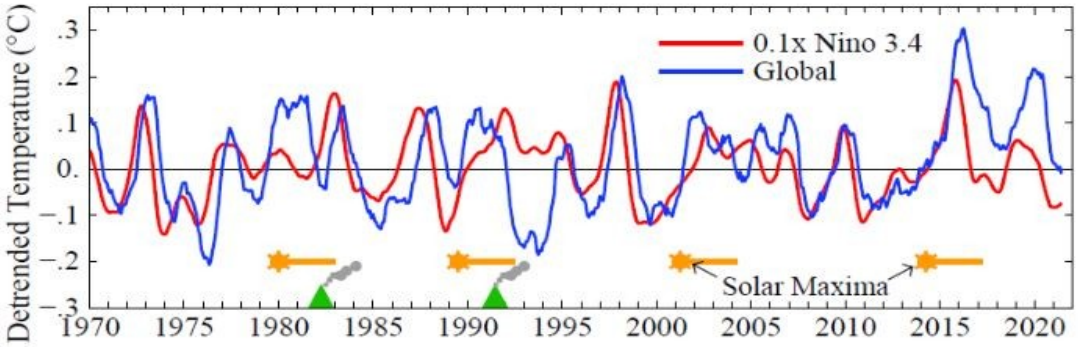


Fig. 2. 12-month running-means of global and Nino3.4 temperature anomalies relative to 1970-2015 trend lines. Green triangles = large volcanoes. Gold bars = 3 years following solar maxima.

2.3.1 El Niño

The biggest and most immediately concerning factor is the El Niño Southern Oscillation (ENSO). The cycle consists of a cool phase called La Niña, or ENSO negative, when Pacific ocean currents absorb extra heat and circulate that heat down into the deep waters, and a warm phase called El Niño, or ENSO positive, when those currents switch and emit that stored heat energy back into the atmosphere. The last super strong El Niño cycle was in 2016 when earth observed its warmest year in 120,000 years.

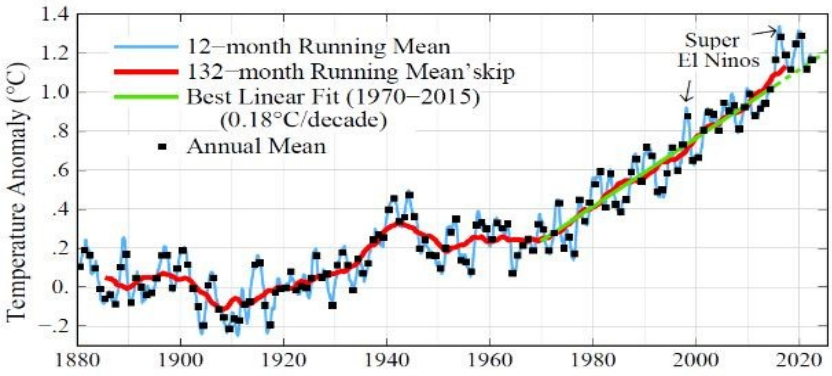


Fig. 2. Global surface temperature relative to 1880-1920 average.

As of March 2023 we have just entered an ENSO neutral phase after an extended cool La Niña phase, with NOAA forecasting El Niño conditions by Sep 2023. Already indications are emerging of a possible super El Niño. Ocean temperatures are currently the hottest they've ever been.

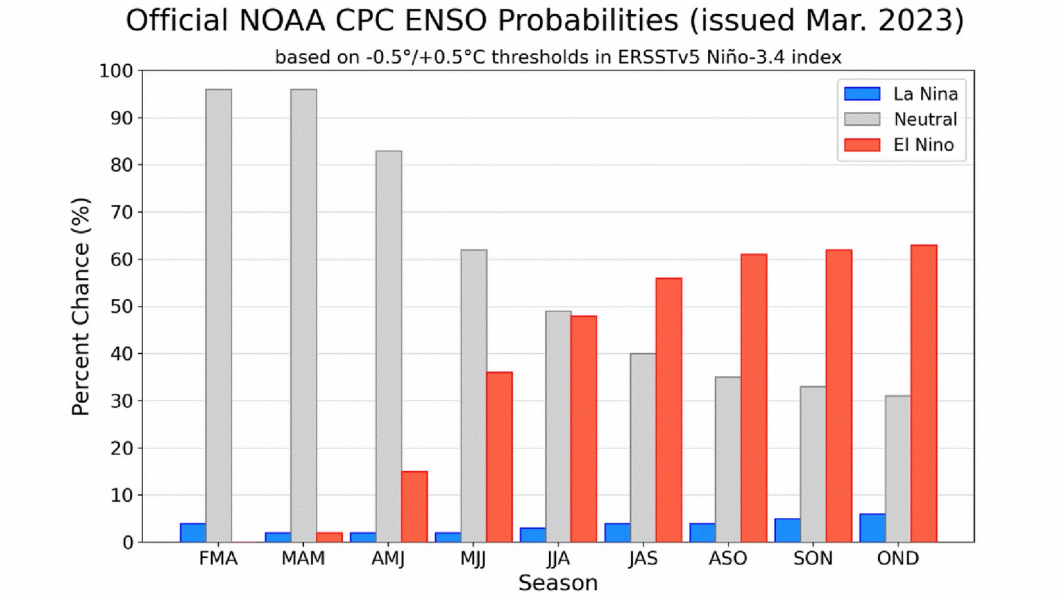


Figure 7. Official ENSO probabilities for the Niño 3.4 sea surface temperature index (5°N-5°S, 120°W-170°W). Figure updated 9 March 2023.

The timing means the strong heating impacts won't arrive until after summer 2023, but summer 2024 will break records.

Quoting Hansen:
"2024 is likely to be off the chart as the warmest year on record… Even a little futz of an El Niño – like the tropical warming in 2018-19, which barely qualified as an El Niño – should be sufficient for record global temperature. A classical, strong El Niño in 2023-24 could push global temperature to about +1.5°C."

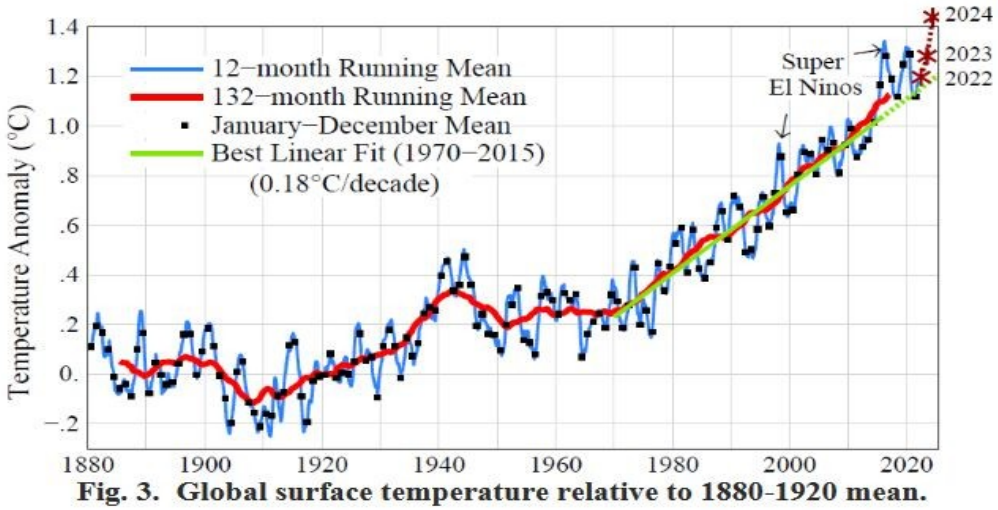
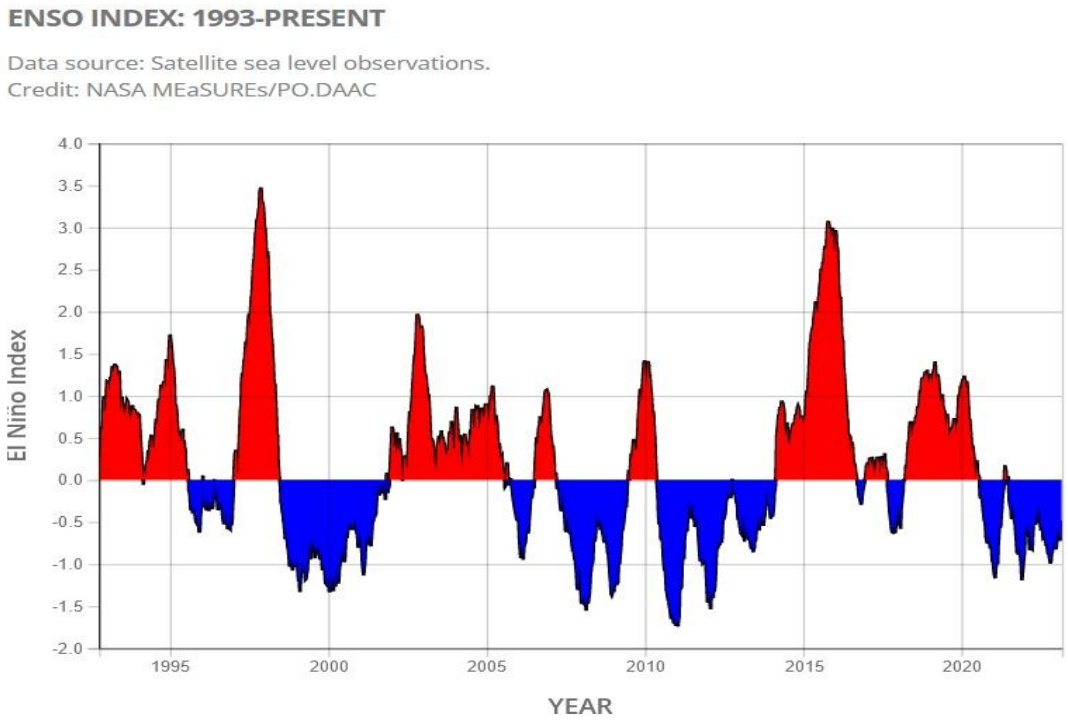


Fig. 3. Global surface temperature relative to 1880-1920 mean.

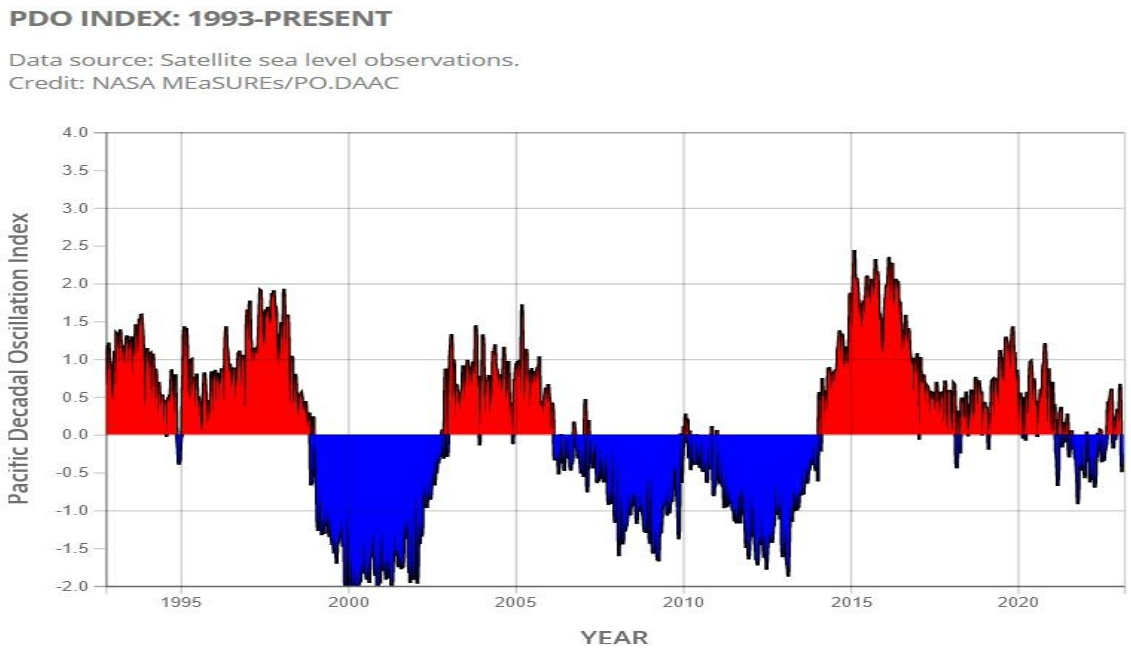
You may notice that ever since the super El Niño of 2016 we have not had a single year below the 1970-2015 trendline. This is in keeping with expected accelerated warming rate discussed more in section 5.2, and represents a step-change in global climate, meaning that we will not return to the green trendline. It is possible that if the coming El Niño is a strong one that we could experience yet another step-change increase.

Current ENSO numerical indicators are available from NOAA here and nice graphics of recent trends are updated here. It is notable in the graph below that the El Niño strength in 2018-2020 was much weaker than the 2016 super El Niño, and yet still managed to match the global temperature level, an indication of how much the baseline had risen in only a few years.



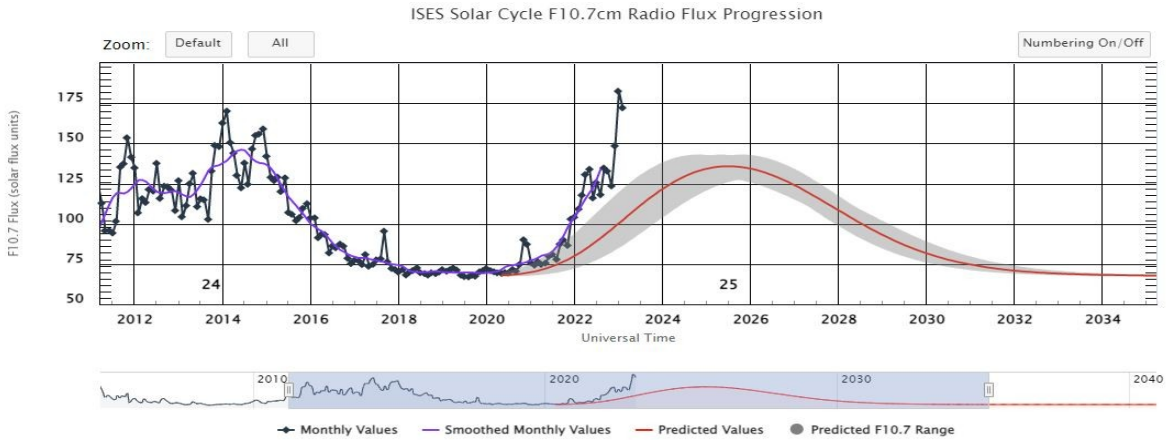
2.3.2 IPO / PDO

The Interdecadal Pacific Oscillation (IPO) and Pacific Decadal Oscillation (PDO) are two very similar terms that may have specific, discreet meanings among experts but among the lay public and science journalists are used interchangeably and for my purposes it is not necessary to delve into the specifics. The short version is that the Pacific Ocean has another powerful recurring pattern besides El Niño that impacts the climate. PDO cycles typically last 10-30 years, much longer than a typical El Niño cycle of 2-7 years. The PDO recently switched to weakly positive after an unusually short negative phase. I'm not going to attempt to provide a forecast, but I would say within the next year we will probably see a clearer signal of where this cycle is going.



2.3.3 Solar Cycle

The solar cycle is a regular and predictable 11 year cycle of sunspot activity related to the reversal of the sun's polarity. The intensity can vary significantly, and the current cycle is already far exceeding predicted activity levels with 2 years still to go before it reaches its maximum.



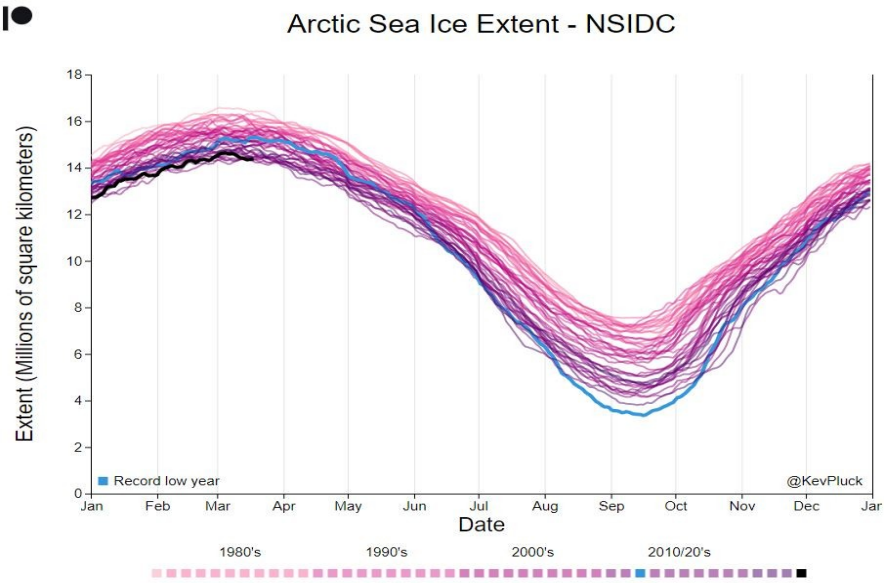
On March 13th, helio-observers recorded a very strong coronal mass ejection (CME) on the scale of the Carrington Event which luckily was aimed away from earth. Simons has stated a strong solar maximum could cause 0.2°C of temporary global warming over the next few years.

2.4 Arctic Ice

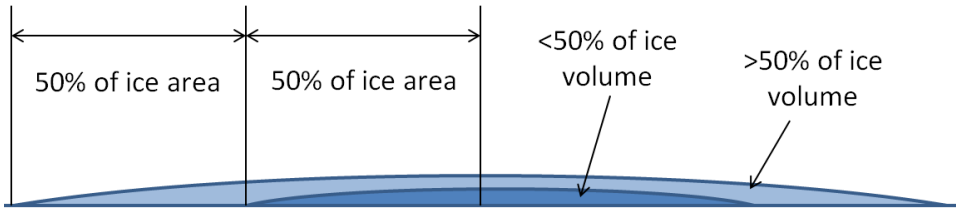
The arctic icecap has steadily dwindled in size and thickness to the point we are now looking at our first ice-free arctic summer (minimum arctic ice is observed in Sep) within the next few years, commonly referred to as a Blue Ocean Event (BOE). When this occurs it will be an extremely important warming

factor for two reasons. First is the change in albedo, which simply means reflectivity. Ice reflects about 80% of incoming solar radiation while ocean water reflects only about 10%. The second is latent heat of melting. **The same amount of solar heat energy required to melt 1 lb of ice will raise the temperature of 1 lb of liquid water by 176°F (80°C).** That is an insane amount of energy currently being stored as latent heat which after a BOE will directly translate into warmer arctic water.

Kevin Pluck is a data visualization pro who created a web interface where you can interrogate ice data and generate graphics. I highly recommend following Kevin on twitter and utilizing the visualization tools available on his website.

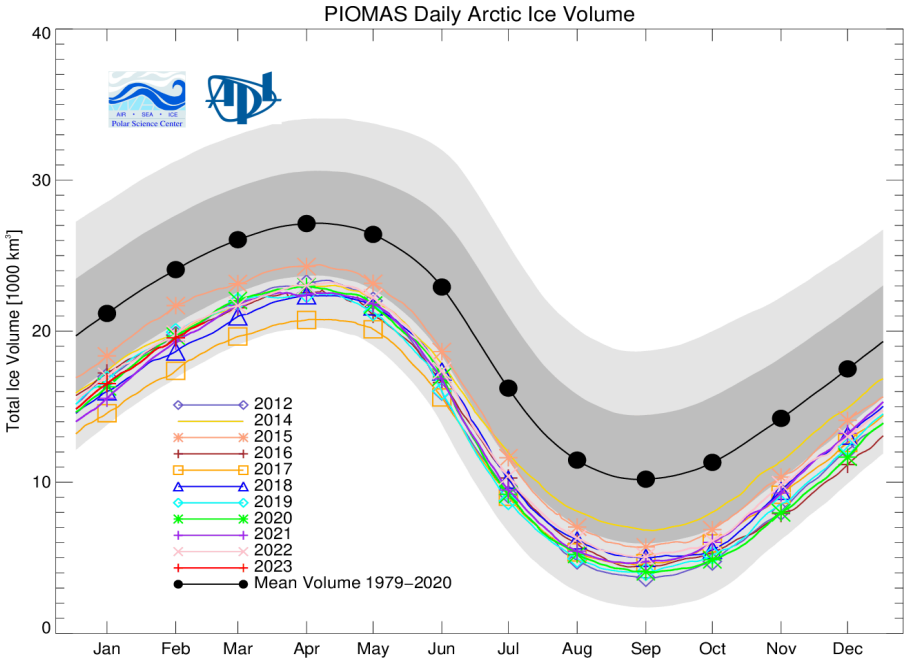


One might think from looking at the graph above that it took 40 years for arctic ice to fall by 50%, so it should take another 40 years to hit zero right? This is incorrect for several reasons. First the warming rate has increased dramatically in recent years and will continue increasing (see section 5.2). The jet stream has been essentially broken since 2020 (see section 6.4) with polar vortex systems wandering deep into N America and Siberia, and warm systems wandering directly over the pole. Also, as ice melts it loses volume and becomes thinner. Shrinking the area of a thick icecap by 50% takes an enormous amount of energy. Melting the wafer-thin remainder is much easier. (I didn't draw the submerged ice in the graphic below but it would share the same basic proportions as the above-water ice)



"Overall, there is almost no ice over four years old remaining—it now comprises just 3 percent of the total ice cover. This… contrasts starkly with the late 1980s when 30 to 35 percent of the Arctic Ocean's ice was older than 4 years."

Ice extent/area is easy to observe with satellites. You will most often see ice extent referenced in arctic news, and it is easy to make the mistake in thinking that ice extent should decrease linearly. If ice volume decreases linearly then we should expect ice extent to decrease exponentially. Accelerated warming exacerbates this even further, so it is entirely reasonable to forecast an ice-free Sep within the next few years. It is a tremendous error for arctic news to focus on extent/area over volume/thickness. Excellent animation of loss of ice volume here. Ice volume data and graphics are available here. Looking at the graph below, zero arctic summer ice in the near future becomes much more easily imaginable.



2.5 Aircraft Contrails

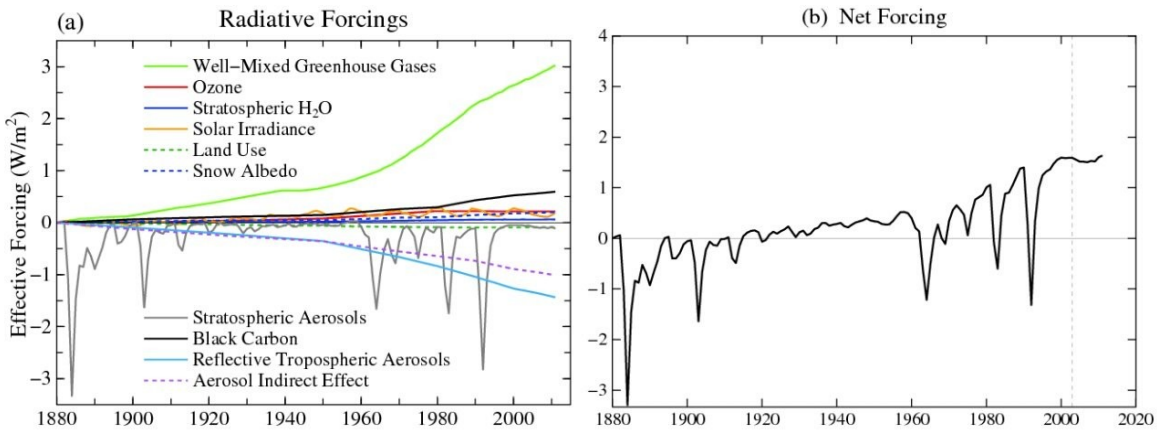
The primary mechanism by which CO2 and other anthropogenic GHGs cause warming is thru a water vapor feedback. Basically, CO2 warms the atmosphere a bit, which allows it to hold more water vapor, and the increased water vapor causes even more warming. Aircraft contrails don't increase the amount of water vapor in the atmosphere, but they mimic the same effect by causing perturbations that condense water vapor into cirrus clouds. The increase in high altitude cirrus clouds caused by global aviation creates a temporary warming effect. This 2021 study found: "Contrail cirrus… yields the largest positive net (warming) ERF term followed by CO2 and NOx emissions" and that even after subtracting out the cooling effect of sulfate aerosols from jet exhaust the non-CO2 (contrail) warming still outweighed aviation CO2 warming. Aircraft contrails are one of the few factors that will yield a small cooling effect after the collapse of civilization, but will be far outweighed by the broader loss of air pollution aerosols (next section) which will cause significant warming.

3. Cooling Factors

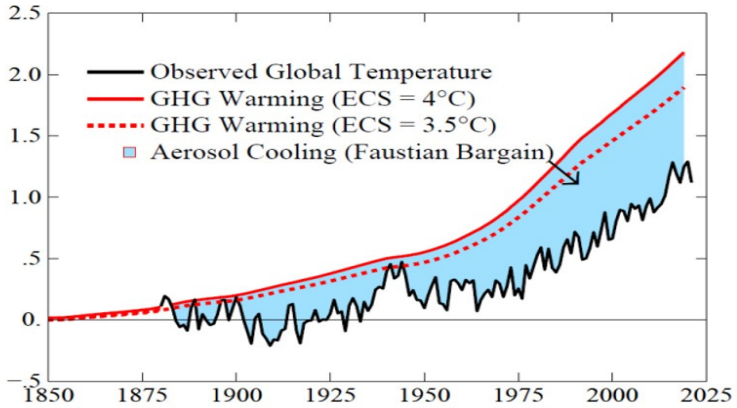
3.1 Aerosols

I can recall hearing the term “global cooling” for the first time in the early 2000s, and I immediately dismissed it as right-wing climate denier propaganda and never looked into it (the fossil fuel industry made a point of emphasizing global cooling, see section 7.1). Turns out it’s an important feature of climate science and ignoring it may be the biggest mistake we ever make. The simplest way to present this is that there are some results of human industrial activity that create warming influences, and some results that create cooling influences. When you add them all together you get the net impact on climate (see chart on the right). In the chart on the left, you can see several types of aerosols listed, stratospheric, tropospheric, and indirect effects. These are essentially air pollution, with two of the biggest sources being coal-burning electrical power plants and diesel exhaust.

Forcings in Hansen et al. (2011)
The following chart of forcings from 1880-2011 is taken from Hansen et al. (2011):



Air pollution kills millions of people every year, approx 100,000 in the US alone. It has been estimated that fossil fuel air pollution is responsible for 1 in 5 deaths globally (pre covid). Sulfates and other pollutants also cause acid rain. At the same time, those suspended air pollution particles (aerosols) make cloud tops brighter, creating a reflective shield in the atmosphere that bounces incoming solar radiation back out into space. This shielding effect protects us from as much as half of global warming.

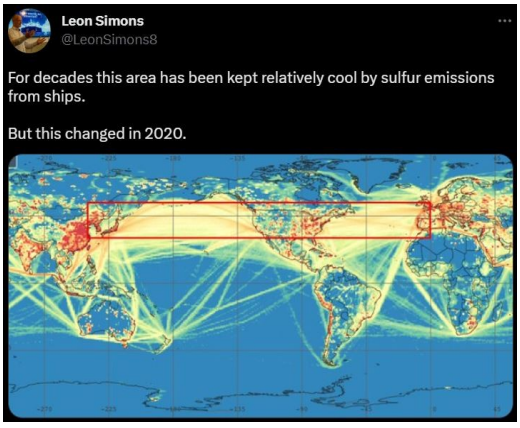


Hansen refers to this as our Faustian Bargain, because we've essentially sold out our future for short term gains. The critical point to identify here is that unlike greenhouse gases, aerosols do not persist in the atmosphere. As soon as we stop creating air pollution the normal cycles of cloud formation and precipitation will wash the aerosols out of the atmosphere within months. Eventually, modern civilization is going to collapse. When that happens, **the aerosol masking effect will end immediately, and an already catastrophic situation will become orders of magnitude worse within a single year**. The danger of this cannot be overstated. As soon as economic activity collapses, global warming will increase by as much as a full 1.0°C.

The paragraph below is excerpted from the IPCC AR6 WG1 report (ESM = earth system models, GSAT = global surface air temperature, SLCF = short lived climate forcings). Note that the warming caused by loss of aerosols begins immediately, with an accelerated rate of warming lasting for several years.

> As a consequence, in idealized ESM studies that assume an instantaneous removal of all anthropogenic or fossil fuel-related emissions, a rapid change in aerosol levels occurs leading to large increases in GSAT with the rate of warming lasting for several years. Similarly, the thermal inertia causes the pulse emissions (Figure 6.15) of SLCFs to have a significant effect on surface temperature even after 10 years.
>
> In summary, for SLCFs with short lifetime (e.g., months), the response in surface temperature occurs strongly as soon as a sustained change in emissions is implemented and continues to grow for a few years, primarily due to thermal inertia in the climate system (*high confidence*). Near its maximum, the response slows down but will then take centuries to reach equilibrium (*high confidence*). For SLCFs with longer lifetimes (e.g., a decade), a delay equivalent to their lifetimes comes in addition to the delay due the thermal inertia (*high confidence*).

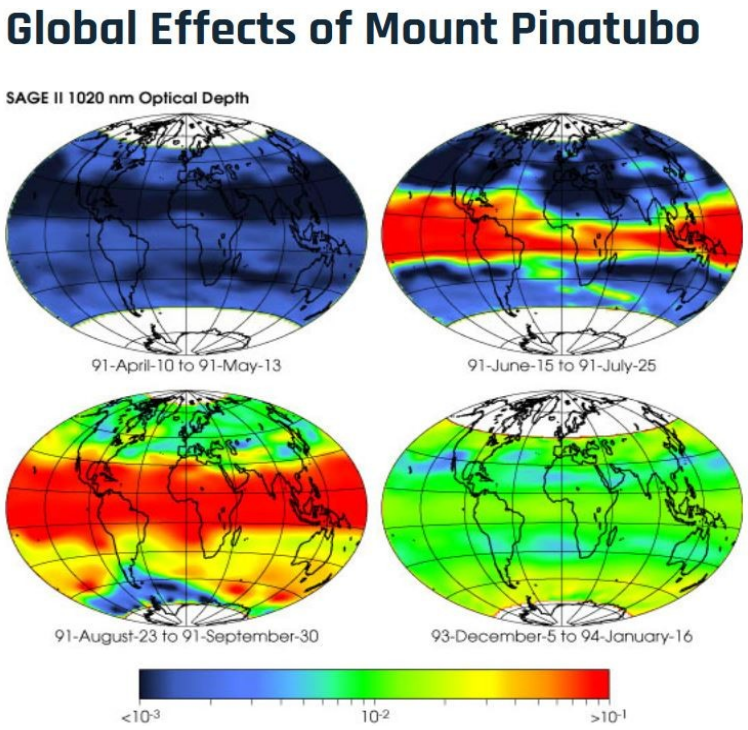
In 2018, the International Maritime Organization (IMO) passed a new rule on shipping fuels aimed at reducing air pollution. The rule specifically targeted sulfur emissions and came into force in 2020. It aims to reduce maritime shipping SOx emissions by 77%. Excellent discussion and graphics on IMO shipping fuel changes here by Simons. And another great discussion by Simons critiquing the newly released IPCC AR6 Synthesis Report SPM for failing to mention cooling effect of sulfates: "worse than nothing".



Similar strong efforts to combat air pollution have occurred recently in China and India. The results of these reductions in air pollution will save lives and improve air quality, but will rapidly increase observed global warming and make near-term collapse all the more likely, after which point billions will die of starvation.

3.2 Volcanoes

Volcanoes are the largest non-anthropogenic source of cooling aerosols and are capable of moderating temperatures for several years after a large eruption. Aerosols from volcanoes tend to last longer in the atmosphere than anthropogenic aerosols because volcanoes launch the aerosols to higher altitudes in the stratosphere where they are not exposed to clouds and precipitation and take longer to filter out. The effects of the 1991 eruption of Mt Pinatubo in the Philippines can be seen in the blue temperature line on the graphic at the start of section 2.3.



Volcanoes aren't necessarily always helpful though. In 2022 the underwater Hunga Tonga volcano erupted 150m below sea level, blasting an enormous amount of water vapor into the stratosphere. This caused a small warming, rather than cooling, effect.

3.3 Geoengineering

If we can create climate cooling impacts on accident, can we also do it intentionally? That is the goal of geoengineering, and various ideas have been floated ranging from simple: surface mounted mirrors (MEER explainer video), to complex: stratospheric aerosol injection, marine cloud brightening, to over the top: refreezing the arctic and Antarctic, and many others. So far no governments have expressed any serious interest in pursuing these. The US govt recently published a 5-year assessment plan to

develop a report on "climate intervention". You may notice all of the links in this paragraph are of the "new bright idea" or "more research is needed" variety, which would have been appropriate 30+ years ago but certainly not today when we stand on the actual brink of global catastrophe. Saudi Arabia last year launched a cloud seeding program, but this small scale effort is aimed at mitigating water shortages rather than altering climate and will likely have a net warming impact.

The risks of various geoengineering schemes are wide and varied, with great uncertainty as to the nature and magnitude of possible unintended side effects. Side effects which could cause problems outside the borders of the nation/state that implemented the program. Hansen writes in Climate Change in a Nutshell: "Some level of geoengineering may be necessary as the world continues to drag its feet on addressing climate change, but geoengineering can and should be minimized." Other groups of scientists have also spoken out against geoengineering, but the time may soon come when conditions are so dire that nations will be willing to accept the risks for any small amount of cooling.

4. Net Zero and Other Myths

4.1 Some Relevant Acronyms

A short glossary to clarify several very similar sounding terms:

ECS: Equilibrium Climate Sensitivity is the eventual temperature that will be caused by a doubling of atmospheric CO2 from the pre-industrial level of 280ppm, including only fast feedbacks, generally taken as occurring around the year 2100. By including the CO2e of other greenhouse gasses, we are currently already at this level (see end of section 2.2). In short, if we suddenly stopped all CO2 emissions right now, ECS is the temperature we would reach by about the year 2100.

ESS: Earth System Sensitivity is basically the same thing but includes all the slow feedbacks fully playing out. The exact time is less certain, but can be assumed to take around 1,000 – 1,500 years.

EEI: Earth Energy Imbalance is different than the previous two terms. ECS and ESS can be thought of as: "if I turn up the stove burner from low to medium, how hot will the water in a pot eventually get?" EEI is a measure of "how fast is the water heating up?" As long as EEI is greater than zero, it means the planet is warming. A larger EEI value means the planet is warming faster. ECS & ESS tell us where we're going, EEI tells us how fast we're getting there.

ECS and ESS are expressed as a temperature in degrees C, while EEI is expressed as a radiative forcing imbalance measured in watts per square meter. W/m^2 can seem a bit abstract so you may see the current EEI expressed as the energy equivalent of 12 atomic bombs per second, or over a million per day, all day every day.

4.2 What Does the IPCC Say?

The concept of negative emissions was first introduced in the 2014 IPCC AR5 report and forms the foundation for Net Zero. Net zero basically says we can keep emitting CO2 from fossil fuels now and clean it up later with negative emissions technology that does not currently exist at relevant scale, while

at the same time slowly transitioning to a mostly fossil fuel free global economy. Net zero is what made it possible to claim to meet the 2015 Paris Agreement goal of limiting global warming to under 2°C by 2100. CO2 emissions "budgets" are developed using projections for these future negative emissions capabilities, and the total budget is then sliced up and divided out among nations.

4.3 Problems with the IPCC Narrative

4.3.1 IPCC Assumptions

IPCC includes only a limited number of fast feedbacks and does not include warming from other climate feedbacks like loss of albedo from melting ice which are assumed to operate on too slow of a scale to be relevant. However, the extremely rapid rate of change (see section 5.2) reflected in the endless stream of "faster than expected" climate news updates indicates that slow feedbacks may not be as slow as we'd like. Hansen has an excellent, thorough discussion of fast and slow feedbacks in Climate Change in a Nutshell and repeatedly makes the point that **slow feedbacks are already coming into play right now**, and that some feedbacks are excluded simply because there is not sufficient confidence on response time, but that we "can and should" still incorporate these slow feedbacks into our planning scenarios (which IPCC does not do).

IPCC makes an optimistic assumption for ECS of 3°C, citing a very likely range of 2-5°C. Even a very small increase to the selected ECS value can have significant impacts on model output for the various modeled pathways. Hansen writes in his Dec 2022 Global Warming in the Pipeline update: "…equilibrium climate sensitivity (ECS) is high, at least ~4°C for 2×CO2. That ECS refers to the climate response including only "fast" feedbacks."

IPCC assumes a minimal value for aerosol cooling effect, and does not model any scenarios that match the current reality of increasing CO2 and methane while simultaneously slashing SOx.

And most importantly, IPCC insists on prioritizing model output over the paleoclimate record. Hansen harps on this point constantly, writing in *Storms of My Grandchildren*:
"I realized that climate sensitivity was in the process of being nailed down—rigorously and accurately defined by the paleoclimate information discussed in this chapter. Of course, even today it is possible to find scientists and published papers concluding that climate sensitivity is quite uncertain. A common approach is to calculate the expected warming of the past century based on assumed climate forcings—then, because of uncertainties in actual forcings, conclude that climate sensitivity is only constrained to lie somewhere within a large range, say 2 to 8 degrees Celsius for doubled carbon dioxide. That logic is a case of failing to see the forest for the trees. Our knowledge is not based on the dullest instrument in our tool bag. Rather it is based on the sharpest, most discriminating information we can muster."

By the "dullest instrument in our tool bag" Hansen is referring to climate models. The sharpest instrument is the paleoclimate record.

In Climate Change in a Nutshell, Hansen writes: "the most relevant tools in the scientific toolbox are: (1) Earth's paleoclimate history, which contains information about how Earth responded to climate forcings

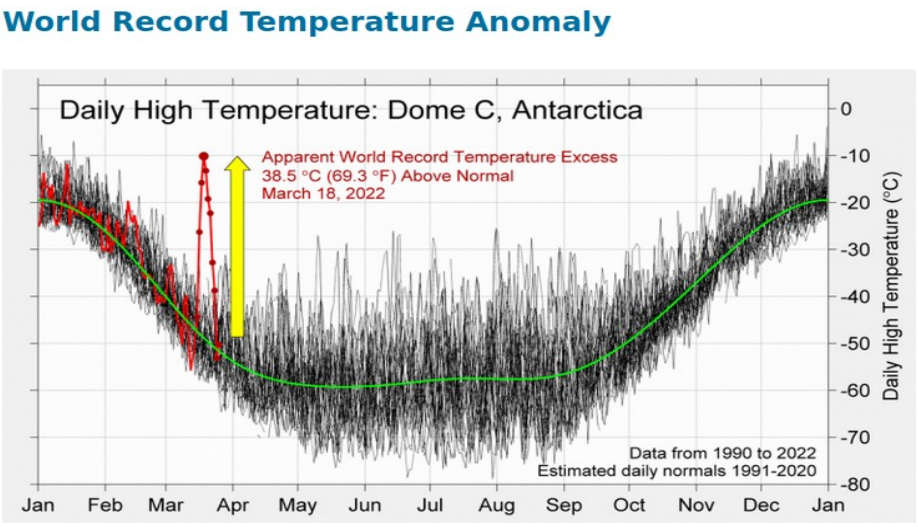
in the past, (2) modern observations of how Earth is responding to natural and human-made climate forcings, and (3) climate models."

In Global Warming in the Pipeline, Hansen writes: "If knowledge of ECS was based only on models, it would be difficult to narrow the range of estimated climate sensitivity – or to have high confidence in any range – because we do not know how well feedbacks are modeled or even if the models include all significant real-world feedbacks. Cloud and aerosol interactions are complex, and even small cloud changes can have a substantial effect. That is why data on Earth's paleoclimate history are so valuable; they allow us to compare different equilibrium climate states, knowing that all feedbacks were in operation."

IPCC is consistently guilty of emphasizing model output over the paleoclimate record.

In the Foreward to What Lies Beneath, Dr Hans Schellnhuber writes: "IPCC is stricken with the *Probability Obsession*… we must never forget that we are in a unique situation with no precise historic analogue… So calculating probabilities makes little sense in the most critical instances, such as the methane release dynamics in thawing permafrost areas... Rather, we should identify *possibilities*, that is, potential developments in the planetary make-up that are consistent with the initial and boundary conditions, the processes and the drivers we know."

Dr Charlie Gardner made an insightful comment after the March 2022 Antarctic heatwave (when temperatures briefly reached 69°F above average) pointing out that: "...last week's temperatures in Antarctica really highlight the limitations of climate modelling. It's not just that models didn't predict this, but that they couldn't - if they had, modellers would have considered them broken, and tried to fix them."



Climate models are fantastic at predicting long term trends, but we absolutely cannot rely on them to predict near term, civilization-threatening extreme events.

4.3.2 Committed Warming

One of the keystones of IPCC projections is the notion that as soon as we stop emitting CO2 then earth will stop warming. Zeke Hausfather is an IPCC author and one of the primary proponents of this position and can often be found on twitter arguing over this very topic. This is a recently developed position supported by one 2008 paper which relies on a bit of slight-of-hand in order to bend a half-truth into a foundation of the entire IPCC narrative. The half-truth is that if Net Zero is achieved, the oceans and land will indeed absorb some CO2 from the atmosphere, slightly decreasing the cumulative GHG load. The first falsehood is the proposition that this will offset the many positive feedbacks in play. Natural sinks would have to offset not just CO2 but also methane and other GHGs. The second, and much larger, falsehood is that Net Zero is simply not possible, as detailed in section 4.3.4. Not in even the remotest way. But it is the only scenario that allows IPCC to write a report that still has living humans at the end of this century.

Even Hausfather is forced to reveal the game towards the end of his article linked above: "The studies featured in this piece all look at the effects of zero-emissions scenarios today or in the next few decades. If, however, zero emissions were to occur later in the century, there is the potential to lock in more carbon-cycle feedback processes – such as melting permafrost – than under current global temperature levels. A world that has warmed by 3C or 4C above pre-industrial levels may lock in more committed future warming than today's world – and more research is needed to explore these effects."

The implication here is that even the official fantasy of Net Zero has fine print indicating a "redeem by" date that, once passed, the terms and conditions change. If you remove the assumption of zero committed warming then all of IPCC's scenarios and pathways are invalid. Every scientist adopting the language of Net Zero is implicitly endorsing this position. I've devoted section 5.1 to expounding this problem.

4.3.3 Carbon Dioxide Removal (CDR)

Net Zero requires massive scale implementation of negative emissions technology that does not exist. That should be a red flag. Peter Kalmus, a climate scientist at NASA JPL, has called CDR "magic fairy dust". We're used to seeing computer technology advance at an exponential rate and it's easy to be complacent and think 'of course we'll make magic technology in time', but CDR means industrial machinery that is nothing like transistors and pixels. Okay so how big a scale are we talking here? At 3:35 in this video interview Dr Hugh Hunt of Cambridge describes it this way: "We don't do anything on this planet at that scale. We don't manufacture food on that scale, we don't mine iron ore on that scale, we don't even produce oil, coal, or gas on that scale." The largest Direct Air Capture (DAC) facility on earth is capable of removing 4,000 tons of CO2 per year. Compared to 2022's emissions of 40.5 billion tons, this facility is able to remove less than 0.00001% of annual emissions. Our current CDR capabilities are quite literally negligible.

Hansen writes in Nutshell: "Implausibility of negative emissions on the required scale is readily apparent." Commenting further on the cost of these activities: "...the cost, in a single year, of closing

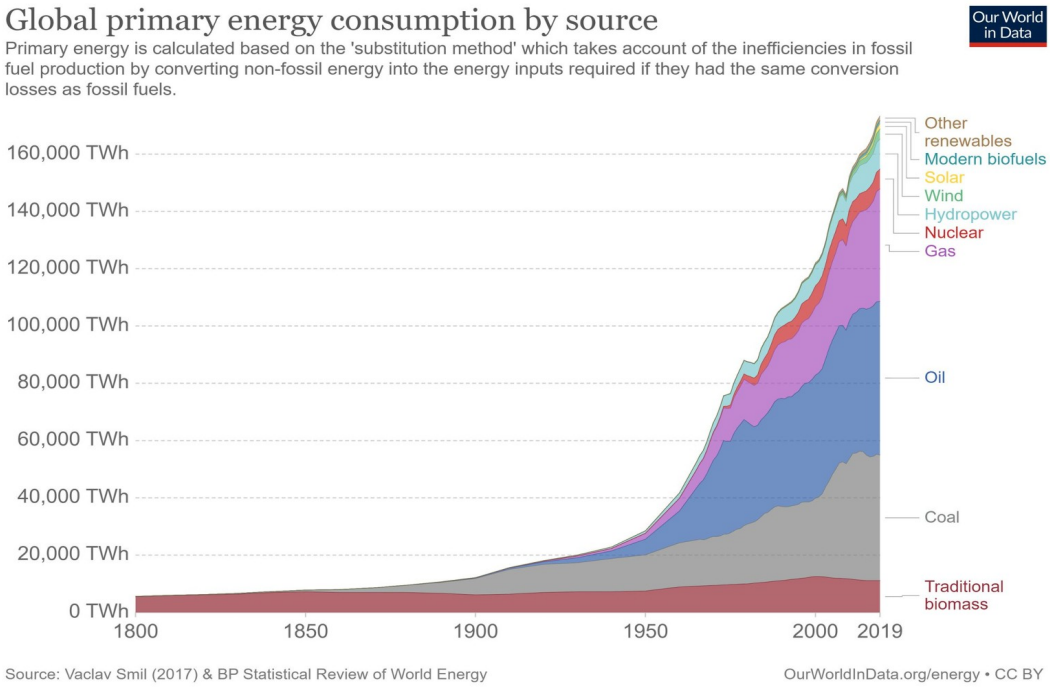
the gap between reality and the IPCC scenario that limits climate change to +1.5°C is already about $1 trillion. And that is without the cost of transporting and storing the CO2."

4.3.4 Decarbonizing

The other key component of Net Zero is to decarbonize electricity and transportation by transitioning the globe to a completely renewable electric grid and eliminating fossil fuel powered vehicles. That way the CDR industry can work on offsetting the remaining fossil CO2 emissions from sectors like agriculture and mining that cannot easily be transitioned to electric power, and begin chipping away at the 1.1 trillion tons of CO2 in the atmosphere.

At every point in history when renewable energy sources have been developed and added into our energy grid, that new renewable energy has been **in addition to** fossil energy sources, renewable energy has never **replaced** fossil energy (because that would require government regulation). Cheap energy supply encourages more energy intensive activities, and overall demand goes up. This phenomenon is known as Jevons Paradox. Ignoring it leads to many people endorsing energy policies that have the opposite of their intended effect.

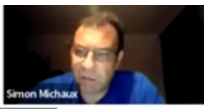
The task then is to decarbonize a global energy mix that looks like this:



What is often ignored in this discussion is the quantities of metals (especially copper) and other materials needed to produce such an incredible amount of renewable energy components.
Dr Simon Michaux of the Finnish geological survey gave a lecture going over global availability of materials needed for a renewable grid transition and has found every single critical metal to be vastly below required reserves. The earth contains less than 20% of the copper needed to produce just the

first generation of renewables (a generation refers to the typical 20 year lifespan of most power generation components). About 20% of the required nickel. Less than 2.5% of the required lithium.

METAL IN 2022 GLOBAL RESERVES



Metal Source: USGS	Total metal required produce one generation of technology units to phase out fossil fuels (tonnes)	Reported Global Reserves 2022 (tonnes)	Global Reseves as a proportion of metals required to phase out fossil fuels (%)	Number of generations of technology units that can be produced from global reserves
Copper	4 575 523 674	880 000 000	19,23 %	
Zinc	35 703 918	250 000 000		7,0
Manganese	227 889 504	1 500 000 000		6,6
Nickel	940 578 114	95 000 000	10,10 %	
Lithium	944 150 293	22 000 000	2,33 %	
Cobalt	218 396 990	7 600 000	3,48 %	
Graphite (natural flake)	8 973 640 257	320 000 000	3,57 %	
Silicon (Metallurgical)	49 571 460	-		
Silver	145 579	530 000		3,6
Vanadium	681 865 986	24 000 000	3,52 %	
Zirkonium	2 614 126	70 000 000		26,8

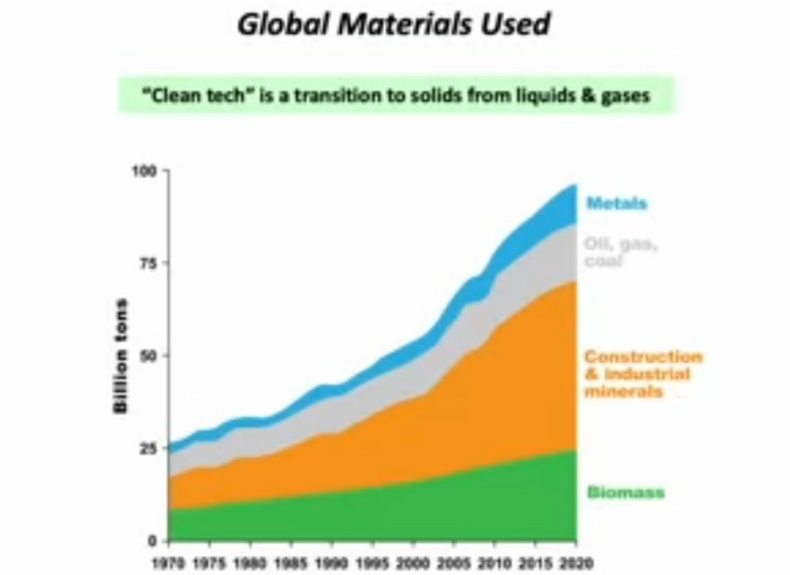
A few key quotes from Dr Michaux's presentation:
(1:06:25) "The idea of growth economics is about to be phased out whether we like it or not. The economic model behind materialism, consumerism, and the social constructs associated with that, will have to go. We've got no choice there… The purpose of this work is to show the shortcomings of the existing paradigm. What will happen is we've got to make a better plan: once we understand our true boundary conditions, what will we really do."

(1:07:45) "The way I convinced my management was pointing out in 2024 or 2025 the captains of industry in Europe who are making electric vehicles and their batteries, will turn to the geological surveys of Europe and say why did you not tell us about this very obvious problem?"

Another recent talk by Mark Mills, a mining industry expert and former CEO of a Canadian mining company, presents similar conclusions.

Some key quotes from Mr Mills:
(12:30) "A movement in oil markets of 5% is massive... this is a change in demand from 700% to 4000% in these metals... that will be required in the coming 2 decades… If it were to be achievable, this would be the largest change in demand of metals in all of human history. It's never happened. **People are suffering some delusions about what is possible in the mining sector**." [emphasis added]

(15:20) "What we're proposing to do with the energy transition... is you will increase the wedge in gray by 10 times."



(15:40) "**The energy system in the future will require the extraction and movement of a quantity of materials equal to or greater than the quantities of materials that humanity extracts, moves, and grows for all other purposes combined**."

(17:40) "In simplistic terms, the world will be short copper in a year or two… Copper does not have a substitute, it's not replaceable… You can pick any metal, there's a shortage of all the metals in coming years."

(19:20) "The average is about 16 yrs to find and open a new mine globally… The world is not even investing 10% of what is required in global mining expansion in order to meet the aspirations... to have the world follow Norway."

(41:40) "We're short on midterm investment, that is the 2-5 year timeframe, in all energy markets which translates into pretty bullish price impacts on commodities for a very long time. How long it lasts will relate more to politics than to what engineers can accomplish."

To conclude this subsection:
Once you understand that CDR is impossible, a renewable grid is impossible, zero carbon transportation is impossible, and therefore Net Zero is impossible, you understand that the purpose of the IPCC reports is simply narrative control.

4.4 What is the IPCC?

First, the IPCC is not a scholarly body, it is not a scientific academy. It is a political body, an office of the United Nations. The "I" in IPCC stands for Intergovernmental. It does not conduct original research on climate but performs essentially a literature review, publishing its findings in regular Assessment Reports. The IPCC's contribution is in the various modeled pathways and global mitigation plans that it develops.

Leaked draft documents from scientists working within the IPCC have revealed the influence of political lobbyists over the final text of IPCC summary reports: "…delegates from Brazil and Argentina successfully removed any mention of the negative impacts of meat on the environment. They also removed recommendations that people in wealthy countries reduce their meat consumption and shift their diets to include more plant-based foods. Meanwhile, Saudi Arabia's delegates made changes throughout the report to position carbon capture and storage (CCS) as a climate solution on par with renewable energy" as well as removing calls for "phasing out all fossil fuels". More discussion on political edits to IPCC reports here.

Kevin Anderson is a climate scientist and professor who has been outspoken for years about the influence of global elites, commonly referred to as the Davos group after the annual World Economic Forum meetings in Davos, Switzerland. He coauthored this 2022 article titled "We must disrupt Davos culture to end decades of failure on climate" which summarizes his 2021 research paper on the same topic. From the article: "Whilst the "expert" community may be working quite impartially, it does so within highly constrained boundaries imposed directly through funding and indirectly through prevailing hierarchies… The prevailing narrative is that we now have to urgently harness society's economic and technological powers to gain control of the climate crisis and safely navigate the so-called Anthropocene. **Central to this view is that we have no time to replace vested interests and question existing norms and power structures**. In stark contrast, our recent paper concludes that it is exactly these interests, norms and structures that continue to be a key impediment to meeting our climate commitments." [emphasis added]

At 4:00 in this interview Anderson states: "The Davos cluster has set the current narrative… and it is supported by the expert community… the only way forward is going to be through different structures of power." At 5:40: "What these [CDR] technologies allow us to do is to… not make significant changes today, it allows us to maintain the current narrative." At 7:10: "In just a handful of years this way of thinking [CDR] has completely colored much of the NGO community… the academic community… and the journalistic community… In academia virtually all of the scenarios that we assume and develop now seem to use the language of negative emissions or CDR as if these things existed, by using the language repeatedly, day after day after day we have almost made them material as if they are real. They are just words of things that might occur in the future but we assume that you can already buy them off the shelves and you can put them into your scenarios… This is so widespread, so ubiquitous, that we are now unable … to come up with alternative narratives from within the academic community, particularly the senior academics who are locked into the existing narrative." Again hammering the main point at 15:15: "The expert community currently just reinforces Davos."

In this recent article, Anderson calls IPCC climate modeling "as damaging to the agenda of cutting emissions as Exxon was in misleading the public about climate science."

Noam Chomsky is most well known for his theory of manufacturing consent. In this 1996 interview clip Chomsky makes the very important point that it's not that journalists (or scientists) are deliberately lying or actively promoting a conspiracy to deceive and mislead the public, they're likely acting to the best of their abilities. The narrative shaping occurs in the hiring process. "If you believed something different,

you wouldn't be sitting where you're sitting." That is the way to understand IPCC reports. These are Davos narratives to ensure that elite power is not challenged regardless of what climate catastrophe may soon occur, and scientists are chosen to write these reports based on their agreement with the Davos narrative.

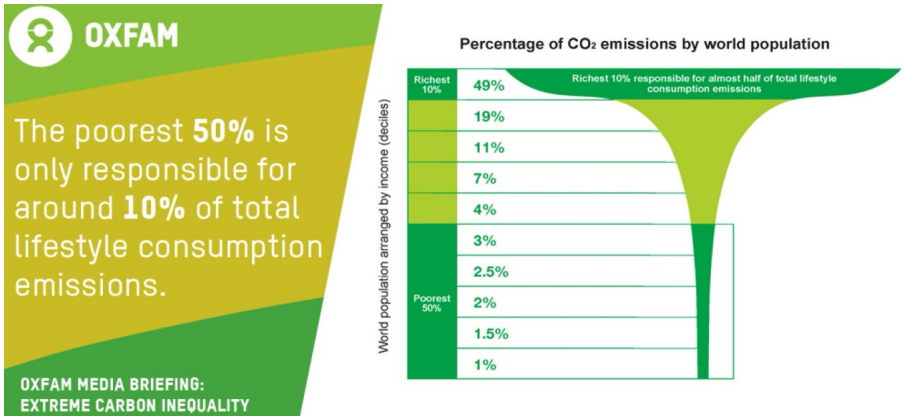
4.5 Distractions

You will frequently see references in climate news to "tipping points" and it is worth taking a moment to explain what tipping points are and aren't. It always seems like some tipping point is getting closer and closer but hasn't passed yet, which means there's still time to fix things right?

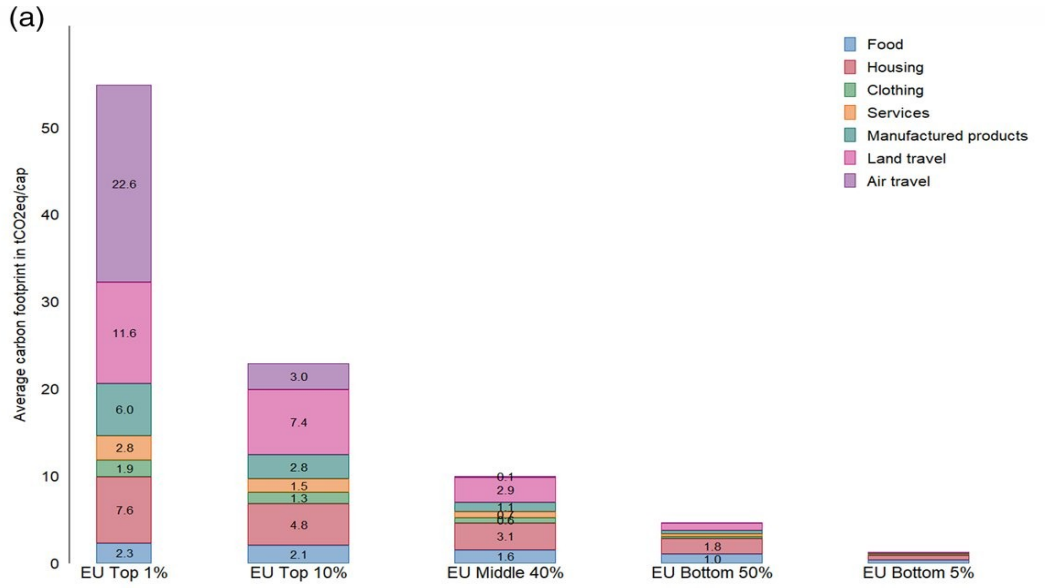
Tipping points apply to individual subsystems, there is not one grand tipping point controlling climate change. There is a tipping point for the Amazon rainforest. For Greenland's ice sheet. There are separate tipping points for several major ice sheets in Antarctica. For arctic permafrost methane. For the Atlantic Meridional Overturning Circulation (AMOC) which stabilizes Europe's climate. For coral reefs, etc, etc. The way I like to explain it is to imagine putting a person in a giant pizza oven. There will be individual tipping points for when various different systems fail. The lungs will have their own tipping point, the skin, the brain, the liver, etc. Focusing on individual tipping points is a distraction, the only thing that matters is getting the person out of the oven as quickly as possible. Letting them stay in the oven and closely monitoring "well their liver function is within normal range" would be insanity. The same is true with earth's climate. Precisely which individual systems collapse or don't and in which order isn't the point. The point is we've placed 1.1 trillion tons of CO2 in the atmosphere, there's no way to remove it, and it's going to make earth unlivable within the lifetimes of most of us alive today.

Milankovitch cycles are another item to just briefly touch on as you may see it mentioned by climate deniers. Milankovitch cycles are regular changes to the earth's orbit that influence earth's climate on the order of tens of thousands to hundred thousand year cycles. Yes they're a real thing, no they don't matter at all to our current anthropogenic warming which is occurring practically instantaneously by comparison.

Possibly the biggest, and definitely the most pernicious distraction is overpopulation. The disparity in emissions and overall consumption between wealthy and poor populations is so massive as to defy comprehension. Climate change, past and present, is caused by the global wealthy.



These disparities exist even within developed nations. The chart below shows the carbon footprint of various income groups within the EU. The top 1% emit more CO2 from the food they eat than the poorest 5% emit for their whole lifestyles. The top 1% CO2 emissions solely from air travel are approx equal to the top 10% total footprint.



It would be trivially easy to feed a global population of 10 billion vegetarians (see section 6.2.2), while even half that number of meat eaters is enough to destroy the planet.

Overpopulation is not a problem: problems are things for which you propose solutions. If you have 10 people in a boat and one person weighs 1,500 lbs while the other 9 people weigh around 100 lbs each, is the boat overpopulated? Using the language of overpopulation sets the target on poor low-emitters and enables fascist genocidal fantasies of the rich who would love to throw the other 9 people out of the boat. Using the language of overconsumption sets the target where it should rightly be, on the wealthy high-emitters. Overconsumption is the problem.

5. Temperature Projections

5.1 Trajectory

The most important paper published in recent years is James Hansen's Global Warming in the Pipeline from Dec 2022. Hansen, with 14 co-authors (including Leon Simons who I've also quoted frequently), published this paper before it completed peer review, making the full paper immediately available to the public. I take this as an indication of the extreme urgency of the message within:

"Improved knowledge of glacial-to-interglacial global temperature change implies that fast-feedback equilibrium climate sensitivity is at least ~4°C for doubled CO2 (2×CO2), with likely range 3.5-5.5°C…. **Global warming in the pipeline is greater than prior estimates**. Eventual global warming due to today's GHG forcing alone – after slow feedbacks operate – is about 10°C." [emphasis added]

Note that Hansen's likely range for ECS is entirely above the IPCC's value of 3°C. The paper states flatly: "**The IPCC AR6 conclusion that 3°C is the best estimate for ECS is inconsistent with paleoclimate data**." The importance of this cannot be overstated. If we end all CO2 emissions today, the earth will warm by "at least" 4°C by 2100, and by 10°C over the next thousand plus years. Remember, CDR is impossible, we cannot build the machinery to remove CO2 from the atmosphere at the scale required to make a difference. We are committed to these temperature increases.

Going back to the previous topic of fast vs slow feedbacks, the paper states: "most climate models are unrealistically insensitive to freshwater injected by melting ice and also that ice sheet models are unrealistically lethargic in the face of rapid, large climate change."

I could make this section much longer by quoting extensively from the paper, but I'll attempt to keep it short and just recommend that everyone should read at least Hansen's Dec update, if not the full Pipeline paper.

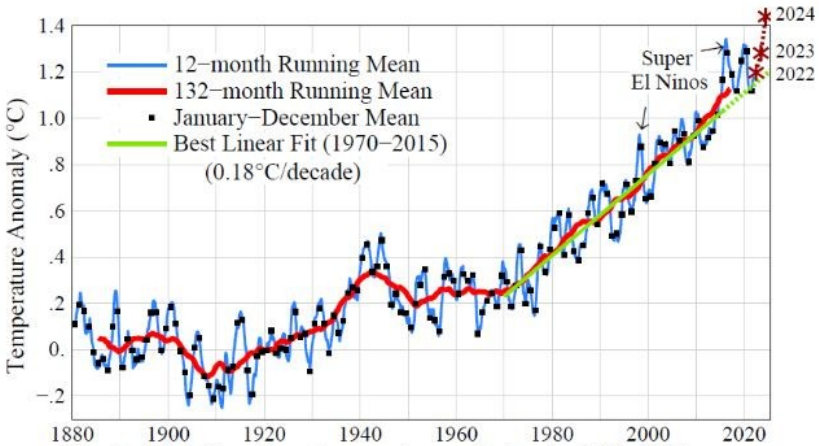
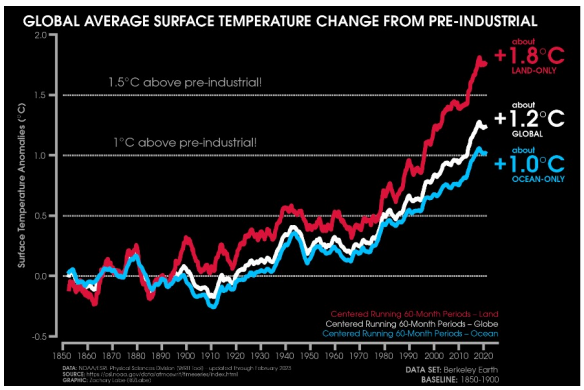
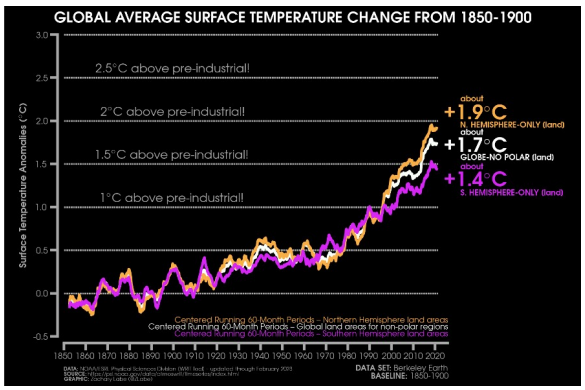


Fig. 3. Global surface temperature relative to 1880-1920 mean.

If we do some simple projections based off of what we know so far, we're looking at 1.5°C by 2024, over 2°C by 2050, 3°C by 2075, and "at least" 4°C by 2100. **<u>This is what everyone should be planning for.</u>** These are global average temperatures, and it is important to emphasize that land warms faster than water, and the northern hemisphere has less water than the southern hemisphere so the NH warms faster than the SH. So when we say 1.5°C global warming we're talking about ~2.2°C on land in the NH, with regional variances meaning some particularly vulnerable areas may warm more than others.





Reminder: these numbers are based on current CO2 levels already in the atmosphere. As calculated in section 2.1, allowing even 9 more years of steady emissions worsens the situation by about 15%, 12 years by 20%, and 15 years by 25%.

Will Steffen gave some context for 4°C of warming in this short lecture extract. 4°C is the same difference in temperature as from the last ice age to the present. "We're talking about a shift as big as between an ice age when mastodons and wooly mammoths were around and humans barely survived, we're talking about the same difference but not in 5,000 years, in one century… In my view it is impossible to survive that sort of change. That's beyond human physiology… In fact large mammals as a whole will not do very good… That's a collapse scenario… because physiologically we can't survive that."

(The following paragraph was added 11 Jul 2023)

Subsequent to publication of this article, Hansen has been frantically attempting to calm the outcries sparked by his Pipeline paper, saying the temperatures in the paper are "not committed". Hansen says "not committed" because he still believes net zero is possible. The argument goes that ECS/ESS values are computed based on constant atmospheric CO2e concentrations, and that after net zero has been achieved the natural sink drawdown mechanisms discussed in section 4.3.2 will cause atmospheric CO2 concentrations to go down, therefore lowering the temperature trajectory. Hansen gets the climate science right, but everything else wrong: net zero is not possible. Further, it is important to remember that the 4°C/10°C temperatures in the Pipeline paper are calculated based on current GHG levels as of the end of 2022 and emissions have still not leveled off. In the years between now and civilizational collapse we will likely emit far more GHGs than any post collapse natural sink drawdown could negate. There is no question that 4°C by 2100 is locked in. Hansen's faith in net zero is not remotely realistic.

5.2 Rate of Change

The primary message of this section is that the temperature projections just made in section 5.1 are a simplistic representation of change. Real change may not happen smoothly but can arrive in sudden, catastrophic bursts. These bursts will happen on top of a baseline warming rate already much faster than we are used to from recent history.

In an update from Aug 2021, Hansen writes: "We should expect the global warming rate for the quarter of a century 2015-2040 to be about double the 0.18°C/decade rate during 1970-2015, unless appropriate countermeasures are taken." The chart below comes from another update from Dec 2022.

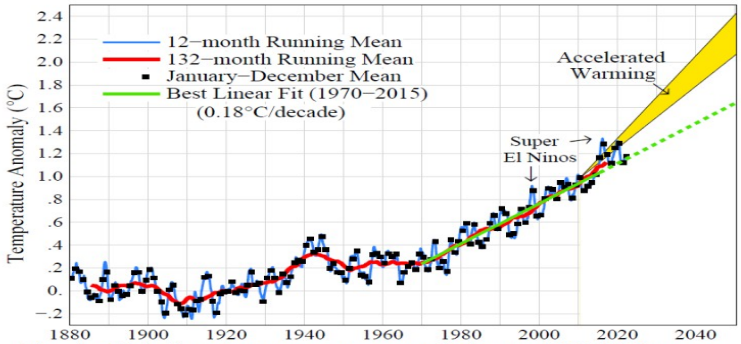
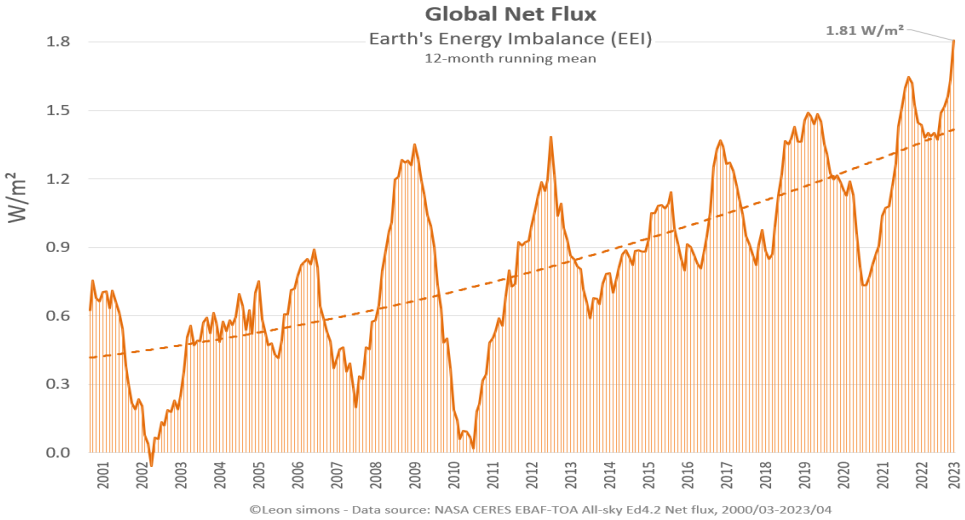


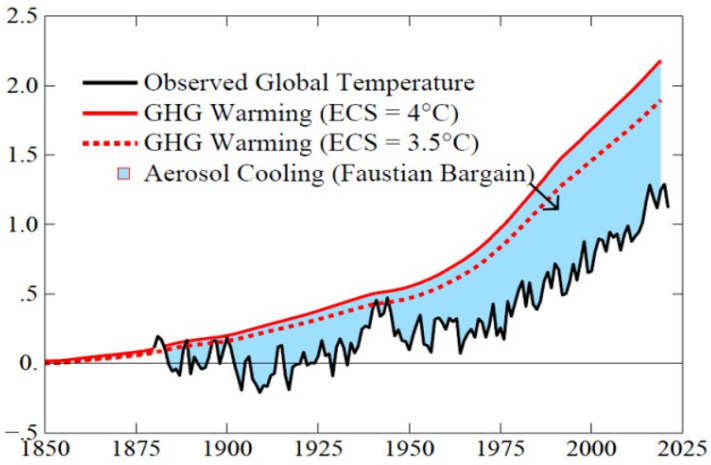
Fig. 4. Global surface temperature relative to 1880-1920 mean.

This very recent [study just published in Apr 2023] found that over the last 20 years the atmosphere is warming 4x as fast as the period from 1961-2000. [Discussion by Simons here].

We know that EEI is a measurement of the speed of warming. Below is a look at [EEI over the past 22 years].



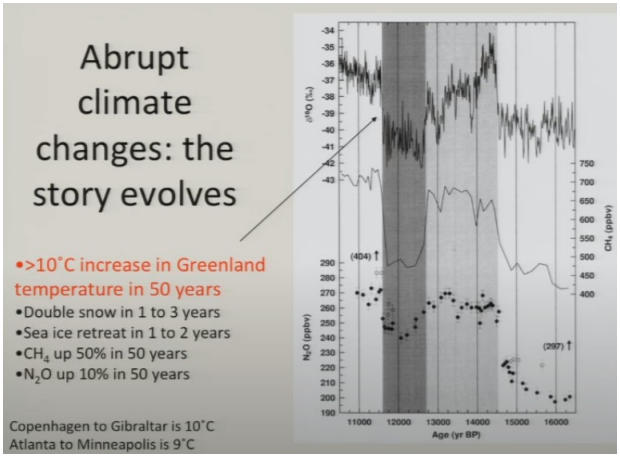
The biggest factor influencing the near term warming rate is the elimination of air pollution, specifically SOx. In a scenario where industrial civilization collapses, the aerosol cooling effect could disappear, resulting in massive warming of 0.5 – 1.0°C within 1 – 2 years.

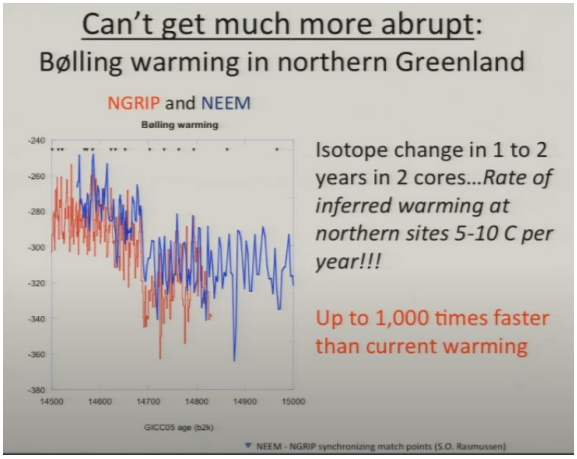


This [2014 AGU presentation by Dr Jim White] of the Institute of Arctic and Alpine Research at Univ Colorado Boulder focuses on Abrupt Change, leading off with the message that "in adapting to change, *speed kills*."

At 13:30: "Up until the 1990's we thought of climate change as mostly "gradual", forced primarily by sun-earth changes. Greenland ice cores and ocean sediment cores changed that view."

His research indicates that study sites in Greenland experienced past abrupt change of 5-10°C within a single year.

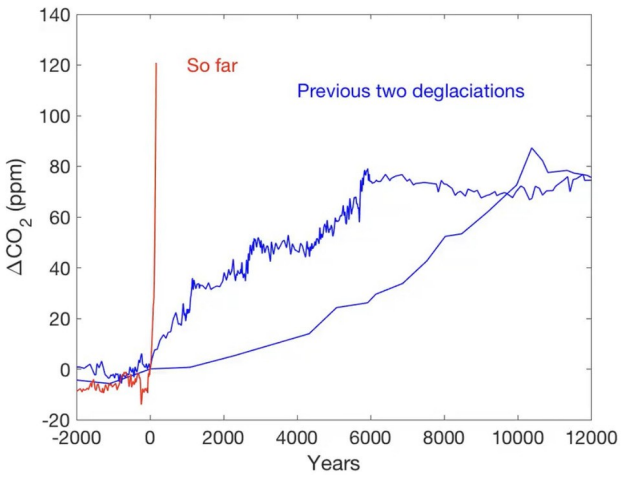




On the topic of Arctic Ocean ice, Dr White states at 24:40: "What you have now is an Arctic Ocean that is largely made up of 1, 2, 3-year ice, and that's very different from an Arctic Ocean made up of multi-year ice… 1-2 year ice is something that can change rapidly… This is a system that has been setup for abrupt change."

Another recent study found: "Ice sheets can collapse into the ocean in spurts of up to 600 metres (2,000 feet) a day… Some ice sheets in Antarctica, including the "Doomsday" Thwaites glacier, could suffer periods of rapid collapse in the near future… Our findings suggest that present-day rates of melting are sufficient to cause short pulses of rapid retreat across flat-bedded areas of the Antarctic ice sheet, including at Thwaites."

These past abrupt melting events resulted from CO2 increases tremendously slower than CO2 emissions rates today, which are rising faster than any event in Earth's history.



The steady rate of warming is becoming faster, and sudden, catastrophic warming events are absolutely possible. It is dangerously wrong to assume that future warming will be anything like recent past warming. We cannot assume that we have time to adequately prepare for future warming or that we can simply deal with events as they unfold.

6. Vulnerabilities

6.1 Risk Assessment

The graphic below is taken from this 2022 study titled: "Exploring catastrophic climate change scenarios" and correctly hilites the focal role of food, water, and fuel as the metaphorical gallows trapdoor upon which civilization incuriously rests.

The paper points out: "The IPCC has yet to give focused attention to catastrophic climate change. Fourteen special reports have been published. None covered extreme or catastrophic climate change."

From the Conclusions section: "There is ample evidence that climate change could become catastrophic. We could enter such "endgames" at even modest levels of warming. Understanding extreme risks is important for robust decision-making, from preparation to consideration of emergency responses. This requires exploring not just higher temperature scenarios but also the potential for climate change impacts to contribute to systemic risk and other cascades… **Facing a future of accelerating climate change while blind to worst-case scenarios is naïve risk management at best and fatally foolish at worst**." [emphasis added]

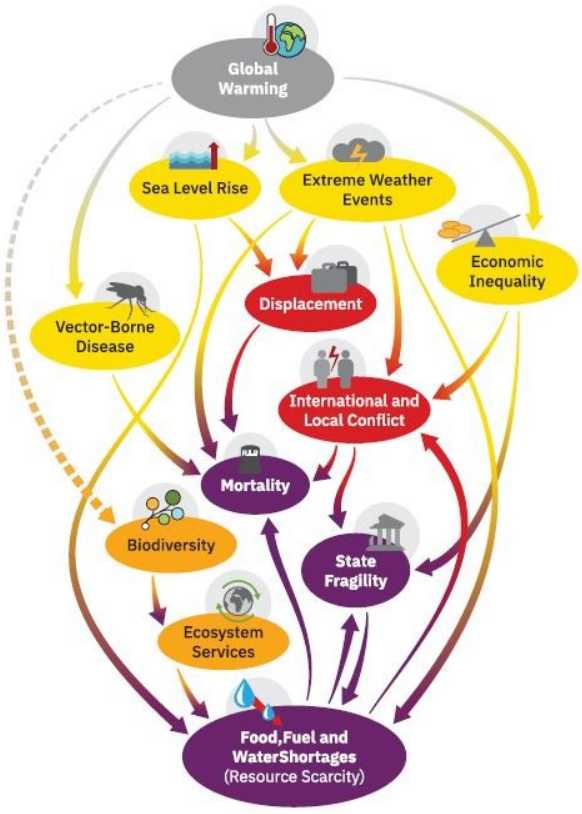


Fig. 3. Cascading global climate failure. This is a causal loop diagram, in which a complete line represents a positive polarity (e.g., amplifying feedback; not necessarily positive in a normative sense) and a dotted line denotes a negative polarity (meaning a dampening feedback). See *SI*

In What Lies Beneath, the authors write: "the World Bank reports "**there is no certainty that adaptation to a 4°C world is possible**."… A 2017 survey of global catastrophic risks by the Global Challenges Foundation found that: "In high-end [climate] scenarios, **the scale of destruction is beyond our capacity to model**, with a high likelihood of human civilization coming to an end."… in the IPCC lexicon, future outcomes are considered 'unlikely' if they lie outside the central 67% of the probability distribution. For many types of risk assessment, however, a 33% chance of occurrence would be very high." [emphasis added]

The report discusses the deceptive nature of "fat tail" distributions: "How likely, for example, are we to experience a catastrophic 6°C warming of the globe?... Well, the mean warming predicted by models is about 3°C, and the standard deviation about 1.5°C. So the positive tail, defined as the +2 sigma limit, is about 6°C of warming… the likelihood of exceeding that amount of warming isn't 2% as we would expect for a bell-curve distribution. It's closer to 10%!"

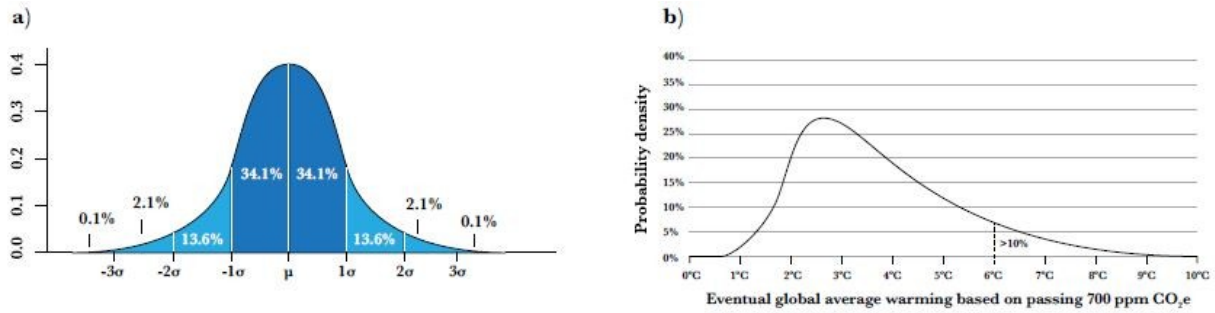


Figure 1: Normal and "fat tail" probability distributions. (a) Normal probability distribution, and (b) an estimate of the likelihood of warming due to a doubling of greenhouse gas concentrations exhibiting a "fat tail" distribution (Credit: Wagner & Weitzman 2015, *Climate Shock: The Economic Consequences of a Hotter Planet*).

Risk is computed by multiplying the likelihood of an outcome by its severity. "IPCC reports have not given attention to fattail risk analysis, in part because the reports are compiled using a consensus method."

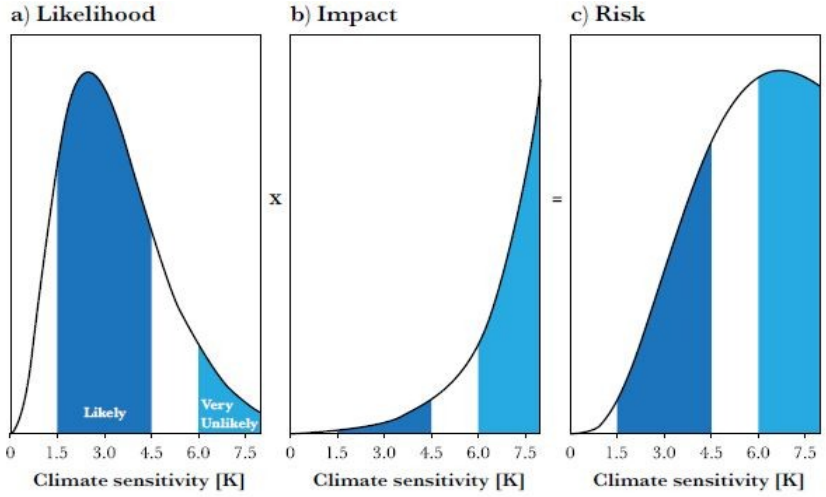


Figure 2: Schema of climate-related risk. (a) Event likelihood and (b) Impacts produce (c) Risk. Lower likelihood events at the high end of the probability distribution have the highest risk (Credit: RT Sutton/E Hawkins).

The authors of this paper, titled "Climate Science Needs to Take Risk Assessment Much More Seriously" ask the question: "Why did the IPCC not long ago produce a risk assessment like that of King et al. (2015)?" From the Conclusions section: "For decision-makers, climate change is a problem in risk assessment and risk management. It is, therefore, surprising that the needs and lessons of risk assessment have not featured more prominently in the consideration of priorities for physical climate science or in the… major IPCC assessment reports… this state of affairs is a result of the siloing of climate science between different disciplines… but it has been exacerbated by a widespread view that the job of the [IPCC] is to provide predictions and projections (with a focus on likelihood rather than risk) and that risk assessment is a job for others."

The King 2015 risk report quotes a 2012 UK Food Research Partnership report which concluded: "The evidence is not available properly to describe with any certainty how variable weather will impact on food production systems and worldwide trade, but our contention is that we need greater investigation of what they could be, with perhaps greater consideration being given to reasonable 'worst case scenarios'… Given that the frequency of weather extremes is increasing, the potential for large impacts, and unprecedented ones, is growing."

King's report concludes: "the risk of a serious weather-related shock to global food production appears to be increasing rapidly due to climate change. Such an event could have serious implications for the stability of global grain markets and human security in vulnerable countries… First, and perhaps foremost, is to better understand the risks. In particular, we need to better understand the evolving risk of weather-related shocks."

The takeaway from this section is that no one is taking risk assessment seriously. The IPCC is not doing risk assessment. The few individual researchers taking the time to investigate are basically saying "we have no idea how bad a worst-case scenario could be". It is beyond ridiculous that we stand less than 18 months from crossing 1.5°C and our risk assessments boil down to "more research is needed."

6.2 Food Supply

There are two distinct vulnerabilities to our food supply: distribution and production.

6.2.1 Food Distribution

The primary near-term threat to human civilization is famine. Americans may think of famine as something that happens elsewhere, not here. This is a mistake. Go to your kitchen cupboard, grab a few items, and look at where they're made. Try the same exercise at the grocery store.

Capitalism has forced the hyper-specialization of various regions into profitable mono-cultures which create single points of failure in the food system. Just one example: 90% of the green leafy vegetables produced in the US from Nov – Mar are grown in the Yuma, AZ area. We import beef from South America and fruits from all over the globe. Staple grains have become just another globally traded commodity like steel or rubber. What this means is that practically nowhere in the developed world, and most especially not in the US, can people support themselves on locally produced foods. Farmers

markets are in no way capable of offsetting a major gap in imported foods. **We are completely dependent on a highly complex global logistics chain in order to eat**.

The famed "efficiency" of capitalism

We've seen in recent years what can happen when that supply chain experiences even minor shocks. Beginning in 2020 we experienced a wide variety of product shortages from Chinese factories closing temporarily to protect workers from covid. We saw massive price spikes on lumber which lasted 2 years. We saw crops destroyed as distributors couldn't rapidly switch from restaurant supply chains to grocery store supply chains. From April 2020: "farmers are dumping as many as 3.7 million gallons of milk each day. A single chicken processor is smashing 750,000 unhatched eggs every week." The highly comedic 2021 grounding of the container ship Evergiven in the Suez Canal caused supply backlogs.

In this interview, George Monbiot discusses complex systems theory and its relation to the vulnerabilities of our food supply. Some important quotes from the interview:

(1:58) "The global food system is beginning to look very much like the global financial system in the run-up to 2008. It's become unbelievably concentrated. According to one estimate 4 companies control 90% of the global grain trade. And those same companies are becoming vertically integrated as well, they're buying into seed, into chemicals, into machinery, into packaging, processing, retailing… They're massive and they're highly interlinked."

(3:10) "Your system is likely to be resilient if no particular nodes within it are dominant. If those nodes are quite weakly connected to each other and if their behavior is not synchronized… because if that's the case shocks can't easily be transmitted throughout the whole system. They stop, there's sort of circuit breakers within that system."

(4:25) "If you have these super dominant nodes… they become very strongly linked to other super dominant nodes and they all begin operating in the same way. That is a highly fragile system, because one thing goes wrong in one node and it can bring the whole lot down."

(5:05) "What we're seeing now is these enormous nodes developing, not just big corporations but also these sort of super exporter nations, particular ports through which the food is passing and particular choke points. So a huge proportion of global food trade goes through the Suez canal, or the Panama canal, or the straits of Malacca, or the Turkish straits, or the Bab-el-Mandeb, or the straits of Hormuz.

And you only need a couple of those to go down and there's very serious trouble… It's not hard to see how the food chain could snap."

(6:20) Commenting on shipping infrastructure improvements: "You think oh well that makes it more efficient so that's good it makes our food supply more reliable, surely. **What that's done is to enable companies to switch from stocks to flows. So they don't hold stocks anymore, it's all "just in time". So if that chain snaps, suddenly there isn't any food. Basically the world's food stocks are at sea at the moment. That is our food stock.** And if that gets jammed up for some reason or another, or if the ships don't get loaded in the first place… then instantly that chain is broken, and not only are people going to go hungry immediately as the shelves will just empty overnight… but also you can then see a chain reaction going on through the whole food system which is exacerbated by speculation, there's massive financial speculation in food now. When they bailed out the banks, you can do that with finance because you can borrow money from the future. You can't borrow food from the future."

(7:40) "It literally keeps me awake at night... I wake up in the middle of the night thinking 'oh christ the [food] supply this can't be true'. But I've been reading these scientific papers now going back 10 years saying "governments you need to be aware of this, this is really really scary, this is worse than you can possibly imagine, because if this goes…" and everyone's ignored it, it's been completely ignored."

6.2.2 Food Production

In the spring of 2022 after Russia launched the Ukraine offensive, world grain market watchers were concerned about the inability of Ukrainian farmers to harvest and transport their winter wheat crop to shipping ports for export. Ukraine produces 9% of the world's wheat exports, among a number of other important agricultural products. India stepped up, announcing: ""We already have enough food for our people but our farmers seem to have made arrangements to feed the world," Modi said in April. "We are ready to send the relief tomorrow"… Now, those lofty goals have been abandoned and wheat exports banned as life-threatening heat waves in South Asia stunt output and push local prices to record highs. The move shocked international markets on Monday — all the more since it came just days after India assured the world that the unprecedented heatwave wouldn't impact its export plans."

This is only one recent story of many. I highly recommend following Jim Baird on twitter (or mastodon). Baird (a pseudonym) claims to be a Canadian agricultural industry expert and regularly posts global agricultural news. This thread contains a trove of news articles spanning years. Skim through that thread and you will quickly realize just how lucky we've been recently, how many near-misses are happening regularly.

The most likely event to trigger a civilizational collapse is what is referred to as a multi-breadbasket failure. From King's Risk Assessment:

"**Food production of the globally most important commodity crops (maize, soybean, wheat and rice) comes from a small number of major producing countries**. The exposure of a large proportion of global production of the major crops is therefore concentrated in particular parts of the globe, and so extreme weather events in these regions have the largest impact on global food production. **Simultaneous**

extreme weather events in two or more of these regions – creating a multiple bread basket failure – would represent a serious production shock, however understanding the covariance of extreme weather events in different production regions is currently under-researched. There is an urgent need to understand the driving dynamics of meteorological teleconnections, such as the El Niño – which may be becoming more extreme - in order to quantify the likelihoods of coincident production shocks in major food-producing regions." [emphasis added]

Essentially, if one region experiences a major crop failure, that is not the end of the world, damaging weather events happen all the time and there is enough supply to handle a one-off regional catastrophe. Simultaneous crop failures are a different matter. As noted in the previous subsection, we do not keep extensive food supplies in storage. Many foods would run out within weeks of the onset of a significant shortage. It is not inconceivable that a significant multi-breadbasket failure could cause half a billion deaths in a single year, including far more deaths in the US than often thought possible.

Additionally, demand continues to increase. "**Demand for food, at a global level, is increasing faster than yields are growing**, leading to increasing pressure on land… Demand growth is driven by population and demographic change, and increasing global wealth." [emphasis added]

In this interview King discusses the threat of seawater inundation onto crop fields. At 1:16:35: "**Once you've been flooded with seawater that's the end of rice production… There will be no global economy like we know it today once rice production collapses like that**".

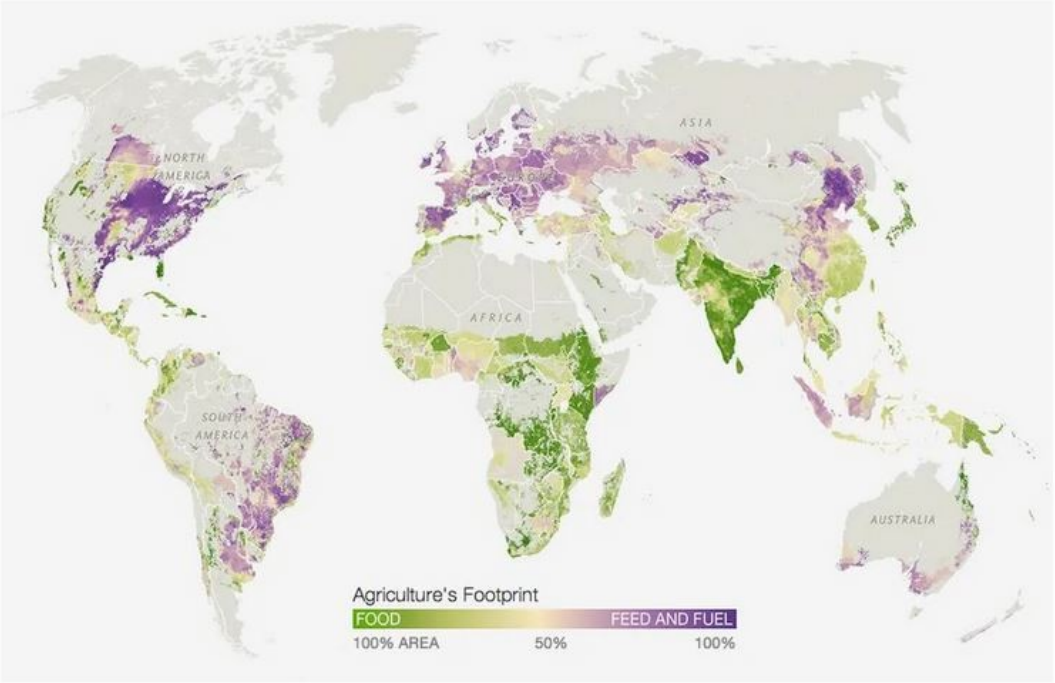
Starting at 1:16:00: "Vietnam will be underwater once a year in 30 years' time… Indonesia: similar. The capital of Indonesia, Jakarta… will not be livable within the next 5-10 years because of frequent flooding. And so now Indonesia is talking about moving its capital to higher land. What we're talking about is a period when rice production in that part of the world collapses… also includes southeast China, flooding of paddy fields massively happening in just 30 years… We're talking about very urgent problems."

At 1:17:20: "**We're going to see the collapse of the global economy well before we hit 4°C**."

This 2021 article describes saltwater intrusion into rice paddies in Cambodia. "Last year, Nget Srey's paddy was almost ready to harvest when her 2½-hectare field became inundated with seawater, wiping out her crops, slashing her main source of income and destroying her way of life. "My paddy was really good by then, and salt water spilled over and it died out. So did other neighbors' rice paddies… Now I am really concerned that I can't farm anymore," she said."

Ironically, food production could be the easiest problem to solve, requiring nothing more than simply switching to plant-based diets, which could reduce agricultural land requirements by 75%. Globally, approx 45% of crops (by calories) are grown not for human consumption but for animal feed and fuels. "The proportions are even more striking in the United States, where just 27 percent of crop calories are consumed directly — wheat, say, or fruits and vegetables grown in California. By contrast, more than 67 percent of crops — particularly all the soy grown in the Midwest — goes to animal feed. And a portion of the rest goes to ethanol and other biofuels. Some of that animal feed eventually becomes food, obviously — but it's a much, much more indirect process. **It takes about 100 calories of grain to produce just 12 calories of chicken or 3 calories worth of beef, for instance**." [emphasis added]

Crops grown for food (green) versus for animal feed and fuel (purple)



Click to enlarge. (**National Geographic**)

Another excellent graphic of the same data here.

"Many of the world's poorest countries eat very little meat." The same wealthy high-emitters who promote the Davos narrative also consume the most meat, so it is practically guaranteed that the wealthy will continue to waste the majority of productive cropland producing animal feed for their meat-heavy diets right up until billions starve.

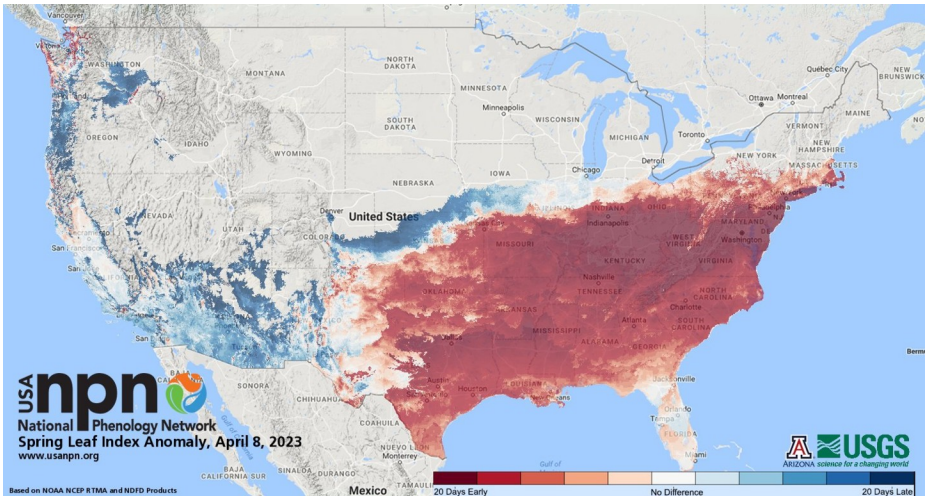
6.3 Globalization

The supply system fragility described above obviously affects far more than just food supply. All other critical supplies and materials needed for civilization similarly depend on foreign production, marine shipping, ports, truck drivers, warehouses, etc. Similar to the grocery store experiment, try going to your local hardware / home-improvement store and look at some "Made In _" labels. Just a couple examples: I found plywood made in Brazil and 1x4 lumber made in Sweden.

Every aspect of our globalized supply chain is hyperfragile. When shocks eventually exceed the system's resiliency, for example if a climate-caused famine creates gaps in those "essential workers" so taken for granted during covid, citizens of industrialized countries will experience shortages of building materials, gasoline/diesel, car repair parts, etc. Those shortages will create feedbacks affecting other sectors. A hyperfragile system pushed beyond its limit will experience impacts far exceeding the magnitude of the shock.

6.4 Shifting Weather Patterns and Climate Zones

The biggest threat to crops is the shifting of weather patterns and climate zones. Crops that are evolved and adapted to a particular climate may not fare as well when the local climate becomes warmer, wetter, drier, etc. From a 2016 study by Zack Labe: "Extremely early springs, such as March 2012, can lead to severe economical losses and agricultural damage when these are followed by hard freeze events… We found a marked increase in the frequency of March 2012-like springs by midcentury in addition to an overall trend towards earlier spring onsets, which nearly doubles that of observational records. However, changes in the date of last freeze do not occur at the same rate, therefore, causing a potential increase in the threat of plant tissue damage." The graphic below is from a recent update.



Global warming doesn't just mean temperatures getting warmer, it also means increasing extremes and variability. The hallmark of the holocene was climatic stability, we've left that era behind. The graphs below are extracted from Hansen's Nutshell, showing that not only has the mean temperature become warmer, but extreme events have become more common, as reflected in the widening of the base of the bell curve at right.

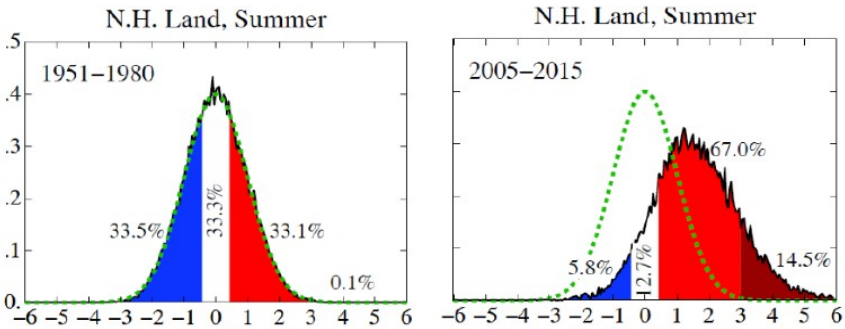


Fig. 22. Frequency of occurrence of local temperature anomalies in Northern Hemisphere land areas in period of climatology (1951-1980) and in recent years. Horizontal axis is the local standard deviation, the typical annual variability, which is greater at high latitudes than at low latitudes. [Hansen and Sato, 2008]

Simons states: “Extremely Hot Summers in the Northern Hemisphere have gone from happening 0.1% of the time in 1951-1980 to 22.1% of the time in 2009-2019. That is over a 200x (20,000%) increase!” Increasing variability means it’s not as simple as just moving farms north as the climate warms, even if that were possible. Refer back to section 5.2 and then consider future food security.

Since approx 2020 the jet stream has essentially been broken. We now see increasing frequency of polar vortex systems diving deep into the mid latitudes, and extreme warm events over the poles. We hear the term “blocking pattern” constantly on the local news describing why a weather system has been stuck in its current configuration for weeks. California has just experienced a solid month of extreme rain and snowfall. “The re-forming Tulare Lake — which was drained for farming a century ago — could remain on the landscape for years, disrupting growers in a region that produces a significant proportion of the nation’s supply of almonds, pistachios, milk and fruit. High-stakes decisions over where that water travels could resonate across the country’s grocery store shelves.”

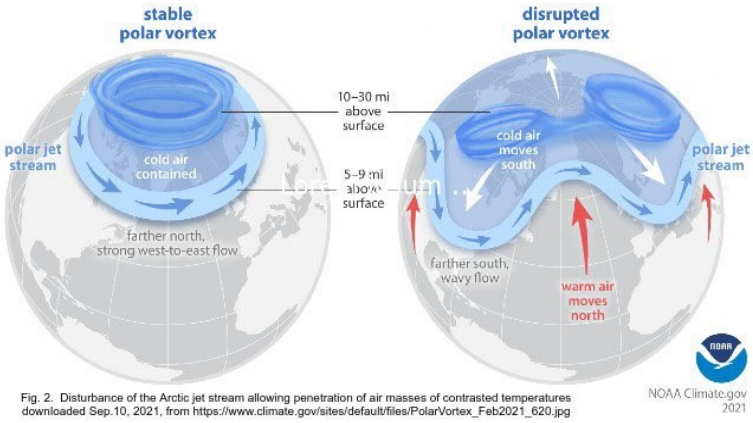
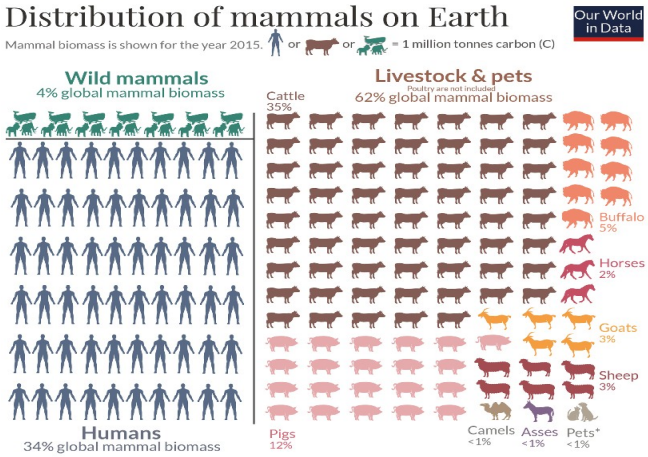


Fig. 2. Disturbance of the Arctic jet stream allowing penetration of air masses of contrasted temperatures downloaded Sep.10, 2021, from https://www.climate.gov/sites/default/files/PolarVortex_Feb2021_620.jpg

Lower latitude weather is governed by Hadley circulations, which are also weakening. “…the [Hadley] circulation has considerably weakened over recent decades. We further show that the weakening of the circulation is attributable to anthropogenic emissions.” Discussion by one of the authors here.

These same shifts in weather patterns and climate zones will affect wild animals as well. Already humans have killed off the vast majority of wild animals and destroyed their habitats for agriculture and development.



The remaining wild animals cannot simply migrate north as climate zones shift for several reasons. First, present climate change is happening far faster than previous natural events, animals cannot move and adapt to new locations fast enough. Second, we've destroyed and/or fragmented enough wild habitat that many animals don't have anywhere to go. It does the animals in the Everglades no good if new swamp regions emerge elsewhere after Florida becomes inundated with seawater if those new swamp regions are not physically connected in a way those animals can safely traverse. Birds that may be able to more easily access new areas cannot be assured of adequate food sources if their preferred prey does not also inhabit these new climate zones. Quoting White again: "speed kills".

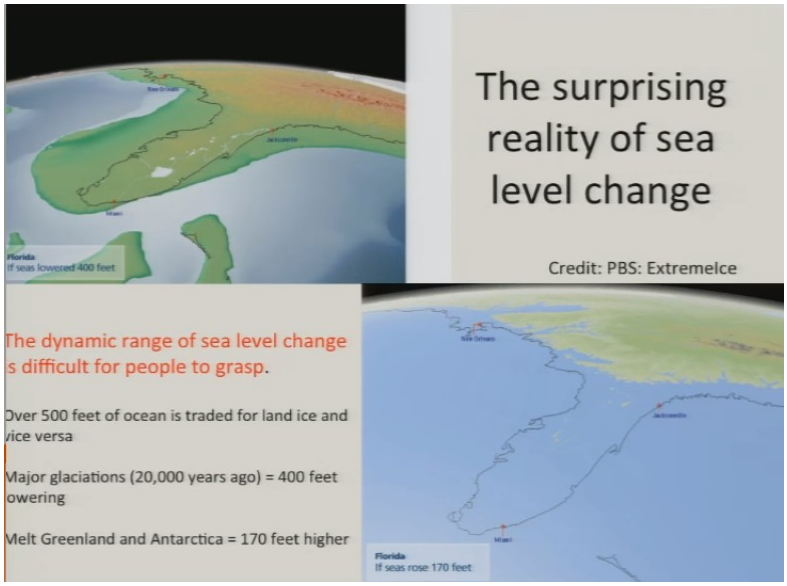
6.5 Sea Level Rise

I have written very little about sea level rise (SLR) so far because it is my least familiar topic, and projections for magnitude and timing both vary widely depending on the source. It is certain that over the next 1,000-plus years that sea level will rise on the order of 60-80 meters, but near term projections are much more difficult to nail down, depending largely on the exact behavior of various ice sheets.

In Hansen's Global Warming in the Pipeline paper he mentions that there will be a forthcoming Sea Level Rise in the Pipeline paper and provides a few summary points. I will likely update this article after that paper becomes available.

- "...continued warming and increasing ice melt can cause shutdown of the overturning ocean circulations within decades and large sea level rise within a century."
- "…it is concluded that the time scale for loss of the West Antarctic ice sheet and multimeter sea level rise would be of the order of a century, not a millennium. Eventual impacts would include loss of coastal cities and flooding of regions such as Bangladesh, the Netherlands, a substantial portion of China, and the state of Florida in the United States... Such outcome could be locked in soon…"

The slide below is taken from White's presentation (see section 5.2) and shows Florida during the last glaciation and after the melting of Greenland and Antarctica.



For my analysis, I consider SLR likely will not become a critical factor until after civilization has already collapsed. SLR will be an important factor threatening the small number of survivors who make it past 2050. At that point a significant concern will be all the abandoned nuclear power plants along coastlines. More than 12 years after the Fukushima disaster, Japan is still dealing with radioactive contaminated water.

6.6 Insurance

Insurance is an easily overlooked but critically important factor to the stability of civilization. As Roger Hallam put it recently: "no insurance, no economy." All property values in the US are underpinned by disaster insurance. If a property is in a flood zone, fire zone, earthquake zone, etc, you must carry the relevant disaster insurance or you cannot get financing. If your property is deemed too high risk for insurance, no one is going to buy it because they will not be able to get financing. If insurers pull out of an area, the property values will tank, essentially becoming stranded assets. If businesses leave then residents don't have jobs. It's yet another example of a fragile system with a clearly defined breaking point that, once passed, will cause tremendous cascading impacts.

"A new study finds homeowners insurance is becoming less available and less affordable in Colorado. The study by the Colorado Division of Insurance shows 76% of insurers decreased the number of Coloradans they cover last year. And over the last three years, the average insurance premium here has jumped nearly 52%. While some insurers are selectively canceling policies in high-risk areas and many are considering mitigation when deciding whether to insure a property, the study says the problem isn't isolated to areas at high risk for wildfire. It found policies are being canceled and premiums are climbing across the state… Colorado has the third-highest risk of wildfire and the second-highest number of hail claims in the country."

"…climate change is destabilizing the insurance industry, driving up prices and pushing insurers out of high-risk markets… climate change is injecting uncertainty into an industry built on risk prediction and has created "a crisis of confidence around the ability to predict loss."… Reinsurance companies, which help insurers pay catastrophic losses, "have been withdrawing from high-risk areas, around wildfire and flood in particular"… Florida's state-run property insurer warned recently that Hurricane Ian had "significantly depleted" its reserves and that it might impose a surcharge on millions of policyholders in the state if another major hurricane generates massive claims. In California, the state-run FAIR plan has accumulated a $332 million deficit while it charges premiums that are too low and has limited reinsurance to cover claims from a catastrophic wildfire… Growing risks from climate change and rising reinsurance costs have caused insurers to raise premiums and pull out of markets, "leaving homeowners with fewer choices, less protection, and more financial distress," Keys said. Watkins said that **when insurance companies stop selling policies in an area, it "can cause ripple effects that endanger entire communities and create a downward spiral that's difficult to emerge from." The spiral could occur gradually, Watkins said, "but it's possible for weakened markets to collapse quickly through a crisis of confidence triggered by one event**."" [emphasis added]

"California's growing wildfire risks have created challenges for its insurance markets in recent years, characterized by rising premiums and deductibles, declines in coverage, and sometimes even policy discontinuance. When homeowners are unable to obtain insurance through the private market, they can turn to the state's Fair Access to Insurance Requirements (FAIR) Plan, a pool made up of all insurers authorized to operate in the state. FAIR Plan policies tend to be high cost and provide substantially less coverage than standard policies. For example, they typically do not offer liability coverage."

"…just those two fire seasons [2017 & 2018] alone decimated more than a quarter century's worth of underwriting profits for the California insurance market."

White, in the video linked in section 5.2, states at 37:00: "The Federal Flood Insurance program could become the largest entitlement program out there. Larger than Social Security, larger than Medicare / Medicaid, given the trillions and trillions of dollars of assets we have on the coasts."

An insurance crisis following a series of major climate related catastrophes such as fires and floods could very easily exceed the severity of the 2008 housing crash. It is not unthinkable that the US could witness millions of internal refugees abandoning stranded assets in uninsurable cities.

6.7 Non-Climate Change Related Threats

Bill Rees is one of a number of climate scientists who portray climate change as one symptom of a larger planetary problem of ecological overshoot. In this excellent lecture he briefly touches on: ocean acidification, freshwater contamination, deforestation, soil erosion, desertification, overfishing and species extinctions.

A few key quotes:
(26:45) "It's not just mammals. Wild bird populations are also tumbling. Domestic poultry now constitute 70% of the world's avian biomass. Average populations of thousands of monitored species of wild vertebrates, birds, fish, mammals, amphibians, have declined ~60% since 1970. Populations of invertebrates, including essential pollinators, are also in free-fall: Butterflies down 53%; beetles down 49%, bumblebees down 46%... All species monitored by WWF are down 68-70% in just 50 years."

(46:40) "**In coming years, there's no question, the human enterprise will contract**."

(50:20) "With a 2 degree increase in mean global temperature, Israel will become uninhabitable." [this particular lecture was given at an Israeli university]

(50:55) "It may take some kind of micro catastrophe to wake enough people up to the fact that they themselves are threatened. See another of our socially constructed myths is that our technology and our wealth will protect us from the worst consequences of this. In North America we're being told that 'oh climate change may be happening but it's happening over there to other people' and that appeals to another natural instinct of humans: we are natural discounters. Human beings prefer the here and now, and close relatives and friends, to any distant place, total strangers, and merely possible future events. So even though science is telling us this is what in the future is going to happen, we tend to displace that

onto other people elsewhere, and hence we don't have to do much over here... We are self delusionists. It had remarkably high survival value 10,000 years ago, but in rapidly changing circumstances such as today it becomes maladaptive."

Destruction of the oceans is far worse than just the direct acts of overfishing, this 2010 study found: "the recent dip in phytoplankton wasn't a passing phase. It had been happening in most parts of the ocean for more than a century. On average, the planet has lost 1% of its phytoplankton every year since 1900... "You compound that over a century, this becomes a huge, huge decline,"... Indeed, Worm's team estimates that phytoplankton numbers have plummeted 40% since 1950. What's more, the team found that phytoplankton numbers were more likely to dwindle in areas of the ocean that were warming, suggesting that climate change is responsible for the drop. The loss of phytoplankton is a huge problem for marine food chains, says Worm, because every creature in the ocean either eats phytoplankton or eats other organisms that depend on it. If their numbers start to decrease, the populations of these species would drop as well. "The rest of the food web would basically contract," he says. Even more chilling… is the potential impact on our atmosphere. The ocean absorbs 40% of the CO2 humans emit. Phytoplankton, in turn, convert that CO2 into oxygen or die and bury it at the bottom of the ocean. If the phytoplankton are disappearing, Richardson says, "the ocean as a carbon sink is declining, and what that means is ultimately more CO2 will stay in the atmosphere instead of being dissolved in the ocean." This 2015 NASA study confirmed the 1% per year decline rate.

PFAS are a threat to drinking water supplies only now beginning to be studied and understood, with regulations lagging far behind.

And lastly we cannot ignore the threat of pandemics such as covid. We have evidence that covid harms reproductive health in addition to the acute and chronic risks of death and disability. This 2021 study found "a consistent association between pregnant individuals with COVID-19 diagnosis and higher rates of adverse outcomes, including maternal mortality, preeclampsia, and preterm birth compared with pregnant individuals without COVID-19 diagnosis." This 2023 article reports finding covid "in fetal brain tissue in instances of pregnant people passing the infection to their children", including increased occurrence of brain hemorrhages.

Each of these threats are worth their own in-depth investigations, and I will not attempt to fully expound upon them here. The point is to hilite how astronomically foolish the IPCC's fantasy of strip-mining the entire planet for copper and lithium is, even in an alternate reality where that was feasible we *still* would be facing near term extinction due to all the other planetary destruction that is not included in discussions of climate change. The standard assumption that "tech will save us, there's no need to overthrow capitalism" is insanity beyond insanity, hubris beyond hubris.

7. Real Scenarios

Having established that the IPCC scenarios are junk, what might the coming decades actually look like? First let's take a look at who the actors are who can actually influence policy and practice.

7.1 Who is at the Wheel?

In as few words as possible: fossil fuel CEOs and billionaires, and their servants in government, determine what path we take; past, present, and future.

From a Jan 2023 study published in Science:
"In 2015, investigative journalists uncovered internal company documents showing that Exxon scientists have been warning their executives about "potentially catastrophic" anthropogenic (human-caused) global warming since at least 1977. Researchers and journalists have subsequently unearthed additional documents showing that the US oil and gas industry writ large—by way of its trade association, the American Petroleum Institute—has been aware of potential human-caused global warming since at least the 1950s; the coal industry since at least the 1960s; electric utilities, Total oil company, and General Motors and Ford motor companies since at least the 1970s; and Shell oil company since at least the 1980s."
"We find that most of their projections accurately forecast warming that is consistent with subsequent observations. Their projections were also consistent with, and at least as skillful as, those of independent academic and government models. Exxon and ExxonMobil Corp also correctly rejected the prospect of a coming ice age, accurately predicted when human-caused global warming would first be detected, and reasonably estimated the "carbon budget" for holding warming below 2°C. On each of these points, however, the company's public statements about climate science contradicted its own scientific data."
"Our findings demonstrate that ExxonMobil didn't just know "something" about global warming decades ago—they knew as much as academic and government scientists knew. But whereas those scientists worked to communicate what they knew, ExxonMobil worked to deny it—including overemphasizing uncertainties, denigrating climate models, mythologizing global cooling, feigning ignorance about the discernibility of human-caused warming, and staying silent about the possibility of stranded fossil fuel assets in a carbon-constrained world."
"On each of these points, however, the company's public statements about climate science contradicted its own scientific data."

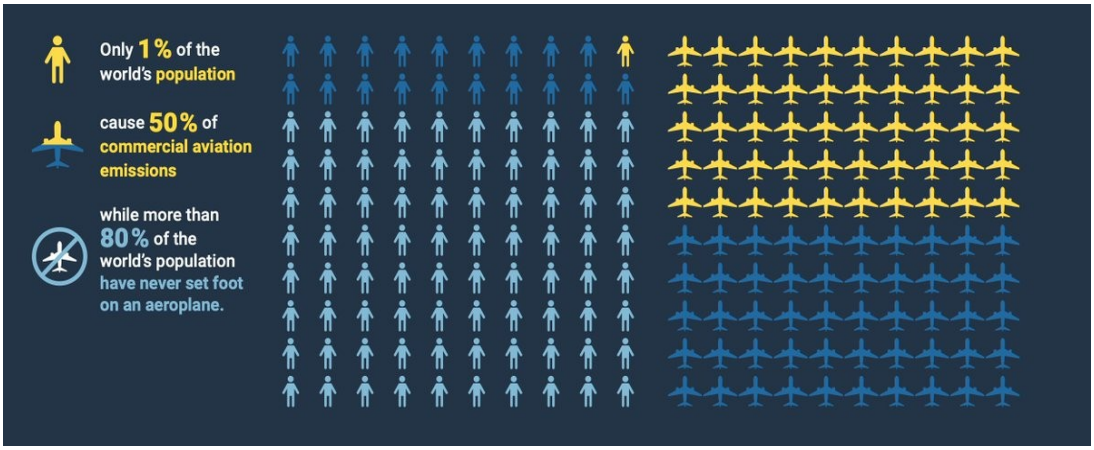
Additional #ExxonKnew documents and information available here. And more from Ben Franta here.

It is absolutely critical to understand that global warming is not happening by accident. Our current predicament is not a surprise. Fossil fuel CEOs and their servants in the US government chose our present reality deliberately, and doubled down on that decision every year for over four decades. Meanwhile, President Biden has approved more new offshore drilling in the Gulf of Mexico and new drilling in Alaska.

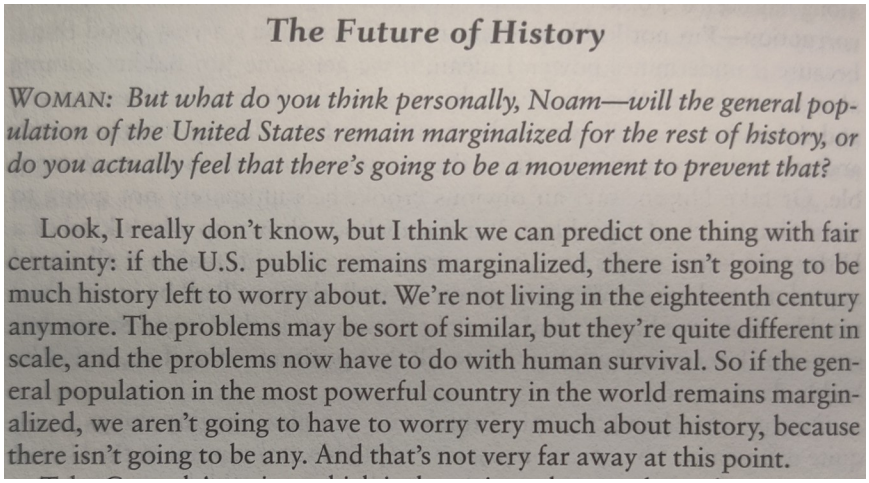
Billionaires, for their part, stand ready to retreat to their bunkers guarded by robot dogs with machine guns. Douglas Rushkoff's 2018 article (recently expanded into a book) describes his encounter with a room full of billionaires:
"Finally, the CEO of a brokerage house explained that he had nearly completed building his own underground bunker system and asked, "How do I maintain authority over my security force after the

event?" The Event. That was their euphemism for the environmental collapse, social unrest, nuclear explosion, unstoppable virus, or Mr. Robot hack that takes everything down. This single question occupied us for the rest of the hour. They knew armed guards would be required to protect their compounds from the angry mobs. But how would they pay the guards once money was worthless? What would stop the guards from choosing their own leader? The billionaires considered using special combination locks on the food supply that only they knew. Or making guards wear disciplinary collars of some kind in return for their survival. Or maybe building robots to serve as guards and workers — if that technology could be developed in time."

Billionaires are, by definition, psychopaths. It is impossible to earn a billion dollars. Take any exorbitant salary you like, let's say $500,000/yr, and calculate how many years you would have to work, spending nothing, to earn your first billion. At $500k/yr it would take 2,000 years. Or, if you simply steal $3 from every single American, you can make a billion in a single year. Billionaires' wealth comes only from wage theft from workers. It is never earned. It is estimated that ~5% of deaths in the US are attributable to poverty, making every billionaire a de-facto mass murderer. No one becomes a billionaire because they are intelligent or talented, people become billionaires because they are able to rob millions of other people into poverty, destitution, and early death and still sleep soundly at night. These are the people determining our future. They are brain damaged by power. They believe they are chosen by the universe to live as gods. If you are banking on billionaires saving the planet because "it's in their best interest," you misunderstand their interests.



Nowhere in this list of relevant actors will you find the general public. Protests, emails to congress, and voting will have no impact. Quoting Chomsky from *Understanding Power*: "if the general population in the most powerful country in the world remains marginalized, we aren't going to have to worry very much about history, because there isn't going to be any. And that's not very far away at this point." Chomsky said that 24 years ago, and in the intervening years the US public has become more repressed and marginalized than ever.



The Future of History

WOMAN: *But what do you think personally, Noam—will the general population of the United States remain marginalized for the rest of history, or do you actually feel that there's going to be a movement to prevent that?*

Look, I really don't know, but I think we can predict one thing with fair certainty: if the U.S. public remains marginalized, there isn't going to be much history left to worry about. We're not living in the eighteenth century anymore. The problems may be sort of similar, but they're quite different in scale, and the problems now have to do with human survival. So if the general population in the most powerful country in the world remains marginalized, we aren't going to have to worry very much about history, because there isn't going to be any. And that's not very far away at this point.

7.2 On a Knife Edge

As of early 2023, we are currently sitting at 1.3°C global warming, having just exited a cool La Nina phase and headed into: 1) a warm El Nino phase, 2) a particularly active solar maximum, and 3) continued massive reductions to sulfur pollution that provides aerosol shielding. **Summer 2024 is going to be bad, worse than anything we've ever seen. It will shock the world**. This is not hyperbole, this is not alarmism, this is the simplest expression of the current facts. Anyone with any understanding of risk assessment or precautionary planning should understand that this is not a joke.

In the movie *Don't Look Up*, when the 3 scientists are presenting their findings to the president, she responds "Do you know how many the-world-is-ending meetings we've had?" We're all a bit crisis fatigued after enduring over 3 years of ever worsening pandemic and constant government and media gaslighting. But you cannot allow cynicism over nuclear war, terrorist attacks, etc to blind you to the fact that we are absolutely balanced on a knife edge right now.

The warming we experience starting in 2024 could very well activate significant methane releases from arctic circle permafrost, or cause the first Blue Ocean Event. Any prolonged decrease in economic activity could drop our aerosol shield even further. If any of those happen we could see 2.0°C by the end of the decade. If all of those happened together it could be 2.5°C or even higher. **Nothing can adapt that fast**.

I do not have a crystal ball, I cannot see the future, but I can damn well see the range of possibilities. The future that most people are blithely assuming and basing their plans on is most certainly not in that window. The next decade is going to catch people by surprise.

7.3 From Famine & Fascism to Collapse & Extinction

Crop production depends on a stable climate. It is not a matter of "if" but of "when" a significant catastrophe occurs. A globally significant famine is going to happen. It could happen in 2 years or it could take 10-15. I can't know that. But the trends are clear. When that happens, the import-dependent US will not be spared. I think the biggest, most critical failure of imagination is in how people

assume the US govt will respond to this catastrophe. In any crisis the response is of equal significance as the actual event. Capitalism solves shortages by increasing price. Other countries may take a more humane approach to food rationing, but the US govt is absolutely not going to supply emergency rations to the public. The poor will simply starve.

The US govt is preparing for climate change by hiring 100,000 additional police officers, an approx 15% increase to our already obscenely bloated, militarized, domestic occupation force of ~680,000. **This is America's climate change adaptation plan: more police**. When collapse begins, the National Guard and militarized police will stand ready to destroy any protest or resistance.

The foundation of capitalism is growth, it's the only way interest rates work. Capitalism requires growth and will absolutely not allow any efforts to scale it down. The US just created the largest ever recorded methane release by blowing up the Nordstream pipelines, with estimates ranging up to 400,000 tons. This act was done in a desperate attempt to prevent the emerging global multipolarity and decline of US dollar hegemony. The US govt is currently pushing China as hard as possible attempting to start a war over Taiwan. "Research shows the US military is one of the largest climate polluters in history, consuming more liquid fuels and emitting more CO2e (carbon-dioxide equivalent) than most countries." The last 100+ years of US history can be summarized as capital's complete victory over workers. From Pinkertons murdering union organizers, to Korea, to Vietnam, the Kent State massacre, the entire Cold War, every action has had as its single aim the subjugation of workers to capital.

"For a conflict to qualify as a civil war, most academics use the threshold of 1,000 dead, which leads to the inclusion of a good number of low-intensity rural insurgencies." The number of Americans killed each year by police has been over 1,000 since 2013 at the latest, with 2022 setting a record. These official numbers are believed to be underreported by over 50%. Therefore it is not unreasonable to state that the US is already in a state of violent civil war, but a civil war where only one side is doing the killing is more accurately called genocide. "For every police officer who was killed by a civilian in 2019, 21 civilians were killed by cops". Logging is nearly 10 times more dangerous than policing. Policing is not even in the top 10 most dangerous jobs in America. Alec Karakatsanis does fantastic work explaining how police departments, police unions, and local politicians spread false information about crime waves to justify ever increasing police budgets, calling the practice "copaganda". He has a forthcoming book on the topic. Police gangs are out of control with Los Angeles and Memphis merely two that have made recent news for egregious violence. I have not even mentioned our horrific prison system, to which I could devote an entire chapter.

There is a saying in the business world: "Do not tell me your priorities, show me your budget and I will tell you what your priorities are". **There is zero chance of developing any meaningful climate resiliency, and significant odds of sharp escalation of violent repression**. Summer 2020 was the most optimal time for American workers to strike and demand fundamental changes. It didn't happen then, and we will never have that amount of leverage again. Covid has been extremely revealing about the nature of power and propaganda. We have seen how billionaire pharmaceutical CEOs can get rival vaccines kneecapped (see Novavax). We have seen how public health agencies function essentially as PR for private business. And we have seen how literally millions of dead and disabled Americans can be

completely ignored in the interest of keeping the economy pumping ever larger portions of our wages into the pockets of billionaires.

The IPCC reports serve to keep everyone distracted right up until collapse. Anyone expecting governments to "wake up" once climate impacts become too large to ignore will be sorely surprised to find only gun barrels in the climate plan. Our government does not stand by ready to help, but ready to violently destroy us when we resist. It is entirely possible (I won't say likely, but definitely possible) that 2024 could be the last US presidential election. Emergency powers should make it possible for whoever holds power at that time to maintain control until collapse of governance.

Additionally, we have fascist accelerationist elements that would exploit our civilizational fragility. This excellent and very in-depth reporting on The Far-Right's Fascination with the U.S. Electric Grid details a coast-to-coast pattern of electrical substation attacks likely inspired by a right wing plan to "push society into collapse. Such a collapse would then allow heavily armed far-right groups to impose their vision for society onto a desperate and vulnerable civilian population." Opportunistic armed groups may further exacerbate a climate-caused crisis, and/or foul up recovery efforts.

A positive revolution requires logistics, primarily food, fuel, and weapons, as well as organization and communication. Globalization means we don't have the ability to seize the means of production at a local scale. Social alienation and ubiquitous surveillance means we are unorganized, lack robust communities to fall back on, and can't communicate securely. Revolution is a tough job even when those factors are met, it is impossible without them. The coming violence will be reactionary, not revolutionary.

Americans are far more vulnerable than we like to convince ourselves. Our society is hyperfragile, meaning that any breakage in one of the many underlying systems can lead to a complete collapse of the entire system. We depend heavily on imports, as detailed in sections 6.2 and 6.3. We depend on crews of workers constantly maintaining our electric grid and telecommunications infrastructure. We produce practically nothing needed for subsistence at the local level. **We have zero resiliency**.

One thing you can always count on billionaires for is hubris. They are actually stupid enough to think they can re-terraform earth after removing several billion "useless eaters". Billionaires likely believe they can survive in their bunkers, and while it is true they will likely be the last to die, they (or their

children) will not survive to the end of this century either. This may be the hardest part for many people to grasp: billionaires do not have a long game. The only way they know how to act is 'all or nothing'. The wealthy despise workers as vermin. They would rather die than share the world's natural wealth, and they may soon grant their own wish: to be dining and drinking champagne on the deck of the Titanic as it slips beneath the waves.

The critical events we have to look forward to in the near future are: increasingly erratic catastrophic weather, multi-breadbasket crop failure, global famine, supply chain failures, government violence, right wing civilian violence, loss of power grids and telecommunications, refugee wars, civilizational collapse, followed by a massive die-off as the aerosol shield disappears and populations revert in a completely unmanaged way to local subsistence without complex supply chains. This last step is where industrialized, first-world nations will fare far worse than they currently expect.

Exactly what follows after that is extremely hard to predict and will depend largely on whether nuclear weapons are detonated during that collapse. But assuming no nuclear war (by no means a safe assumption), I would expect that by 2050 when global average temperature is at least 2°C that no organized governments will remain, no global logistics or fossil fuel transport or refining, no large scale fossil-fuel dependent agriculture, no dense cities, all nuclear power stations abandoned and leaking. Global population will be clustered in whatever geographical regions turn out to suffer the least inhospitable weather (very hard to predict where those will be).

I have previously quoted Will Steffen saying 4°C is not survivable by humans (section 5.1). Here are a few more comments on extinction from scientists.

This article by Bill Rees is titled Yes, the Climate Crisis May Wipe out Six Billion People: "a climate symposium organized to discuss the implications of a 4C warmer world concluded, "Less than a billion people will survive." Here Schellnhuber is quoted as saying: "At 4C Earth's... carrying capacity estimates are below 1 billion people." His words were echoed by professor Kevin Anderson of the U.K.'s Tyndall Centre for Climate Change: "Only about 10 per cent of the planet's population would survive at 4C. Similarly, in May of this year, Johan Rockström, current director of the Potsdam Institute opined that in a 4C warmer world: "It's difficult to see how we could accommodate a billion people or even half of that."

Borrowing a couple quotes from this thread by Roger Hallam:
Peter Kalmus: "I am working on projections of extreme humid heat, and hopefully will soon be communicating the results publicly (and refining them over time). They are harrowing. All of this activism MUST be seen in the context of potential for future death and suffering. When billions of lives are at stake, including the lives of people we love or even our own lives, then yes, risking arrest to try to stop that through nonviolent civil disobedience is probably "worth it" for a lot of us."

James Dyke: "Most people are oblivious to the fact that we have already produced irreversible climate change. The Holocene is over. What we do next determines what sort of future we have, indeed if we have any sort of future, on planet Earth."

It's notable to look at how some of those estimates are worded. We're not talking about a best guess 1 billion with error margins plus/minus. We're talking about 1 billion on the high end, with the unspoken low end of the estimate range being zero. And these estimates come from people with full faith in their governments to enact and build meaningful climate resiliency plans before then, in some cases currently employed by the US government (Kalmus), speaking on the record where they can be quoted on the internet by people like me. At every step we've consciously made the worst possible decisions, allowing a small number of psychopaths to lead and decide for the complacent masses. The idea that we'll somehow pull our act together at the last minute and hit the high end is not serious.

All this is just the first step along the road to an eventual 10°C earth already baked into present CO2 levels.

8. Conclusion

8.1 It's Simpler Than You Think

If there is one key takeaway from all this, it's that climate change is far simpler than we've been led to believe. You can throw out all the talk of Net Zero, Carbon Dioxide Removal, Scenarios & Pathways, Carbon Budgets, and whatever other buzzwords IPCC will introduce next.

The physical climate facts are: we've put over a trillion tons of CO2 into the atmosphere that we cannot remove, along with other GHGs it will warm the globe by at least 4°C by 2100 (even if all emissions stopped today), agricultural failure is imminent within a decade or so.

The socio-political facts are: hyperfragile modern civilization will collapse following agricultural failure. We're not going to geoengineer our way out of this. There will not be a revolution. Fascism is ascendant and governments will protect billionaires and sacrifice the working class.

There's nothing we can do except try to soften the blow on children and the most vulnerable.

After 1,500 years or so the earth will have warmed 10°C, which will be practically a sterilizing event for the planet. Earth will be doing good to still have anything larger than bacteria alive. If complex life ever evolves on this planet again, the only sign humans existed will be a geological layer of plastic microparticles.

8.2 Why Don't Scientists Agree?

There are several reasons why most scientists are happily trotting along with Net Zero.

Some are simply lying. Climate scientist James Dyke posted recently: "Last year I asked someone who, let's say has quite a bit of experience in climate politics, if they thought we were going to pass 1.5. They said: of course, but we can't say that yet. I asked them: well what should we say about 1.5. There was a long pause...". Climate scientist and author Bill McGuire wrote An open letter to all climate scientists, saying: "I have talked to many of you in private, and the response – without exception – has been that the true situation is far worse than you are prepared to admit in public."

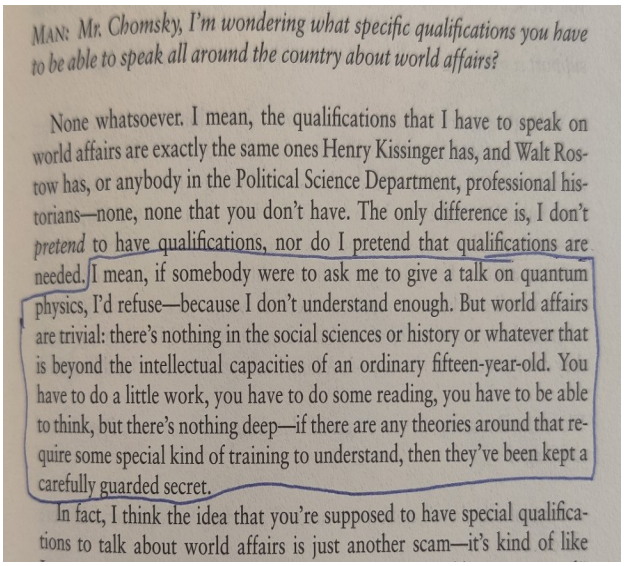
Others, to put it bluntly, are idiots. The majority of what we call "scientists" today should more properly be called technicians or specialists. Increasing complexity means that it takes an entire career of study to reach the cutting edge and be able to advance the discipline. If it took 15 years to learn to be a truck driver we wouldn't call truck drivers scientists. These are not well-rounded thinkers, a far cry from what used to be called "natural philosophy". They are as narrow-focused and siloed as it is possible for a human to be. They have zero understanding of the world they live in or its politics, how fragile their life support systems are, or where their food comes from. Most have zero knowledge or understanding of ecology. James Hansen is an Andrew Yang supporter for god's sake, he seriously wants to put a millionaire con artist in charge of solving climate change. This is not something that a competent adult can think. Bill Rees can barely make it through a single paragraph without broadcasting his extreme fixation on overpopulation. I trust climate scientists to crunch numbers and nothing more. A kinder way to say this would be that it is extremely difficult to do both production and analysis at the same time. It is difficult, all-consuming work to develop, compile, coordinate, and present specialized new findings. It is a tall order to expect a person engaged in that effort to also conduct a thorough analysis of disciplines outside their own.

This comment by Professor Ray Wills is illustrative: "Science is naturally conservative, and so if projections from models are wrong, science [is] most often wrong by understatement". I can hardly express how galactically wrong this is. In science/engineering, "conservative" means a low tolerance for risk. For example if you ask an engineer to design a bridge for you that can support trucks weighing up to 40 tons, a "conservative" engineer will design a bridge with a factor of safety to ensure it can actually support trucks up to 50 or 60 tons. The greater the factor of safety, the more "conservative" the design. If climate scientists are underestimating climate impacts, that is the **opposite** of a conservative approach. This illuminates which threats climate scientists consider most important and worth hedging their bets against. Rather than taking a conservative approach to human safety (up to and including the threat of human extinction), climate scientists chose to hedge against getting yelled at or laughed at for being alarmist. That is the primary threat that they felt the need to take a conservative approach to defend against: the thought of getting egg on their face was more frightening than the prospect of human extinction.

Another reason is that we're asking the wrong people. I do not ask a doctor what type of oil to run in my car's engine. I do not ask an engineer what multivitamin I should take. And I do not ask a climate scientist how living systems are going to respond to calculated warming, or how societies will respond when people are starving to death by the hundreds of millions. They don't know. It's outside their realm of expertise (but of course they're happy to pontificate). Climate science is possibly the most complicated application of advanced 3D fluid physics out there. Every climate scientist is also a skilled mathematician, and likely a programmer. However, after producing their numbers, they have nothing more to add to the conversation than any layman. It doesn't help the matter that agricultural sciences are full of conservative climate-deniers. Those are the folks who should really be sounding the alarm right now, but I have zero hope that any Texas A&M grads are going to lead the charge in challenging the Davos narrative on climate change, or encouraging plant-based diets.

A final lens to understand the failure of climate scientists to recognize the reality of our situation is explained by Noam Chomsky, who has repeated, emphatically, for decades that analyzing global geopolitics is staggeringly simple, "an ordinary fifteen-year-old" can do it (from *Understanding Power*). As a linguist, his education and research / career expertise have no relation to his writings on geopolitics. When asked what qualifications he has to support his assertions, he responds (paraphrasing): "I have none and I need none".

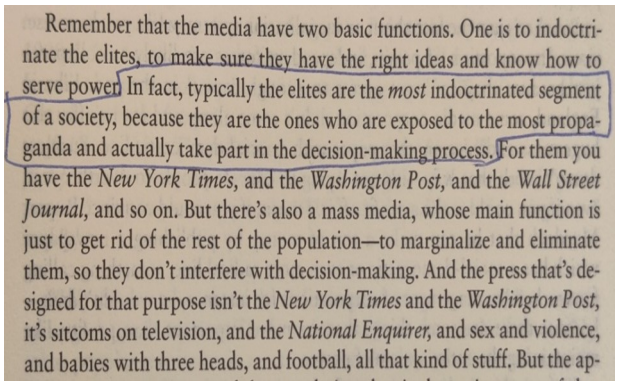
Echoing some of the points made by Kevin Anderson in section 4.4, Chomsky writes: "typically the elites are the most indoctrinated segment of a society, because they are the ones who are exposed to the most propaganda and actually take part in the decision-making process."



MAN: *Mr. Chomsky, I'm wondering what specific qualifications you have to be able to speak all around the country about world affairs?*

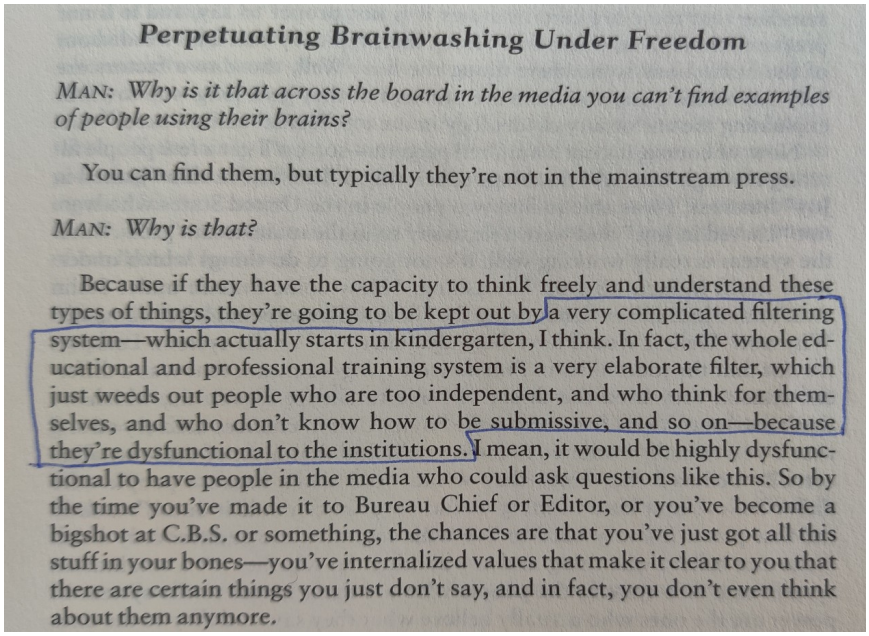
None whatsoever. I mean, the qualifications that I have to speak on world affairs are exactly the same ones Henry Kissinger has, and Walt Rostow has, or anybody in the Political Science Department, professional historians—none, none that you don't have. The only difference is, I don't *pretend* to have qualifications, nor do I pretend that qualifications are needed. I mean, if somebody were to ask me to give a talk on quantum physics, I'd refuse—because I don't understand enough. But world affairs are trivial: there's nothing in the social sciences or history or whatever that is beyond the intellectual capacities of an ordinary fifteen-year-old. You have to do a little work, you have to do some reading, you have to be able to think, but there's nothing deep—if there are any theories around that require some special kind of training to understand, then they've been kept a carefully guarded secret.

In fact, I think the idea that you're supposed to have special qualifications to talk about world affairs is just another scam—it's kind of like



Remember that the media have two basic functions. One is to indoctrinate the elites, to make sure they have the right ideas and know how to serve power. In fact, typically the elites are the *most* indoctrinated segment of a society, because they are the ones who are exposed to the most propaganda and actually take part in the decision-making process. For them you have the *New York Times*, and the *Washington Post*, and the *Wall Street Journal*, and so on. But there's also a mass media, whose main function is just to get rid of the rest of the population—to marginalize and eliminate them, so they don't interfere with decision-making. And the press that's designed for that purpose isn't the *New York Times* and the *Washington Post*, it's sitcoms on television, and the *National Enquirer*, and sex and violence, and babies with three heads, and football, all that kind of stuff. But the ap-

He describes a selection process that begins in kindergarten. These comments are aimed at journalists but apply equally well to climate scientists.



Perpetuating Brainwashing Under Freedom

MAN: *Why is it that across the board in the media you can't find examples of people using their brains?*

You can find them, but typically they're not in the mainstream press.

MAN: *Why is that?*

Because if they have the capacity to think freely and understand these types of things, they're going to be kept out by a very complicated filtering system—which actually starts in kindergarten, I think. In fact, the whole educational and professional training system is a very elaborate filter, which just weeds out people who are too independent, and who think for themselves, and who don't know how to be submissive, and so on—because they're dysfunctional to the institutions. I mean, it would be highly dysfunctional to have people in the media who could ask questions like this. So by the time you've made it to Bureau Chief or Editor, or you've become a bigshot at C.B.S. or something, the chances are that you've just got all this stuff in your bones—you've internalized values that make it clear to you that there are certain things you just don't say, and in fact, you don't even think about them anymore.

I beg you all to please go to your local library, ask for a copy of *Understanding Power*, sit down in a comfy chair and read chapter 4. In 30 minutes you will have attained a level of understanding held by less than 1% of the American population and you will know exactly why climate scientists are not screaming about near term extinction.

The ultimate effect on the public of all this is that no one knows what to think. The IPCC says everything's fine, that magical technology will fix everything. Fox News says it's all fake, made up by scientists for some reason that Fox can never explain. Hannah Arendt summarized the effect perfectly in a 1974 interview:
"The moment we no longer have a free press, anything can happen. What makes it possible for a totalitarian or any other dictatorship to rule is that people are not informed; how can you have an opinion if you are not informed? **If everybody always lies to you, the consequence is not that you believe the lies, but rather that nobody believes anything any longer**. This is because lies, by their very nature, have to be changed, and a lying government has constantly to rewrite its own history. On the receiving end you get not only one lie — a lie which you could go on for the rest of your days — but you get a great number of lies, depending on how the political wind blows. **And a people that no longer can believe anything cannot make up its mind. It is deprived not only of its capacity to act but also of its capacity to think and to judge. And with such a people you can then do what you please**." [emphasis added]

This is the position we find ourselves in today. It is true of climate change, it is true of covid, it is true of every significant issue in the modern world. We are lied to so consistently and pervasively that most of the public gives up on the very idea of knowing the truth about anything. Our cultural over-emphasis on credentialism undermines interdisciplinary analysis and critical thinkers that challenge the status quo.

8.3 Notes

I owe an enormous debt to Mark Cranfield who tirelessly communicates the urgent facts of our situation on his twitter account, painstakingly linking source documents so anyone can evaluate and draw conclusions. Mark is a career Risk Assessor and brings a desperately needed independent perspective to the matter.

I have linked extensively to various updates by James Hansen but wanted to also include a link to his main webpage. The updates are only available as PDFs, or if you sign up to his email list (which I recommend you do) you can get emailed links to html versions of future updates. Hansen is in his 80's which means he's not chasing academic clout and approval as many of the career scientists contributing to the IPCC reports likely are, which grants him an important degree of editorial freedom.

I produced this article primarily to share with family and friends. Anyone finding this on the internet may be asking who I am, what are my credentials. I've provided sufficiently extensive source links that you don't need to take my word on anything, read the sources and make your own conclusions. I have disabled comments on this post so that it stays clean and doesn't become a troll mess, and because the information presented should speak for itself. I am not interested in debating or arguing any of this, however if you have questions you can reach me by email at SamHall20@proton.me.

I've made several edits after publication to clarify or correct certain sections. I am not attempting to bring the whole article up to date or include the incredible global climate developments that have occurred since the initial publication.

"Fortune is of sluggish growth, but ruin is rapid."

- Seneca