CO_2's Moneyball Moment

The alarmist narrative (more accurately a mantra) is simple. Humanity's fossil fuel use is almost exclusively responsible for the atmospheric Greenhouse Gas (primarily CO_2) concentration rise since the pre-industrial era. Notwithstanding that the narrative ignores water (roughly 95% of the Greenhouse gases in the atmosphere), those rising concentrations will lead to catastrophically high temperatures and complete global ecosystem destruction. Just one major problem. There is no empirical CO_2/Temperature dataset that shows CO_2 driving the climate on any statistically significant historical time scale (a very basic Scientific Method requirement). CO_2 concentrations may contribute to temperature changes, but they do not effectively drive the climate. The natural forcings (solar, ocean, volcanic, etc.) easily and regularly dominate CO_2. Those points will not be adjudicated here. This discussion (through several segments) will just put forward empirical data showing how insignificant CO_2's (and even humanity's) influence really is.

The premise driving this discussion revolves around a quote by Billy Beane (played by Brad Pitt in the movie Moneyball), *"If he's a good hitter, why doesn't he hit good?"*. The concept applies equally well to CO_2 and Climate Change. If CO_2 is such a good Climate Driver, why doesn't it drive Climate good? My apologies for the grammar. I have put a teaser together in my CSS-53 – CO_2's Moneyball Moment post.

The empirical data does not back up the simplistic, unscientific All CO_2, All the Time alarmist narrative. The paragraph below is a quick review of CO_2's ineffectiveness (all of which are backed up by empirical data).

CO_2 does not control the temperature in Greenland or Antarctica (where virtually all our planetary ice exists). Our ability to produce CO_2 will end centuries to millennia before polar temperatures allow any significant melting. Temperatures fluctuated significantly over most of the last 10,000 years while CO_2 remained virtually flat (i.e.: CO_2 does not act alone). Those natural forcings were still active through the Modern Temperature Record (MTR) and will continue to be active in the future. CO_2 does not correlate with Sea Levels. The All CO_2, All the Time computer models are self-acknowledged to "run way too hot" and use unrealistically (implausible to impossible) high emission scenarios. Extreme weather events are declining as CO_2 concentrations continue to rise. The solar forcings (ignored in the computer models that "run way too hot") correlate to the MTR better than CO_2 alone. CO_2's Equilibrium Climate Sensitivity (ECS, the temperature increase associated with a doubling of CO_2) is unsettled science. The likely value is somewhere below 1 °C (well below the IPCC's very unsettled 1.8 to 5.6 °C range). CO_2 is not dangerous at 1.8 °C ECS (where the models get close to reality). In the real world not dangerous at all. Our ability to mitigate 'Climate Change' is remarkably pathetic. Based on 100% global adherence to the 2015 Paris Accord commitments, an expenditure of 2 trillion dollars per year (150+ trillion dollars) will reduce the temperature rise in 2100 by just 0.17 °C (using the IPCC science and the implausibly high RCP8.5 emission scenario). With the NetZero ideology push, those costs have gone up to the 10+ trillion dollar per year range. The cost benefit analysis based on the Paris Accord commitments is ridiculous and dangerous. What does that say about NetZero ideology?

There is no economic, technical, scientific, safety, or even environmental justification for the ideological energy transition being forced on the entire world (a transition that we cannot afford). Ultimately, CO_2 is a minor contributor to 'Climate Change'. A more practical and realistic approach to 'Climate Change' is adaptation, with continued energy conservation, real pollutant reductions and research and development on energy alternatives. CO_2 is not a pollutant; it is essential to all life on this planet. We should be celebrating rising CO_2 levels and promoting clean CO_2 emission opportunities.

The following discussion is divided into 9 segments that lay out the empirical data showing that CO_2 is not a "good Climate Driver". A summary of each segment is laid out below.

Segment 1 - Polar Ice will Melt and Inundate the Planet's Coastal Regions

That premise requires that Greenland and Antarctica Ice Caps melt catastrophically. But CO_2 is not driving Greenland Temperatures. Greenland temperatures are driven by Ocean Cycles (primarily the Atlantic Multi-decadal Oscillation (AMO)). The Ocean Cycles are moving into their cold phase and will take Greenland's temperatures down with them. Antarctica's temperatures have been statistically flat since records began (no evidence of CO_2 influence). And ultimately, humanity's ability to produce CO_2 will disappear centuries before either Greenland or Antarctica ever get close to the melting point (0 °C).

Segment 2 – Sea Level Rise Will Inundate the Planet's Coastal Regions

Catastrophic Sea Level Rise (SLR) would require Greenland/Antarctica contribution (neither of which is responding materially to CO_2 concentration increases). And reviewing historical Sea Levels shows very clearly that SLR is not accelerating (i.e.: SLR trends are linear) over the long term (1850s to the present) and CO_2 does NOT correlate to (let alone drive) Sea Level Rise. Not surprisingly, Sea Levels are driven by Ocean Cycles.

Segment 3 – CO_2 – Temperature Correlations in the Recent Past

The general CO_2/Temperature Correlation that exists from the pre-industrial era (pre-1850) is used to justify the CO_2 focused alarmist narrative and our insane climate policies. If CO_2 is driving the climate (i.e.: temperature), why does the temperature fluctuate independently of CO_2? This question can be applied to humanity's entire history. Temperatures fluctuated significantly over the entire Holocene (the pre-industrial era) despite a virtually flat CO_2 concentration. The natural forcings (primarily solar, directly and indirectly) responsible for those fluctuations were still active during our industrial growth and will still be active in the future (just not in the models). Temperatures began warming out of the Little Ice Age centuries before CO_2 began rising and long before humanity's emissions were significant (87%+ of our emissions have been post-1950).

Segment 4 – Computer Models (GIGO)

Computer Modeling is a tool, not a proof. The models are only as good as the assumptions and algorithms provided by the programmers. In the "Climate Change" arena, the programmers have already proclaimed that their models "run way too hot" and the RCP8.5 emission scenario (self-proclaimed by the alarmist community, business-as-usual) has been declared to have a low likelihood of occurring by the IPCC. Implausible to impossible would be more accurate, but RCP8.5 is still routinely used. These model projections are still being used to drive climate policy. For the record, those models did not predict the anomalously high temperatures over the last two years either.

Segment 5 – Extreme Weather

Extreme Weather Events are not getting worse or more frequent. Empirical data shows that Extreme Weather Event frequency and strength are statistically flat or more often declining as CO_2 concentrations have been increasing.

Segment 6 – Solar Forcing (Total Solar Irradiance (TSI), as a proxy)

The alarmist community ignores solar forcing by arbitrarely choosing just one of the many TSI reconstructions available. In reality, the Modern Temperature Record (MTR, 1850 to the present) can be modeled more accurately with just natural forcings than just CO_2 alone. Pre-MTR, CO_2 forcing alone is useless since CO_2 concentrations are virtually flat.

Segment 7 – CO_2's Equilibrium Climate Sensitivity (ECS)

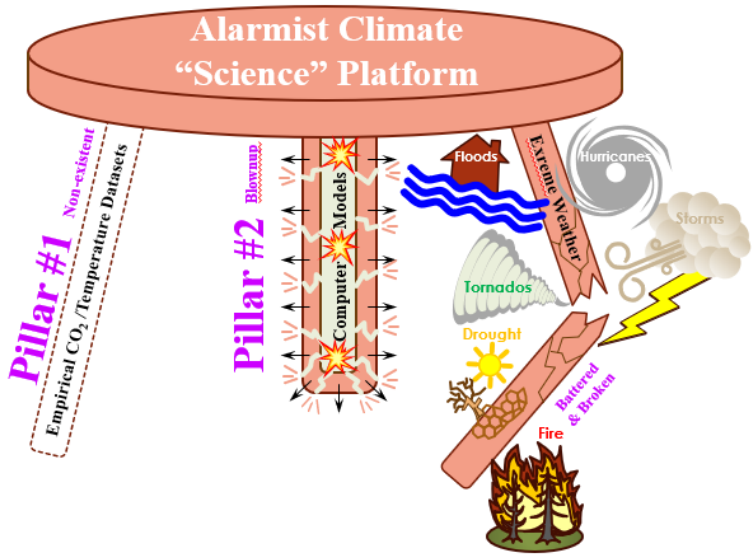
CO_2's ECS is far from settled science. The IPCC uses a range of 1.8 to 5.6 °C in their models (i.e.: they do not know the ECS value). The few IPCC models that come close to matching observed temperatures use the low end of that range. An in-depth analysis that factors in Urban Heat Island Effects (UHIE), realistic solar contributions, absorption saturation limits and measured radiation levels to space suggest that the ECS may be much lower (less than 1.0 °C). Not dangerous, not an Emergency.

Segment 8 – GDP Growth and Climate Change

GDP growth is affected by "Climate Change", but that effect is small according to the IPCC, Canada's Parliamentary Budget Office (PBO), and Bjorn Lomborg. The PBO forecasts that Canada's GDP will be 6.6% lower at the turn of the century due to Climate Change. Instead of roughly 400% growth, we will only grow by 393.4% (i.e., we will still be rich). Assuming the entire globe adheres to the 2015 Paris Accord commitments, the PBO forecasts that Canada's GDP could be improved by 0.8% (just $17 billion), but at what cost?

Segment 9 – The Cost of Temperature Reductions

Like CO_2's ECS, the final costs are far from settled. The Paris Accord commitments were in the 1 to 2 trillion dollar per year range. With governments and global organizations like the UN and WEF involved, the 2 trillion-dollar estimate would be a safer bet. But with the onset of NetZero madness, the yearly expenditures have been pushed into the 10 trillion dollar per year range (according to McKinsey & Company). I have even heard a 27 trillion/year estimate. But sticking with the 2 trillion/year Paris commitments, how much will we reduce the temperature rise by 2100. If every country adheres to their Paris commitments, the temperature reduction would be just 0.17 °C (negligible and unmeasurable). Again, at what cost? At 2 trillion dollars per year that is roughly 170 trillion dollars for 0.17 °C (10 trillion dollars for every 1/100th of a degree). Like ex-Prime Minister Justin Trudeau (and very likely our new Prime Minister (Mark Carney)), not worth the cost.



The fight against "Climate Change" is almost purely ideological. The definition of

"Climate Change" in this context is essentially All CO_2, All the Time. The Catastrophic Anthropogenic Global Warming (CAGW) alarmist narrative platform can be visualized as the three-legged stool shown on the previous page. That platform's support is effectively dependent on just three principles.

1. CO_2 concentrations (primarily human emissions) are driving the climate.
2. Computer Projections (masquerading as proof) are showing that rising CO_2 concentrations are leading to catastrophically higher temperatures.
3. Rising CO_2 concentrations are leading to more and more severe extreme weather events.

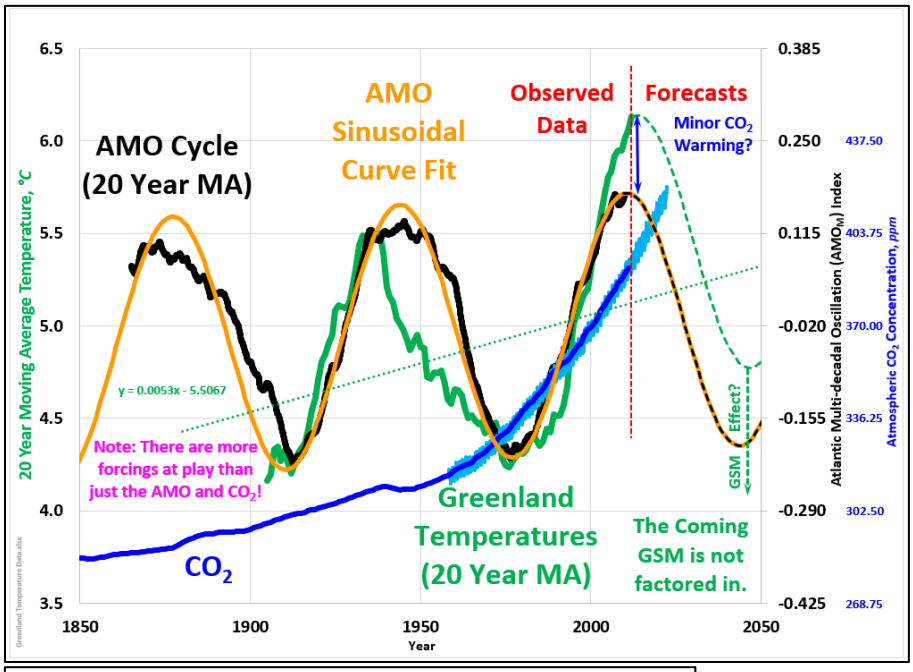
None of those supports are backed up by empirical data.

1. This support leg is nonexistent. There are literally no empirical CO_2/Temperature datasets that show CO_2 driving the climate on any statistically significant historical time scale (a very basic Scientific Method requirement).
2. This support leg has already been blown up internally. The programmers have self acknowledged that the models "run way too hot" and the IPCC and others have discredited the high emission scenarios like RCP8.5. Current emissions are running below the RCP4.5 scenario.
3. This support leg has been battered and broken by the Extreme Weather Event empirical data sets. Extreme Weather Events have been statistically flat or declining as CO_2 concentrations have been rising.

The scientific support for the CAGW alarmist narrative just does not exist. The sooner our society realizes that, the sooner we can start fixing the future that lies ahead for our children and grandchildren. Continuing to waste money on these unnecessary, simplistic, unscientific green initiatives (NetZero, etc.) will just add to the already debilitating debt levels we will be passing on to them. On top of that we are ignoring the real threat that Climate Change poses. The natural forcings (solar, ocean, cloud cover, geotechnical, etc.) which have easily overpowered CO_2 historically are pointed towards colder temperatures. We all need to wake up and soon.

CSS-53 – CO_2's Moneyball Moment
https://climatechangeandmusic.com/co2s-moneyball-moment/

Segment 1 - Polar Ice will Melt and Inundate the Planet's Coastal Regions



A few of the many alarmist headlines!

The Middle East is warming up twice as fast as the rest of the world

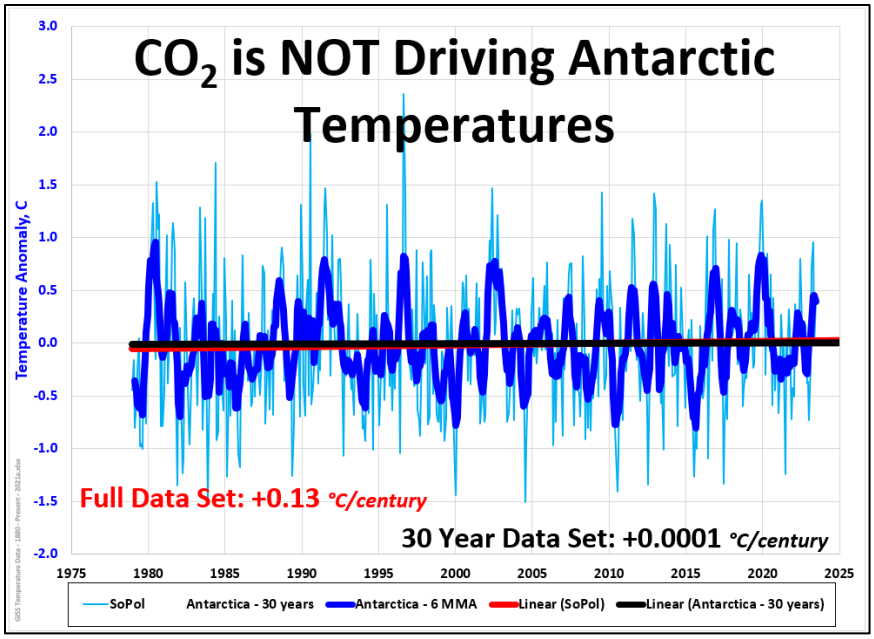
Why Singapore is heating up twice as fast as the rest of the world

Canada's climate is warming twice as fast as global average

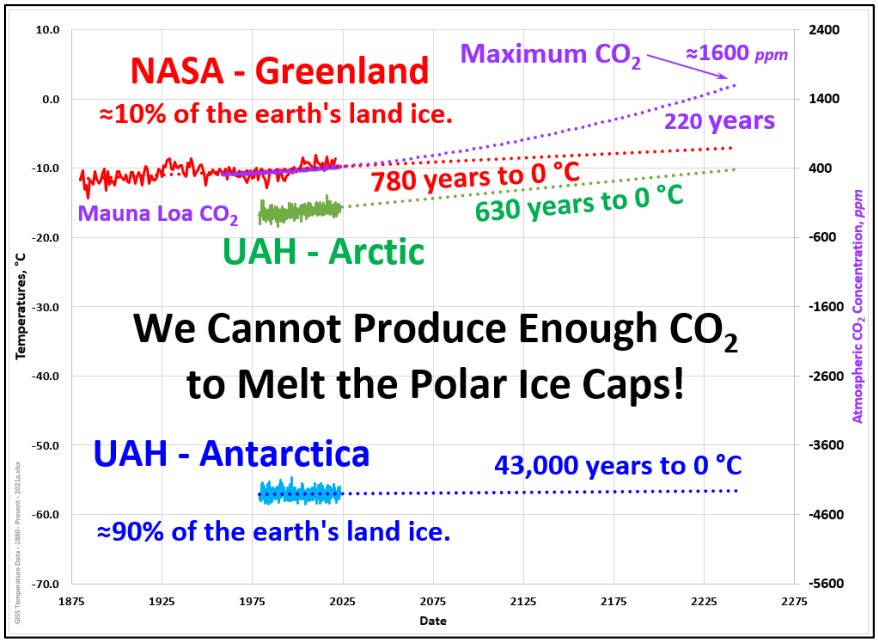
Finland is warming twice as fast than the rest of the planet

Most of the planet's ice is located at the two poles. Obviously, the sea ice (at either pole) will have no effect on sea levels. The Sea Level Rise (SLR) "threat" comes from the land ice (roughly 10% and 90% in Greenland and Antarctica, respectively). For that SLR to happen, temperatures must rise (and significantly for the alarmist reality). So, are rising CO_2 levels impacting the temperatures in Greenland and Antarctica at a material level? Not according to the empirical data. This plot shows the average "homogenized" Greenland temperature (20 YMA, based on NASA/GISS station data) plotted with the Atlantic Multi-decadal Oscillation (AMO) and atmospheric CO_2 concentrations. Obviously, CO_2 is not the dominant climate driver in Greenland and its future influence will decrease based on CO_2's exponential decline in effectiveness. Note, Greenland (warming at a modest, roughly 1 °C/century rate) is not warming at twice the rate of the rest of the planet (as media reports suggest for most other locales). Given the obvious AMO influence, temperatures in Greenland will be decreasing over the next few decades. Those temperature declines will be augmented by the solar forcings currently being ignored by the alarmist community.

Rising CO_2 concentrations are obviously not going to lead to massive melt problems in Greenland. That leaves Antarctica as the alarmists' hope for devastating SLR. Unfortunately (for the alarmists), the Antarctic temperatures are also not cooperating. The University of Alabama, Huntsville (UAH) Lower Troposphere Satellite Antarctic Temperature Anomalies (shown here) have been statistically flat since satellite records began. The surface station data shows similar trends. For those that are not aware, Antarctica experienced its coldest 6-month period EVER over the Southern Hemisphere's 2021 winter season.



Neither Greenland nor Antarctica is melting away anytime soon (as shown here). The average UAH Arctic temperatures and Mauna Loa CO_2 concentrations have also been added. If earth's CO_2 concentrations continued their rise unabated, humanity would exhaust their oil, gas, and coal reserves in a bit more than two centuries. Over that time, we would raise CO_2 concentrations to roughly 1600 ppm. The associated temperature increase would be in the 2 to 4 °C range (dependant on the climate sensitivity used (which is not settled science)). Assuming the alarmist narrative is correct (i.e.: Greenhouse gases (primarily CO_2) are responsible for the recent temperature rise on our planet), our ability to produce CO_2 will cease centuries before Arctic/Greenland temperatures approach the melting point and millennia before Antarctic Temperatures get anywhere remotely close. These projections do not take into account the natural forces that will be driving future temperatures down. On a decadal basis the cooling drivers are the ocean cycles (AMO, PDO, etc.) and solar influence (GSM, cosmic rays, electromagnetic field strength, etc.). On a millennial basis, the Milankovitch Cycles will drive us into another deep ice age.



CO_2 is exerting little to virtually no influence on polar temperatures. So, how can CO_2 have any real impact on the leading example of dangerous "Climate Change" consequences, Sea Level Rise (SLR)? SLR is covered in the next section and has been looked at in many of my past posts. The empirical data speaks for itself, but there is more detailed discussion at the following links.

CSS-13 – A Look at Homogenization
https://climatechangeandmusic.com/a-look-at-homogenization/

CSS-47 – CO_2 and Sea Levels DO NOT Correlate
https://climatechangeandmusic.com/co2-and-sea-level-do-not-correlate/

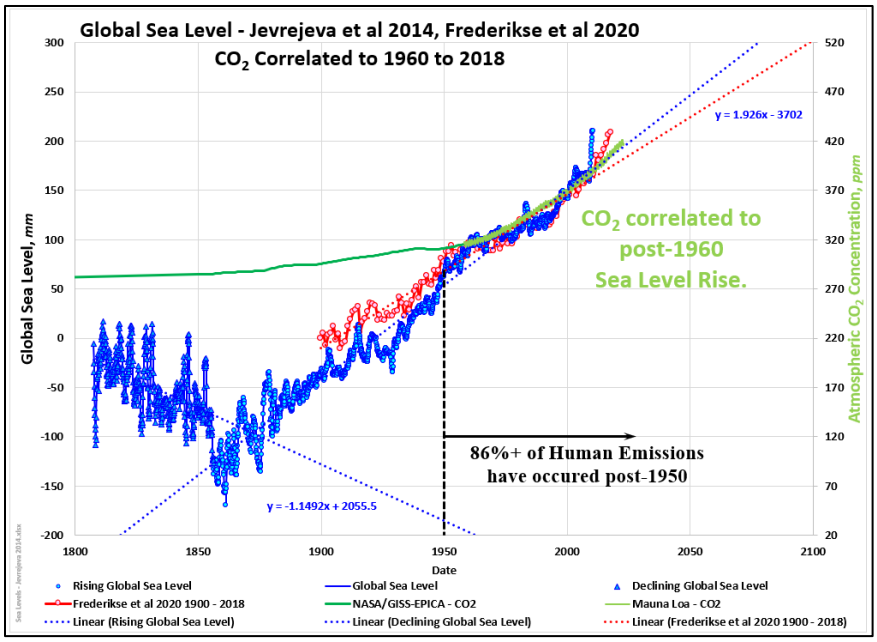
CSS-53 – CO_2's Moneyball Moment
https://climatechangeandmusic.com/co2s-moneyball-moment/

CSS-61 – Sea Levels and Temperatures
https://climatechangeandmusic.com/sea-level-and-temperatures/

OPS-55 – The State of Climate Science
https://climatechangeandmusic.com/the-state-of-climate-science/

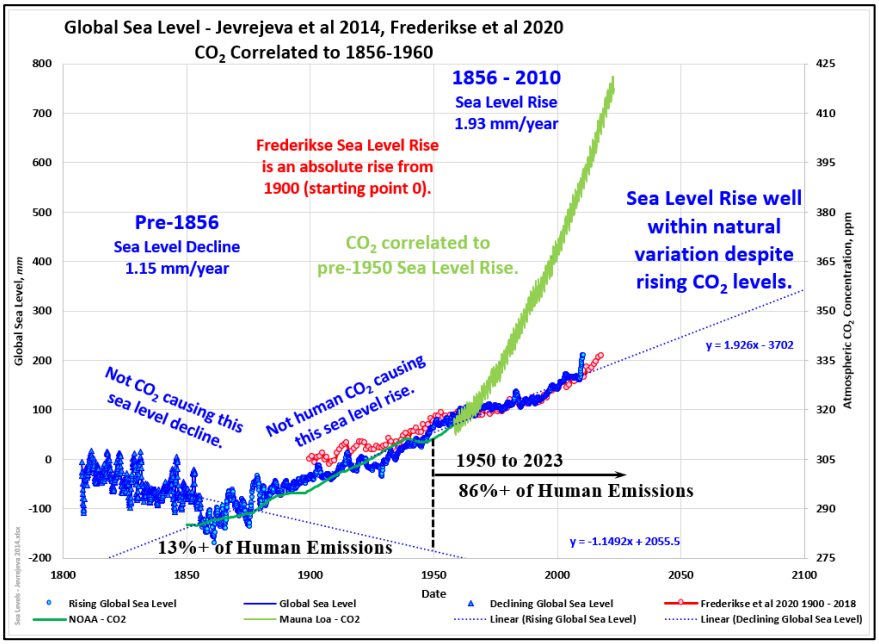
OPS-72 – Where are Greenland's Temperatures Headed?
https://climatechangeandmusic.com/where-are-greenlands-temperatures-headed/

Segment 2 – Sea Level Rise Will Inundate the Planet's Coastal Regions

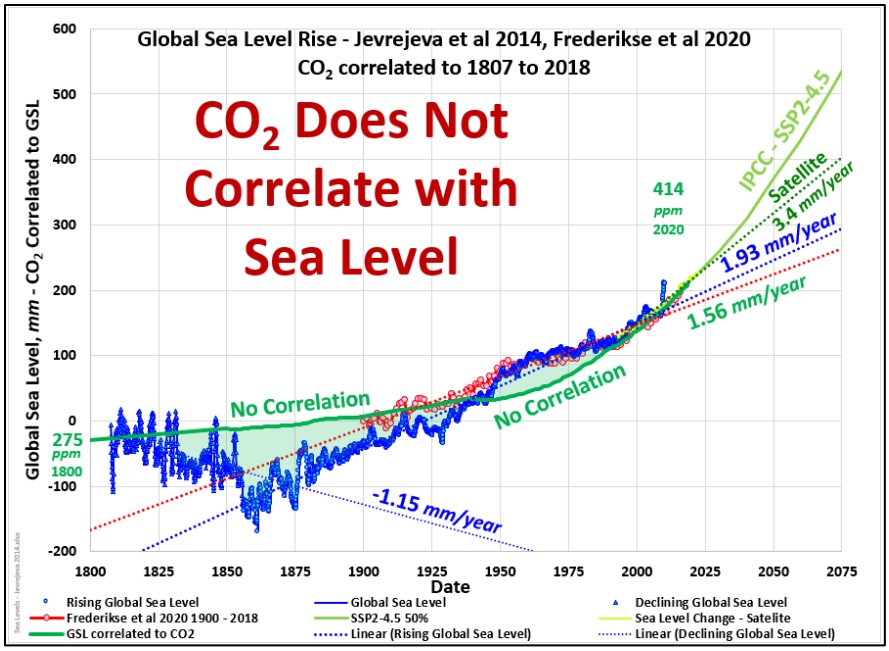


Segment 1 already touched on Sea Level Rise status. Significant SLR would be dependent on the very highly unlikely scenario where Greenland and more importantly Antarctica were to melt catastrophically. Refer to Segment 1.

Two Sea Level data sets are shown in each of the first three plots. The red curve was constructed by Frederikse et al (2020) and appears prominently in NASA's Sea Level discussion page. The blue curve was constructed by Jevrejeva et al (2014). Apparently Jevrejeva et al had the audacity to look at data pre-1900. Remember the alarmist narrative, effectively All CO_2, All the Time. That viewpoint is obviously flawed. A correlation can be forced over the 1960 to 2020 period, but then you need to supply an alternative explanation for pre-1960 Sea Levels. Maybe, just maybe CO_2 is not primarily responsible for "Climate Change" on our incredibly wonderful and complex planet. Note, post-1950 is the most logical period to look for anthropogenic (human) influence since 87%+ of humanity's emissions have occurred over that period. The 1960 to 2020 period was chosen for a reason and includes more than just human influence (as will be shown).

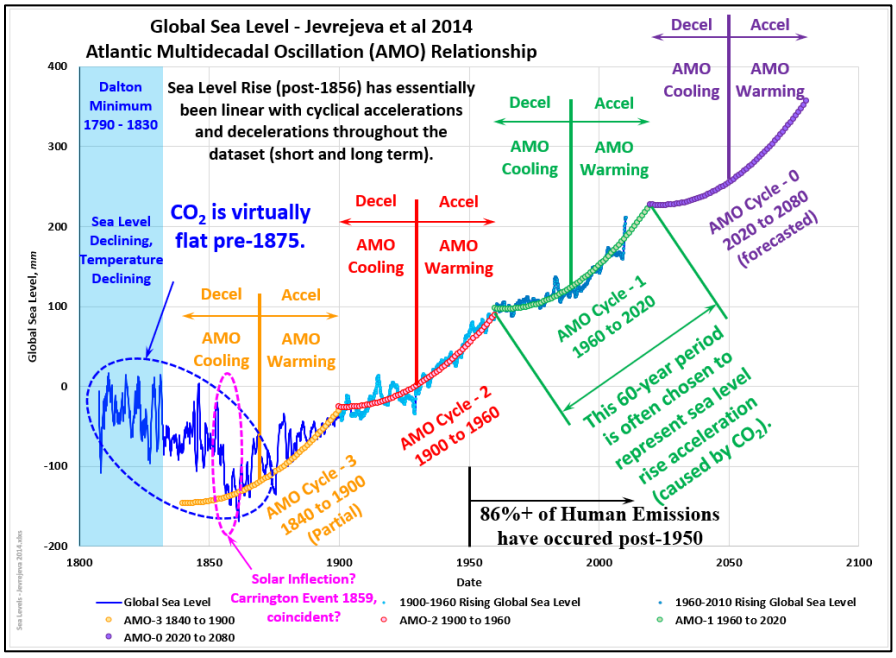


The second plot shows CO_2 correlated to the 1856 to 1960 period (the shorter 1900 to 1960 period, important later) will give similar results. Note, these correlations are all referenced to the Jevrejeva et al data. The correlation is a good one if you choose to ignore the rather significant deviation beginning around the middle of the last century and those alarmist narrative killing sea level declines pre-1856.

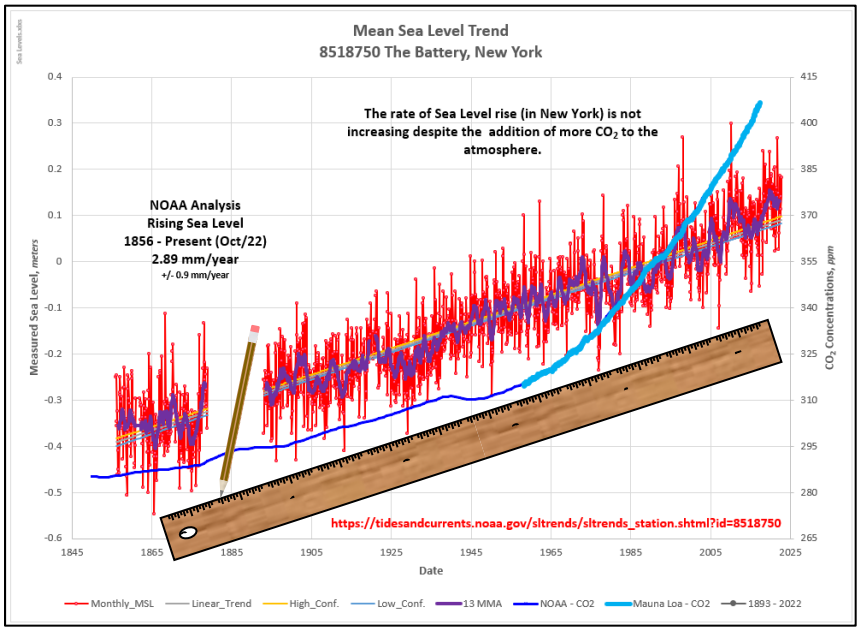


Let us address that elephant in the room. How can Sea Levels be declining pre-1856 when CO_2 is rising (however slowly)? Obviously, CO_2 concentrations do not correlate with Sea Level changes and are not the only climate driver acting on the planet (on time frames that can affect our future). That begs the question, what is driving sea level changes? Whatever the driver pre-1856, that driver must be significantly stronger than any forcing post-1856. Sea levels are tied directly to temperature. Given Sea Levels are declining pre-1856, so must be temperatures (not convenient for the alarmist narrative).

There is only one source that could supply the energy that produces the significant Sea Level inflection point in 1856, the Sun. Ocean cycles, CO_2, etc. produce only minor perturbations in the generally linear SLR trends post-1856. The 1856 sharp reversal from declining to rising Sea Levels coincides with the Total Solar Irradiance (TSI) rise out of the Little Ice Age (LIA), the start of our electromagnetic field weakening, and an unusually strong solar outburst (the 1859 Carrington Event solar flare/Coronal Mass Ejection (CME)). The sun is acting up again. A strong flare/CME was released March 12th, 2023, on the far side of the sun that would likely have caused massive grid failures. Given the solar activity forecasts from a variety of sources (including NOAA), we are transitioning to a Grand Solar Minimum (GSM) where the delivered solar energy is decreasing, producing declining temperatures and ultimately a new Sea Level Inflection point that will lead to declining Sea Levels.



The fourth plot (shown previously) addresses the post-1856 SLR and the associated forcings. The first plot showed the potential CO_2/Sea Level correlation over the 1960 to 2020 period. The post 1960 period is often used to push the SLR is accelerating narrative. And if you limit your analysis to that period, the statement appears correct. A look at longer time frames produces a much different picture. Since the 1856 inflection point, the general SLR trend has been linear. There is 30-year de/acceleration cycle in the data that corresponds closely and logically to the Atlantic Multi-decadal Oscillation (AMO). Was CO_2 really responsible for the 1960 to 2020 period SLR or were the same forcings that produced the 1900 to 1960 de/acceleration responsible? The AMO is headed into its 30-year cold phase, kicking off the next 60 year de/acceleration event.



A quick note to address SLR acceleration. The recent satellite estimates show a minor acceleration. The Tidal gauge data does not since the long-term trends are linear (whether Sea Level is rising or falling) with significant fluctuations unrelated to CO_2.

Obviously, CO_2 has little to no effect on Sea Levels.

More discussion and links can be found at

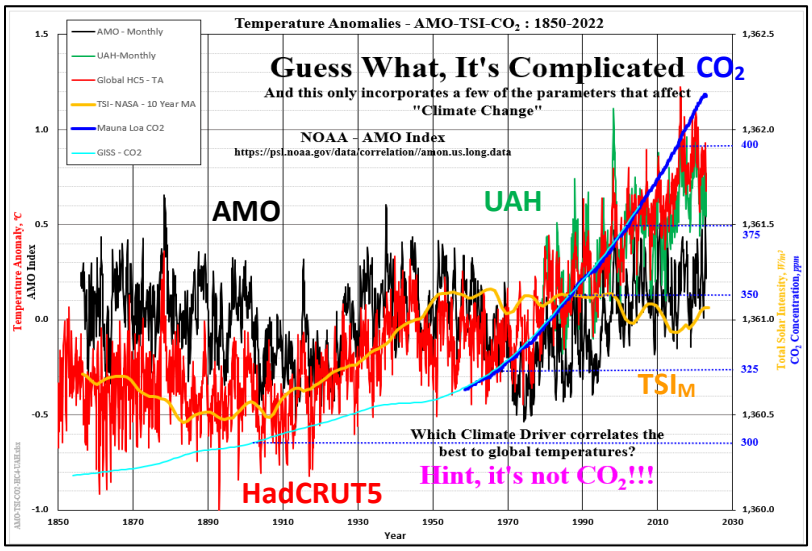
CSS-33 – Sea Level Rise – Is There Acceleration?
https://climatechangeandmusic.com/sea-level-rise-is-there-acceleration/.

CSS-46 – Sea Level – Fact Check
https://climatechangeandmusic.com/sea-level-fact-check/

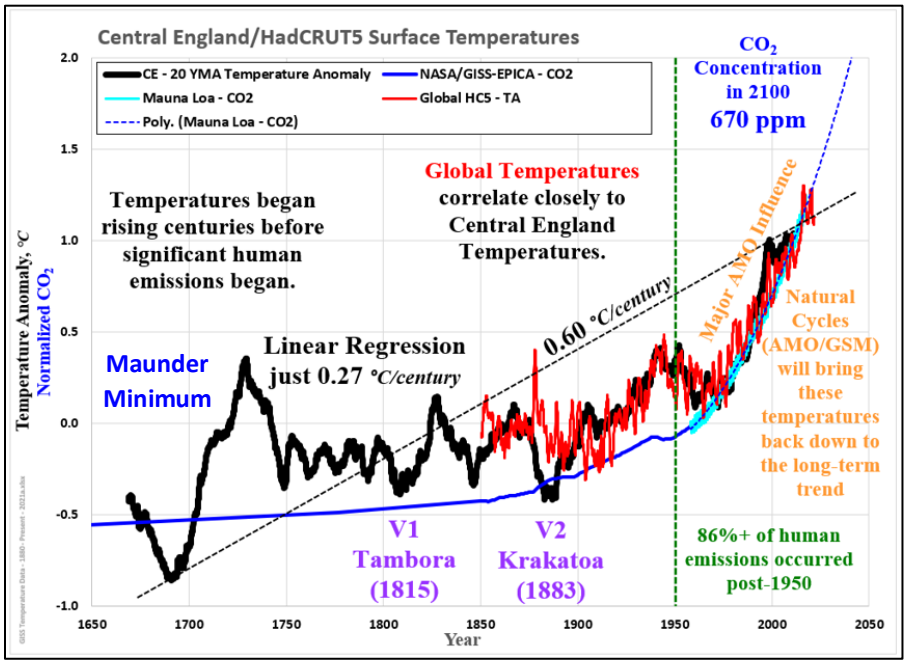
CSS-47 – CO_2 and Sea Level DO NOT Correlate
https://climatechangeandmusic.com/co2-and-sea-level-do-not-correlate/

CSS-61 – Sea Levels and Temperatures
https://climatechangeandmusic.com/sea-level-and-temperatures/

Segment 3 – CO_2 – Temperature Correlations in the Recent Past

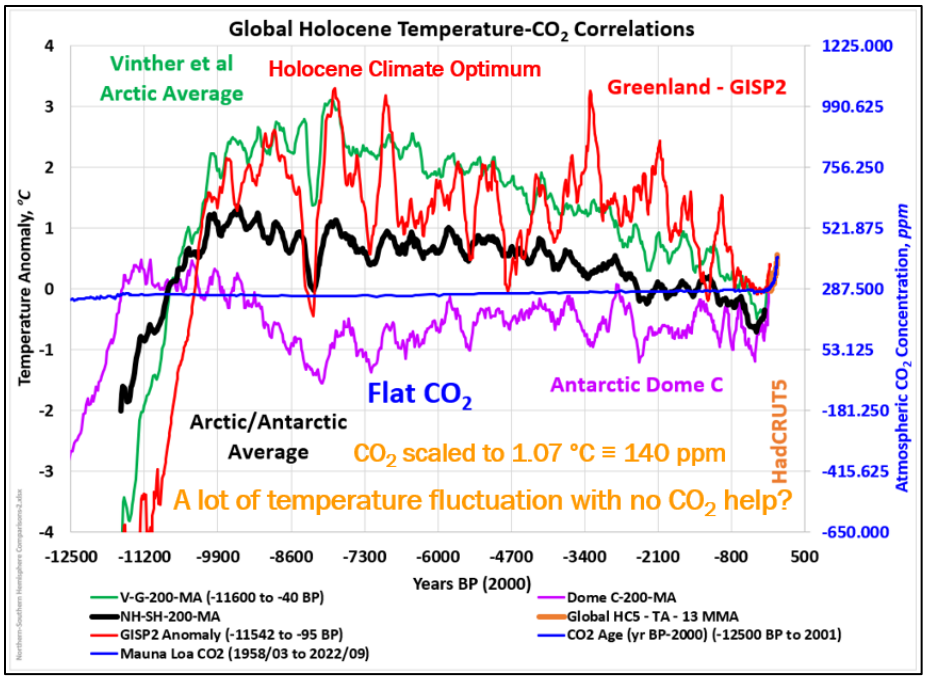


Virtually the whole premise for the CAGW alarmist narrative relies on the perceived correlation between CO_2 and Global Temperature over the Modern Temperature Record (MTR, 1850 to the present). And yes, there is a general correlation between the two parameters. What the alarmists do not bother to mention is the correlation between natural forcings (primarily Solar Activity) and Global Temperatures is actually better. Those correlations will be discussed further in a later discussion on Solar Activity. They also fail to mention the homogenization (i.e.: data manipulation) applied to the global surface temperature datasets designed to improve that correlation. There are many forcings that drive the climate on our planet. CO_2 is just one of them. As shown in the above plot, Climate Change is complicated (and only three forcing parameters are shown here). In the real world, all these parameters affect global temperatures (including but not limited to CO_2). Historically, natural forcings have dominated CO_2's minor influence and that will continue in the future. The Atlantic Multi-decadal Oscillation (AMO) and Total Solar Irradiance (TSI, as a proxy) can be used to produce a much better temperature correlation than CO_2 (as shown in my Open Letter Addendum and OPS-8 – Basic Climate Model posts). Note that CO_2 is roughly correlated to the post 1970 period. Given that 87%+ of humanity's emissions have occurred post-1950, this period is where our influence would be seen. Note that, somehow temperatures declined from around 1945 to 1975 in unison with the AMO and despite rising CO_2 levels. You might also note that the AMO is rising along with CO_2 post 1970 and would be a significant contributing factor to those temperature rises.

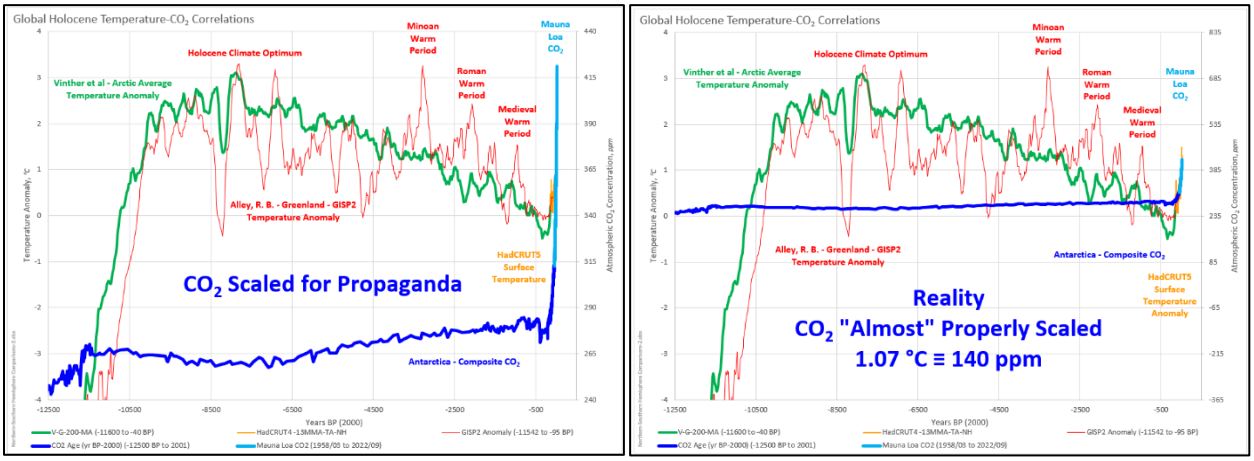


Our temperature history began before 1850. The plot to the left shows the HadCRUT5 and Central England Temperature (CET) plotted against CO_2. On this longer time scale, the CO_2 and Temperature correlations are non-existent. CO_2 cannot possibly explain the cold

associated with the Maunder Minimum and the Little Ice Age (LIA) in general. The CET is obviously localized, but apart from the late 1800s deviation (likely due to the large Krakatoa eruption), the two temperature plots do overlay one another closely. Given that the AMO has a significant influence on both global temperatures and CETs the correlation is not that surprising and allows the use of the CET as a general proxy for global temperatures.



But ultimately, we are not limited to the CET. We have very good proxy data available in the ice core data from both hemispheres. Some of that data (plotted to the left) shows several Holocene temperature profiles plotted against CO_2. Note that CO_2 is scaled to reflect the alarmist narrative that the 140 ppm increase in CO_2 is responsible for the 1.07 °C temperature rise (the IPCC estimate) since the pre-industrial era.



The alarmist community prefers to plot CO_2 on a propagandist scale (above left) versus the more appropriately scaled (almost reality) version on the right. Which one looks scarier to you?

When CO_2 is plotted on a "realistic" scale, the alarmist narrative (essentially All CO_2 (the primary climate driver), All the Time) fails miserably. Temperatures have fluctuated significantly over the Holocene Interglacial Warm Period despite a virtually flat CO_2 profile. Obviously, there are more climate drivers than CO_2 alone. Those natural forcings (primarily solar (directly and indirectly) were responsible for the pre-MTR temperature fluctuations, not CO_2. Those natural forcings did not arbitrarily shut down during the MTR period. They were still active (just not in the computer models). And those natural forcings will still

be active in the future (but again not in the models (those ones that are self-acknowledged to "run way too hot")). The AMO and TSI are headed lower over the net few decades and will take temperatures down with them. Remember, colder temperatures are a lot more dangerous than the warmer temperatures CO_2 would bring on their own. Cold kills both directly and indirectly through shorter growing seasons and crop failures. That is the future that the global warming alarmists are ignoring. CO_2 will continue rising despite the trillions of taxpayer dollars our ideological leaders will unnecessarily throw at the perceived problem. Historically, CO_2 has only marginal correlations with temperature and no empirical data backing up the premise that CO_2 is the primary climate driver. As temperatures drop in the future (like they did from 1945 to 1975), we can drive another nail into the alarmists' CO_2 narrative. Unfortunately, there will be more policy damage before our course is ultimately corrected.

Open Letter Addendum
https://climatechangeandmusic.com/addendum/

OPS-8 – Basic Climate Model
https://climatechangeandmusic.com/basic-climate-model/

CSS-16 – Central England Temperature - Model
https://climatechangeandmusic.com/central-england-temperature-model/

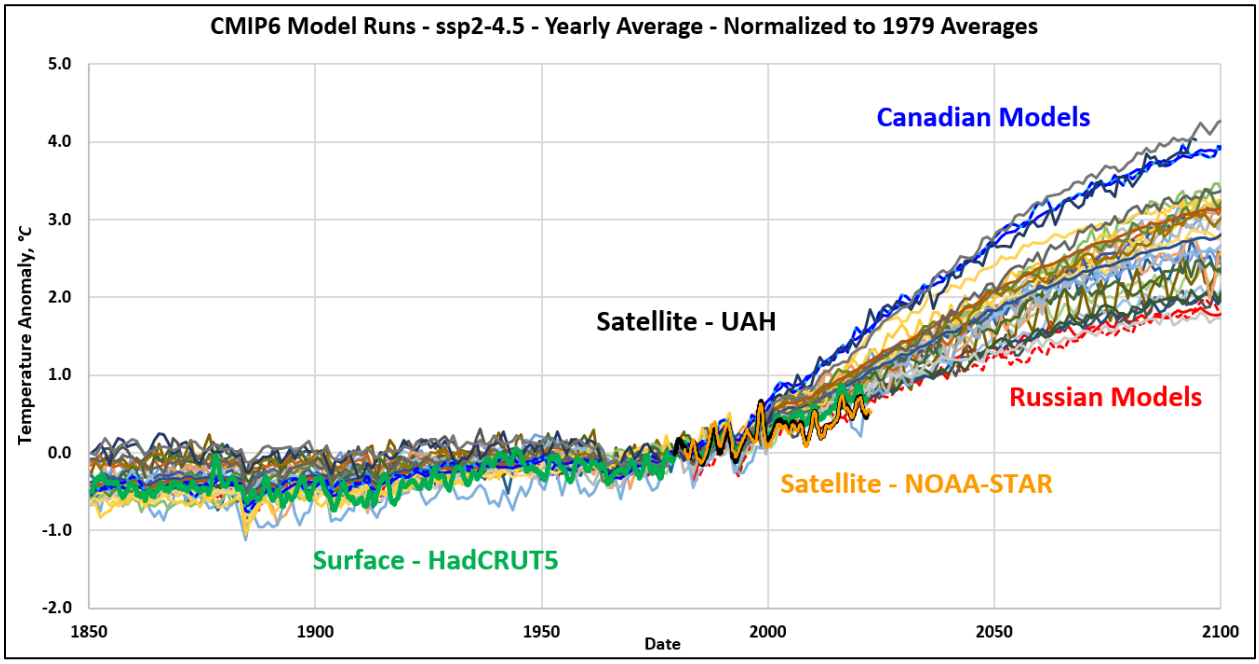
CSS-29 – Climate Model – TSI-AMO-CO_2
https://climatechangeandmusic.com/climate-model-tsi-amo-co2/

Segment 4 – Computer Models (GIGO)

The alarmist community relies heavily on their computer model projections to instill a deep societal fear of catastrophic temperature increases, so they can push their unnecessary, simplistic, dangerous alarmist (All CO_2, All the Time) narrative. There is a very basic rule that applies to computer simulations. Garbage In, Garbage Out (GIGO). Computers are just a tool. Their output is totally dependent on the programming and the data input supplied by the programmer and is ultimately proof of absolutely nothing.

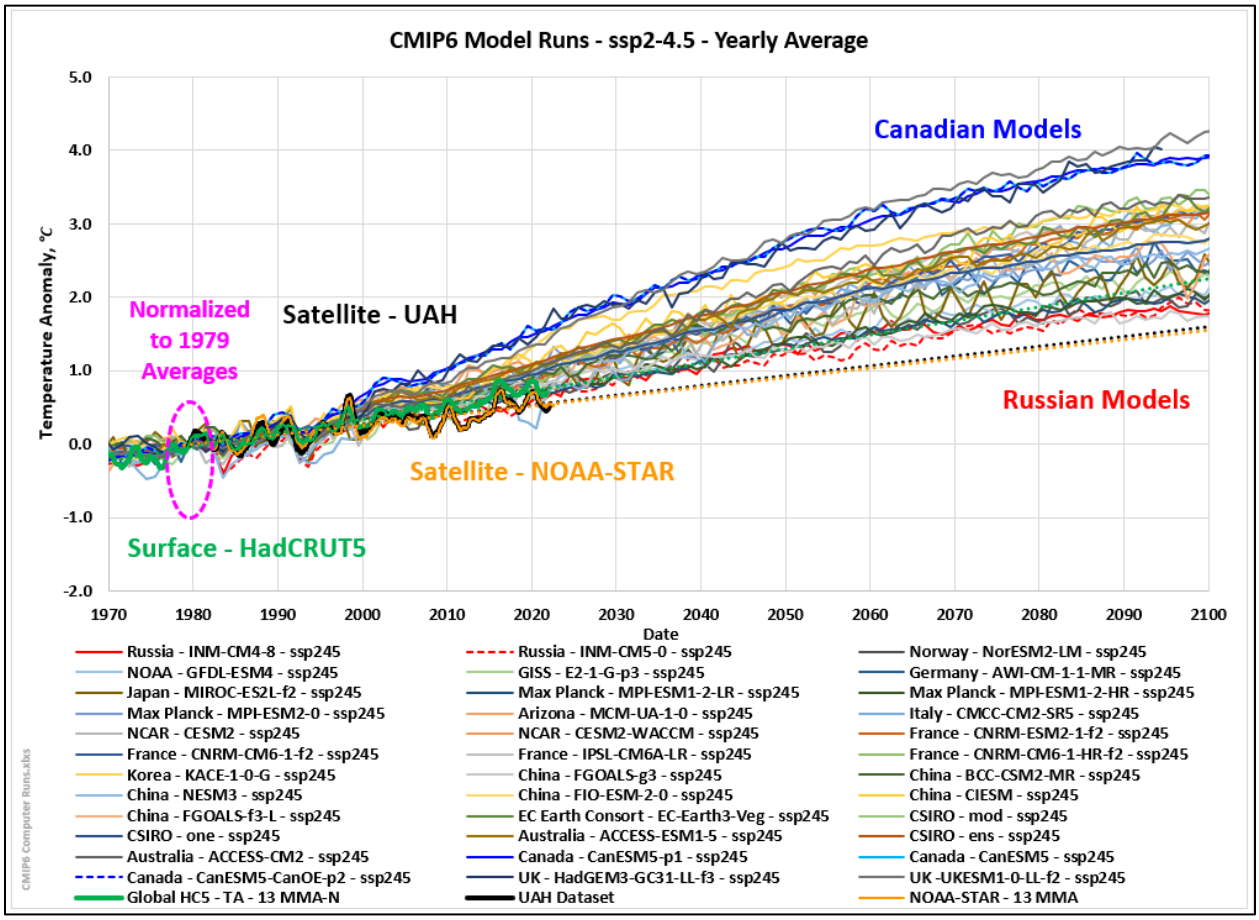
Before I get into the main discussion, I should point out that the IPCC has long acknowledged that *"the climate system is a coupled non-linear chaotic system, and therefore the long-term prediction of future climate states is not possible"*. The Intergovernmental Panel on Climate Change (IPCC) has also acknowledged that the higher emission scenarios (like ssp5-8.5) have a low likelihood of ever happening. Most knowledgeable researchers classify ssp5-8.5 emission scenario as somewhere between implausible to impossible. Current emissions are tracking below the ssp2-4.5 scenario (which is neither alarming nor dangerous). Since COP26 (4 years ago), the UNFCCC (the IPCC's parent organization) has stopped using the ssp5-8.5 scenario, yet the ssp5-8.5 scenario is still being used by organizations like Environment Canada, the City of Calgary, etc. to guide policy. Maybe they should start following "the science". And lastly, the climate modellers have acknowledged that the models "run way too hot". The GIGO rule obviously applies to climate modelling when the projections are acknowledged outright to be wrong. Backup (links/discussion) can be found in my OPS-55 – The State of Climate Science post.

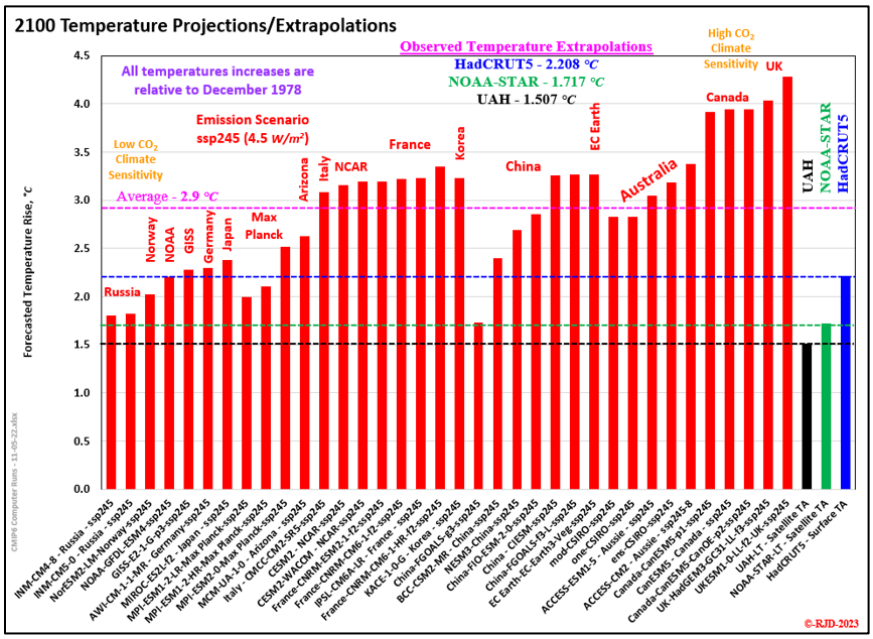
So now we can look at what that output looks like. The projections shown below were downloaded directly from the World Meteorological Organization's (WMO) website. The data has been normalized to the early satellite period (1979). The projections are compared to the **HadCRUT5** global surface data estimates and two satellite datasets (**UAH** and **NOAA-STAR**). The two **Russian models** are amongst the very few that



come close to matching the observed temperature profiles. The three **Canadian models** ("the science" Justin Trudeau followed and I suspect Mark Carney follows) are up in the stratosphere (totally unrealistic).

Additional plots will be progressively more focused. More detail and links can be found in my [CSS-30 – CMIP6 Climate Model] post.

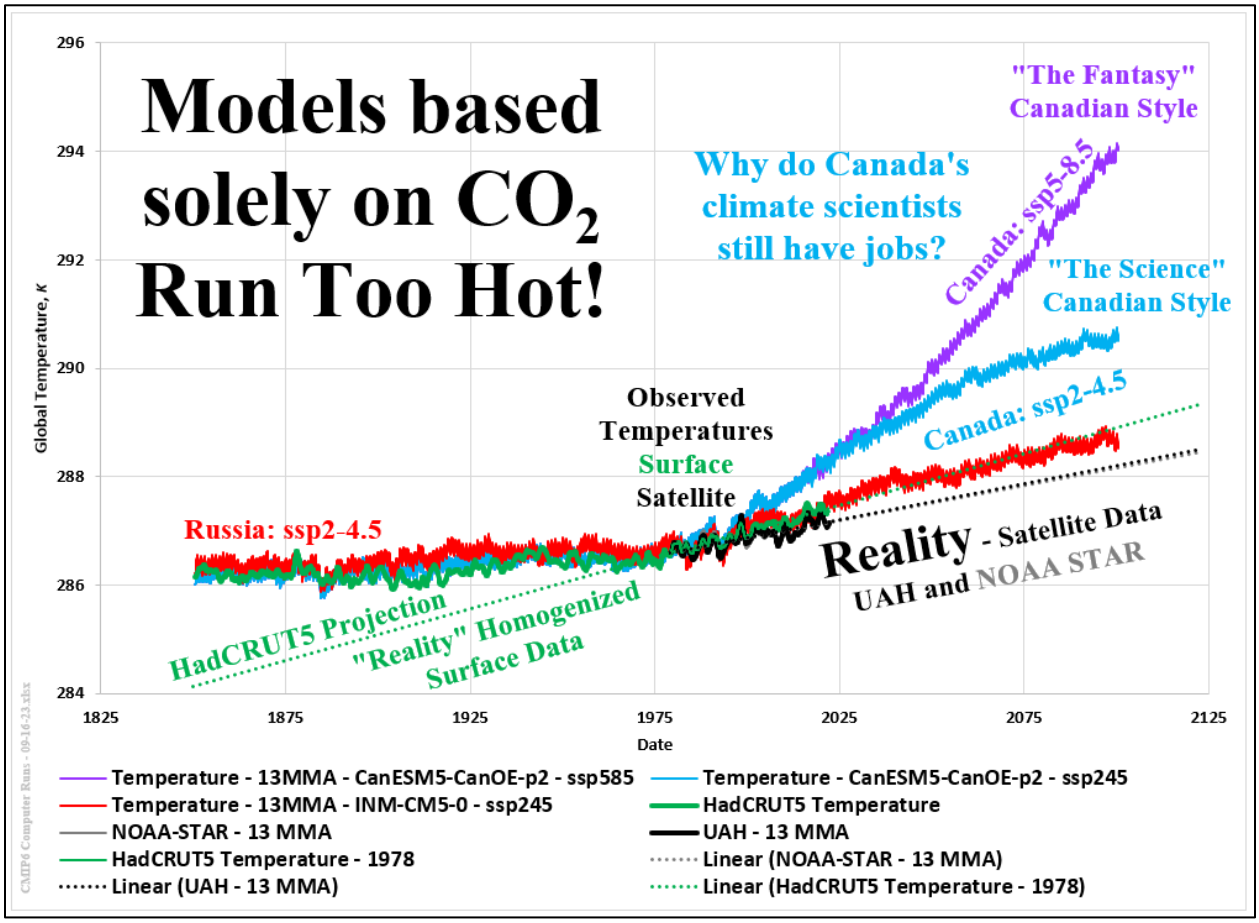




The above plot focuses in on the satellite period and the extrapolations out to 2100 (for both the models and the observed data). Note that every model projection is above the observed satellite temperatures and most of the model projections are above the "over-homogenized" (i.e.: manipulated) HadCRUT5 surface data estimates. That means very simply that every model projection is wrong (GIGO on full display). The chart to the left shows the

same data in a different format. Is there any wonder why the models are self-acknowledged to “run way too hot”.

You should also note that these runs are all based on the moderate ssp2-4.5 emission scenario. Higher emission scenarios would just be that much more inaccurate. The final plot (below) compares a **Canadian ssp2-4.5** and a **Russian ssp2-4.5** model. The **Canadian ssp5-8.5** model has also been added for



comparison. The Russian model comes close to matching the “over-homogenized” HadCRUT5 surface temperature data but is noticeably higher than the two satellite temperature datasets. The Canadian models are out to lunch but that is “the science” ALL our Canadian political leadership and their media and academic minions follow. And despite the IPCC denunciation that group is still using the implausibly high ssp5-8.5 emission scenario to push their unnecessary, expensive, and dangerous “green” initiatives. You might ask why do the models “run way too hot”? We can start with the GIGO argument, but to get more specific, the alarmist community (and the modellers) have focused in on one small component of the climate system (CO_2) and have ignored/minimized the many other more dominant radiative forcings (primarily solar (directly and indirectly)). Quite ironically, they have also shown that “their science” is not all that settled given these models use CO_2 Equilibrium Climate Sensitivities (ECS) that range from 1.8 to 5.7 °C. The difference between the Russian and Canadian ssp2-4.5 runs is very likely due to this substantial ECS differential. The ECS (very likely lower than 1.8 °C) will be discussed in more detail in its own segment.

To summarize, the billions spent on climate models has been a complete waste of money and the green policies should be shelved until some realism is brought back into the climate discussion.

CSS-6 – Dr. John Christy – January 2021 Presentation
https://climatechangeandmusic.com/john-christie-january-2021/

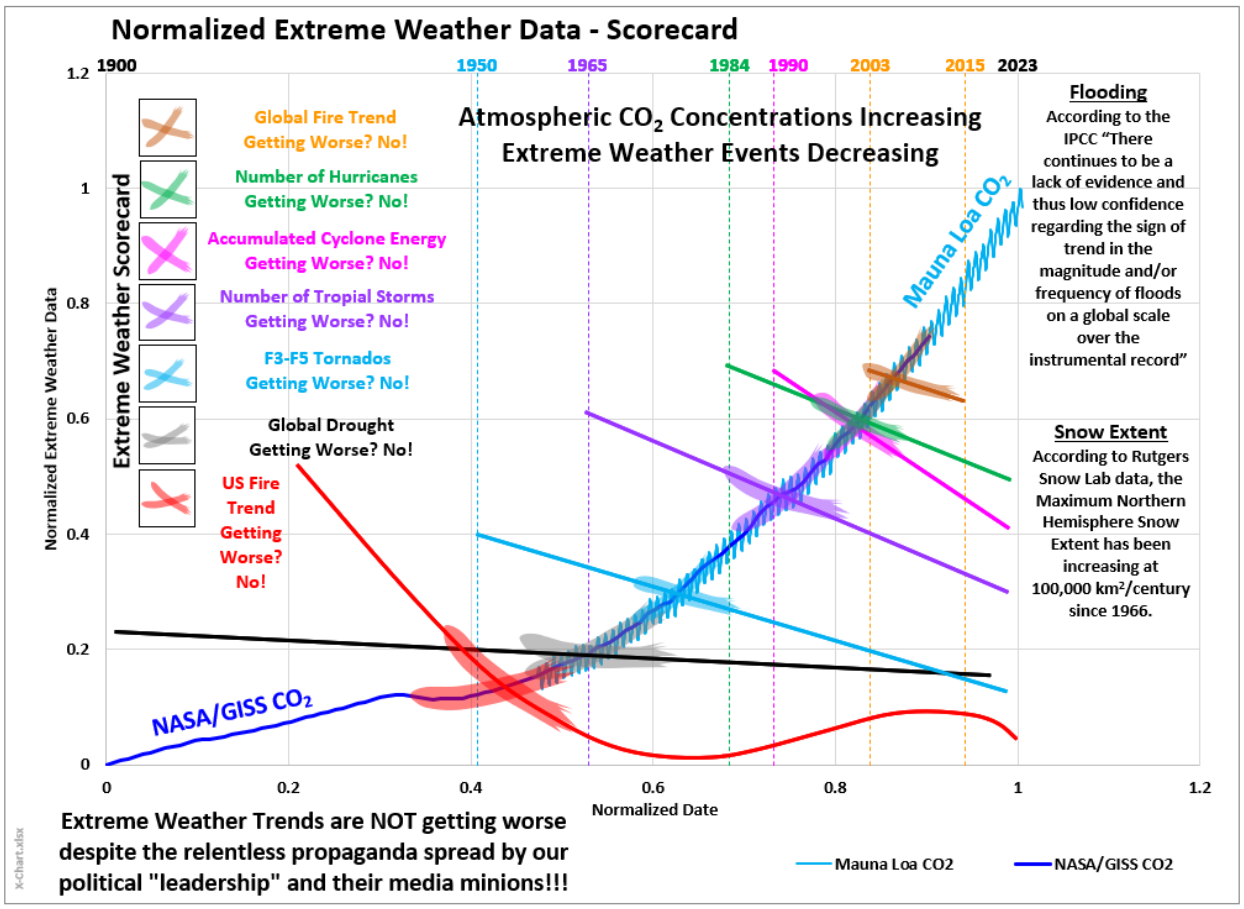
CSS-29 – Climate Model – TSI-AMO-CO_2
https://climatechangeandmusic.com/climate-model-tsi-amo-co2/

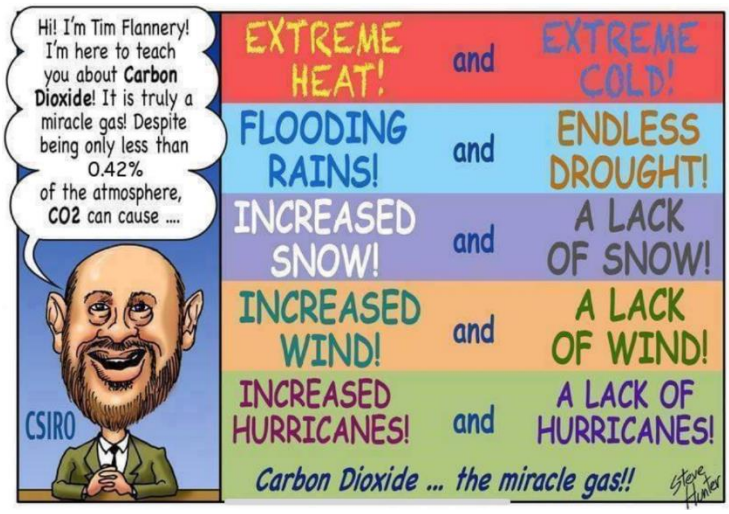
CSS-30 – CMIP6 Climate Model
https://climatechangeandmusic.com/cmip6-climate-models/

OPS-55 – The State of Climate Science
https://climatechangeandmusic.com/the-state-of-climate-science/

Segment 5 – Extreme Weather

Where do I start? I could and I will point out that the premise that extreme weather is getting worse is just plain wrong. The global empirical data shows the exact opposite premise. Fire statistics are trending lower, storm data (hurricanes and tornados) are trending lower, global drought area is trending lower, global flooding (according to the IPCC) is statistically flat, Northern Hemisphere snow conditions are rising. So, exactly what extreme weather is getting worse? There may be localized areas that are seeing more extreme weather activity, but the global numbers are not getting worse. For reference, the chart below

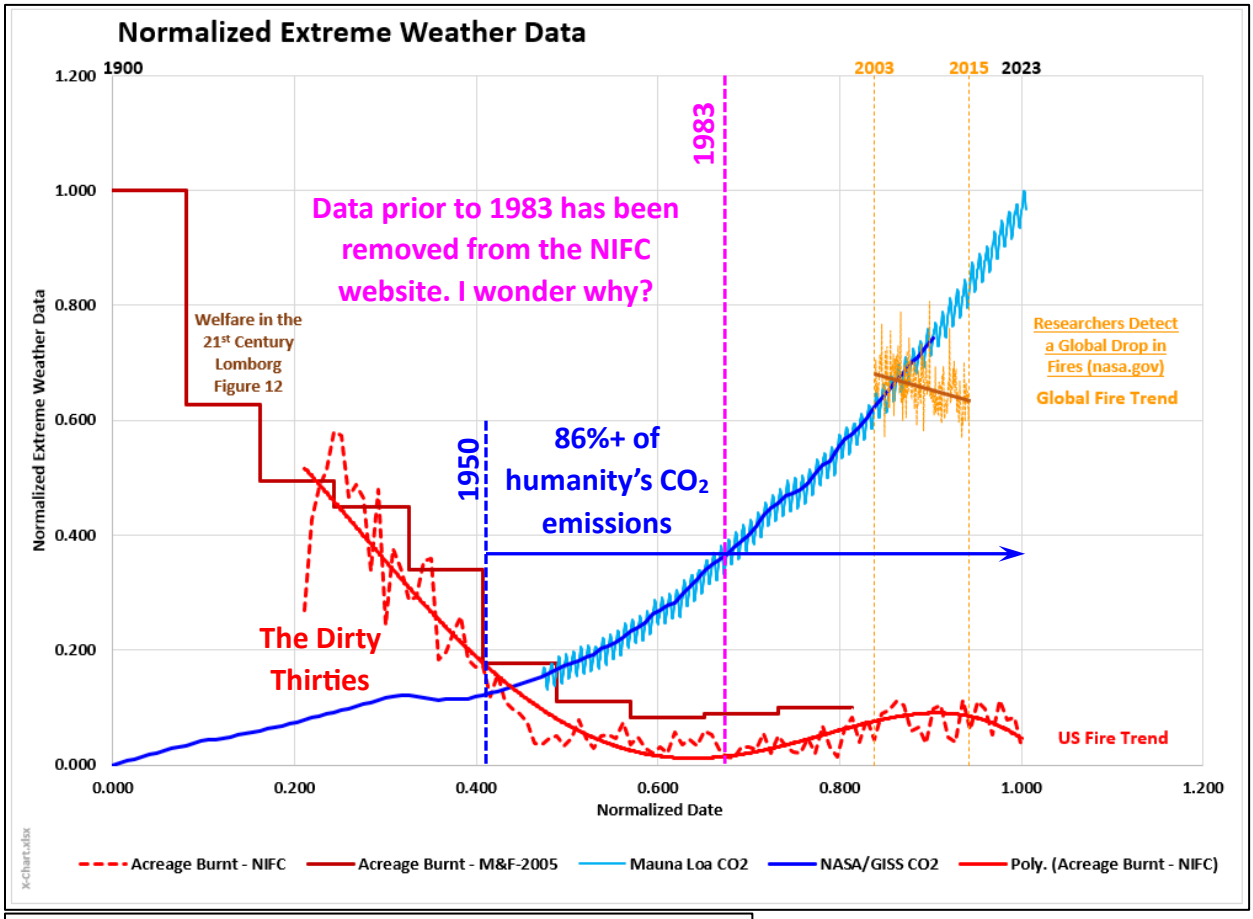


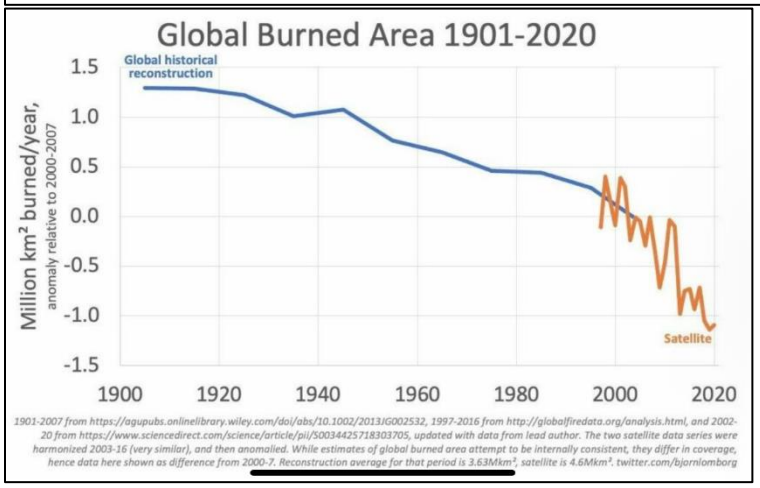


shows many of the extreme weather trends. The data has been normalized so that all the datasets can be shown on one plot. The detailed data and some additional discussion can be found in my CSS-52 – Extreme Weather Events post. The carton image to the left sums up the delusion that pervades the alarmist community quite well. Extreme Weather is just one of the more prominent delusions. As an alternative to empirical data, the alarmist community has taken to putting together attribution studies to

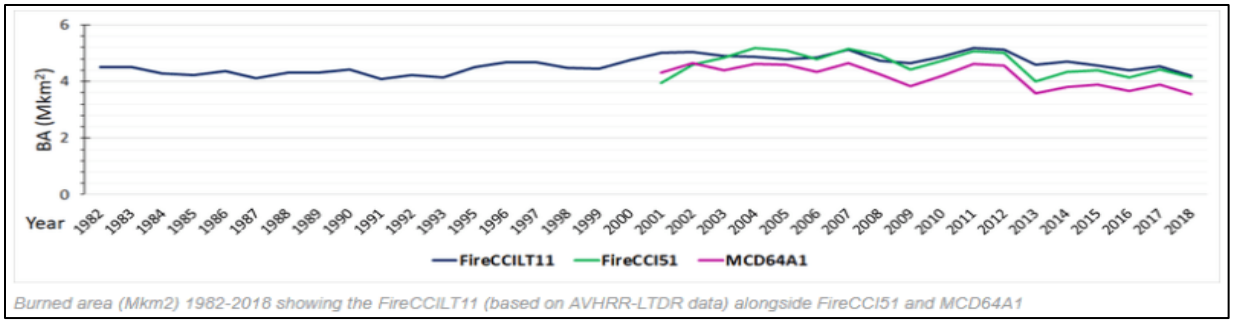
show how "climate change" (i.e.: CO_2 emissions) are contributing to every hurricane, fire, tornado, etc. I fail to see how that is possible when those extreme weather events have generally been statistically flat or have headed lower as CO_2 emissions have steadily risen. This inconvenient conundrum could represent the difference between the real world and the virtual reality world that exists within the attribution computer models. Those very same models that have been self-acknowledged to "run way too hot" and are very likely still hanging on desperately to the implausibly high ssp5-8.5 emission scenario. Like the earlier model projections, attribution studies are just as ideological and just as worthless.

The charts below focus on the just the fire data from a few different sources. The satellite data was pulled





from NASA in the larger plot. The smaller plot is an image from Bjorn Lomborg's work (the source is in the text below the image). The US Fire Trend data was downloaded from the National Interagency Fire Center (NIFC) website. The earlier decadal averages come from another Bjorn Lomborg piece of work (Welfare in the 21st Century). The chart on the following page provides some

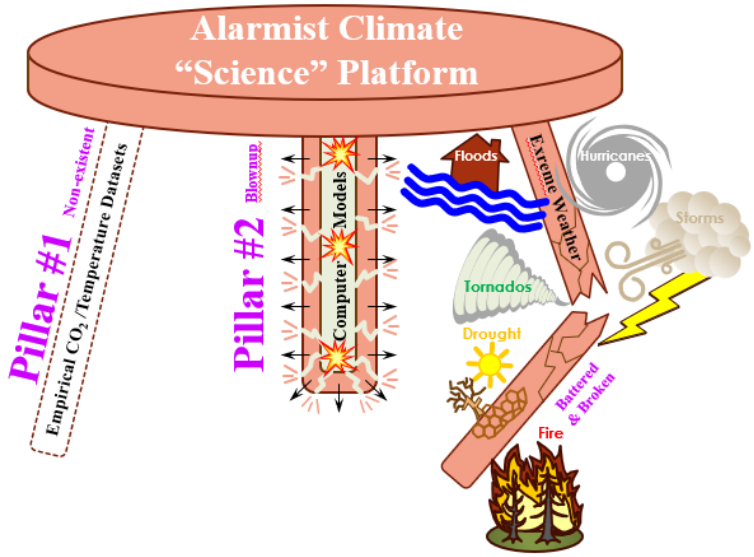


Burned area (Mkm2) 1982-2018 showing the FireCCILT11 (based on AVHRR-LTDR data) alongside FireCCI51 and MCD64A1

additional data sources for global fire statistics. Nowhere in the empirical data are global fire statistics raging out of control. The alarmist community will go to the NIFC database and argue that fires in the US have been rising and CO_2 (i.e.: climate change) is responsible. But the dataset now starts in 1983, ignoring the much larger burn acreages from long before human CO_2 emissions were a factor (87%+ of humanity's emissions are post-1950) and ignores the pause in acreage burnt growth since the turn of the century.

Alarmists also seem to forget that climate occurs over long periods of time. The very tragic and devastating fires in Lahaina, Hawaii and the record acreage burnt in Canada (18.5 million hectares (Mha)) are examples of anomalous events (within natural variability ranges) not evidence of climate change. Climate changes over decades, centuries, and millennia, not days, weeks, or even years. Statistically, the climate in Hawaii has not changed since the islands were discovered, let alone catastrophically. In my opinion, the Lahaina tragedy was manmade and was directly related to poor fire management and ill-advised climate policy. With respect to Canada, the record high acreage burnt was no more indicative of "climate change" than the record low acreage burnt in 2020 (0.23 Mha). CO_2 increases were not responsible for the burnt acreage rise from 0.23 to 18.5 Mha in just 3 years. The trends are more indicative of "climate change" and those trends were statistically flat (slightly down) until last year.

Similar discussions can be had for other extreme weather events. To close off, I would like to tie segments 4 and 5 together with the very basic statement, there are no empirical CO_2/temperature datasets that show CO_2 driving the climate on any statistically significant historical time scale. The whole alarmist narrative/platform is based almost entirely on CO_2 being the driver, projections based on climate models that are self-acknowledged to "run way too hot" and every fire, hurricane, etc. is evidence of climate change. The current state of the climate science platform (alarmist style) is poised to collapse in the general public's eye (as shown in the image to the left). That collapse has been evident in the empirical data for a long time; the general public is still playing catch-up. Would you sit on this stool? More discussion/links are available in my [OPPS-29 – Climate Change – "The Science"] post.



CSS-52 – Extreme Weather Events
https://climatechangeandmusic.com/extreme-weather-events/

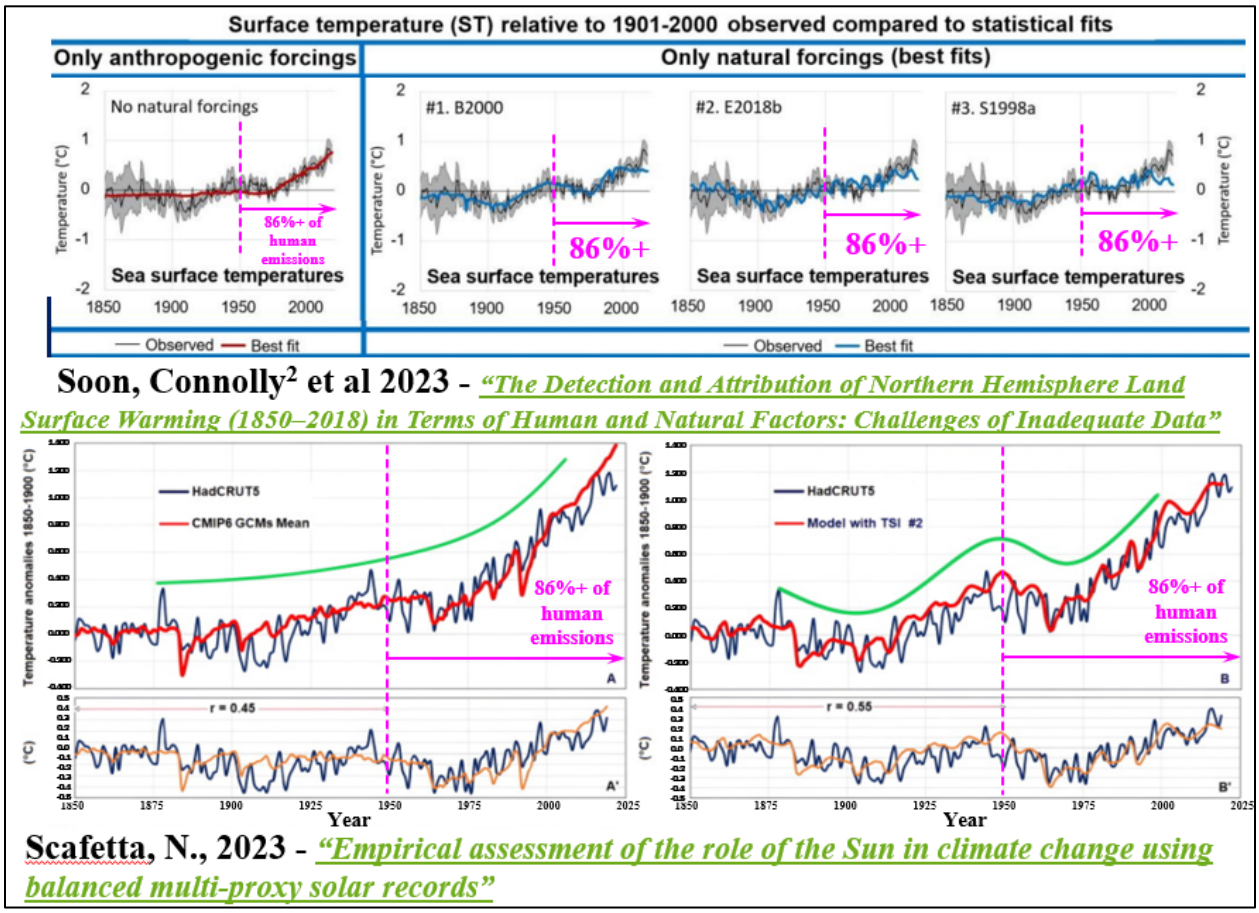
OPPS-27 – A Single Event is NOT a Trend
https://climatechangeandmusic.com/a-single-event-is-not-a-trend/

OPPS-28 – CO_2 Ideology Does NOT Drive the Climate
https://climatechangeandmusic.com/co2-ideology-does-not-drive-the-climate/

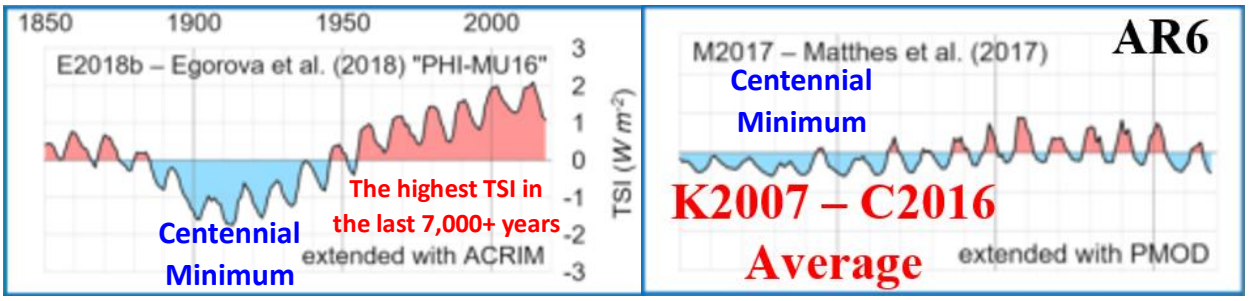
OPPS-29 – Climate Change – "The Science"
https://climatechangeandmusic.com/climate-change-the-science/

Segment 6 – Solar Forcing (Total Solar Irradiance (TSI), as a proxy)

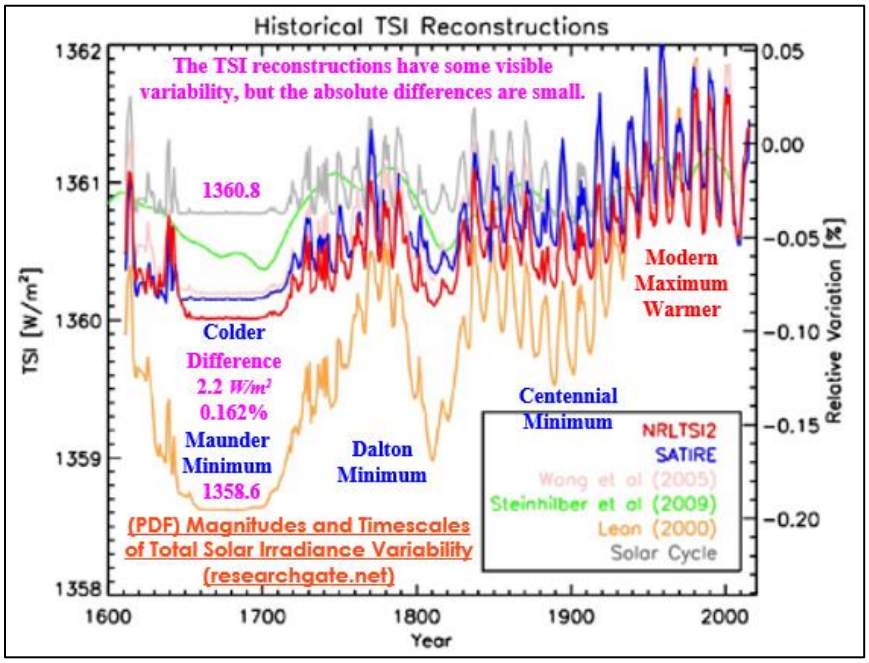
The alarmist community has made a living (literally, there are trillions of dollars at stake) out of ignoring solar activity and their effects on the global climate (both directly and indirectly (ocean cycles, cloud albedo, electromagnetic/cosmic ray influences, etc., etc.)). This is not new news. The images below have been pulled from two recent (2023) papers and clearly show that the MTR record can be modeled more closely with natural forcings (primarily solar) than CO_2. Not surprising, given that close to 100% of the energy this planet receives comes from that stellar furnace. Yet somehow the sun does not have any measurable impact on our climate (according to the alarmist narrative)?



In reality, climate change (as mentioned earlier in Segment 3) is complicated but can be closely modeled with just TSI and the AMO. CO_2 can and should be used to tighten up the correlation, but CO_2 is not the primary driver. How exactly does the IPCC effectively ignore solar forcings? They (through their rather sparse solar/astrophysics contingent) have arbitrarily chosen one of the few TSI reconstructions that fit their alarmist narrative. As laid out in the Soon, Connolly[2] et al 2023 paper, there are at least 27 different TSI reconstructions (many of which correlate very closely with the MTR). More recently, TSI reconstructions have increased to the 40+ range. Like temperatures, TSI reconstructions are available pre-1850. The Nicola Scafetta 2023 paper presented several of these longer TSI reconstructions. One of which was prepared by the Naval Research Lab (NRLTSI2). The NRLTSI2 TSI reconstruction is a middle of the road option (that I originally downloaded from NASA) and has been my choice for my evaluations.



The pre-MTR CO_2/Temperature correlations are non-existent. As shown in Segment 3, CO_2 levels were essentially flat over the pre-MTR Holocene while the temperatures fluctuated significantly and often.



Obviously, there were natural forcings active throughout the Holocene (including the MTR). Those natural forcings will still be active in the future despite the alarmists' decree that they have effectively ceased to exist. The solar/astrophysicist community including NOAA are forecasting a Grand Solar Minimum (GSM) over the next few decades like the Maunder Minimum (i.e.: little to no sunspot activity).

GSMs are traditionally associated with colder temperatures, civil strife, starvations due to shorter growing seasons, pestilence, etc. The Little Ice Age (LIA) lasted for centuries (1300 to the mid 1800s) and was visible in both hemispheres. In addition to the Maunder and Dalton Minimums, the LIA also encompasses the Wolf and Spörer Minimums. Not surprisingly, the LIA corresponded to the lowest TSI over the last 7,000+ years. And inconveniently for the alarmist narrative, the last half of the 20th century corresponded to the highest TSI over the last 7,000+ years.

Only an ideological, fully vested CO_2 alarmist (and there are plenty of them) would outright dismiss the obvious solar correlations and hang their hat on a non-existent CO_2 correlation! Remember there are no empirical CO_2/Temperature datasets that show CO_2 driving the climate on any statistically significant historical time scale (a basic Scientific Method requirement).

The Detection and Attribution of Northern Hemisphere Land Surface Warming (1850–2018) in Terms of Human and Natural Factors: Challenges of Inadequate Data
https://www.mdpi.com/2225-1154/11/9/179

Empirical assessment of the role of the Sun in climate change using balanced multi-proxy solar records
https://www.sciencedirect.com/science/article/pii/S1674987123001172?via%3Dihub

CSS-29 – Climate Models – TSI-AMO-CO_2
https://climatechangeandmusic.com/climate-model-tsi-amo-co2/

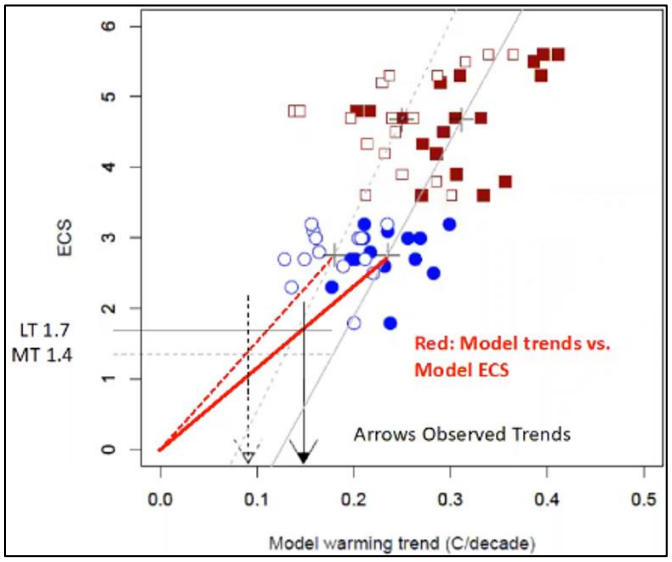
CSS-42 – The Role of the Sun – Scafetta 2023
https://climatechangeandmusic.com/the-role-of-the-sun-scafetta-2023/

CSS-51 – Soon-Connolly – Solar Forcings
https://climatechangeandmusic.com/soon-connolly-solar-forcings/

OPS-52 – Solar Activity – NOAA Forecast
https://climatechangeandmusic.com/solar-activity-noaa-forecast/

Segment 7 – CO_2's Equilibrium Climate Sensitivity (ECS)

CO_2's ECS is very likely the most important "Climate Science" parameter out there. Not because the parameter itself is that important. CO_2 is a minor climate driver (i.e.: a small ECS) and is easily overpowered by a wide variety of natural radiative forcings (solar activity, ocean cycles, orbital mechanics, cosmic ray flux, cloud albedo, etc.). The parameter is important because of the unscientific liberties taken by the alarmist community. As discussed earlier, the General Circulation Models (GCM) use a wide range of ECS values (1.8 to 5.7 °C, as shown to the left). For clarification, the ECS corresponds to the expected temperature increase that can be expected from a doubling of atmospheric CO_2 concentrations once a new equilibrium state has been achieved. Firstly, that is a huge range (all of which are actually higher than the theoretical ECS) and certainly not settled science.



Many sensitivity studies have been done over the years and are summarized in the plot down and to the left. This chart was published in Nicola Scafetta et al's 2017 paper "Natural climate variability, part 2: Interpretation of the post 2000 temperature standstill". An updated plot (down and to the right) was put together by Kenneth Richards on the NoTricksZone website. The updated chart has not been peer reviewed, but there are links included for the additional papers. As shown, over time the estimates of climate sensitivity have been trending down (towards and likely lower than the IPCC's lower end estimate of 1.8 °C). Why are the IPCC estimates so high in their models that "run way too hot"? Well, they arbitrarily assume that any CO_2 warming would lead to more evaporation (i.e.: a higher atmospheric water vapor), leading to a positive water vapor

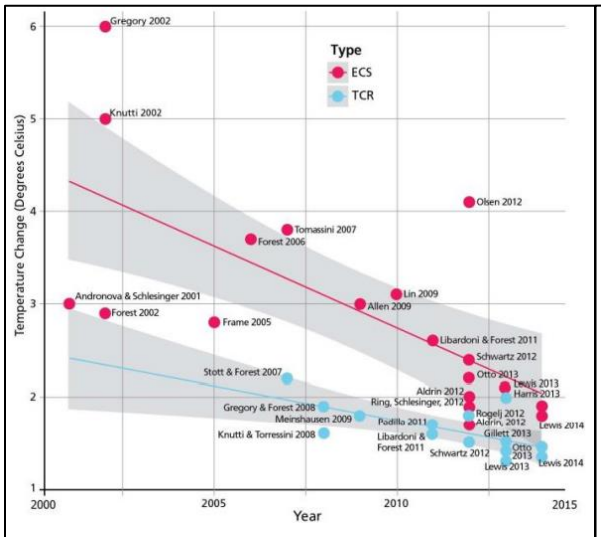
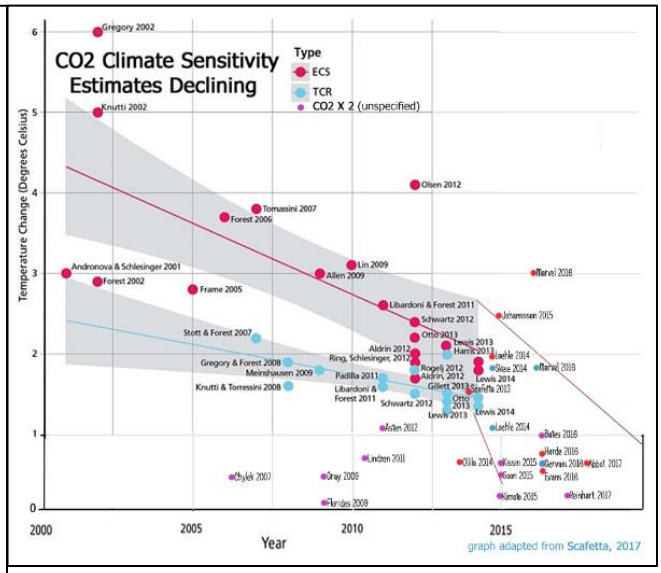
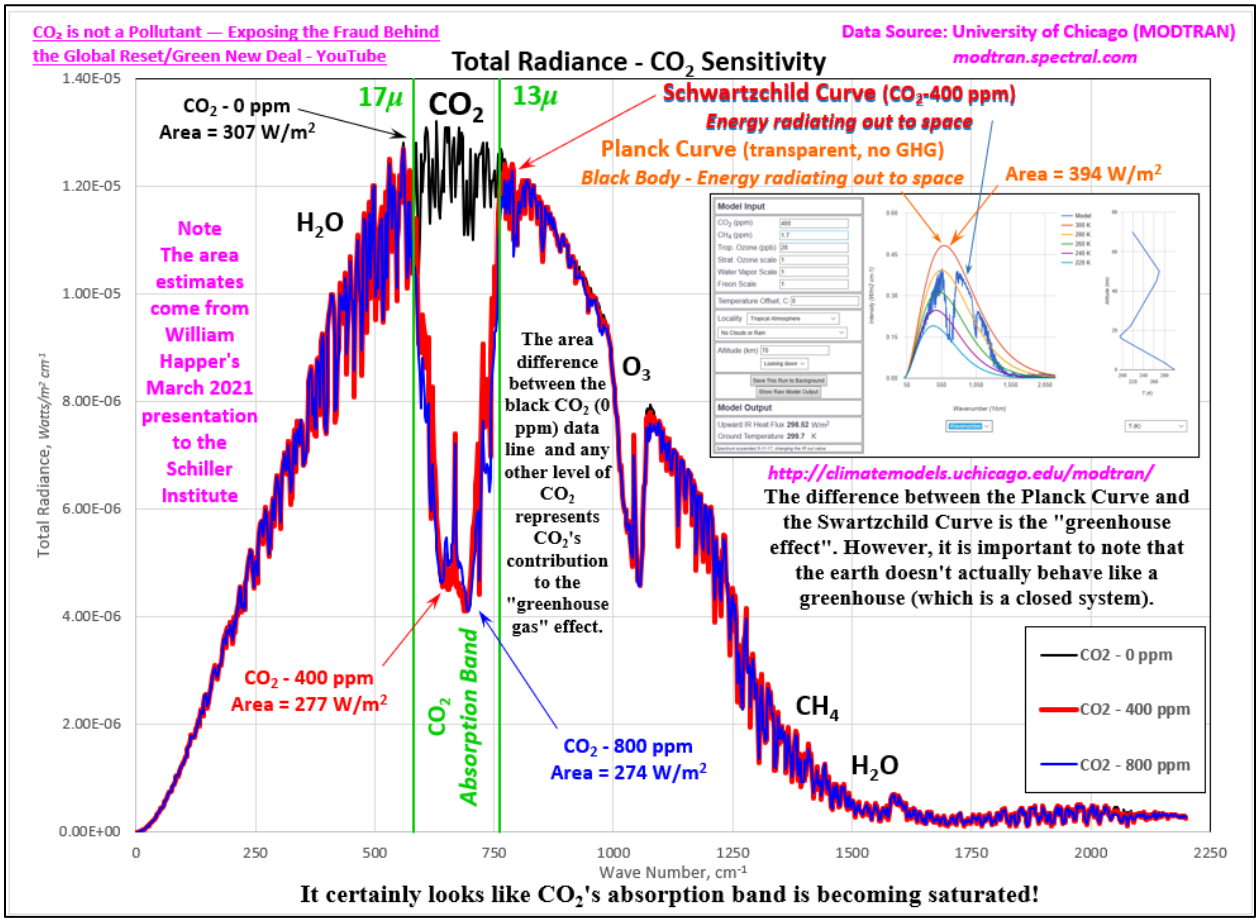


Figure 7. Compilation of published transient climate response (TCR) and equilibrium climate sensitivity (ECS) values to atmospheric CO2 doubling. (Adapted from Figure 1 in Refs. [20,27] where all references listed in the figure are reported: from link)

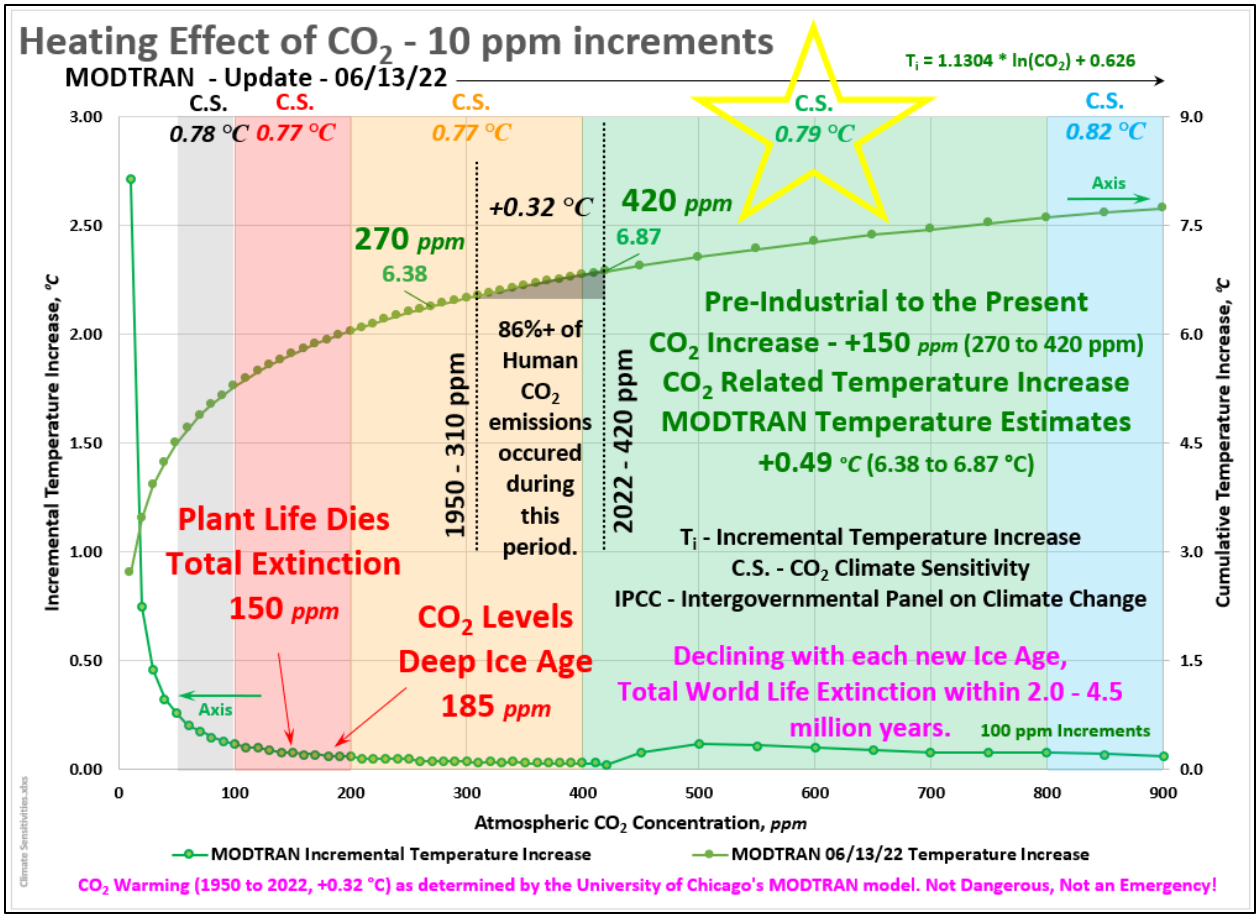


feedback and higher induced sensitivities. Just one problem, there is no evidence that this feedback exists in the real world. Maybe their models would not run so hot if they used realistic sensitivities (and natural forcings).



So, what is a realistic ECS? The trends suggest that they are less than 1.8 °C and once factors like Urban Heat Island Effects (UHIE) and natural forcings are properly taken into account, the ECS likely drops to the 1.0 °C range. A recent paper (2021, "Relative Potency of Greenhouse Molecules") by van Wijngaarden and Happer has shown that CO_2's warming capacity is approaching saturation (i.e.: most of CO_2's warming has already been realized). The Schwartzchild curves above show the effect a doubling of CO_2 (from 400 to 800 ppm) would have on radiation levels (not much). By looking at radiation levels returning to space (as measured by satellites and closely matched by the University of Chicago's MODTRAN model) you can back out CO_2's ECS. Those results are shown in the graph on the following page. CO_2's contribution to global warming to date is roughly 6.8 °C. Humanity's physical capacity to add CO_2 to the atmosphere is limited to roughly 1600 ppm. Based on the MODTRAN model, CO_2's ECS is roughly 0.8 °C, limiting our warming capacity to another ±1.6 °C (assuming we could actually burn all our hydrocarbon and coal reserves).

CO_2 ECS is not settled science. But when the energy radiating out to space, UHIEs, and natural forcings are factored into the discussion, the ECS levels are very likely around 0.8 °C. These levels are not dangerous and do not justify the ideological, unnecessary, ridiculously expensive green policies being pushed on our society (in my opinion).



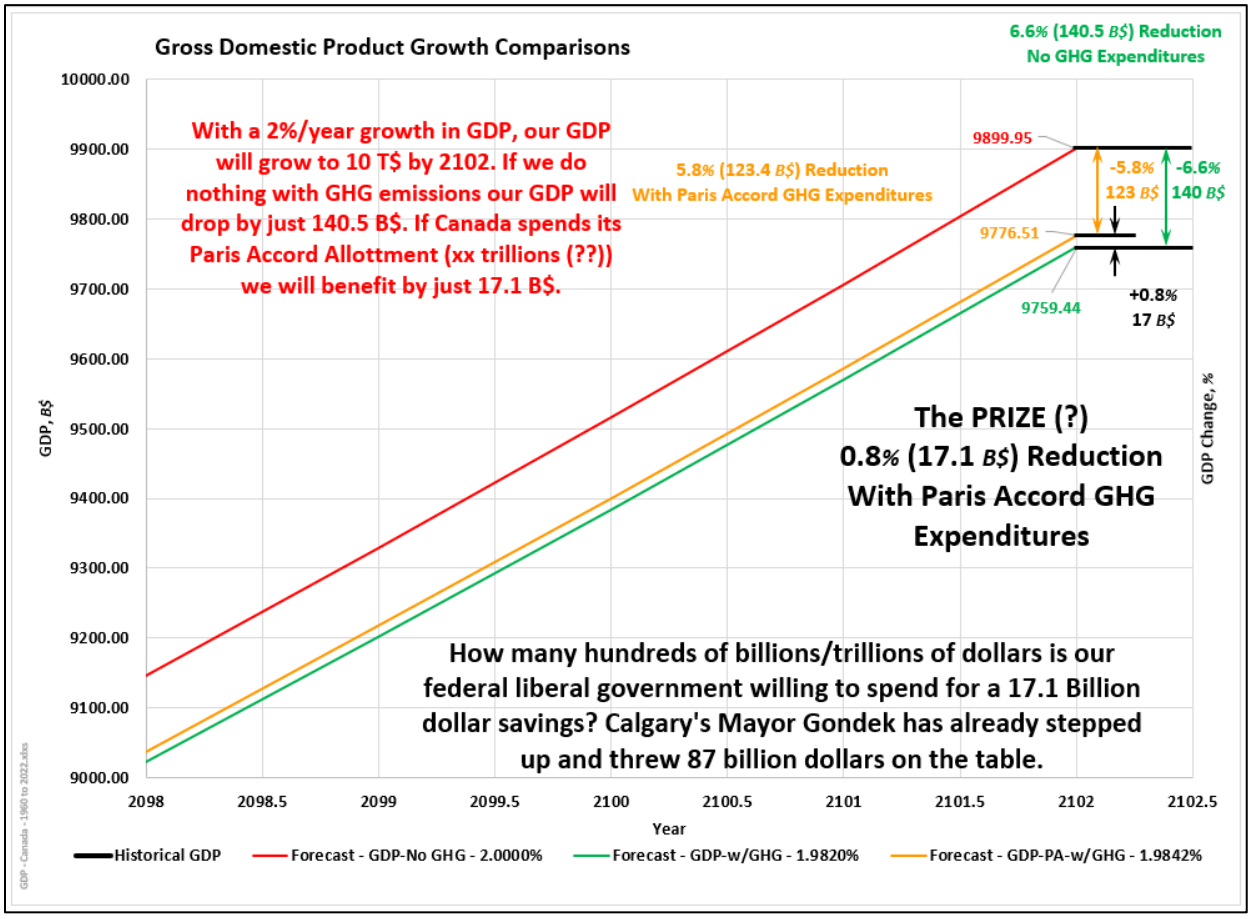
CSS-7 – CO2 – The FECKLESS Greenhouse Gas
https://climatechangeandmusic.com/co2-the-feckless-greenhouse-gas/

CSS-21 – CO2 - Visualized Temperature Contribution
https://climatechangeandmusic.com/co2-visualized-temperature-contribution/

Note: the image shown above has been updated from the one included in the CSS-21 post. The CSS-21 post needs to be updated, but the general discussion will not change significantly.

Segment 8 – GDP Growth and Climate Change

The premise of this discussion series has been the ineffectiveness of CO_2, hence the portrayal as CO_2's Moneyball Moment (if CO_2 is such a good climate driver, why does it not drive the climate good). The poor grammar was intentional. The previous seven segments focused on existing empirical/technical data. This segment moves the discussion into the economic realm and will generally answer the question, how much does climate change affect Gross Domestic Product (GDP)?



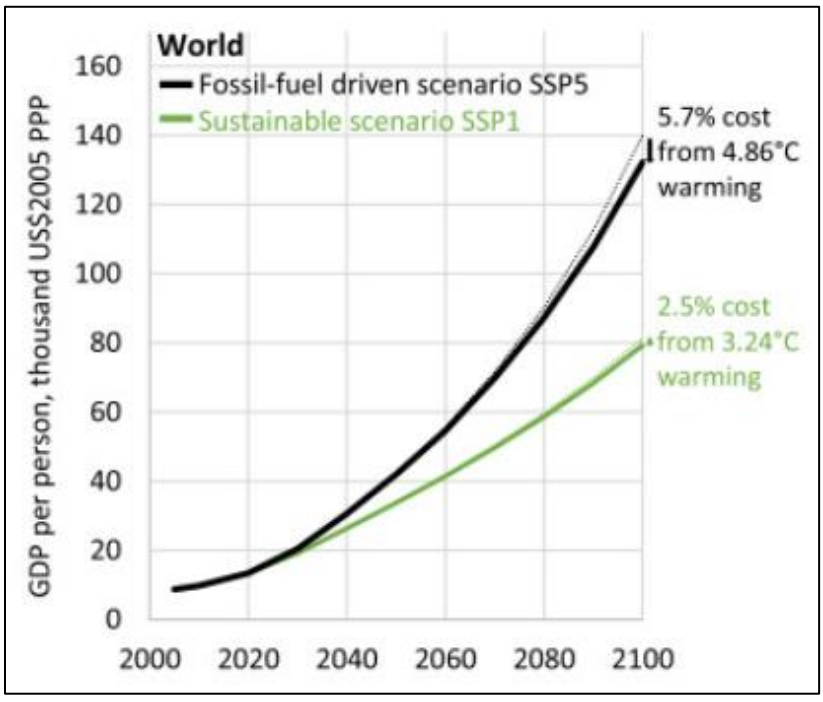
We will start with the government of Canada's Parliamentary Budget Office's (PBO) November 22nd, 2022 Report (Global greenhouse gas emissions and Canadian GDP). The PBO conducted a series of model runs that quantified the effect climate change would have on Canada's GDP growth. There are three model runs considered. One with no climate change impacts, one with climate change but no mitigation and one with full global compliance to the 2015 Paris Accord commitments. Climate Change affects produced a Canadian GDP drop of just 6.6%, 80 years from now. To put those numbers in perspective, that would mean (based on a modest (but probable) growth rate of 2.0%/year), our GDP would grow from roughly $2 trillion/year to roughly $10 trillion/year (roughly a 378% wealth increase). With unmitigated climate change impacts (i.e.: no spending on climate change), our GDP growth would be lower by just the 6.6% (limiting our growth to just 371.4%). Our GDP would be just $140 billion dollars lower.

Before preceding any further, I should point out that the PBO is using the implausibly high ssp5-8.5 emission scenario. The 6.6% and $140 billion reductions in GDP are very obviously overstated and will be

lower based on a reasonable emission scenario (ssp2-4.5) as per the discussion in Segment 5). The same will be true for the other two runs.

The third run assumes that the entire world honors their 2015 Paris Accord commitments. The chances of that are doubtful given the performance to date and the very real fiscal headwinds that the world will be facing over the next few decades. But for the purposes of this discussion, we will accept the premise as stated. Meeting those commitments would improve Canada's GDP by just 0.8% ($17 billion). Over the next 80 years, the cumulative 2015 Paris Accord commitments would improve our GDP by $443 billion. Based on a discount rate of 3%, that improvement is equivalent to roughly $84.7 billion (coincidentally the amount Calgary's City Council has approved to address the "Climate Emergency"). Canada is committing themselves to spending 100s of billions to trillions of dollars to offset that small relief. Realistically, a full cost/benefit analysis should be (or more accurately should have been) the top priority of any government before another penny of taxpayer money is spent on these unnecessary, unscientific, "green" initiatives.

My recent posts (PSS-6 – Climate Change – Quick Cost/Benefit Analysis and OPPS-32 – Liberal – Net Zero – Cost Benefit) have shown that we (Canadian taxpayers) will be spending trillions to save billions, even when using our newly elected Prime Minister Mark Carney's low ball Net Zero capital expenditure estimate of $2 trillion. The Canadian federal government's 2022 budget estimates put the costs at $125 to 140 billion/year to 2050 ($3.5 to $3.92 trillion). For additional perspective, if you use the McKinsey and/or Fraser Institute (Vaclav Smil) global estimates ($380 and $552 trillion, Canadian), respectively, Canada's 1.5% of global emissions balloons our costs out to $5.7 and $8.3 trillion, respectively. I am assuming those costs cover federal, provincial and municipal requirements. What they do not cover is the costs to maintain Net Zero. Every wind and solar project, every battery storage back-up, and every Electric Vehicle (EV) needs to be replaced every ±20 years. To provide some perspective, the costs to build enough battery back up for Alberta's current electrical grid would cost on its own ±2 trillion. You need to spend that 3 or more times over the rest of this century assuming the raw materials are even available. Strongly suggesting that the Carney estimate is grossly inadequate. How much practical benefit does that provide, roughly $10 trillion dollars for every 1/100th of a degree Celsius of reduced temperature rise (i.e.: completely meaningless)!



For perspective, the PBO's estimate is consistent with other detailed estimates. The chart to the left was pulled from a recent Bjorn Lomborg report, *"Welfare in the 21st century: Increasing development, reducing inequality, the impact of climate change, and the cost of climate policies"*. Both the PBO (6.6% - Canadian) and Lomborg (5.7% - Global) use the implausibly high ssp5-8.5 emission scenario. As shown, lower emission scenarios will

logically produce smaller reductions (2.5% for the SSP1 case shown here). Lomborg goes on to state "*With almost similar population, the SSP5 world will be almost twice as rich at an annual GDP of $1,034 trillion versus $563 trillion in the SSP1 world.*" Contemplate that statement and ask yourself how much money we should be wasting to cut our grandchildren's net worth by $471 trillion (45.6%)?

OPPS-22 – Parliamentary Budget Office – GDP & Climate Change
https://climatechangeandmusic.com/parliamentary-budget-office-gdp-climate-change/

OPPS-23 – PBO – Trudeau's Business Acumen
https://climatechangeandmusic.com/pbo-trudeaus-business-acumen/

OPPS-32 – Liberal – Net Zero – Cost Benefit
https://climatechangeandmusic.com/liberal-net-zero-cost-benefit/

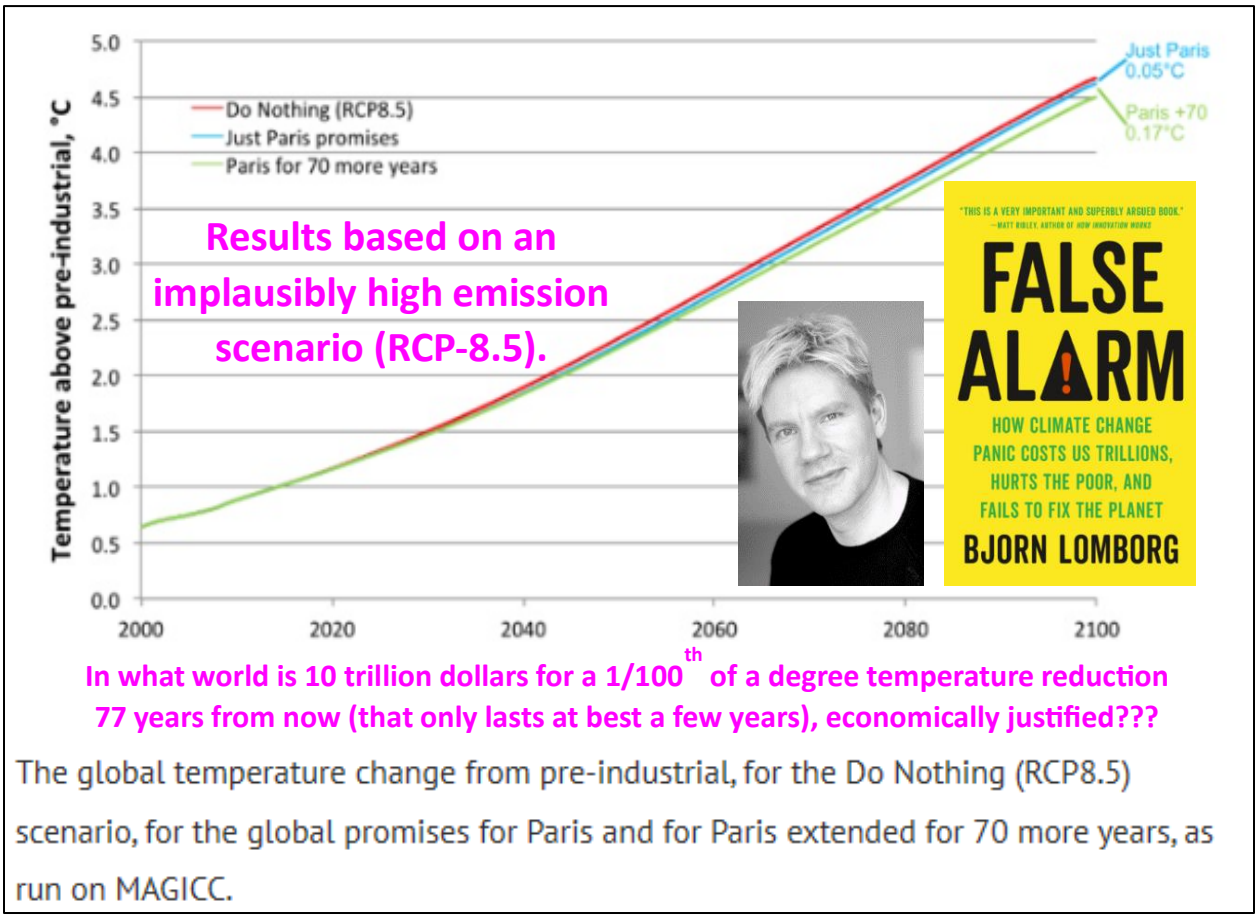
PSS-4 – Who is Justin Listening To?
https://climatechangeandmusic.com/who-is-justin-listening-to/

PSS-6 – Climate Change – Quick Cost/Benefit Analysis
https://climatechangeandmusic.com/climate-change-quick-cost-benefit-analysis/

Lomborg (2020): *Welfare in the 21st century: Increasing development, reducing inequality, the impact of climate change, and the cost of climate policies.*
https://www.sciencedirect.com/science/article/pii/S0040162520304157

Segment 9 – The Cost of Temperature Reductions

The discussion touched on the economics in Segment 8. This segment will add to that discussion but will first lay out what the temperature reductions might be. Bjorn Lomborg mentioned his 2016 work in the 2020 paper linked in Segment 8, "*The difference in temperature by 2100 is 0.17°C (Lomborg 2016)*". This assumes that the world's 2015 Paris Accord Commitments were extended from 2030 to the end of the century. If the world abandons their post-2030 commitments after 2030, that temperature reduction would only be 0.045 °C. Note, that these estimates use the IPCC science and are (as usual) based on the implausibly high RCP8.5 (like ssp5-8.5) emission scenario. Given that most of the Paris commitments have already fallen far behind, 0.045 °C may be optimistic. For the purposes of this discussion, the 0.17 °C

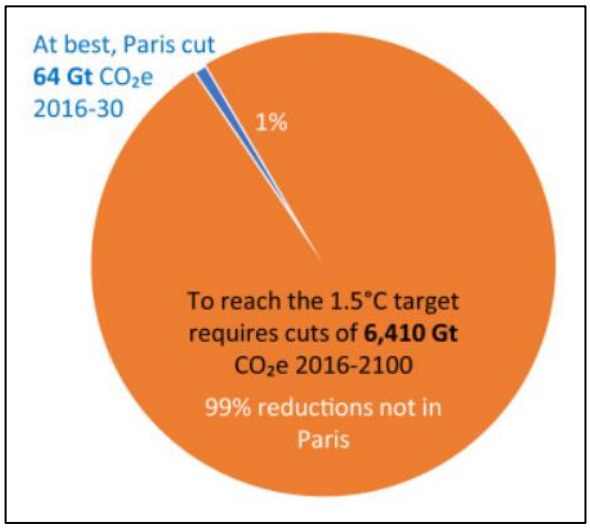


The global temperature change from pre-industrial, for the Do Nothing (RCP8.5) scenario, for the global promises for Paris and for Paris extended for 70 more years, as run on MAGICC.

reduction in 2100 will be used going forward. Based on a more realistic emission scenario like ssp2-4.5 that temperature reduction would be lower still. These estimates are problematic in so many ways (even assuming "the IPCC science" is correct). That 0.17 °C temperature reduction is significantly lower than margin of error in both the models and our ability to estimate average global temperatures. So, how will we know if the models are correct come 2100? Given that the modelers have already self-acknowledged that the models "run way too hot", we can safely assume that they will not be correct.

That 0.17 °C reduction is based on models that effectively react almost exclusively to changes in atmospheric CO_2 concentrations. So, what happens to the temperature estimates when natural forcings are added back into the discussion? That would lower the CO_2 climate sensitivities and therefore the temperature estimates associated with any CO_2 influence. Might just fix that 'our models are running way

too hot' problem as well. Just one more parameter that would suggest a temperature reduction that is less than 0.17 °C. Note, I am still committed to using the 0.17 °C reduction for this discussion.



Adding in the climate change mitigation costs now will give us a general cost/benefit perspective. The costs are one of those unsettled points in the climate change discussion. The only constant is the unending growth in the estimates. The early estimates for the 2015 Paris Accord commitments were in the 1 to 2 trillion dollars per year range (globally). That number (for Paris alone) is approaching the 2 trillion dollar/year range according to Lomborg's 2020 paper. Sadly, it is not surprising that we are at the high end of the early estimates, given both government and UN/WEF involvement.

But the ideological madness does not stop there. As Lomborg has shown (to the left), the Paris Accord commitments are a small portion of what is required to meet the alarmist's perceived goals. So, why stop at 2 trillion dollars/year? With some NetZero by 2050, ESG, Green New Deals, etc. thrown into the mix, those costs have ballooned into the $10 trillion dollar/year range. According to the recent McKinsey & Company report (The net-zero transition), *"Capital spending on physical assets for energy and land-use systems in the net-zero transition between 2021 and 2050 would amount to about $275 trillion, or $9.2 trillion per year on average, …"*. Those are US dollars. As Canadians we must factor in the conversion from Canadian dollars. The previous lost decade of Liberal economics has not helped our conversion costs, and the future is looking less optimistic as the "new" cast of liberals (the same characters just shuffled around) looks to dig in on their ideological "green" ideologies.

What are we getting for those trillions of dollars per year? Not much apparently. Based on the Paris Accord commitments, we saw minor improvements in GDP (0.8%, 17 billion dollars, 80 years from now) and a small, unmeasurable temperature difference (maximum 0.17 °C). If we assume that the 2015 Paris commitments are 2 trillion dollars/year over 85 years (for simple math), the total outlay will be 170 trillion dollars for 0.17 °C. We, the taxpayer, are paying 10 trillion dollars for every $1/100^{th}$ of a degree of temperature reduction (or from a more incomprehensible perspective, 1 quadrillion dollars for every 1 °C). Will the Net-Zero expenditures have the same metrics? Not likely, given that the Paris Accord commitments will have addressed most of the easy, cheaper CO_2 reduction options.

All these fanciful green initiatives assume that we will have the financial, technological, and material resources to magically manifest their green utopia. A discussion for another time, but the chances of that happening are effectively zero. For those that are interested in that discussion, I suggest that you investigate the book that I and six other authors published late in 2024. *"Energy & Climate at a Glance – Canadian Edition 2024"*, designed as a short, easy to read resource (focused on Canada) that covers policy, economics, health & safety, environmental, and relevant scientific principles. The book can be purchased from the Friends of Science Society for $15 plus shipping charges (link below). Note, the authors do not receive any of the proceeds.

Energy & Climate at a Glance – Canadian Edition – Book Form | Friends of Science
https://friendsofscience.org/energyandclimateataglance.html

McKinsey & Company: The net-zero transition: What it would cost, what it could bring
https://www.mckinsey.com/capabilities/sustainability/our-insights/the-net-zero-transition-what-it-would-cost-what-it-could-bring

Halfway Between Kyoto and 2050 – Zero Carbon Is a Highly Unlikely Outcome – Vaclav Smil (the Fraser Institute), May 28th, 2024
https://www.fraserinstitute.org/studies/halfway-between-kyoto-and-2050

Lomborg (2020): ***Welfare in the 21st century: Increasing development, reducing inequality, the impact of climate change, and the cost of climate policies.***
https://www.sciencedirect.com/science/article/pii/S0040162520304157

Lomborg (2016): Impact of Current Climate Proposals
https://onlinelibrary.wiley.com/doi/epdf/10.1111/1758-5899.12295?src=getftr