Fact checking the fact checkers

What Climate Feedback gets wrong in its attempted takedown of CO2 Coalition commentary

Gregory Wrightstone

On Earth Day this year, the Washington Times published an op-ed that I wrote titled "There is no climate emergency - We love CO_2 and so should you." Not long after publication, the paper's Facebook post on the commentary was labeled "false and misleading" and their ad for it was rejected. This was based on a lengthy "fact-check" titled Washington Times presents list of false and misleading statements about the impacts of CO2 and climate change by Climate Feedback (CF). It was composed by eight scientists and upon detailed review of their "fact-check," it became clear why they were not labeled "experts."

In order to rebut this review, I asked six of the top experts in the world in various fields related to climate change to assess the statements by the Climate Feedback reviewers for accuracy and validity. All the scientists I consulted are members of the CO2 Coalition, a non-profit scientific coalition based in Arlington, Va. All agree that there is no man-made climate emergency.

Since many of the sections contain duplicative statements alleging various supposed "false" claims and statements in my commentary, I have distilled them to eleven primary statements of supposed "fact" used to "debunk" the op-ed. Climate Feedback claims and quotes are in red.

In each case, we find that the Climate Feedback reviewers are the scientists providing muddled, misleading, and false information.

CF Claim #1: Wrightstone fails to disclose conflicts of interest

> *CF: the sponsored article fails to disclose conflicts of interest. As Kerr said to Climate Feedback, "Gregory Wrightstone is a professional in the fossil fuels industry. He works on shale gas and oil in the Appalachian Basin.*

Response 1 - Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, expert reviewer of the United Nations Intergovernmental Panel on Climate Change, author of Inconvenient Facts: The science that Al Gore doesn't want you to know

That is factually and blatantly incorrect (even though if it were true, it would not matter). I am not employed in the energy sector. I receive zero funding from the fossil fuel industry. If the authors get this basic "fact" wrong, how can we rely on any later statements of "fact." Several of the Climate Feedback reviewers have definite unrevealed conflicts of interest, including Amber Kerr, who is a paid consultant for Carbon Direct, a consulting firm that provides advice to companies concerning carbon offsets. I doubt that she would be employed long in this capacity if she produced any science that disputes the "consensus" opinion on climate change.

CF Claim #2: Continents near the equator were too hot to support life in the past

> *During some of that ancient history, continents near the equator were too hot to support life (Amber Kerr)*

Response 2a: Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, espert reviewer of the United Nations Intergovernmental Panel on Climate Change, author of Inconvenient Facts

Dr. Kerr's statement that continents near the equator were too hot to support life at some undefined point in Earth's history is not supported by any reference or source by her. None of our distinguished scientists at the CO2 Coalition have ever heard of such a claim and we can find no supporting evidence to substantiate this. When making a statement that is far outside the mainstream thinking, it is incumbent on the claimant to provide a reputable source. In addition, she and several of the other Climate Feedback authors, in this and later sections, appear to be unaware that greenhouse warming mostly affects the higher latitudes and poles, with greatly diminished effects near the equator (Lindzen 1997).

Contrary to her contention that extreme heat in the future may result in temperatures too hot to sustain life, some of the most populated cities in the world today are in areas with the hottest temperatures like India, Indonesia, and sub-Saharan Africa.

It should be noted that Africa, a continent that straddles the equator, is home to two desert regions that are nearly devoid of life today. Both are found at about 30 degrees north (Sahara) and south (Kalahari and Namib) of the equator. Note that the equator is home to abundant and thriving ecosystems in the equatorial rainforests, just opposite of what Ms. Kerr seems to allege. The lack of life in the desert areas and the abundance of life at the equator are not driven by changes in CO_2, but rather high precipitation or the lack thereof by the rising (wet) and falling (dry) of the Hadley cells.

Response 2b: Dr. Patrick Moore - Ph.D. in Ecology, Co-founder of Greenpeace, Director CO2 Coalition

Dr. Kerr's statement is simply ridiculous and without support. Some of the richest ocean biodiversity, including corals and fish, is found today in the hottest oceanic waters in the Indonesian Archipelago. Warmer is better for many species of ocean life.

CF Claim #3: Modern temperatures are higher than any in 12,000 years

> *Wrightstone states that our current global average temperatures are remarkable "only if your record is limited to the last 150 years or so." That is not correct. The prevailing understanding in paleoclimatology is that our current global average temperatures are the highest since before the last Ice Age more than 12,000 years ago[9]. (Amber Kerr)*

Response 3: Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, expert reviewer of the United Nations Intergovernmental Panel on Climate Change, author of Inconvenient Facts

Dr. Kerr's contention that "the prevailing understanding in paleoclimatology" is of warmer modern temperature than the entire Holocene (12,000 years) is patently false. Nearly all within the paleoclimate community on both sides of the issue agree that a much warmer period occurred 6,000 to 8,000 years ago, including Dr. Michael Mann, NASA, and the IPCC. The very study cited by Kerr does not support this idea and is described in some detail in the next section. The vast majority of paleoclimate studies agree that the most recent warming period, known as the Medieval Warm Period was warmer than today including summaries of more than 1,000 papers that are documented here, here and Figure 1, below.

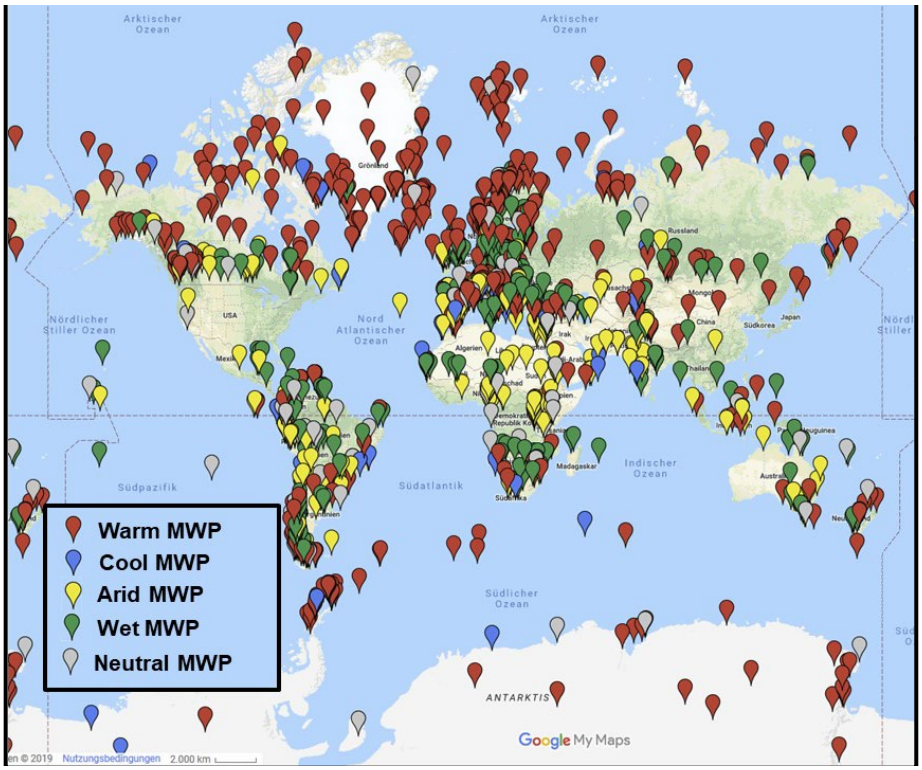

Figure 1 - Review of >1,000 studies confirm majority agree that the Medieval Warm Period was warmer than present
Modified from Lüning (2020)

In support of her contention that current temperatures are warmer than any in the last 12,000 years, Amber Kerr references Kaufman (2020) which is a global multi-proxy paleo-temperature reconstruction. The portion of the study that deals with paleoclimate is excellent and shows the high temperatures of the Holocene Optima with thousands of years of declining temperature. In the summary, Kaufman pasted modern instrument data onto the paleoclimate data, but he specifically warned against comparing the two, as Dr. Kerr has done here.

This paper does not state that paleoclimate records show our current global average temperatures are the highest since the last Ice Age. Kaufman warns against comparing his low-resolution proxy data against high-resolution modern instrument data stating, “most of the paleotemperature time series are not sufficiently resolved temporally to meaningfully compare with instrumental-based observations” and “2000-year-long records provide a bridge between the overall lower-resolution time series of this database and the highly detailed, but relatively brief instrumental-based record of climate.” And finally: “The resolution of the paleoclimate proxy data over the past 12,000 years is about 150 to 200 years. Global instrumental data measures temperatures hourly and daily which are then averaged for monthly and annual presentation. For a fair comparison, instrumental records would need to be averaged over a time period of 150-200 years. In other words, you can’t compare apples to oranges which Dr. Kerr has done here.

Perhaps Dr. Kerr either did not read the paper or did not read it closely enough because the authors state “The warmest 200-year-long interval was also centered on 6.5 ka and was 0.7 °C warmer than the 19th Century.”

Kaufman's most recent previous study (McKay and Kaufman 2014) was found to have multiple glaring errors that required a complete correction (Ahmed 2015). In the corrected study, the authors admitted that our modern warming, which they defined as the period 1971 – 2000, was NOT the warmest 30-year period in 2,000 years, but the third warmest (Figure 2). The warmest such period occurred during the Roman Warm Period, centering on the year 395 AD, so even the author she references disagrees with her statement.

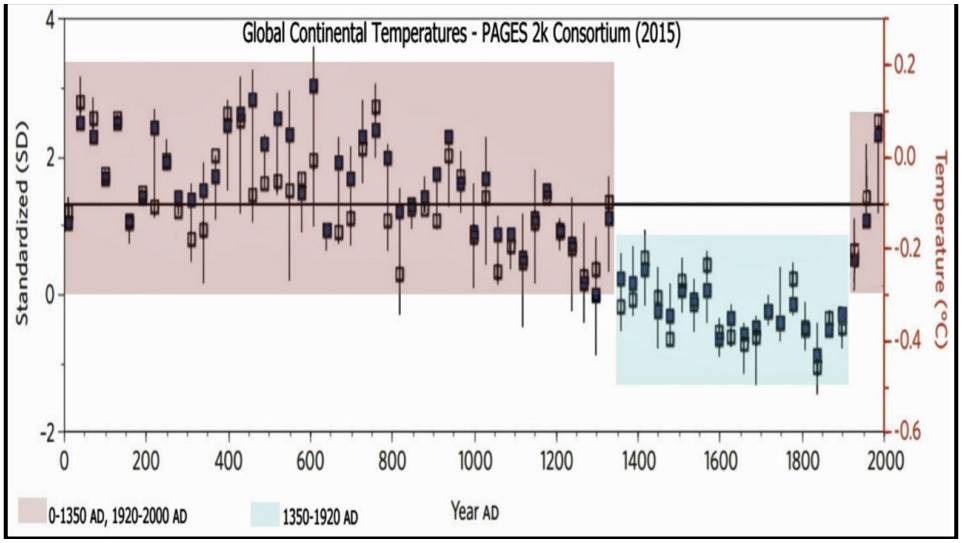

Figure 2 - Modified from Gosselin (2018)
Source data: Ahmed (2015)

In my subsequent communication with Dr. Kerr she added another study she indicated would support her contention of unusual and unprecedented warming over many thousands of years, stating "previous studies using proxy data to reconstruct global average surface T, such as Marcott, et al (2013), have reached similar conclusions." She apparently is completely unaware that it too had been found to be fatally flawed with even the author admitting that the modern data should not be relied on, after all it consisted of just one data point "The 20th century portion of our paleotemperature stack is not statistically robust, cannot be considered representative of global temperature changes." In fact, Australia's National Science Agency, CSIRO was asked for evidence of anything unprecedented in climate due to human carbon dioxide, and despite nearly 50 years of climate research, it could only provide the discredited Marcott (2013) paper on temperatures and the discredited Harries (2001) paper.

Astrophysicist and Geoscientist Professor Willie Soon was scathing in his assessment of CSIRO's use of Marcott (2013) by saying "Two weeks after publication this paper was completely destroyed and yet, someone as high up as CSIRO trying to say this paper is legitimate and can be used as a supporting scientific evidence, is scientific malpractice".

CF Claim #4: Future temperatures are likely to be >12 degrees Celsius (23 degrees Fahrenheit)

> *If current warming trends continue, then by mid-next century we will likely achieve temperatures not seen since the early Eocene, more than 50 million years ago (Burke et al., 2018). (Amber Kerr)*

Response 4a: Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, expert reviewer of the United Nations Intergovernmental Panel on Climate Change, author of Inconvenient Facts (credit Renee Hannon for input)

According to Amber Kerr, temperatures are "likely" to increase to those which were present during the Eocene, or at least 23 degrees Fahrenheit higher than our present temperatures. The temperature, based on HadCRUT4 has risen about 1 degree C since 1900. If that is the "current trend" and it continues, then we could expect about one degree C increase by 2150,

The Burke, 2018, article is guilty of the same comparison of Paleoclimate low-resolution "proxy" data to high-resolution instrumental temperature data. Their figure 1 and supplemental figure 1 is extremely misleading with no mention of data resolution on the y-temperature axis and even worse show a distorted non-uniform time x-axis.

For example, the Marcott data has a temperature resolution average over 300 years, Dome C over 370 years, and the marine benthic oxygen isotopes probably 500+ years. The benthic oxygen values are first converted to sea temperatures approximations and then to surface temperature approximations. In contrast, Instrumental data are direct measurements of temperature, not proxies, taken on a daily and monthly basis. For a more honest presentation, the instrumental temperature data should be averaged over 300+ years. Also, if they used a uniform time scale on the x-axis, the instrumental data and RCP projections would be a mere dot.

Importantly, Burke claims the figure referenced by Kerr is just an illustration and not the basis for quantitative climate similarity analysis. It's scary, unrealistic, and not a properly scaled figure.

Response 4b: Dr. William Happer - Dr. William Happer, Professor Emeritus in the Department of Physics at Princeton University. He is a specialist in modern optics, optical and radiofrequency spectroscopy of atoms and molecules, radiation propagation in the atmosphere, and spin-polarized atoms and nuclei. He has published over 200 peer-reviewed scientific papers and invented the sodium guidestar that is used in astronomical adaptive optics to correct for the degrading effects of atmospheric turbulence. He was awarded the Alexander von Humboldt Award in 1976, the 1997 Broida Prize and the 1999 Davisson-Germer Prize of the American Physical Society, and the Thomas Alva Edison Patent Award in 2000.

The IPCC claims an " equilibrium climate sensitivity," S, (the steady-state temperature increase from doubling CO_2) of somewhere between S= 2 C and S= 4.5 C. To good approximation, every doubling of CO_2 concentration increases the temperature by the same increment. The real sensitivity is probably less than S= 1 C but let us see what CO_2 increases would be needed to get 12 C of temperature increase, if we take the upper bound of the IPCC's range of sensitivities. The CO_2 concentration would have to increase from N0 = 410 ppm, today's approximate concentration, to N > N0 x 2^(12 C/ 4.5 C) = N0 x 6.35 = 2603 ppm. So, we would need to add 2600 - 410 = 2193 ppm of CO_2 to the atmosphere. There probably is not enough economically recoverable fossil fuel around to provide that much CO_2.

But suppose the fuel can be found. For the past decade concentrations of CO_2 have been increasing at about 2.3 ppm/year. At this rate, the time required to add 2193 ppm to the atmosphere would be 2193/2.3 years = 953 years. For smaller, more realistic sensitivities, much more fuel and much longer times would be needed. There is no scientifically plausible way for Earth's temperature to rise by 12 C by the middle of the next century.

CF Claim #5: Ecosystems and humanity are being harmed from increased temperature and rising CO2 levels

There is no science nor is there any data that globally support the assertion that ecosystems are thriving or that humanity would benefit from increasing temperature or increasing carbon dioxide. There are literally tens of thousands scientific publications that indicate that ecosystems are increasingly being degraded due to climate change and other impacts

Response 6a: Dr. Patrick Michaels - Past president of the American Association of State Climatologists. Research professor of Environmental Sciences at University of Virginia for 30 years and Senior Fellow at the CO2 Coalition. Michaels was a contributing author and is a reviewer of the United Nations Intergovernmental Panel on Climate Change

Climate Feedback contests Wrightstone's claims that "our planet's ecosystems are thriving, and that humanity is benefiting" from increases in CO_2 and temperature.

In fact, scientists have noted greening of terrestrial ecosystems for decades, and it has been profound, as shown by Zhu et al., (2016) in a Nature Climate Change paper titled "The Greening of the Earth [sic] and its Drivers". Central to the paper is a map of changes in Leaf Area Index over a nearly two-decade period (Figure 3):

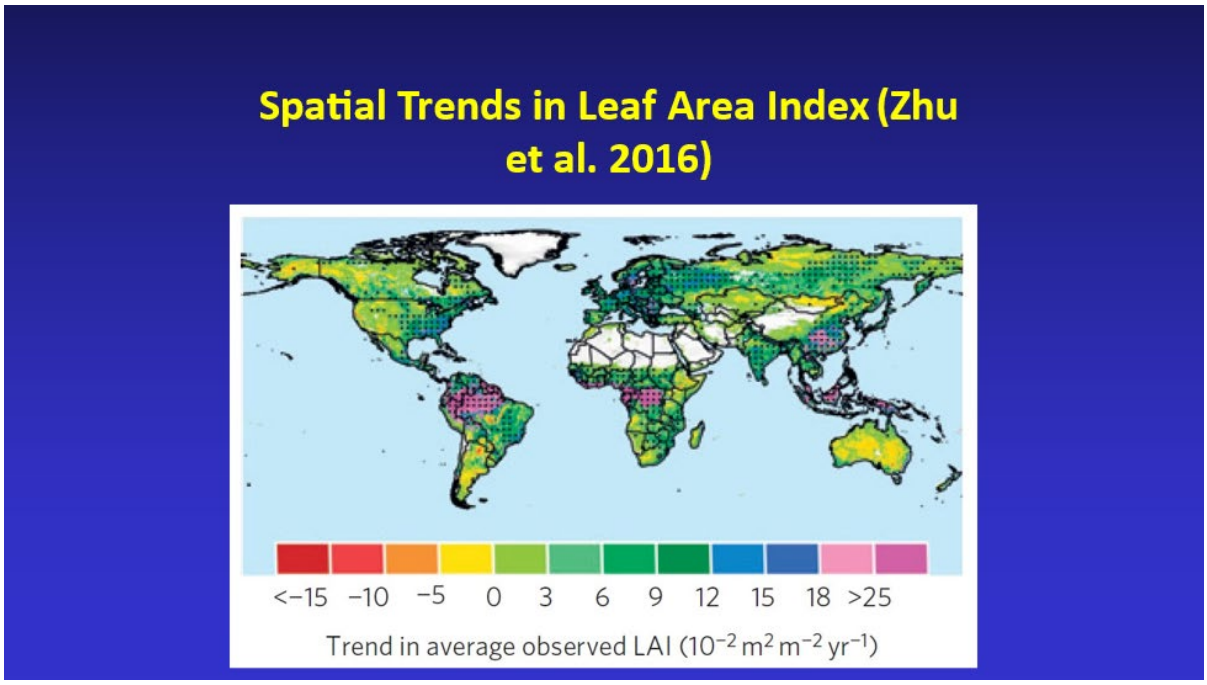

Figure 3 - Changes in Leaf Area Index beginning in 1982

Note the places with the greatest changes are in purple and correspond to the locations of the world's tropical rainforests. Changes are significant where stippled. Also, note the absence of statistically significant declines in LAI.

Zhu et al. (2016) also performed a factor analyses to isolate the causes of the planetary greening. They found 70% was caused by the direct effect of increasing atmospheric carbon dioxide, 9% from increased nitrogen deposition, 8% from climate change itself (largely in Northern Hemisphere high latitudes) and 4% from land use change.

So, it appears that Climate Feedback somehow missed that a total of 91% of global terrestrial greening is a result of human activity, or that the global food supply is clearly growing steadily and has been ever since Paul Ehrlich wrote over fifty years ago (1969: The Population Bomb) that food supplies were about to rapidly decline.

CF Claim #6 a) Warming and CO2 do not play primary roles in increasing crop production and b) future warming will have a negative effect on agriculture

Other plants do not profit from higher CO2, and their photosynthesis rates have been shown to decrease under higher CO2. More importantly, higher CO2 has been shown to reduce the nutritional quality of some plants we depend on, such as wheat (Katrin Meissner)

Increases in extreme weather events can have strong negative effects on crop productivity and are expected to negatively impact food production (Sara Vicca)

(G)lobal warming is already negatively impacting global food production, at least in some regions (*Alexis Berg)*

Wrightstone confuses correlation with causation when he discusses the fact that over the past century, global agricultural productivity has increased, and weather-related deaths have decreased. We cannot thank anthropogenic climate change for this. Rather, better infrastructure and better health care have reduced the number of people who die from environmental factors such as weather. Progress in crop science and technology (as well as unsustainable depletion of the biosphere) have enabled a steady upward trend in crop production, outweighing any marginal effects of CO2 and warming. (Amber Kerr)

It is ethically indefensible that Wrightstone celebrates potential gains for agriculture in the global North while ignoring the numerous studies that describe damages in the global South. (Amber Kerr)

Response 6a: Dr. William Happer - Dr. William Happer, Professor Emeritus in the Department of Physics at Princeton University. He is a specialist in modern optics, optical and radiofrequency spectroscopy of atoms and molecules, radiation propagation in the atmosphere, and spin-polarized atoms and nuclei. He has published over 200 peer-reviewed scientific papers and invented the sodium guidestar that is used in astronomical adaptive optics to correct for the degrading effects of atmospheric turbulence. He was awarded the Alexander von Humboldt Award in 1976, the 1997 Broida Prize and the 1999 Davisson-Germer Prize of the American Physical Society, and the Thomas Alva Edison Patent Award in 2000.

All the statements of Mr. Wrightstone's op-ed were based on very sound science. In contrast, the Climate Feedback review includes made-up, false assertions and personal attacks.

Scientific studies show clearly that CO_2 has been a significant contributor to the increased yields of agriculture and forestry over the past fifty years. The contributions have been particularly striking in arid regions because more CO_2 increases the drought resistance of crops. Long-term satellite measurements of plant cover show particularly pronounced greening in arid regions of the Earth, many in the tropics and subtropics.

The most reliable proof of the benefits of CO_2 to plants is the use of additional CO2 in commercial greenhouses to accelerate growth. Greenhouse operators are willing to accept the cost of added CO_2 and the necessary equipment for CO2 enrichment. The improved yield and quality of their plant products, from vegetables to marijuana, more than pays for the investment.

These statements confirm that what Mr. Wrightstone said is "not untrue = true." In the field, both C4 and C3 plants grow better with more CO_2 because more CO_2 makes plants more drought resistant. C3 plants also benefit because more CO_2 reduces photorespiration, which saps some 25% of photosynthetic efficiency. All forest trees and a major fraction of agricultural crops (wheat, rice, soybeans, cotton, etc,.) use the C3 photosynthetic pathway. With more atmospheric CO_2, C3 plants get a double benefit: more drought resistance and less photorespiration.

Response 6b: Dr. Patrick Michaels - Past president of the American Association of State Climatologists. Research professor of Environmental Sciences at University of Virginia for 30 years and Senior Fellow at the CO2 Coalition. Michaels was a contributing author and is a reviewer of the United Nations Intergovernmental Panel on Climate Change

Climate Feedback does not appreciate that the overestimation by climate modeling errors (discussed later in Section 12) are fatal for the reliability of virtually all ecosystems impact models (including agriculture). The vast majority of moisture that falls in the midlatitude growing regions (some of the most productive agricultural land on earth) originates in the tropics. Large and systematic errors in the tropical vertical precipitation forecasts for the future make them simply unreliable, as it is the tropical lapse rate that largely governs how much oceanic moisture is transferred into the larger global atmosphere. In fact, the sign of large precipitation changes can be positive or negative at the same location, depending upon the model.

Climate/crop models generally attempt to parameterize the effects of year-to-year weather fluctuations as inducing departures from smooth technological trends reflecting fertilizer use, varietal and mechanical improvements, etc…

Figure 4, calculated from global FAO data for the four major crops, shows 1) at this level, the global food system is highly buffered from overall weather effects, and 2) there's absolutely no evidence that the residuals from the technological trend are increasing (i.e. the weather component is not becoming larger).

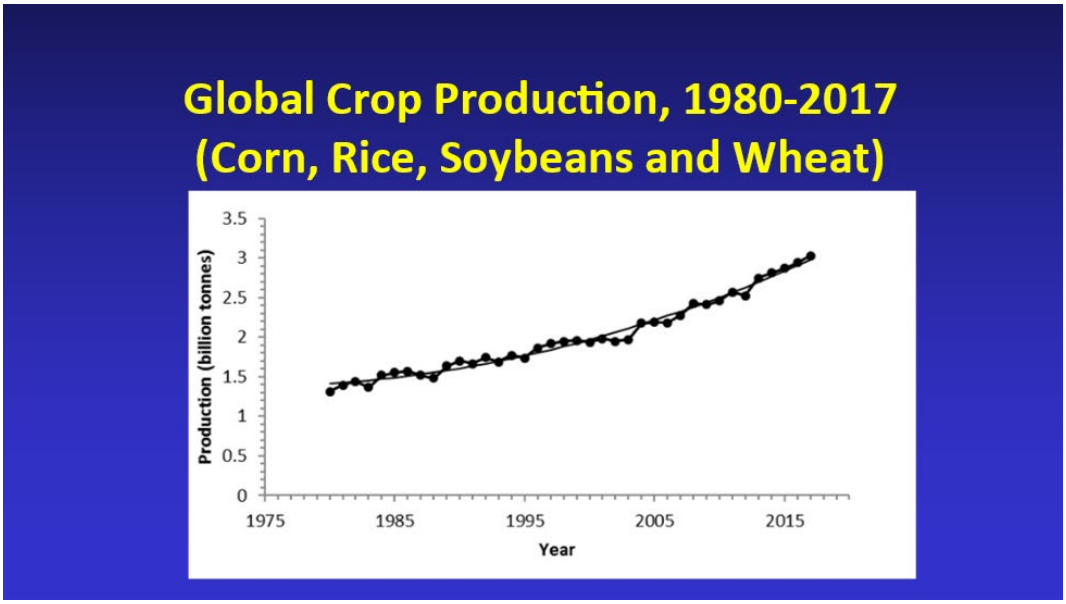

Figure 4 - Total production for the four major crops. The simple second-order fit explains over 99% of the year-to-year variability, leaving little room (about 1%, globally)

for a stochastic or systematic weather or climate effect. Raw data from the FAO, United Nations.

Response 6c: Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, Expert Reviewer for the IPCC, author of Inconvenient Facts

In a follow-up email exchange with me, Dr. Kerr admitted to the huge positive impact that increasing CO_2 is having on crop growth:

> *"In my own subfield, climate change impacts on agriculture, I find it irksome that most models and published studies intentionally omit the CO2 fertilization effect (citing too much uncertainty, or assuming there will be acclimation to higher CO2). But so far, data suggest that the CO2 fertilization effect can be a significant boon to agriculture in temperate regions."*

In the peer-reviewed literature, there is little support for the frequently cited notion that tropical and sub-tropical areas are currently experiencing a decline in agricultural productivity. The CF reviewers appear to be basing a projected decline in crop productivity in the tropics and low latitude regions to climate models and worst-case scenarios that significantly over-predict warming as discussed by Dr. Happer in Section 4b and by Dr. Michaels in Section 12.

Contrary to the claim of crop endangerment from rising temperature and increasing CO_2, there are hundreds of studies that document just the opposite. Many of these are captured by Dr. Craig Idso here: Interactive Effects of CO2 and Temperature on Plant Growth. These peer-reviewed papers show the following important considerations:

1) crops tend do better at higher temperatures thanks to CO_2, which raises the optimum temperature for photosynthesis (often by a much larger value than that predicted by the models for warming),

2) CO_2 helps ameliorate temperature-related stress.

Real-world data contradict the idea of heat-related crop declines in the Earth's hottest regions. For example, in India, 2020 was expected to break all-time records for wheat harvested for the second year in a row.

In the United States, increasing yields of corn in bushels per acre show a remarkable correlation to increasing CO_2 emissions (Figure 6). To argue that this increase is due to improvement year-after-year in agricultural practice is just not believable.

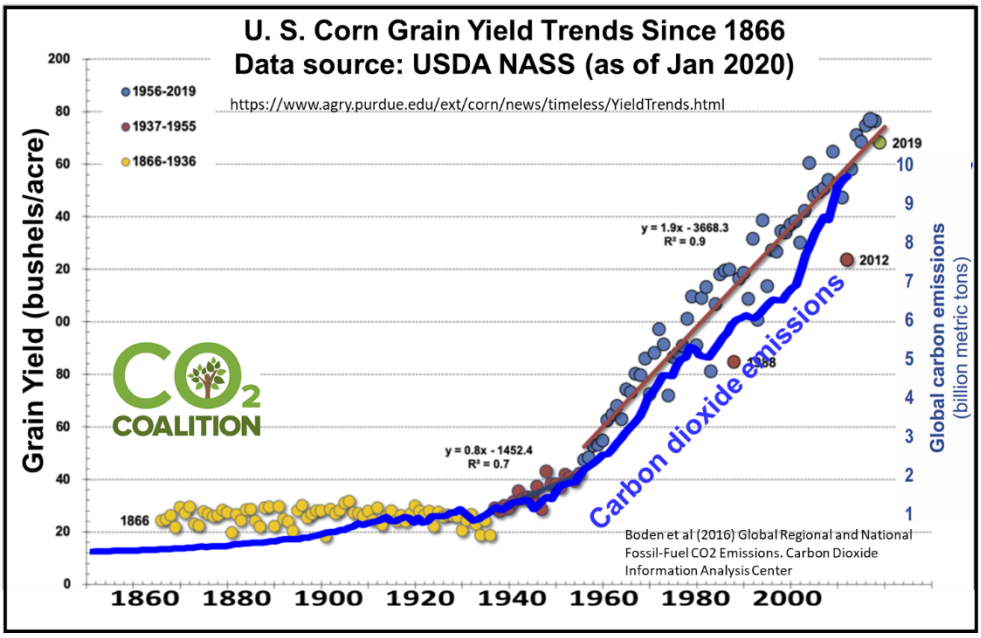

Figure 5 – U. S. corn yield trends vs. global carbon emissions

CF Claim #7: Extreme weather and related deaths are increasing

Unfortunately, droughts, forest fires and heat waves are increasing world-wide, and so do temperature-related deaths. The statements made here are invented by the author and entirely "at odds with reality". (Wolfgang Cramer)

Droughts and aridification have increased in many regions of the world. For example, in Europe and North America. Forest fires have increased and now show the fingerprint of global warming, e.g. in Australia and the Arctic. Heat waves have increased in frequency, intensity and duration. (Katrin Meissner)

Response 7a: Jim Steele - Biologist, formerly Principal Investigator for the Neotropical Migratory Bird Monitoring of Riparian Habitats on the Tahoe National Forest (USFS) and Director of SFSU's Sierra Nevada Field Campus, Author of Landscapes and Cycles: An Environmentalist's Journey to Climate Skepticism

Despite accurately asserting droughts, forest fires, and heat waves have declined substantially despite rising CO_2 concentrations as the earth has grown greener, Wrightstone is slandered by "fact-checker" Wolfgang Cramer who falsely suggests his statements were "invented" and "entirely at odds with reality". However, peer reviewed science supports Wrightstone, not the fact checkers. In 2013 climate scientists published *Monitoring and Understanding Changes in Heat Waves, Cold Waves, Floods and Droughts in the United States, State of Knowledge*.[1] They reported, "Instrumental data indicate that the Dust Bowl of the 1930s and the 1950s' drought were the most widespread twentieth-century droughts in the United States (see Fig. 1), while tree ring data indicate that the mega-droughts over the *twelfth century* exceeded anything in the twentieth century in both spatial extent and duration". Stahl (2007)[2] similarly reported that relative to the 1930s' and 1950s' extremes, multi-decadal droughts during the cooler Little Ice Age were more severe and longer lasting "including the 16th century "mega-drought" which may have been the most extreme drought to impact North America in the last 500 years."

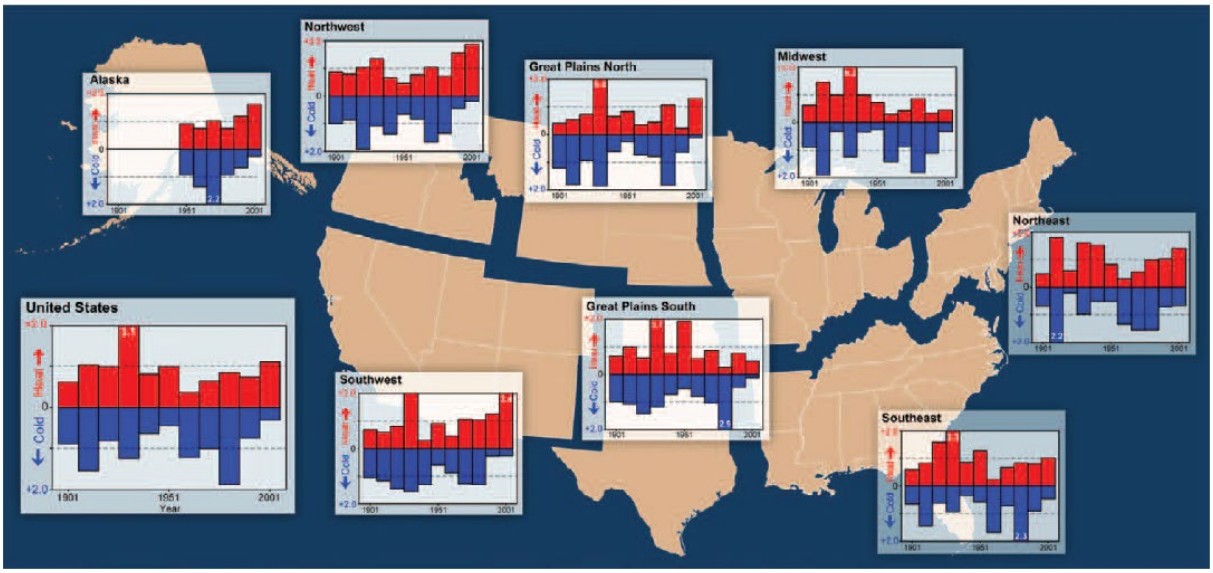

FIG. 1. Time series of decadal-average values of heat wave (red bars) and cold wave (blue bars) indices. These

Figure 6 – Decadal average of heat waves and cold waves

In addition to his factual reporting of the satellite-observed greening of the earth that has been attributed to increased CO_2 (70%) and warming (8%), the main thrust of Wrightstone's article points out there's a wealth of scientific data revealing "droughts, fires and heat waves" are driven by other climate factors unrelated to rising CO_2. The so-called fact checkers failed to acknowledge how long-term climate dynamics clearly altered the frequency, intensity and locations of droughts, fires and heatwaves. In order to attribute blame to CO_2-driven warming, they referred to published studies that only examined drought, heatwaves and wildfire trends over the past 50 years. A timeframe far too short for a meaningful climate analysis.

For example, Sinha (2017) provides evidence that India's periodic droughts lessened as the world ascended from centuries of the Little Ice Age. Between 1350 and 1850 AD when CO_2 concentrations were very low, at least five episodes of mega-droughts devastated southeast Asia. Droughts in 1899 and 1918 affected about 70% of India, as the earth warmed further only 53% of the country experienced drought by 1972, 48% by 1987 and just 20% by 2002. Such benefits of a warmer world only become obvious on this larger time scale. During the last Ice Age, the Sahara Desert was more expansive than today. As the world began warming 14,000 years ago, the Sahara's desert sands became covered with grasslands, extensive year-round shallow lakes, and a rich diversity of wildlife and human inhabitants. Simultaneously Africa's increased precipitation brought snow to the top of Mt Kilimanjaro, causing its glaciers to grow. This period is known as the Green Sahara or the African Humid Period. When the world then began to cool 5000 years ago, northern Africa experienced severe droughts as northern Africa again reverted back to the Sahara Desert.

The changes in the Sahara are attributed to a shift in the global band of intense tropical rains identified by the Intertropical Convergence Zone (ITCZ). As Ice Age glaciers retreat from the northern hemisphere, the ITCZ moved northward, providing enough rainfall north of the ITCZ to generate the Sahara's grasslands. When orbital cycles altered insolation and began cooling the

north, the ITCZ moved southward again which reduced Sahara rainfall. Similarly, the ITCZ moved south during the Little Ice Age when solar output fell during sunspot minimums. Felis (2018) determined that the eastern Sahara-Arabian desert became more arid than today from ~1750–1850, concurrent with India's cold-induced mega-droughts.

The southward movement of the ITCZ also alters global atmospheric circulation. The ocean's subtropical pressure systems which now inhibit the flow of moisture from the ocean to the land and create the Mediterranean climates, also moved southwards during the last Ice Age and the LIA. That allowed more moisture to transfer from the Pacific Ocean to inundate western North America. Much of America's current deserts became covered by inland seas; Lake Bonneville covered much of Utah while Nevada was largely covered by Lake Lahontan. As the glaciers melted and the ITCZ and pressure systems moved northward, rains were diverted and the American west dried out. All that remains of Lake Bonneville is the Great Salt Lake. Similarly during the Little Ice Age, when the ITCZ moved southward for a few centuries, water levels in the Great Salt Lake rose[6] to relative highs in 1600[7].

In Europe the more southern ITCZ location, likewise, removed the blocking effects of the North Atlantic Oscillation, allowing more rains to reach the Alps, causing its greatest glacial advances in 6,000 years. Vincent (2005)[7] reported glaciers advanced as periods of higher winter precipitation were 25% higher than the twentieth century average. The Little Ice Age Paradox was so named because European glaciers retreated despite cold LIA temperatures. However, as the ITCZ moved northward rains were blocked causing glaciers to retreat.

Fact checker Katrin Meissner denigrated Wrightstone's article as an "aggregation of false statements" with a "few partially right statements, taken out of context and presented in a misleading way." However, it was Professor Meissner who engaged in "misleading statements" suggesting rising CO_2 was causing droughts and aridification to increase in many regions such as Europe and North America. She referenced Buntgen (Fig 4) who indeed reported greater aridity in Europe, but that research also showed the drying trend had been ongoing for 2,000 years, unrelated to CO_2 concentrations. One extreme 300-year drying period culminated in Europe's Renaissance Drought, followed by the wet period during the LIA with growing glaciers, and now the drying out period of modern times as the ITCZ moves northward from its LIA location.

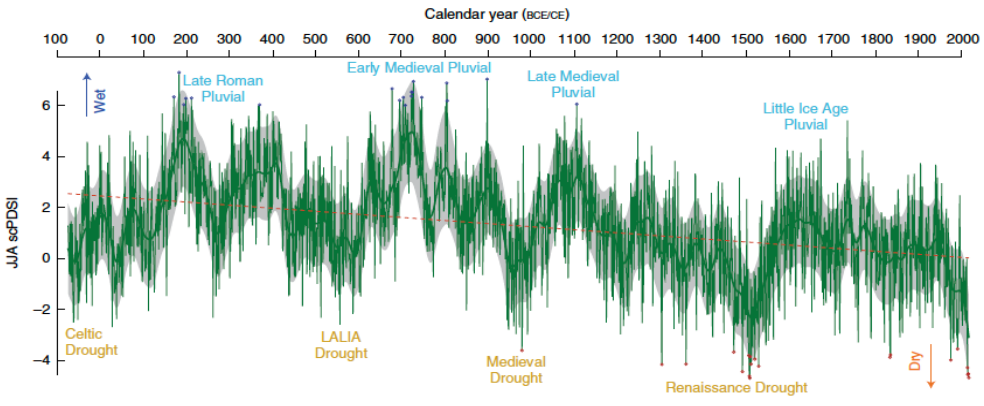

Fig. 4 | Reconstructed central European summer variability over the past 2,110 years. Reconstructed JJA scPDSI from 75 BCE to 2018 CE (Supplementary

Figure 7 – 2,100 years of reconstructed central Europe wet vs. dry

Meissner also failed to account for the ITCZ's role in drying out western North America as the Little Ice Age (LIA) ended around 1850, and failed to mention the effects of the EL Nino Southern Oscillation (ENSO) or the related Pacific Decadal Oscillation. As Pederson (2005) documented, the western United States experienced three heavy wet periods during the Little Ice Age (LIA). Similar to the LIA events in Europe, the accompanying heavy rains drove glaciers in Montana's Glacier National Park (GNP) to their greatest extent in at least 6,000 years. As the LIA ended and the ITCZ and the high-pressure system moved northward, GNP experienced a series of droughts. Between 1901 and 1960 GNP's largest glaciers had lost 65% of their LIA ice.

El Nino, La Ninas and the Pacific Decadal Oscillation also affect global droughts. Some of the most devastating droughts in India and SE Asia occur in association with extreme El Niño events as the focus of heavy rains moves eastward across the Pacific. El Nino brings more rain to Peru and the southern half of western North America. Conversely, La Nina episodes locates more rains over SE Asia but bring stronger drought to the American southwest. During the negative phase of Pacific Decadal Oscillation, not only are La Nina events more common but the associated droughts are more intense. When the negative PDO phase coincides with La Nina, the Southwest and southern Rockies including Arizona, Nevada, Utah, Colorado, and Wyoming experience greater drought and worse wildfires. Between 1700 and 1975, 69% of the largest fires (Schoennagel (2005) in Rocky Mountain National Park occurred when a La Nina coincided with a negative PDO, although those phases coincided only 29% of time.[12]

Even though Harvard fact checker Alice Berg acknowledged the global area burnt from wildfires had decreased by 25% over the last 20 years, Cramer and Meissner falsely insisted climate change was increasing wildfires pointing to the western USA. In reality, identifying an increase in wildfires requires cherry picking a trend that starts in 1970 (Westerling 2008). Fire experts reported "a decline in wildfire in the Southwest, due to the region-wide onset of intensive livestock grazing beginning in the late 1800s followed by the beginning of organized fire suppression" In a comprehensive assessment of the acres burnt in the contiguous United States, the US Forest Service reported, (Keane 2002) "3 to 6 times more area must be burned to *restore* historical fire regimes"

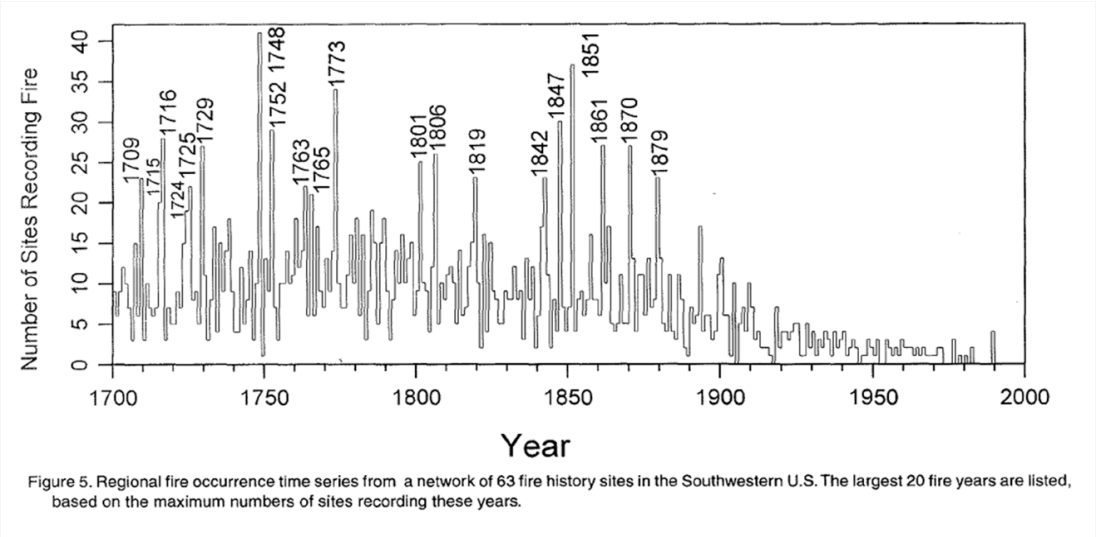

Figure 5. Regional fire occurrence time series from a network of 63 fire history sites in the Southwestern U.S. The largest 20 fire years are listed, based on the maximum numbers of sites recording these years.

Figure 8 – Regional fire occurrence over 300 years

Berg countered the decrease in observed area burnt by wildfires by arguing warming would cause more fires, but agricultural expansion restricted how much land can burn, so expect more fire in the future. Yet Berg herself misleadingly omitted all the critical factors that have been documented to increase wildfires. Fuel loads have built up due to fire suppression causing bigger fires. As populations increase, fire ignitions are increasingly caused by humans and ignitions occur all year instead of being limited to the season of natural lightning. According to Balch (2017)[13], between 1992 to 2012 human ignitions account for 84% of all wildfires and 44% of the total area burned. In addition, disturbance of natural landscapes has caused the spread of invasive cheat grasses. These grasses die in early summer and require just 1 hour of warm dry temperatures to become highly flammable. Warm dry summers happen whether or not there is global warming. Larger wood requires kindling to provide enough heat to burn, and the spread of invasive grasses supplies that.

Sagebrush habitat dominates the American west and rarely burned due to the lack of ground fuel, perhaps burning once every 60-100 years. But introduced cheat grass dominates sagebrush habitat which now burns every 3-5 years. The 2012 Rush Fire was California's 4th largest fire since 1932, burning 272,000 acres of sagebrush habitat in northeastern California. It then continued to spread burning an additional 43,000 acres in Nevada. The 2018 Carr Fire was California's 7th largest fire and threatened the town of Redding, California. It started when a towed trailer blew a tire causing its wheel rim to scrape the asphalt. The resulting sparks were enough to ignite roadside grasses. Grassfires then carried the flames into the shrub lands and forests, as burning grasses served as kindling to ignite less-flammable trees.

Those who are wedded to the idea of a CO_2 caused catastrophe cherry pick the fires in California to attribute those fires to CO_2 caused global warming. In addition to the other causes of California fires, local maximum temperatures where fires got started, have not exceeded the warmth of the 1930s. So, one must ask who is fact checking the so-called fact-checkers. As Mr. Wrightstone accurately reported, the changes in droughts, fires, and heat waves do not correlate with rising CO_2, but are more accurately attributed to other factors.

Response 6b: Dr. Patrick Michaels - Past president of the American Association of State Climatologists. Research professor of Environmental Sciences at University of Virginia for 30 years and Senior Fellow at the CO2 Coalition. Michaels was a contributing author and is a reviewer of the United Nations Intergovernmental Panel on Climate Change

From the extensive media coverage of extreme weather, one would think that drought and tropical cyclone activity must be going up. But the most recent comprehensive report of the IPCC says this about drought:

> In summary, the current assessment concludes that there is not enough evidence at present to suggest more than low confidence in a global scale observed trend in drought or dryness (lack of rainfall) since the middle of the 20th century due to lack of direct observations, geographical inconsistencies in the trends, and dependencies of inferred trends on the index choice.

And here is a plot of the Accumulated [tropical] Cyclone Energy index since the beginning of global satellite coverage:

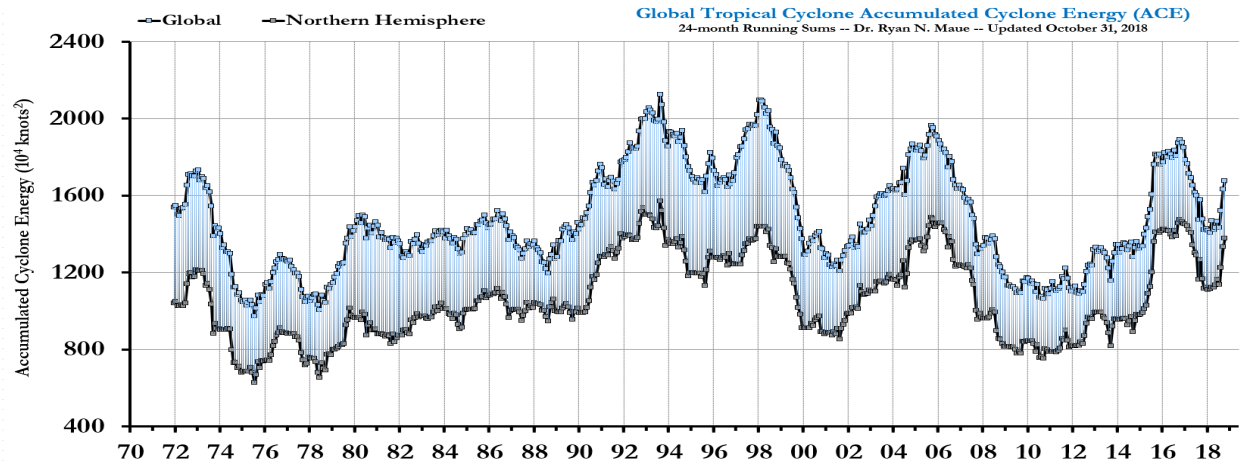

Figure 9 – Accumulated [tropical] cyclone energy. From Maue, 2011 and updates

It would be easy, but boring, to go on and on about Climate Feedback. In general, after adjusting for population and property values there's actually a slight negative trend in weather-related damages. It strains credulity to believe that a 1°C change in global average surface air temperature would nullify and reverse centuries of economic development, alleviation of poverty, and increasing life expectancy, given that *Homo sapiens* lives and prospers when adequately protected in temperatures from -40°C to +50°. That one degree is less than the difference in mean annual temperature accomplished by moving approximately 50 miles south in the mid-latitudes, and we all know *that's* fatal.

CF Claim #8: Coral reefs are negatively affected by man-made warming

current warming levels already have very noticeable negative impacts on marine ecosystems (i.e., coral reefs) (Alexis Berg)

Heat waves are becoming more frequent and more severe in many parts of the world. They even occur in the ocean and are one of the key drivers for the loss of tropical coral reefs. (*Wolfgang Cramer)*

Response 11: Dr. Peter Ridd – Physicist, PhD from James Cook University, formerly head of the Physics department at James Cook University from 2009 to 2016, and head of the Marine Geophysical Laboratory at that institution for 15 years.

Those of us in North Queensland Australia, who live right next to the Great Barrier Reef, find it incredible that the world has been convinced that the Reef is on its last legs. Nothing could be further from the truth. It is spectacular, and one of the most pristine ecosystems on earth. Once the COVID restrictions ease, come and see for yourself.

Below, I have summarized bullet points of the primary facts disputing the idea of the declining health of corals and reefs.

(1) Corals like it hot. The region with the most diverse and fastest growing corals on earth, called the "Coral Triangle", is around Indonesia and Papua New Guinea, which is also the hottest major water mass on earth - the Indo-Pacific warm pool.

(2) For every degree (Celsius) temperature increase, corals grow about 20% faster. Corals in the coldest parts of Australia's Great Barrier Reef (GBR) grow at about half the rate of the same species of coral in the Coral Triangle. (Lough 2000)

(3) Corals experience temperature variations often up to 10 degrees over a year, which is large compared to the modest increase in water temperature over the last century of, at most, one 1 degree Celsius (1.5 F) in tropical waters. It is implausible that all the corals on earth live in water so close to their thermal maximum that this small increase in temperature is causing mass coral death, as reported in the media.

(4) Coral bleaching events, where coral turns white during hot weather, which have been reported *ad nauseum* in the media, are entirely natural events that have always occurred. They are not a new phenomenon as is often reported. What has changed is the technology to monitor them, and the explosion in the number of scientists interested in reefs. These did not exist a few decades ago. (Hao et al 2021, Oliver et al 2018, Yonge et al 1931)

(5) Bleaching is not a death sentence; most corals fully recover. (Marshall 2006, Australian Inst. Of Marine Sciences)

(6) Unlike most other organisms, corals have a remarkable adaptation that makes them more able to deal with changing climates, natural or man-made, than other organisms. Inside the coral, which is an animal, lives a type of algae called zooxanthellae. The algae give the coral energy in return for a cosy environment. There are many different species of algae, and the coral can select the species that allow it to best cope with the required temperature. In fact, coral bleaching is part of the process that coral does this. When a coral bleaches, it expels the algae (turning white) and will likely take from the surrounding water a different species of algae.

Whereas most organisms need to go through many generations of evolution to change their genetic makeup to be suited for a different temperature, corals can do it in a few months by changing the algae that lives inside them. Rather than being the poster child for representing the impact of climate change, corals are among the best adapted organisms to deal with changing temperature. This should not be surprising. They have lived over hundreds of millions of years when the climate has been much hotter, and colder, than present. They have come through changes in climate that were far more dramatic than the gentle temperature changes we have seen over the last century (Baker 2003, Buddemeier 1993, Marshall and Baird 2000, Guest et al 2012).

(7) Corals need this mechanism because of the way they reproduce. They produce larvae which drifts in the current. And unlike seeds from trees which fall close to the parent and therefore in the same climate, coral spawn may drift many hundreds of miles where the water temperature is different.

(8) Corals reefs, especially Australia's Great Barrier Reef, go through natural cycles of destruction where huge amounts of coral occasionally die. Hurricanes are by far the most important cause. For example, a hurricane in 2009 killed half the coral on the southern Great Barrier Reef – an area the size of Maine. But by 2016, the coral had fully recovered. It always has, and it still does. The events are like bushfires. They look terrible. And the media, and some opportunistic scientific organizations, can use graphic images of dead coral

for nefarious purposes. What is almost never reported is the way the coral grows back strongly (De'ath et al 2012).

CF Claim #9: Climate change will have a negative economic effect

An IPCC special report also states, "Economic losses from weather- and climate-related disasters have increased (Summary)

(T)he societal consequences of these changes (economy, health, etc.) will be disastrous for a large part of the world's human population in the near future. (*Wolfgang Cramer)*

Economic losses from weather- and climate-related disasters have increased. (IPCC)

Response 11: Dr. Patrick Michaels - Past president of the American Association of State Climatologists. Research professor of Environmental Sciences at University of Virginia for 30 years and Senior Fellow at the CO2 Coalition. Michaels was a contributing author and is a reviewer of the United Nations Intergovernmental Panel on Climate Change

Climate Feedback quotes a recent report from the United Nations' Intergovernmental Panel on Climate Change (IPCC) that states, "Economic losses from weather- and climate-related disasters have increased."

Here the IPCC is only trivially correct. Yes, weather-related losses must go up because there are more people with more stuff experiencing the same weather. A more clear-eyed analysis would look at global weather-related damages as a percent of global GDP, as in Figure 2.

Roger Pielke, Jr., in a 2018 publication in the refereed journal Environmental Hazards, used insurance industry data from Munich Re and United Nations GDP data, and found a slightly negative trend in damages over time.

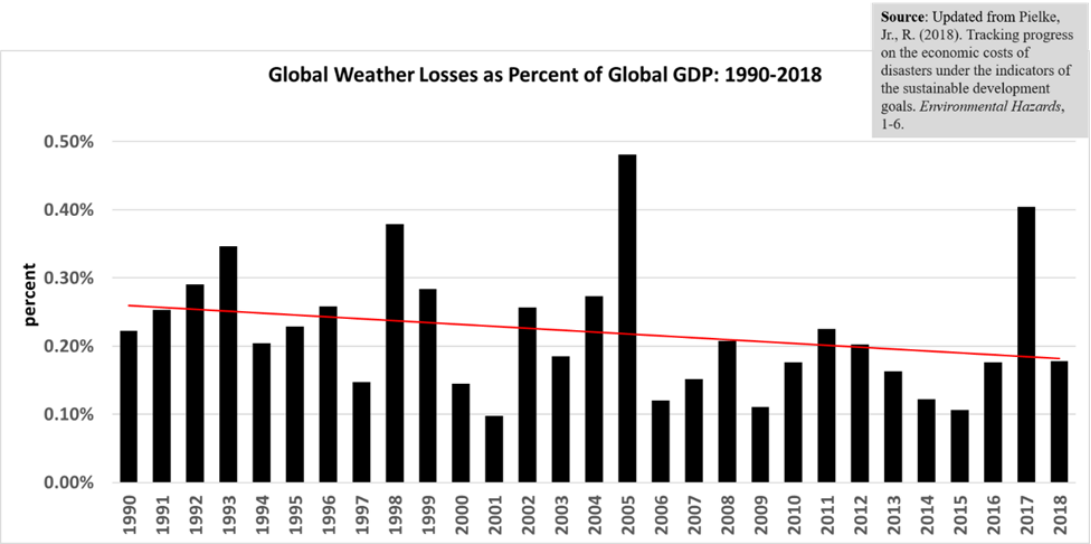

Figure 10 – Global Weather-related Losses as Percent of Global GDP through 2018. Source: Pielke, Jr., 2018 update of 2017 paper in Environmental Research.

Does the observed slight decline in relative damages mean that the social cost of carbon dioxide emissions could be negative (i.e. a benefit)? There is a certain logic. In the developed world, life expectancy has nearly doubled since 1900, and, in the U.S., per-capita net worth has increased more than elevenfold. Could this be a part of a globally positive effect?

Dayaratna et al. (2020) examined the behavior of the "social cost of carbon" (SCC) adjusting its agricultural terms to reflect recent research on growth enhancements. While yields may be enhanced by as much as 25% in most of these models, Munier et al (2018) found much larger increases in both natural and agricultural ecosystems. He segregated satellite data over six different vegetation types around the globe.

The most common ones in Munier et al. (2018) are collectively referred to as grasslands, land largely used to provide standing crops for livestock. He found the leaf area increasing at a remarkable 5 percent per year, over a 17-year period, which gave a net increase of 85 percent. This no doubt creates a remarkable increase in the amount of harvestable high-quality animal protein.

Dayaratna et al. also followed 2003 Office of Management and Budget guidelines for regulatory calculations, using discount rates ranging upwards of 3% (OMB recommends using values as high as 7%). They also used temperature scenarios consistent with the low-sensitivity climate simulations, described below, that provide the most accurate simulations of observed tropical tropospheric temperatures since the beginning of the global satellite-sensed temperature records in 1979.

Under these assumptions, under every different discount rate, Dayaratna et al. found the SCC to be slightly negative. Again, this shouldn't be surprising given the relative prosperity and high quality of life in developed countries that rely heavily upon carbon-based fuels.

CF Claim #10: Climate Feedback reviewers rely on unlikely and worst-case climate models to predict future calamities

Response 12: Dr. Patrick Michaels - Past president of the American Association of State Climatologists. Research professor of Environmental Sciences at University of Virginia for 30 years and Senior Fellow at the CO2 Coalition. Michaels was a contributing author and is a reviewer of the United Nations Intergovernmental Panel on Climate Change

Indeed, the earth's surface temperature has risen; about 0.9ºC since 1900. Surface thermometers show two distinct periods of warming, as shown in the history from the Climate Research Unit (CRU) at the University of East Anglia, a long-standing record that has been in the peer-reviewed literature for literally decades and is constantly improved.

The two periods of warming, roughly 1910-45, and then 1976-98 are statistically indistinguishable in their slopes, but the first one likely has only a very small component from increased carbon dioxide. A ball-park calculation follows:

Ice core data from Law Dome show the surface concentration was only around 298 ppm when the first warming began, which gives a CO_2 forcing of +0.35 w/m^2 over the background, based upon the standard formula (dRF= 5.35ln(298/279)). Note that this is a very liberal calculation because the concentration at the beginning of the CRU record is closer to 285ppm.

Stevens (2015), citing Carslaw et al. (2013) gives a sulfate forcing of -0.3 watts/m^2, resulting in a near-zero net combined forcing. Tuning the models to somehow account for this warming with such a small radiation change as would be the case in 1910 implies an enormous sensitivity. If that were actually true, current temperatures would be so high that there would be little policy debate.

The rise from the mid-19th century (when the record begins) is again only from roughly 285 parts per million (ppm) to 298. For comparison it is around 417ppm now.

Satellite-sensed temperatures from the NOAA microwave sounding units (MSU) represent a truly global record (with a only very small blank spot over each pole). Unfortunately, there have been controversial revisions of surface records that mitigated a much-discussed "pause" or "hiatus" in warming from roughly 1998 through 2012. But it is very apparent in the MSU satellite data.

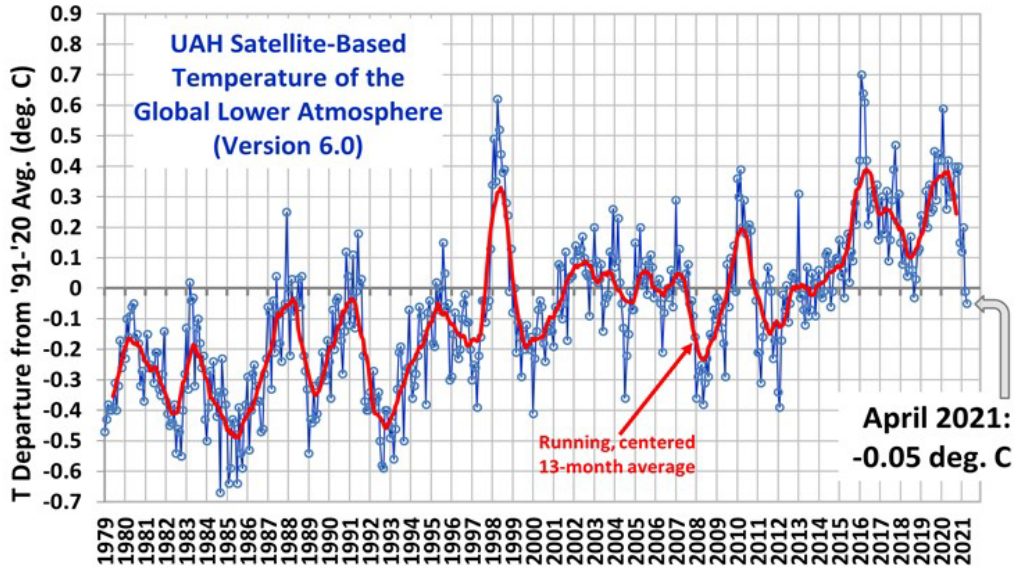

Figure 11 – The most recent iteration of the MSU temperatures. These are roughly in the 850-300mb layer. Source: https://www.drroyspencer.com/2021/05/uah-global-temperature-update-for-april-2021-0-05-deg-c/

Note that in the in the post-1998 period there really is only one significant period of warming, from 2012 to 2016.

The satellite data underscore the fact that most climate models, as shown in our next figure, tend to predict quasi-linear warmings, owing in part to the fact that the temperature response to a given increment of carbon dioxide is logarithmic, while the increase in CO_2 is a low-order exponent. The summation of the two indeed can be linear. The slope of the entire satellite record has been very constant at around 0.13 to 0.14°/decade averaged over the entire 42-year record, which is slightly less than half of the warming rate predicted by the models for recent decades.

The actual warming attributable to carbon dioxide is given by the United Nations' Intergovernmental Panel on Climate Change (IPCC) in its last (2013) comprehensive report is a vague "more than half" of the change since 1950. This would vary from approximately 0.3 to 0.6°C, based upon the CRU history.

It is important to note that all quantitative projections of warming—including those of the IPCC, the various US "National Assessments" of climate change impacts on the country, and indeed even the EPA's 2009 "Endangerment Finding" (which is still the document of record) are all based upon complicated General Circulation Models (GCMs) or even more complicated Earth System Models (ESMs).

With one exception these models are predicting far too much warming in a climatically critical region of the atmosphere, the tropical troposphere.

The following figure is a detailed version of Figure 1 in Christy and McNider (2017), showing GCM and ESMs from the CMIP-5 model collection that was featured in the last IPCC report, in comparison to tropical temperatures measured by weather balloons, satellites and global reanalysis. The failure of the models is, with one exception, starkly obvious, and the similarity of the balloon, satellite and reanalysis data is a reassuring indication that the CMIP-5 models simply got it wrong.

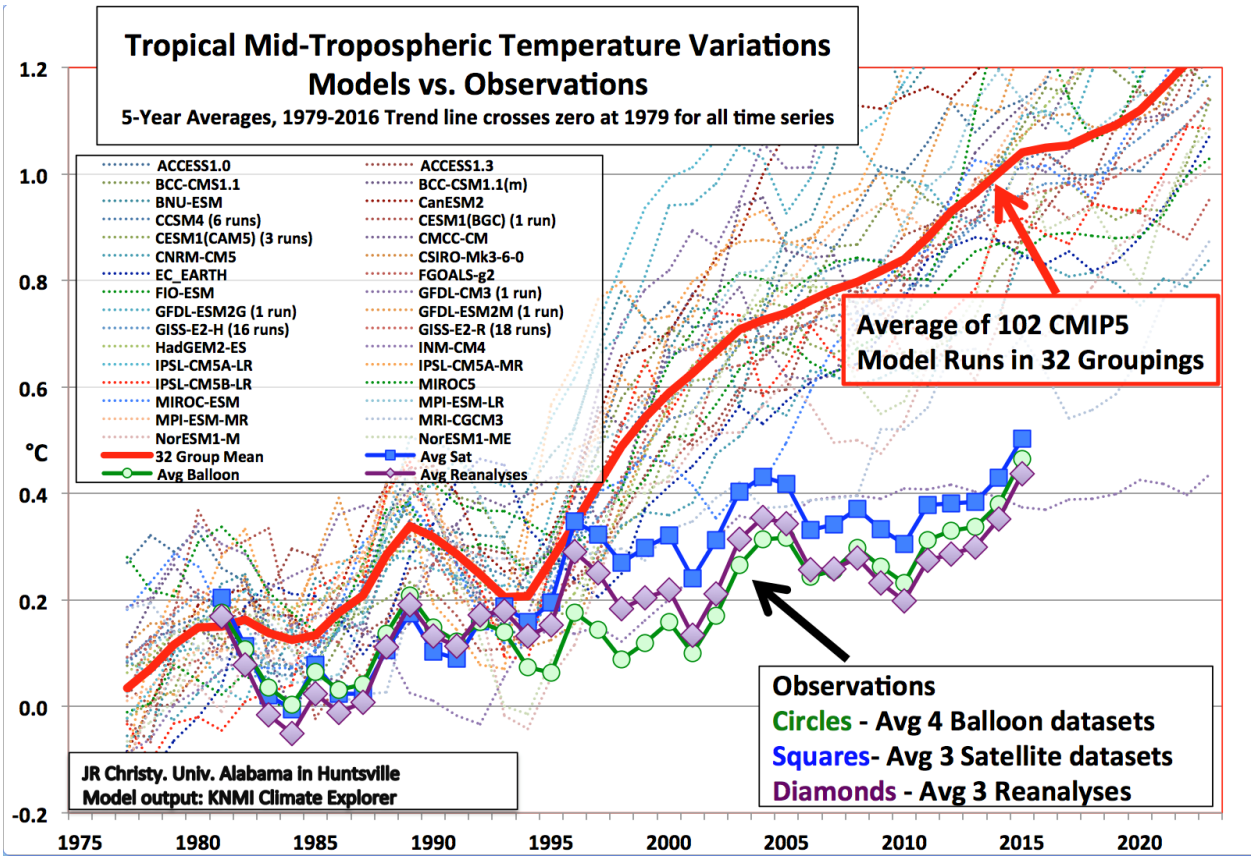

Figure 12 – Predictions vs. reality

The one model that works is the Russian INM-CM4, which also has the least prospective warming of all of them, with an equilibrium climate sensitivity (ECS) of 2.05°C, compared to the CMIP-5 average of 3.4°C

If the National Assessments or the IPCC followed best scientific practice (which is what operational meteorologists do every day!), they would emphasize this working model and eschew the broader, obviously incorrect, community of others.

A closer inspection of the predicted and observed warming trends in the vertical is from Figure 2 in Christy and McNider (2017):

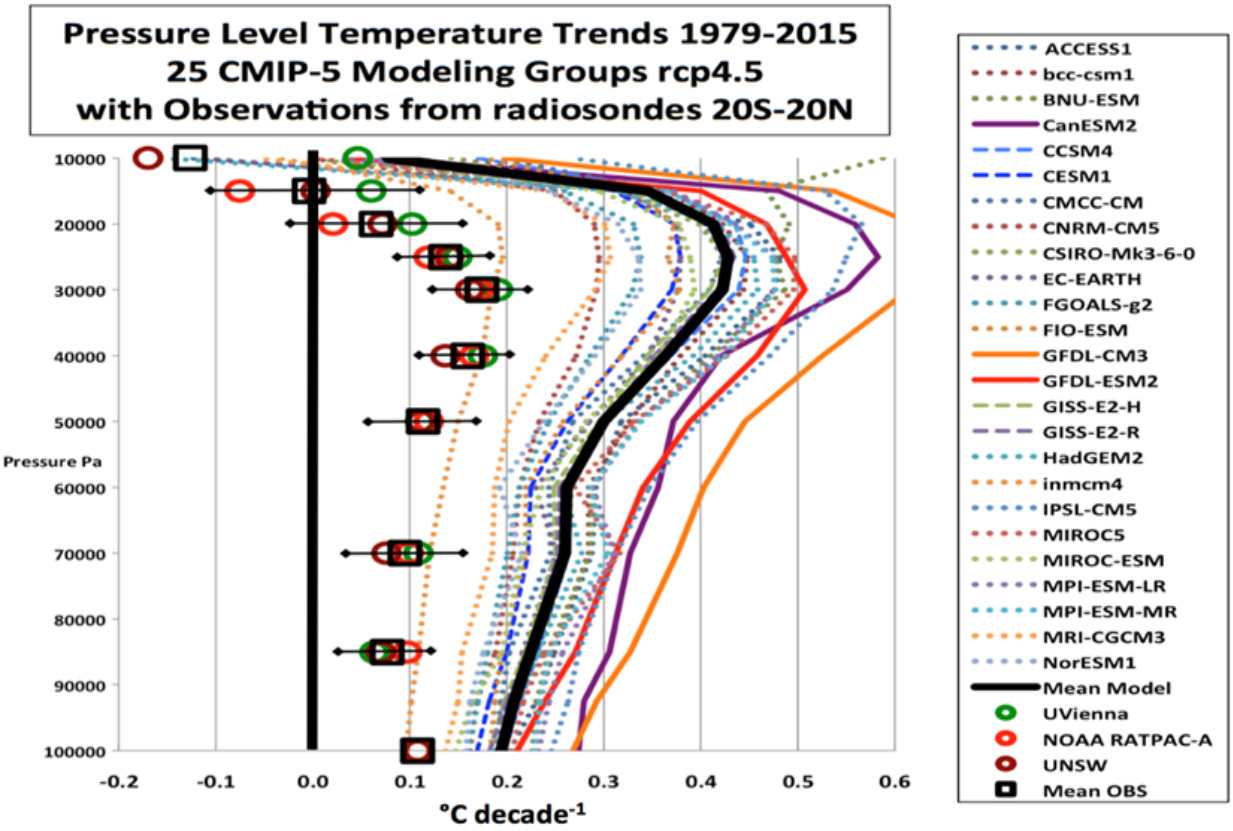

Figure 13 – Thick black line: Average warming trends per decade. Thin colored lines: Average warming trends for each model. Colored geometric figures: Observations. The vertical axis is height as measured by atmospheric pressure. The maximum error is around 200mb ("20000" on the graph). The average predicted warming rate at this level is a remarkable six times what is being observed. CMIP-5 model family.

Since this work was done, we have begun to see the next (CMIP-6) series of models. As shown by McKitrick and Christy (2020), they are even worse. And the one of two that works, the Russian INM-CM4.8, has even less warming than its predecessor, with an ECS of 1.8°C, compared to the CMIP-6 community value of around four degrees.[1] (The other one is also a very low ECS model from the same, group, INM-CM5.)

Quoting from their conclusion:

> The literature drawing attention to an upward bias in climate model warming responses in the tropical troposphere extends back at least15 years now (Karl et al., 2006). Rather than being resolved, the problem has become worse, since now every member of the CMIP6 generation of climate models exhibits an upward bias in the entire global troposphere as well as in the tropics.

Climate Feedback does not appreciate that these errors are fatal for the reliability of virtually all ecosystem (including agriculture) impact models. The vast majority of moisture that falls in the midlatitude growing regions (some of the most productive agricultural land on earth) originates

[1] Most (not all) of the CMIP-6 models were available for McKitrick and Christy (2020); this figure is the mean ECS of what was released through late 2020.

in the tropics. Large and systematic errors in the tropical vertical precipitation forecasts for the future make them simply unreliable, as it is the tropical lapse rate that largely governs how much oceanic moisture is transferred into the larger global atmosphere. In fact, the sign of large precipitation changes can be positive or negative at the same location, depending upon the model.

CF Claim #11: Wrightstone confuses natural drivers from man-made CO_2-driven warming

The author makes the frequent mistake of mixing natural variability (the slight warming after the Little Ice Age) and current warming, which is due to greenhouse gas forcing. These processes are well understood by climate scientists. In fact there is no alternative explanation for the recent rapid warming, as described in this Climate Feedback review. (Wolfgang Cramer)

Response 13: Gregory Wrightstone - Geologist, Executive Director of the CO2 Coalition, Expert Reviewer for the IPCC, author of Inconvenient Facts

As Dr. Michaels stated in the previous section, the earth's surface temperature has risen about 0.9° C since 1900. The HadCRUT4 thermometer record reveals that there were two distinct periods of warming in the 20th century, roughly 1910-45, and then 1976-98. The slopes of the two periods are indistinguishable, although the earlier one occurred during a period of low CO_2 of less than 300 ppm and any CO_2 warming would be negligible, while the latter occurred at levels more than 400 ppm.

The figure below shows both of the warming periods and I challenge you to decide which one occurred in a low- CO_2 environment and which one happened at >400 ppm.

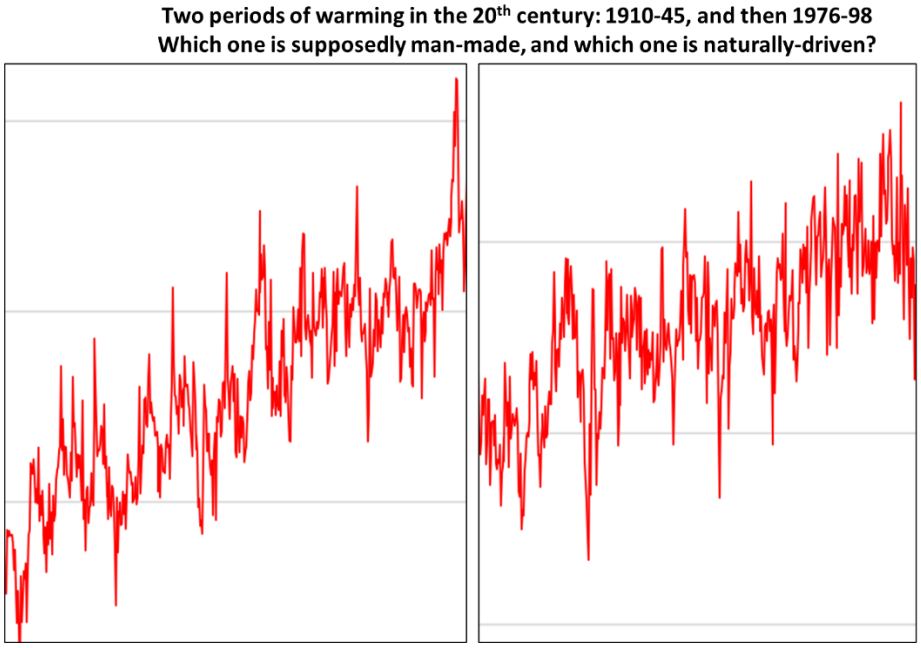

Figure 14 – Which 20th century temperature increase is the one supposedly caused by CO2-driven warming?

The Central England Temperature Record is shown below and is the oldest continuous thermometer record available and dates to 1659. Also shown are global carbon emissions documenting a 250-year record of warming in a low CO_2 environment. The first 200-plus

years of the warming would have near -zero to negligible CO_2-driven warming. Also note that the highest rate of warming occurred during the first 40 years from 1695 to 1735 as the Earth began to recover from the coldest temperatures in 12,000 years (Little Ice Age).

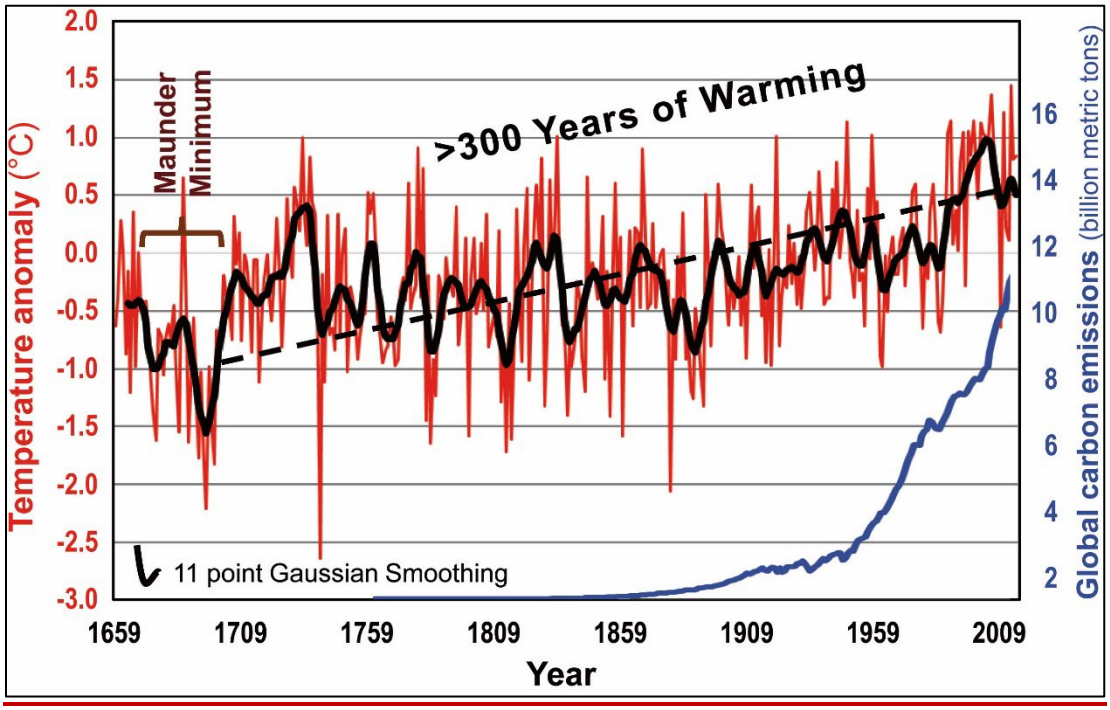

Figure 15 – More than 250 years of warming occurred before man started adding large amounts of CO2 to the atmosphere.

References

Ahmed M, Anchukaitis K., Asrat, A et al (2015) Correction: Corrigendum: Conti-nental-scale temperature variability during the past two millennia. Nature Geosci 8, 981–982 (2015). https://doi.org/10.1038/ngeo2566 https://www.nature.com/articles/ngeo2566#citeas

Australian Institute of Marine Science (2016). Coral bleaching events. [online] Aims.gov.au. Available at: https://www.aims.gov.au/docs/research/climate-change/coral-bleaching/bleaching-events.html.

Baker, A.C. (2003). Flexibility and Specificity in Coral-Algal Symbiosis: Diversity, Ecology, and Biogeography of Symbiodinium. Annual Review of Ecology, Evolution, and Systematics, 34(1), pp.661–689.

Balch (2017) Human-started wildfires expand the fire niche acrossthe United States https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5358354/

Buddemeier, R.W. and Fautin, D.G. (1993). Coral Bleaching as an Adaptive Mechanism. BioScience, 43(5), pp.320–326.

Büntgen (2021) Recent European drought extremes beyond Common Era background variability https://www.nature.com/articles/s41561-021-00698-0

Carr Fire Wikipediaa https://en.wikipedia.org/wiki/Carr_Fire

Cascading Effects of Fire Exclusion in Rocky Mountain Ecosystems: A Literature Review. https://www.fs.usda.gov/treesearch/pubs/5132

Christy, J. R., and R. T. McNider, 2017. Satellite bulk tropospheric temperatures as a metric for climate sensitivity. *Asia-Pac. Jour. Atm. Sci.* **54,** 511-518

Climate Research Unit, University of East Anglia, 2020. Latest update of CRU surface temperatures: https://crudata.uea.ac.uk/cru/data/temperature/

Dayaratna K.D., McKitrick, R., and P.J. Michaels, 2020. Climate sensitivity, agricultural productivity and the social cost of carbon in FUND. *Envi. Econ. and Policy Stud.* ***22****,433–448*

De'ath, G., Fabricius, K.E., Sweatman, H. and Puotinen, M. (2012). The 27-year decline of coral cover on the Great Barrier Reef and its causes. Proceedings of the National Academy of Sciences, 109(44), pp.17995–17999.https://www.aims.gov.au/reef-monitoring/gbr-condition-summary-2017-2018

DeRose (2014) Tree-ring reconstruction of the level of Great Salt Lake, USA https://journals.sagepub.com/doi/abs/10.1177/0959683614530441

Felis et al. (2018) Mild and Arid Climate in the Eastern Sahara-Arabian Desert During the Late Little Ice Age, Geophysical Research Letters DOI: 10.1029/2018GL078617

Guest, J.R., Baird, A.H., Maynard, J.A., Muttaqin, E., Edwards, A.J., Campbell, S.J., Yewdall, K., Affendi, Y.A. and Chou, L.M. (2012). Contrasting Patterns of Coral Bleaching Susceptibility in 2010 Suggest an Adaptive Response to Thermal Stress. PLoS ONE, 7(3), p.e33353

Hao Wang, Kefu Yu, Shichen Tao, Shendong Xu, Tsai-Luen Yu, Chuan-Chou Shen, Shaopeng Wang (2021) New evidence for the periodic bleaching and recovery of Porites corals during the mid-late Holocene in the northern South China Sea, Global and Planetary Change, Volume 197.

Lindzen R (1997) Climate dynamics and global change; Annu. Rev. Fluid Mech. 1994.26:353-78 https://www.annualreviews.org/doi/abs/10.1146/annurev.fl.26.010194.002033?journalCode=fluid

Lough, J.M. and Barnes, D.J. (2000). Environmental controls on growth of the massive coral Porites. Journal of Experimental Marine Biology and Ecology, 245(2), pp.225–243.

Luening S (2021) Mapping the Medieval Climate Anomaly https://www.researchgate.net/deref/http%3A%2F%2Ft1p.de%2Fmwp

Marcott SA, Shakun J, Clark PU, Mix AC (2013a) A Reconstruction of Regional and Global Temperature for the Past 11,300 Years; Science08 Mar 2013 : 1198-1201

Marshall, P. and Schuttenberg, H. (2006). A Reef Manager's Guide to Coral Bleaching. Townsville, Australia.: Great Barrier Reef Marine Park Authority.

Marshall, P.A. and Baird, A.H. (2000). Bleaching of corals on the Great Barrier Reef: differential susceptibilities among taxa. Coral Reefs, 19(2), pp.155–163.

Munier, S., et al., 2018. Satellite Leaf Area Index: Global Scale Analysis of the Tendencies per Vegetation Type over the Last 17 Years. *Remote Sensing* **424**, https://doi.org/103390/rs100300424

McKay N and Kaufman D (2014) An extended Arctic proxy temperature database for the past 2,000 years; Sci Data 1, 140026. https://doi.org/10.1038/sdata.2014.26

McKitrick, R., and J. R. Christy 2020. Pervasive Warming Bias in CMIP6 Tropospheric Layers. *Earth and Space Sci.,* **7**, e2020EA001281. https://doi.org/10.1029/2020EA001281

Office of Management and Budget, 2003. Circular A-4, *Regulatory Analysis, https://www.federalregister.gov/documents/2003/10/09/03-25606/circular-a-4-regulatory-analysis*

Oliver, J.K., Berkelmans, R. and Eakin, C.M. (2018). Coral Bleaching in Space and Time. In: M.J.H. Van Oppen and J.M. Lough, eds., Coral bleaching : patterns, processes, causes and consequences. Springer-Verlag Berlin Heidelberg.

Pederson (2005) Long-Duration Drought Variability and Impacts on Ecosystem Services: A Case Study from Glacier National Park, Montana https://journals.ametsoc.org/view/journals/eint/10/4/ei153.1.xml

Peterson, T., et al. (2013) Monitoring and Understanding Changes in Heat waves, Cold Waves,

Floods and Droughts in the United States, State of Knowledge. Bulletin of the American Meterological Society. June 2013, p. 821-834. https://journals.ametsoc.org/view/journals/bams/94/6/bams-d-12-00066.1.xml

Pielke, R., Jr., 2018. Tracking progress on the economic costs of disasters under the indicators of the sustainable development goals. *Envi. Hazards,* 1-6.

Rush Fire Wikipedia https://en.wikipedia.org/wiki/Rush_Fire

Schoennagel (2005) Enso And Pdo Variability Affect Drought-Induced Fire Occurrence In

Rocky Mountain Subalpine Forests https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1890/04-1579

Sinha (2010) A global context for megadroughts in monsoon Asia during the past millennium https://www.sciencedirect.com/science/article/abs/pii/S0277379110003598

Stahl (2003) Tree-ring reconstructed megadroughts over North America since A.D. 1300 https://link.springer.com/article/10.1007/s10584-006-9171-x

Steele (2019) How Bad Science & Horrific Journalism Misrepresent Wildfires and Climate

Stevens, B., 2015. Rethinking the lower bound of aerosol radiative forcing. *J. Clim.* **28,** 4794-4819

Vincent (2005) Solving the paradox of the end of the Little Ice Age in the Alps

https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2005GL022552

Westerling (2008) Climate change and wildfire in California https://link.springer.com/article/10.1007/s10584-007-9363-z

Yonge, C.M. and Nicholls, A.G. (1931). The Structure, Distribution and Physiology of the Zooxanthellæ. Great Barrier Reef Exped 1928-29 Sci Rep, 1, pp.135–176.

Zhu, Z, et al., 2016. Greening of the Earth and its Drivers. *Nature Cli. Chg.* **6**, 791-793