

# Virginia and Climate Change

Separating Fact from Fiction





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## Background

The CO2 Coalition was established in 2015 as a 501(c)(3) for the purpose of educating thought leaders, policy makers, and the public about the important contribution made by carbon dioxide to our lives and the economy. The Coalition seeks to engage in an informed and dispassionate discussion of climate change, humans' role in the climate system, the limitations of climate models, and the consequences of mandated reductions in CO2 emissions.

This report is based principally on the work of the following:

- **Dr. Patrick J. Michaels**, Senior Fellow for the CO2 Coalition and Competitive Enterprise Institute, past Virginia State Climatologist; past President of the American Association of State Climatologists
- **Gregory Wrightstone**, geologist, CO2 Coalition Executive Director and Expert Reviewer for the U.N. Intergovernmental Panel on Climate Change
- **Dr. James Ferguson**, VMD, MS, MAR, Diplomat ACVN, ACT, Professor Emeritus, Professor of Nutrition, Department of Clinical Studies, School of Veterinary Medicine, University of Pennsylvania, priest of Anglican Church
- **Dr. John Christy**, Distinguished Professor of Atmospheric Science and Director of the Earth System Science Center at The University of Alabama in Huntsville, Alabama's State Climatologist. Awarded NASA's Medal for Exceptional Scientific Achievement in 1991
- **Dr. William Happer**, Professor Emeritus in the Department of Physics at Princeton University. He has published over 200 peer-reviewed scientific papers. He is a Fellow of the American Physical Society, the American Association for the Advancement of Science, and a member of the American Academy of Arts and Sciences, the National Academy of Sciences and the American Philosophical Society.

These and other contributors to this evaluation represent the fields of climatology, meteorology, physics, geology, agronomy and more.

## Executive Summary

Claims of rising temperatures, severe weather and dangerously rising sea level along with dire predictions of more of the same – all purportedly driven by man-made emissions of carbon dioxide – have been used to justify various efforts of Virginia's government to control the uncontrollable: Earth's climate.

Using widely accepted data and analytical methods, the CO2 Coalition finds no scientific basis of these justifications. Moreover, state programs to reduce emissions of carbon dioxide by discouraging the use of fossil fuels – while expensive – will have no measurable effect on atmospheric temperature or weather. In other words, there is no climate emergency and spending money to address one is foolish at best.

A summary of specific findings follows:

**Severe Weather:** Natural disasters worldwide have been in a 20-year decline. a period of both rising temperature and increasing atmospheric carbon dioxide, countering claims of linkage with increasing natural calamities.

**Temperature & Carbon Dioxide:** Records since the early 20th century show periods both of increasing warmth and cooling, demonstrating questionable direct correlation between temperature and carbon dioxide levels.

**Heat Waves & Droughts:** Both have declined in recent decades. The most frequent and severe heat waves occurred in the 1920s and 1930s. A full 68% of Virginia's record highs were set between 1922-41, with none being recorded in the last 20 years. The number of days in a heat wave have declined over the last 70 years.

**Virginia Temperature in Future Context:** Computer models on which Virginia's climate programs are based have systematically over-predicted Virginia warming in recent decades. A methodology so flawed has no place in deliberating climate policies as it provides no reliable clues for near-term temperatures.

**Climate Change & Agriculture:** Consistent with global trends, Virginia crop yields have been increasing since the 1930s with the adoption of hybrid corn, greater use of fertilizers, and more efficient farming. In addition, modest warming and increasing carbon dioxide have turbocharged harvests.

**Regional Sea-Level Rise:** There is no acceleration in sea-level rise as recorded by tide gauges. However, local rises can have a strong geological component, as is the case in Virginia, where the rise is amplified by the well-documented isostatic

rebound along the eastern seaboard. This non-climatic phenomenon can account for 21st-century relative sea-level rises of nearly 20 inches in parts of the Atlantic Coast.

**Meaningless Climate Programs:** Using the methodology of the U.N. Intergovernmental Panel on Climate Change, the amount of global warming “mitigated” by eliminating all Virginia emissions of carbon dioxide from 2010-2100 (climate sensitivity of  $2.0^{\circ}\text{C}$ ) would be to avoid  $0.0021^{\circ}\text{C}$  of warming — a number so small as to be unmeasurable.

**Conclusion:** Clearly there is no correlation between carbon dioxide emissions and the safety of Virginians. In fact, the weather has been relatively benign in recent decades as Virginia agriculture has benefited from modest warming and increasing carbon dioxide. Efforts to modify the climate are wasteful economically and meaningless in their effect.

## Introduction

The Commonwealth of Virginia has entered into three wide-ranging initiatives that attempt to roll back emissions of greenhouse gases within the state's borders. The cumulative effect of these three programs would be to increase transportation and electricity costs, restrict citizens' options to freely select their mode of transportation and to provide costly incentives to government-preferred energy sources (wind and solar).

**Program #1** - In 2020, former governor Ralph Northam authorized the entry of the Commonwealth into the **Regional Greenhouse Gas Initiative (RGGI)**<sup>1</sup>. This is a consortium of northeastern states that impose a cap-and-trade program on power plants by capping the carbon dioxide (CO<sub>2</sub>) emissions from electric generators, causing electricity prices to increase while subsidizing wind and solar generation. Many countries in Europe are currently experiencing significant energy price increases and shortages with similar systems in place. Governor Glenn Youngkin has signed an executive order to remove the state from RGGI.

**Program #2** - In 2020 then Governor Ralph Northam approved the **Virginia Clean Economy Act (VCEA)**<sup>2</sup>. This bill requires the state to replace all fossil fuel-generated electricity with renewable energy by 2045. According to the U.S. EIA, in 2020, 65% of all electricity consumed in Virginia was generated by coal or natural gas-fired facilities (EIA 2021) that will be shuttered in 20 years if the plan is fully implemented. According to the bill, the state will achieve this goal through the development of large-scale solar, offshore wind projects and small-scale nuclear.

**Program #3** - The third program to be signed by Governor Northam was the **Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding** (2021)<sup>3</sup> regulating commercial vehicles. Under the MOU, Virginia joins a multi-state commitment for 30 percent of new truck and bus sales to be zero-emission by 2030 and 100 percent zero-emission by 2050.

According to supporters of these programs, the regulations, taxes, and subsidies within these "clean" energy schemes were needed because the Commonwealth's carbon dioxide emissions are contributing to dangerous CO<sub>2</sub>-driven warming. Dire warnings were issued linking current and future environmental calamities to man-made warming unless Virginia reduced, or better yet, eliminated its greenhouse gas (GHG) emissions. Justifications included linkage between emissions and increasing drought, river and shoreline flooding, heat waves, extreme weather, health risks and agricultural degradation.

Within this report, we ask and answer the following questions:

- Is the Commonwealth currently experiencing more extreme weather and negative environmental degradation due to increasing temperature?
- Are the models used to predict future changes accurate enough for the state to take drastic and likely economically harmful measures?
- If the state did reduce its emissions as envisioned, what effect would this have on global and local temperatures?
- Is the current warming, combined with increasing carbon dioxide, harmful or a net benefit?

Included within this paper, some of the world's top experts in various fields provide the data, science and facts to answer these questions and more.

# Analyses

## Climate Change and Virginia

Justifications for Virginia to impose increased regulations and taxation on fossil fuels and fossil fuel-generated energy are based on dire warnings of existing and future CO<sub>2</sub>-driven catastrophes. In this document we will review and assess the claims of looming disaster that have been used by supporters of the extensive deployment of expensive and unreliable “renewable” energy sources. We will show that stated claims of current and future net harm from continuing emissions of carbon dioxide (CO<sub>2</sub>) are unsupported by the facts.

Here we will review various aspects of climate change in Virginia in the context of regional, national and global climate data. We conclude that Virginia’s participation in the various attempts to reduce global atmospheric temperature is climatically meaningless and based on flawed assumptions.

If it can be demonstrated that the clean energy plans are climatically inconsequential, then the governmental bodies tasked with review of these programs should “follow the science” and reject the economically costly programs that have no utility.

The observed facts, as documented within this report, do not support any attempt to moderate the global atmospheric temperature via reductions in greenhouse gases (GHG) in Virginia, the United States or globally.

## Severe Weather

Claims of increased severe weather related to increased man-made GHG emissions are one of the most cited reasons to rein in our production of possible planet-warming emissions.

We should examine what the most respected governmental and scientific bodies have to say about the connection between severe weather and human-caused changes in climate. The United Nations’ Intergovernmental Panel on Climate Change (IPCC) periodically summarizes climate science<sup>4</sup>. It is an exhaustive literature review of climate science and states: “*Many weather and climate extremes are the result of natural climate variability... Even if there were no anthropogenic changes in climate, a wide variety of natural weather and climate extremes would still occur.*”

The UN’s World Meteorological Organization goes even further<sup>5</sup>, saying:

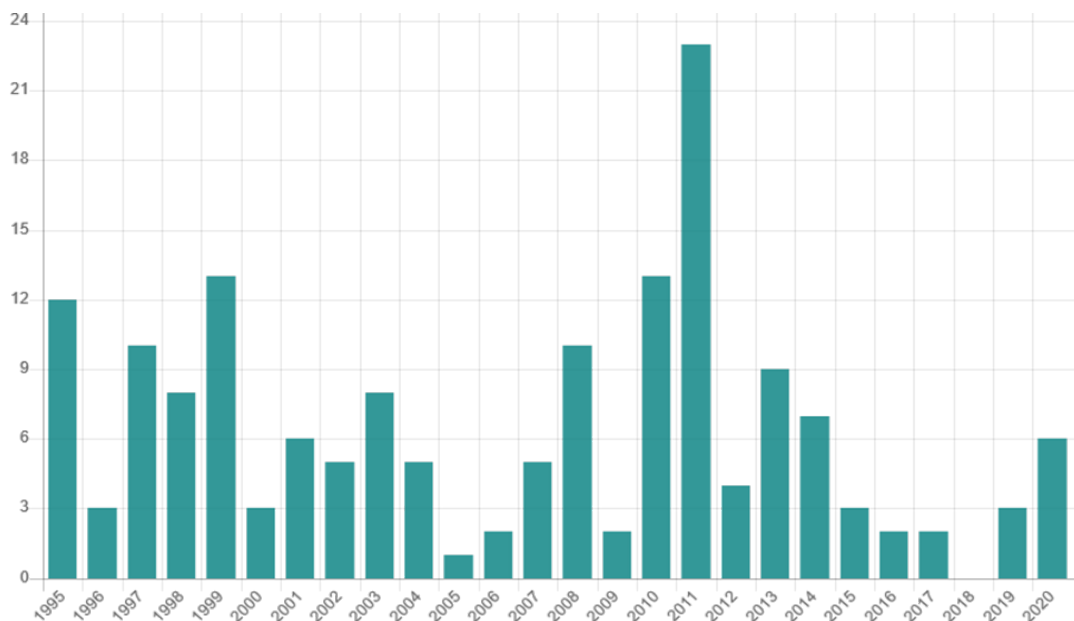
“... *any single event... cannot be attributed to human-induced climate change, given the current status of scientific understanding.*”



A frequent misunderstanding concerning heat and extreme weather events, like thunderstorms, tornadoes and intense downpours is the notion that GHG-related warming leads to more severe weather. The meteorological fact is that most extreme weather events are caused, not by rising temperatures, but by increasing temperature differentials, both in the vertical and the horizontal.

As an example, it is well known (and has been for over a century) that GHG related warming is more in night than day temperatures, and more in cold air than warm air. This means 1) that it is more confined to winter than summer, and 2) that the temperature gradient between the high latitude (polar) regions and the mid and low latitudes is lessened.

Elementary meteorology reveals that it is the strength of this gradient that supplies kinetic energy to the mid-latitude jet streams, and that these are in large part responsible for the development of strong cyclones, which are an important component of the development of extremely destructive (Category EF4 and EF5) tornadoes. The weakening of this gradient may indeed be responsible for the decline in these tornadoes that has occurred since the full deployment of the National Weather Service Doppler (WSR-88D) radar systems (Figure 1)<sup>6</sup>.



*Figure 1 - Number of extremely destructive (EF4 and EF5) tornadoes since Doppler radar coverage became complete shows a slight decline. Data Source: National Weather Service, National Oceanic and Atmospheric Administration*

The most reputable disaster reporting agency in the world, the Centre for Research on the Epidemiology of Disasters (CRED) reports that natural disasters worldwide have been in a twenty-year decline. The CRED data, as gathered in their EM-DAT

database is shown below and as displayed by Our World in Data<sup>7</sup> show a significant decline in such disasters over the last twenty years. (Note that the initial 30 years of data from 1970 to about 2000 was the time period in which CRED was building out their reporting and reflects increasing numbers of nations and regions reporting on such calamities, rather than actual numbers of disasters)

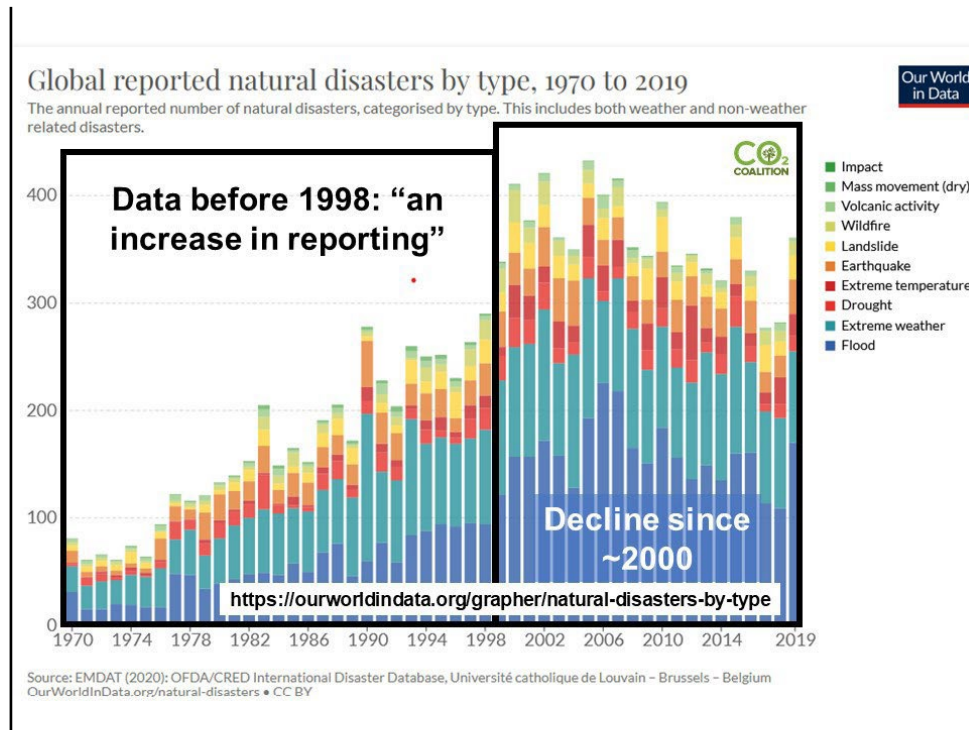


Figure 2 - Global reported natural disasters by type<sup>7</sup>

Within the United States, the extreme-weather related death rate per million has declined a remarkable 98% (Figure 3) since the early 20<sup>th</sup> century<sup>8</sup>.

Are disaster costs increasing? The simple answer to that is “yes, but”, because when expressed as a percent of GDP, on both the global and North American scale, relative costs are actually declining.

What of the reports of increasing damages that permeate the media? These are *raw* damage figures, not adjusted for the fact that there are simply more people with more stuff (like beach houses, for example) that are in the way of the weather. Roger Pielke, Jr., of the University of Colorado has published the definitive work (Figure 4) that compares disaster costs to GDP and has repeatedly found more evidence for a decline and no evidence for an increase<sup>9</sup>.

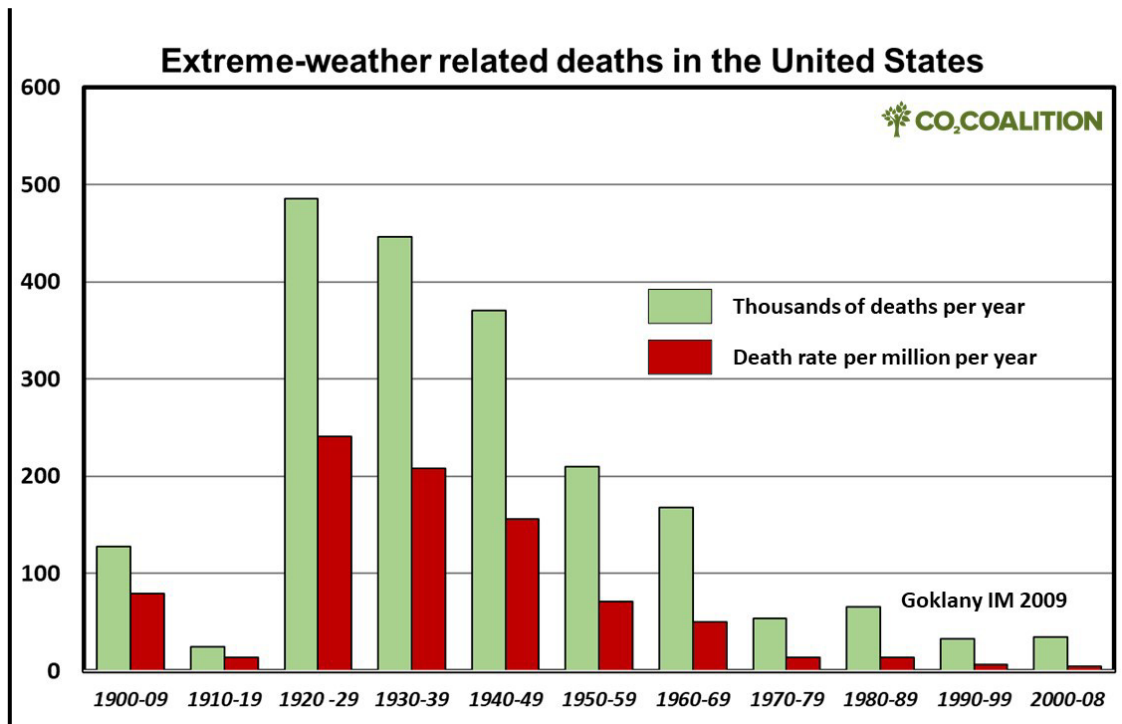


Figure 3 – Extreme -weather related deaths – Goklany 2009<sup>8</sup>

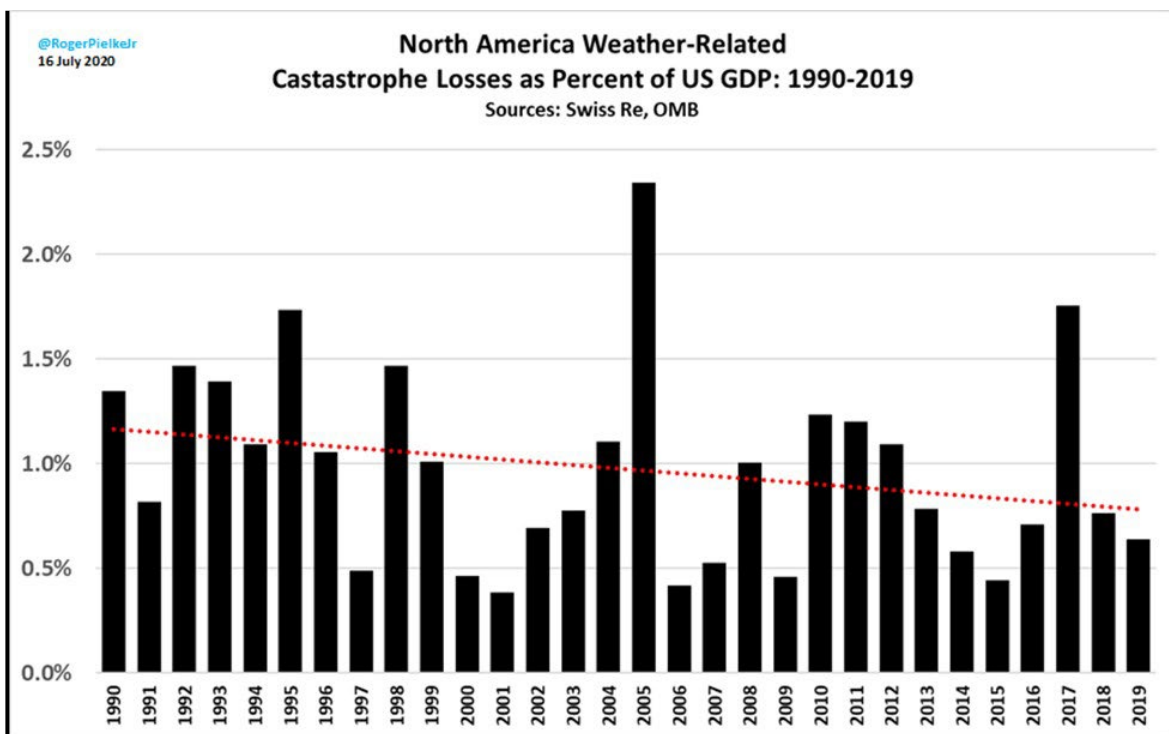


Figure 4 - North American weather-related catastrophe losses as percent of GDP are declining. Pielke (2020)<sup>9</sup>

There is no reason to believe that Virginia, or any group of states would run significantly counter to these trends. Further, these beneficial changes have occurred during a period of both rising temperature (see next section) as well as growing concentration of atmospheric carbon dioxide, countering claims of linkage with increasing natural calamities.

### **Modern Temperature History vs. Atmospheric Carbon Dioxide**

By far, the human emission with the potential to affect surface temperatures the most is carbon dioxide, almost exclusively from the combustion of the fossil fuels (coal, natural gas, and liquid petroleum) that drive the world's economic engine. Making any case that would radically reduce economic development must by its nature be very strong.

Earth's surface temperature has risen around one degree Celsius since 1850 (Figure 5)<sup>10</sup>. The "background" carbon dioxide concentration, prior to the Industrial Revolution and extensive modification of land surfaces is a universally accepted value of 279-280 parts per million (ppm) by volume. By 1850, when the global thermometric temperature record begins, it had risen to 285 ppm<sup>11</sup>. For perspective, the current atmospheric concentration is about 416 ppm (December 2021), given by the long-term record from Mauna Loa in Hawaii, by far the most highly cited carbon dioxide record in the scientific literature.

There are two periods of warming in the CRU record. The first one is 1910-45 with a warming of very close to a half-degree Celsius. During that time, European Environmental Agency data<sup>11</sup> show a CO<sub>2</sub> rise from 300 to 310 ppm, or 10.3%.

The second warming in the CRU history, beginning around 1976, is 0.6°C, while the CO<sub>2</sub> concentration increased by 77 ppm, or over seven times the change in the early portion of the century that occurred with a half-degree warming.

It is obvious that the first warming of the 20<sup>th</sup> century has little to do with carbon dioxide. If a 10-ppm change induced a warming of 0.5°C, observed temperature change caused by the 77-ppm change would have to be several *times* that, which is obviously not the case.

Another temperature anomaly unexplained by atmospheric carbon dioxide increases is the approximate 30-year cooling trend that extended from the mid-1940s to the late 1970s. This temperature decline coincided with the post-World War II economic boom and the beginning of the introduction of the first significant increases in CO<sub>2</sub> from human sources. If CO<sub>2</sub> were a primary driver of warming, it is difficult to reconcile decades of cooling just as CO<sub>2</sub> levels were increasing.

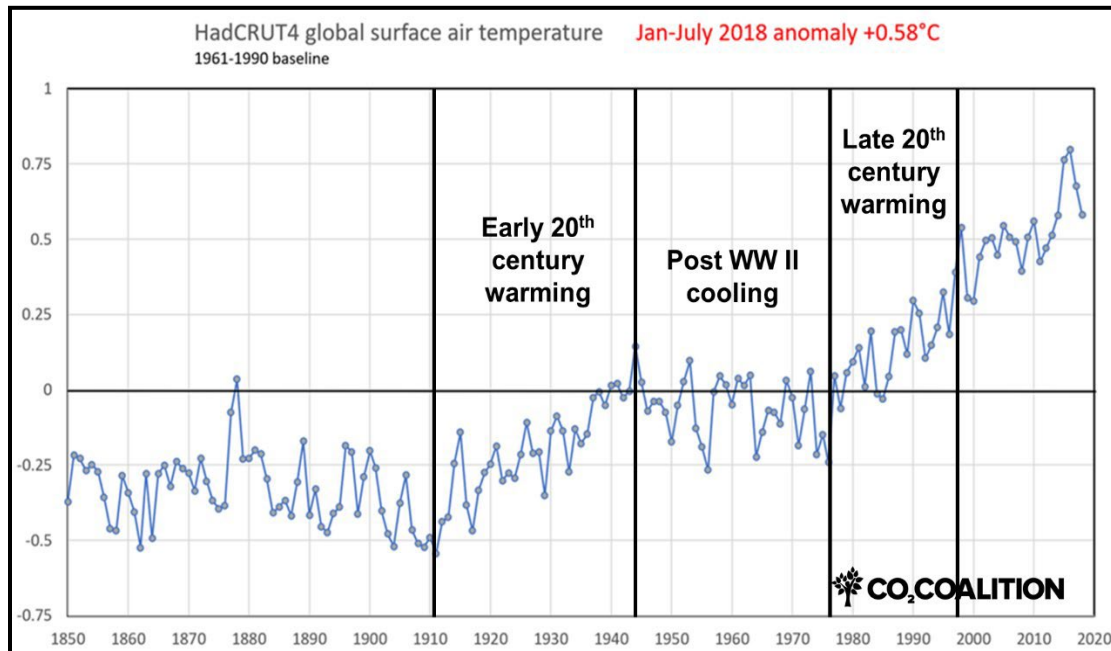


Figure 5 - Global surface average temperature anomalies from the Climate Research Unit (CRU) at the University of East Anglia

Virginia's temperature history from the National Centers for Environmental Information<sup>12</sup> (Climate) is only somewhat comparable to the global history, despite experiencing the same changes in atmospheric concentrations of GHGs.

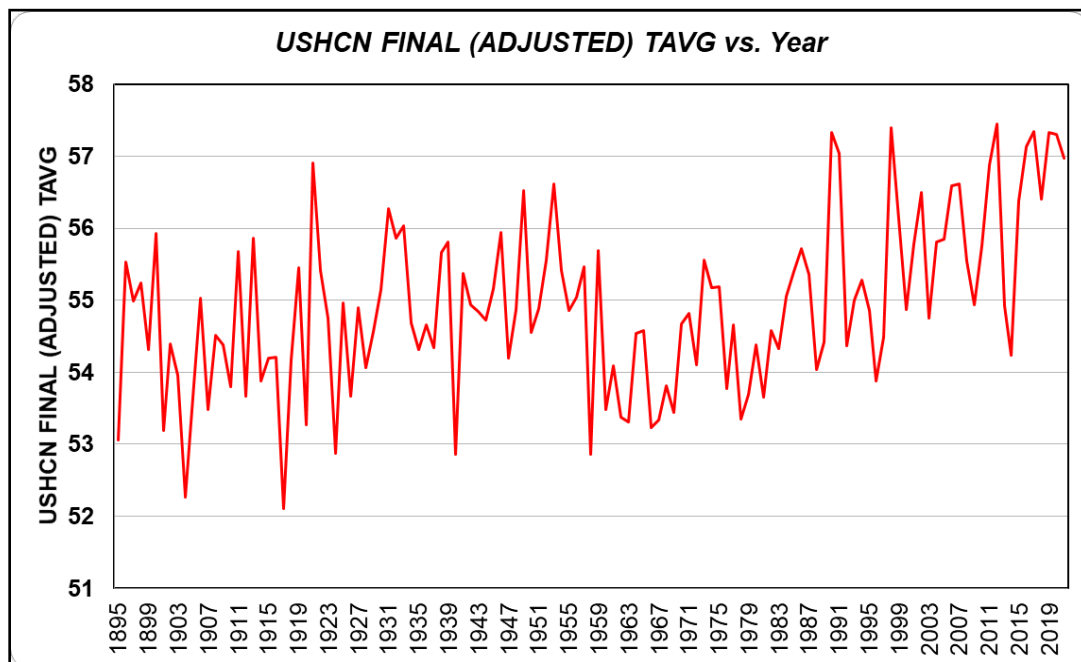


Figure 6 - Virginia temperature history from the National Centers for Environmental Information (Climate). The record begins in 1895.



Like the global history, it shows two periods of warming, with the first beginning around 1910 and ending around 1950. It is approximately  $0.8^{\circ}\text{C}$  (the right axis is in degrees C). Unlike in the global record, this warming was followed by a very sharp drop in temperature in the next decade. The magnitude of this cooling is several times greater than what is in the CRU global record.

Warming resumes after 1960 but is very choppy and noisy. For example, there is no warming trend at all (though there is a lot of noise in the data) from roughly 1990 to 2016, which differs greatly from the smooth warming trend in the global CRU data.

The post-1960 warming in the Virginia record must be viewed in the context that temperatures *fell* approximately  $1.0^{\circ}\text{C}$  from 1950 to 1960, so this warming starts from an anomalously cold base.

It must be noted that the temperature data shown above in Figure 6 has been altered to lower temperatures prior to 1994 and to increase the measured values in recent years. The overall effect of this manipulation is to amplify recent increases in temperature. Figure 7 below shows the raw unaltered data.

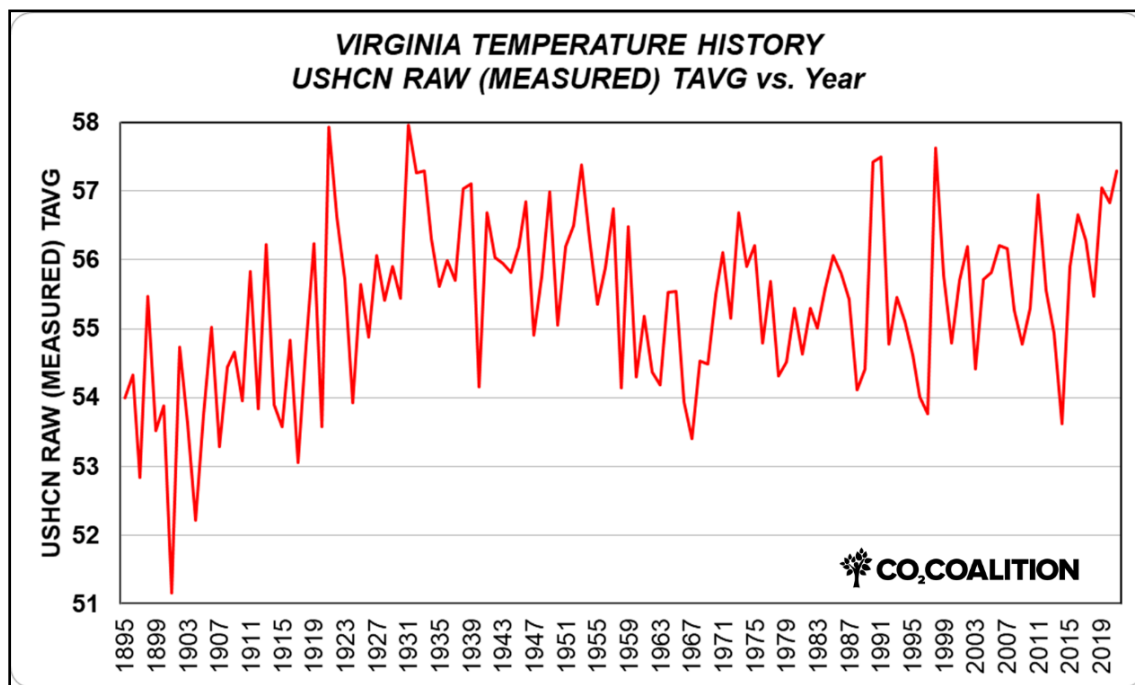


Figure 7 – “Raw” unaltered Virginia temperature history from the National Centers for Environmental Information (Climate).

Note that the global data indicates that any temperature increases possibly driven by carbon dioxide-related warming are confined to the post-1976 period (there are also other causes), so much of the second warming *in Virginia* prior to then (i.e.

from 1960-76) is more likely due to random factors compensating for the unusual cooling spike from 1950 to 1960.

The modest warming seen over the last 100-plus years has resulted in a reduction of very cold nighttime temperatures, lessening Virginia citizens' needs for winter heating and energy demand.

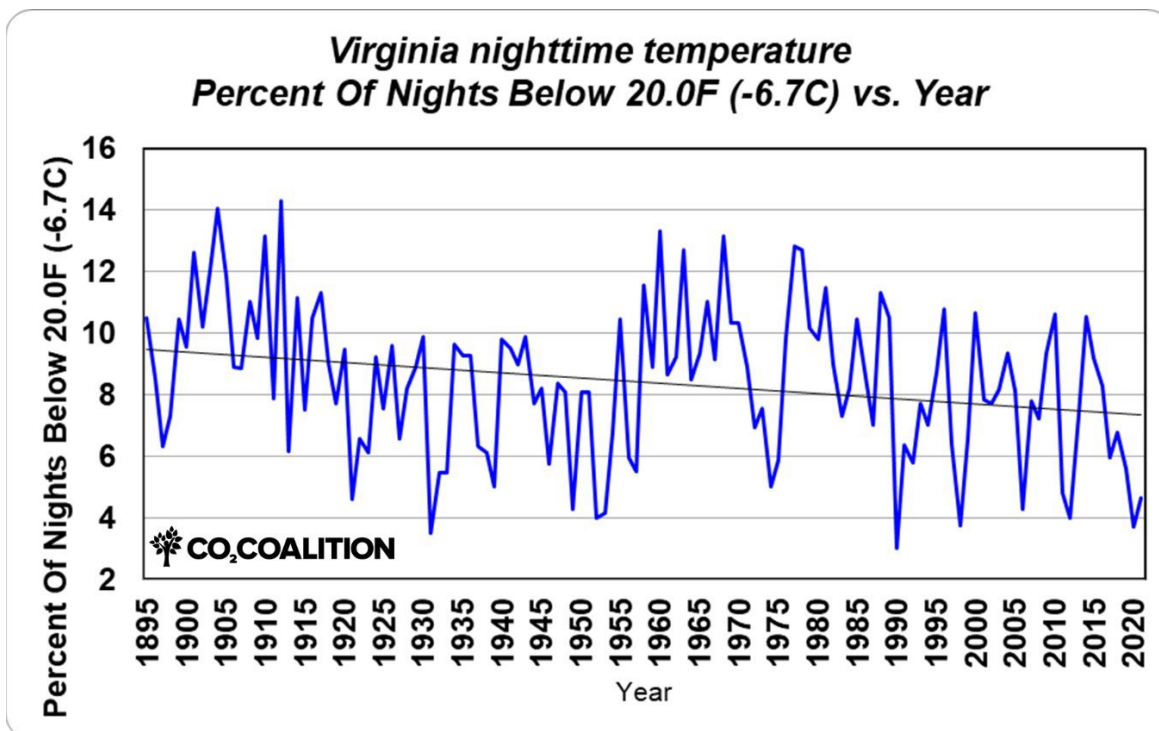


Figure 8 – Virginia nighttime temperature – percentage of nights below 20.0°F (- 6.7°C)

### Heat Waves

There is little dispute that the most frequent and severe heat waves in both the United States and in Virginia occurred some 90 to 100 years ago in the 1920s and the 1930s<sup>13</sup>. In Virginia, the temperature record of USHCN data reveals that very hot days have not been increasing (Figure 9).

The Figures 10 and 11 were created by Dr. John Christy, Professor of Atmospheric Science and Director of the Earth System Science Center at the University of Alabama in Huntsville and Alabama's State Climatologist. The data was accessed from the U.S. Historical Climatology Network (USHCN)<sup>14</sup>, December 2021. Where appropriate, they compare national, U.S. Southeast, and Virginia-only data.

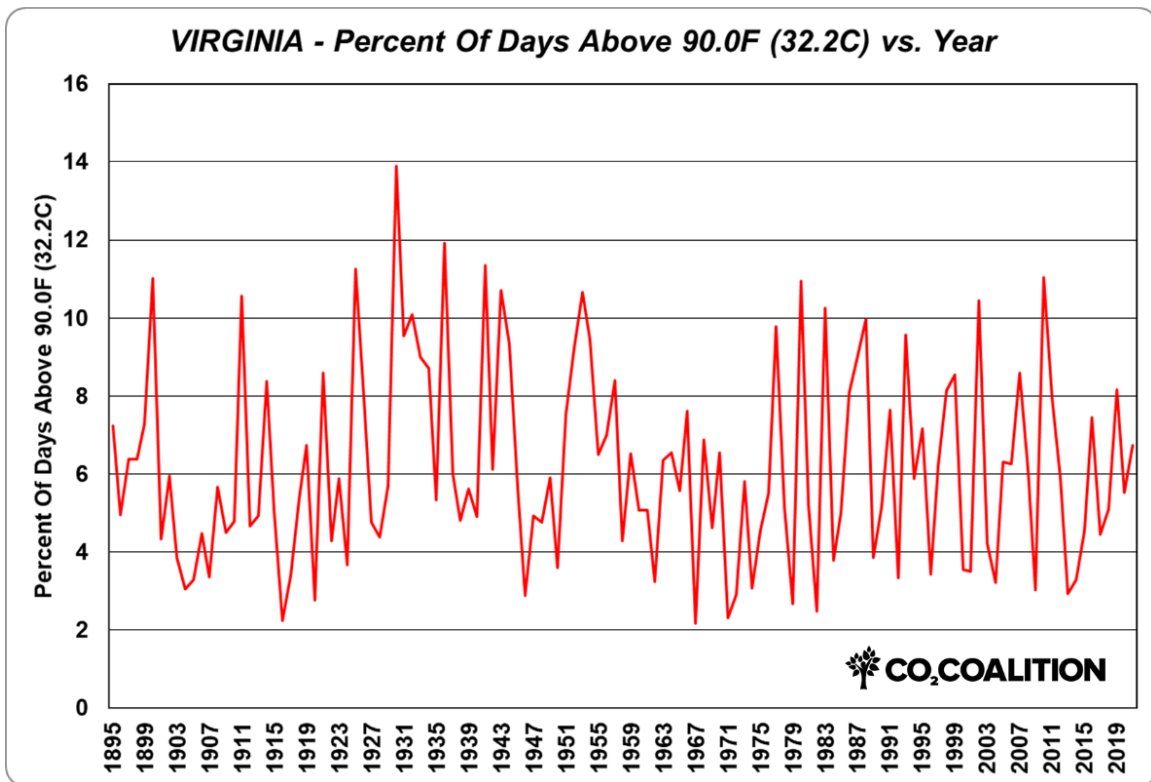


Figure 9 – USHCN data showing percentage of days per year with very hot temperatures.

The USHCN data are higher quality than many of the other NOAA stations, selected in part because of minimal urbanization. *Notably, Reagan National Airport (DCA) is not included in the HCN set because it is undergoing a tremendous amount of spurious urban heat island warming (amongst the largest in the world), which has little to do with GHG increases. Very hot temperatures at Reagan National often generate headlines, but these heatwaves are largely an artifact of the D.C. heat island.*

Figure 10 is particularly revealing, showing the percentage of stations that recorded all-time high temperatures over each ten-year period in Virginia. A full 68% of all record highs in the state were set in the period 1922 to 1941 and **no records have been set in the last twenty years**. (Note that the ten-year periods were selected to utilize the most up-to-date data through the end of 2021).

Further, the percent of all-time high temperature records in Virginia is inordinately confined to the 1922-31 decade, due in part to the extreme heat of the summer of 1930.

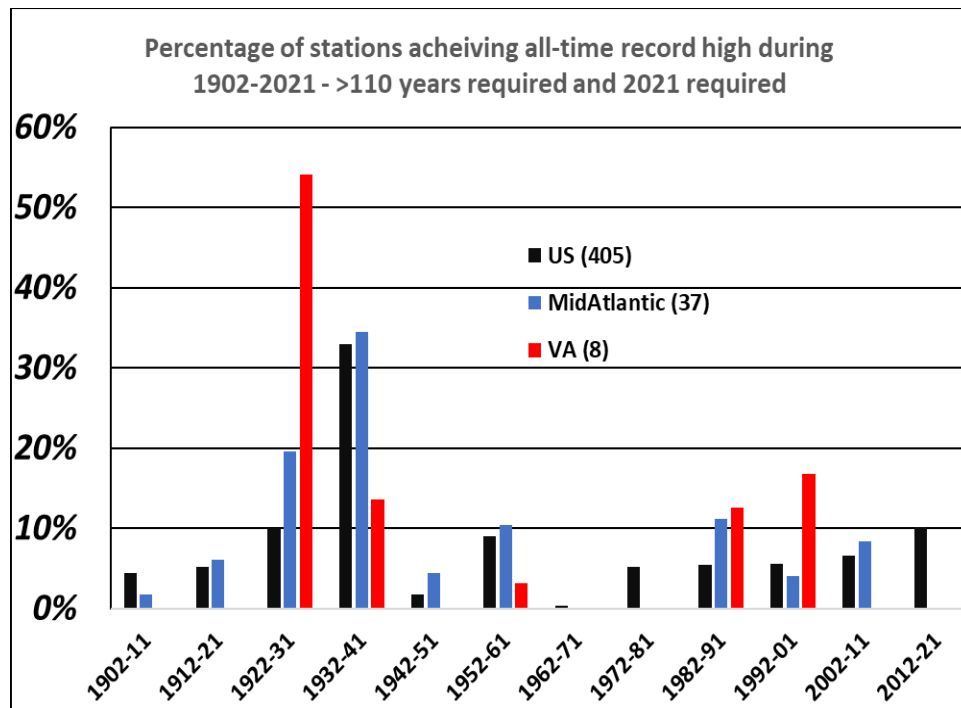
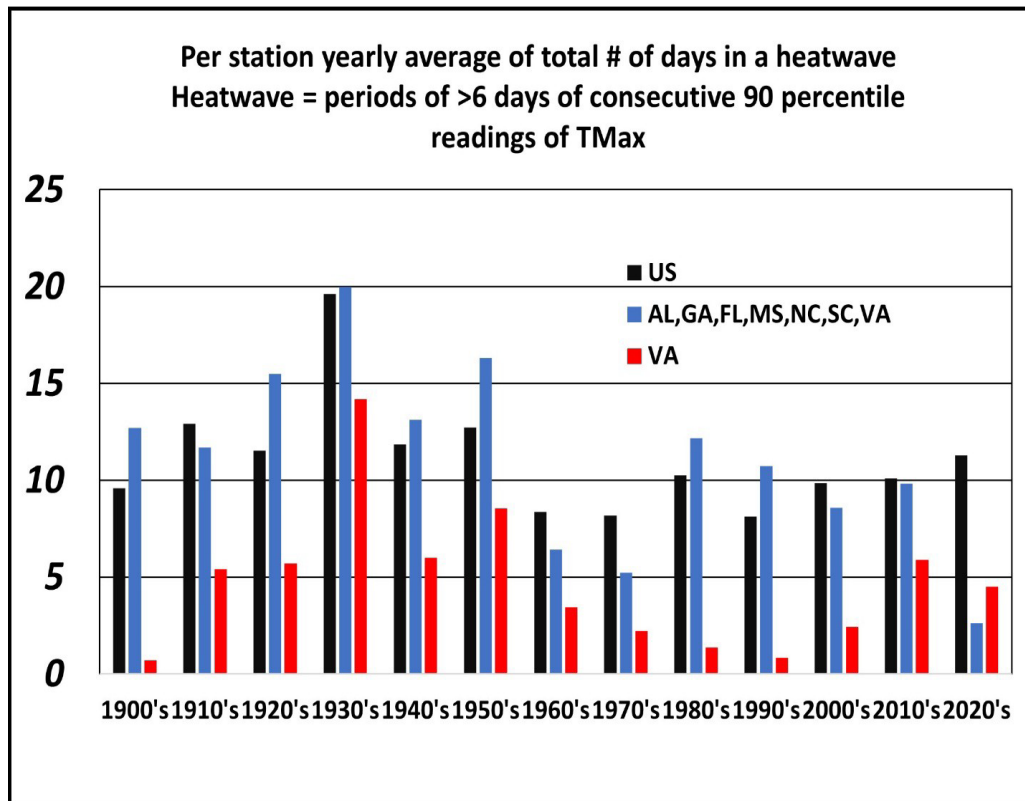


Figure 10 - The percent of stations with all-time highs, per decade, per station.  
 Data source: USHC "Heatwave" is defined as more than six consecutive days in which the high temperature is in the 90th percentile or above.

Figure 11 shows the annual average number of heat waves per station in Virginia, broken out by decades. The most recent four full decades (1980 to 2019) had an average of 2.6 heat waves per year (on a per-station basis) versus the average of 4.7 heat waves annually since 1900. The heat waves of recent decades are of about half the frequency of the baseline since the beginning of the 20<sup>th</sup> century. Rather than an increase in the number of days in a heat wave, the numbers have been in decline over that last 70 years.

The facts belie claims of currently unusual heat waves. The vast majority of the heat waves occurred in the 1930s (both for Virginia and the nation) and happened long before there were large man-made contributions of carbon dioxide into the atmosphere. The CO<sub>2</sub> concentration in 1850 (the beginning of the global temperature record in Figure 1) is 285 ppm. In 1930 it was 307 ppm, an increase of a mere 8%, while the current concentration of 416 ppm is 46% above 1850<sup>11</sup>.

Claims that Virginia heatwaves are increasing in magnitude and frequency as a result of changes in atmospheric GHGs are not supported by the facts.



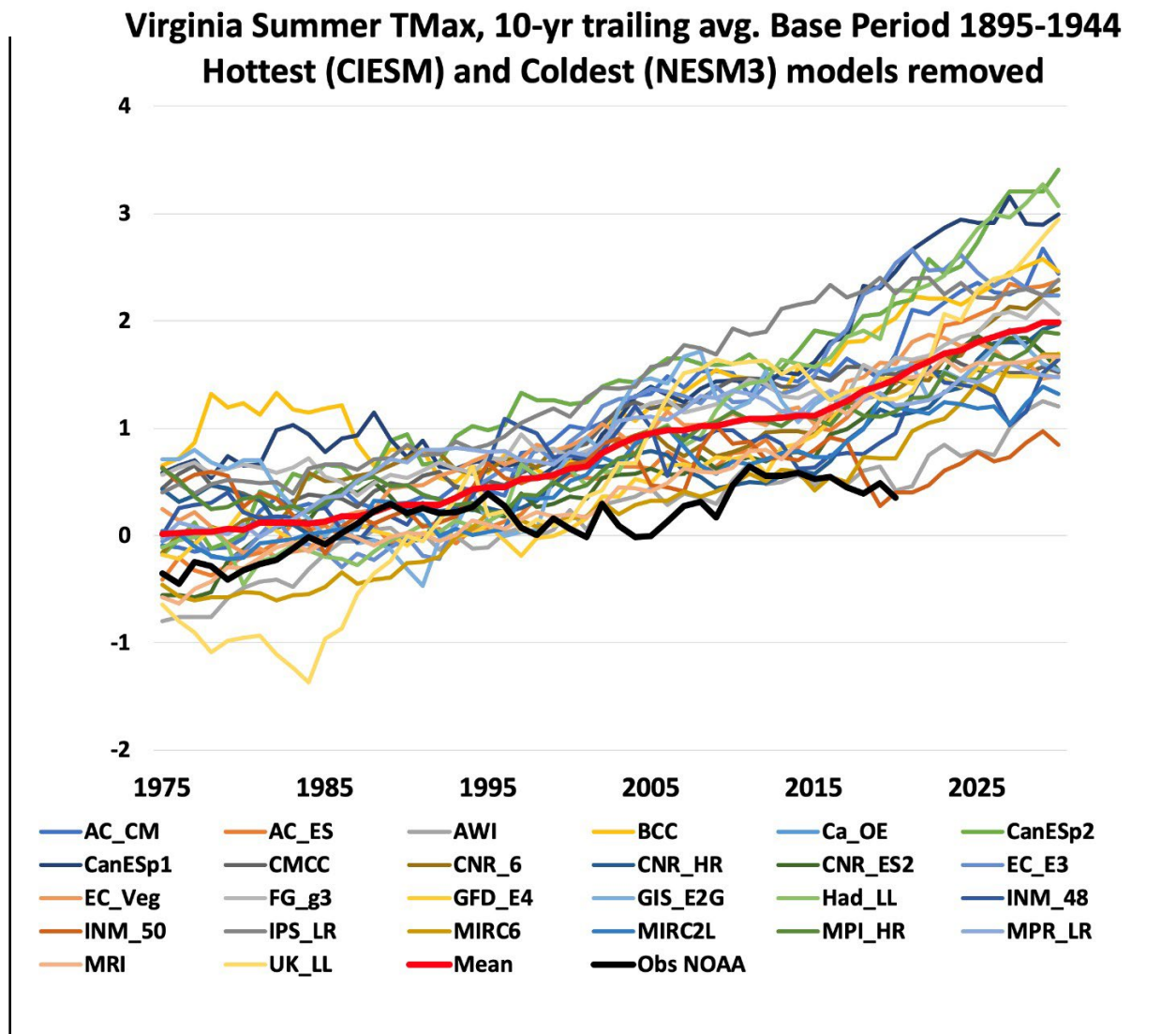
*Figure 11. USHCN days per year in heatwave, on a per-station basis. The parameter is essentially the same as used in the NCA4 - Russo et al. 2014. The days within “heatwaves” which were periods of at least 7 consecutive days in which the daily TMax exceeded the 90%tile value for that day.*

### *Virginia Temperature in Future Context*

The various “National Assessments” of climate change impacts on the U.S. or the Scientific Assessments of the United Nations’ Intergovernmental Panel on Climate Change (IPCC) all rely upon models to estimate future climate. (Indeed, the EPAs 2009 “Endangerment Finding” from carbon dioxide and other greenhouse gases is also exclusively model-based). The “clean energy” programs adopted by Virginia also rely on these climate models to project a future dangerous rise temperatures to justify imposing increasing taxation and regulations.

Consequently, when weighing the advisability of Virginia’s participation in these schemes, it is advisable to see how Virginia temperatures are performing compared to the latest suite of climate models that will populate the completed version of the upcoming (2022) sixth Assessment. This model group is called the CMIP-6 suite<sup>15</sup>.





*Figure 12 - Predicted (CMIP-6 colored lines) versus observed (USHCN) summer temperatures in Virginia. The solid black line is the Virginia mean, and the solid red is the model mean. Figures are ten-year trailing means. It is clear that there is a continuing and increasing disparity between models that form the rationale for “clean energy” programs and the observed Virginia summer temperatures. Illustration from John Christy, State Climatologist for Alabama.*

As is shown in Figure 12, predictions from the climate models, which are the rationale for Virginia’s climate programs, have systematically over-predicted Virginia warming in recent decades. If the basis for implementing RGGI and VCEA is so systematically flawed, these models should have no place in formal debate on Virginia’s climate policies. Put simply, the latest (and presumably best) generation of climate models provides no reliable information about Virginia’s future temperature. To “Follow the Science” is to admit that the climate models provide no reliable clues for near-term Virginia temperatures.

## Virginia Precipitation and Drought

Virginia precipitation data<sup>16</sup> is very noisy (as is most statewide precipitation data in the U.S.) and show no obvious trend that maps on to global temperature anomalies.

Global temperatures began the second rise of the 20<sup>th</sup> century in the mid-1970s, but Virginia precipitation does not show any trend until the turn of the 21<sup>st</sup> century and that is much too short of a time period to draw any conclusive judgements on future trends (Figure 13).

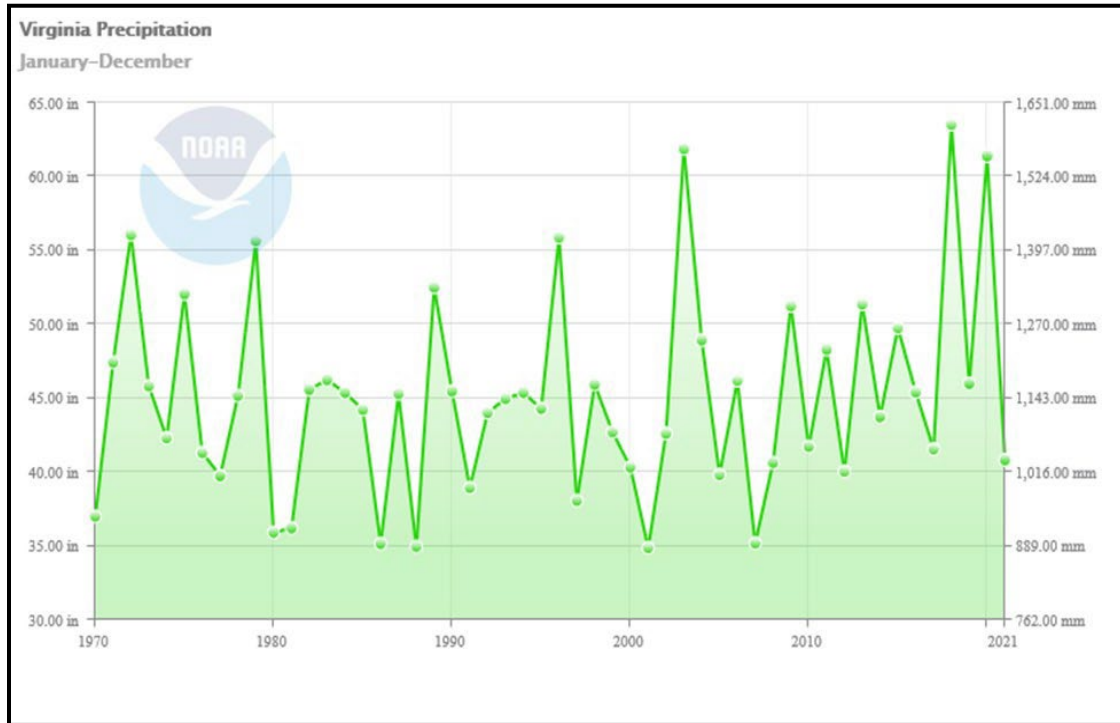


Figure 13 - Virginia annual precipitation data since 1970 (NCEI 2021)

Virginia drought is a much different story and is consistent with the regional and global “greening” that has been detected by satellites for nearly fifty years.

There are many ways to estimate drought, but the most durable are the various versions of the integrated Palmer Drought Indices, developed in the mid-20<sup>th</sup> century, and extensively used by state and federal agencies tasked with monitoring moisture conditions.

The extreme droughts of the 1930s are evident in data for Virginia (Figure 14), but what is more interesting is the propensity for moisture surplus, indicated by the green bars, beginning in the late 1960s and continuing until today. *In other words, the warming of the Virginia record correlates with an improvement in moisture status statewide.* This is especially beneficial for Virginia’s heavily forested landscapes and large agricultural industry.

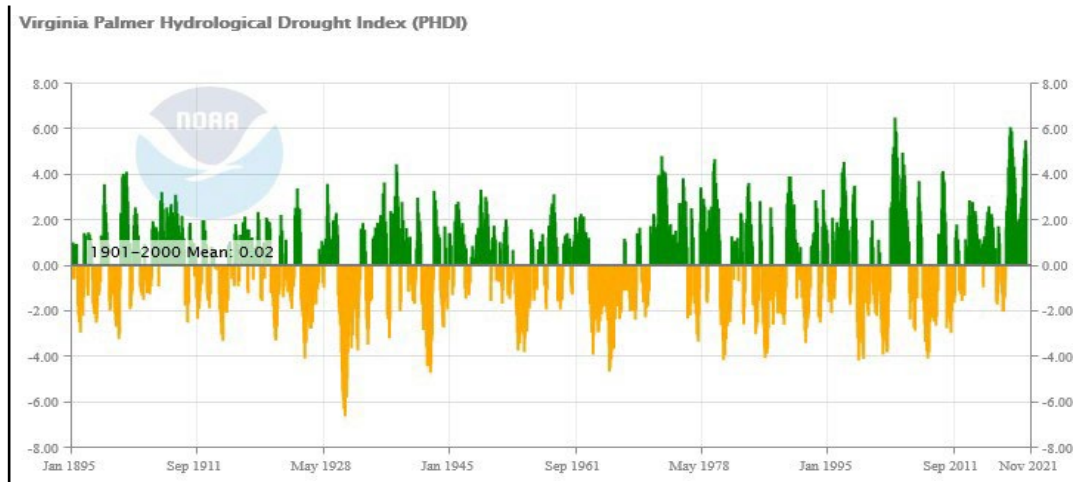


Figure 14 - Monthly Palmer Hydrologic Drought Index (PHDI), 1895-present.

*Brown values indicate moisture deficit, while green ones indicate moisture surplus<sup>15</sup>.*

In the following section, we discuss the positive effect of increasing CO<sub>2</sub> on plant growth via CO<sub>2</sub> fertilization. However, another benefit of more carbon dioxide is that plants require less water to thrive and survive. More CO<sub>2</sub> means that plants' transpiration process is reduced, leading to less water loss. Since more water stays in the ground, aridity of the soil is reduced.

Our persistent tendency towards moisture surplus remains a propitious feature of Virginia's recent climate.

## Climate Change and Agriculture

Linkage between agricultural decline and supposed carbon dioxide-induced climate change is used as another justification for RGGI and VCEA. The specter of crop failure and hunger are used to create fear of looming food shortages in order to rationalize an embrace of these programs.

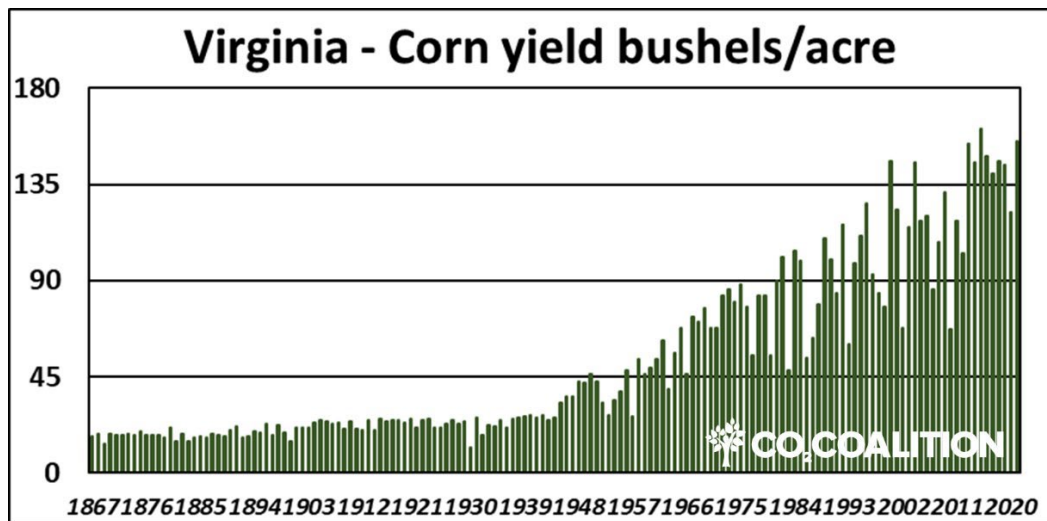
If a CO<sub>2</sub>-fueled rise in temperature was leading to degradation of our food supply, it should be easily recognized in crop-growth records. The facts provide ample evidence that just the opposite is occurring. The combination of modest warming, increasing CO<sub>2</sub> fertilization effect and technological innovation is fueling crop growth both globally and closer to home in Virginia.

A summary of 270 laboratory studies by Dr. Craig Idso<sup>17</sup> of 83 food crops showed that increasing CO<sub>2</sub> concentrations by 300 ppm will increase plant growth by an average of 46% across all crops studied.

This is over and above the remarkable trend in Virginia yields (shown in Figure 15 for corn) that begins in the 1930s with the widespread adoption of hybrid corn,

increasing fertilizer application, and more efficient farming techniques. These include changes in tillage, agricultural machines, and satellite-driven “precision” farming, as well as the direct “fertilization” effect of increasing atmospheric carbon dioxide, as noted by Idso.

What is remarkable is the strongly linear increase in yields, which is characteristic for most crops grown in the U.S. Extraordinary and persistent crop growth increase is not limited to the United States, but extends globally Figure 16).<sup>19</sup>



*Figure 15 – Virginia corn-yield trends are similar to those in the nation as a whole, with the increase beginning in the late 1930s with the widespread adoption of hybrid varieties. Source: USDA<sup>18</sup>*

Conversely, a large number of studies show the adverse effects of a low-CO<sub>2</sub> environment. For instance, Overdieck (1988)<sup>20</sup> indicated that, compared to today, plant growth was reduced by 8% in the period before the Industrial Revolution, with its low concentration of 280 ppm CO<sub>2</sub>.

While it is only common sense that plants thrive in response to higher CO<sub>2</sub> concentrations, it is also relevant that the ancestors of the plants on which we rely first evolved and prospered when CO<sub>2</sub> levels were up to 10 times today’s levels. Therefore, the proposed attempts to reduce CO<sub>2</sub> concentrations would be bad for plants, bad for animals, and bad for humankind.

Agriculture has also benefited from the modest warming of about 1 °C the Commonwealth has experienced over the last 100+ years. Warming temperatures mean that growing seasons are lengthened, allowing additional harvests of hay and silage. Killing frosts end earlier in the spring and arrive later in the autumn.

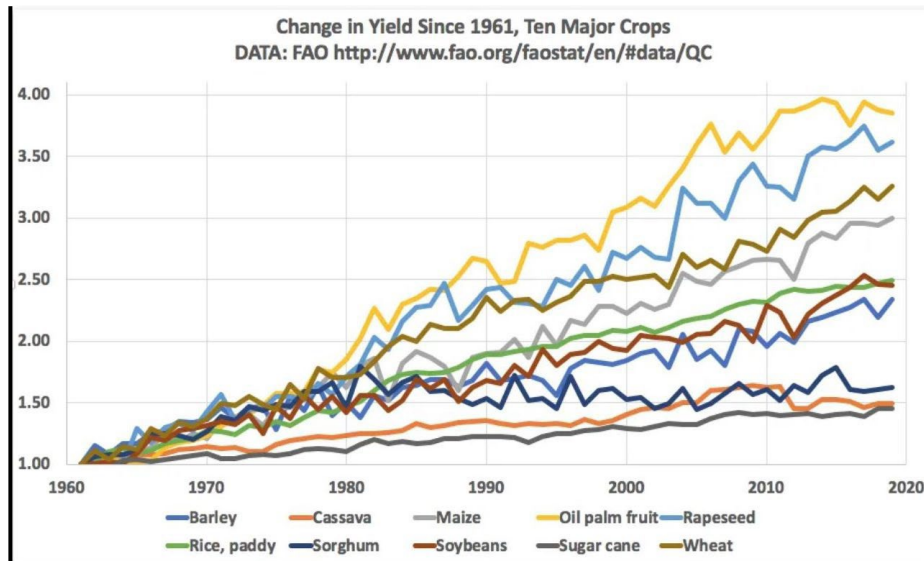


Figure 16 - United Nations FAO (2020) Change in global crop yield since 1961<sup>19</sup>

## Global Tropical Cyclone Activity

With more than 7,200 miles of shoreline, Virginia has justified concerns about hurricanes and the devastation that can be unleashed by these storms. The primary source for cyclone data is from Dr. Ryan Maue who painstakingly developed the global accumulated cyclone energy (ACE) index for all tropical cyclones since detection coverage became uniform with the advent of global satellite coverage in 1970. The data show no increase in either the number of storms or in the energy.

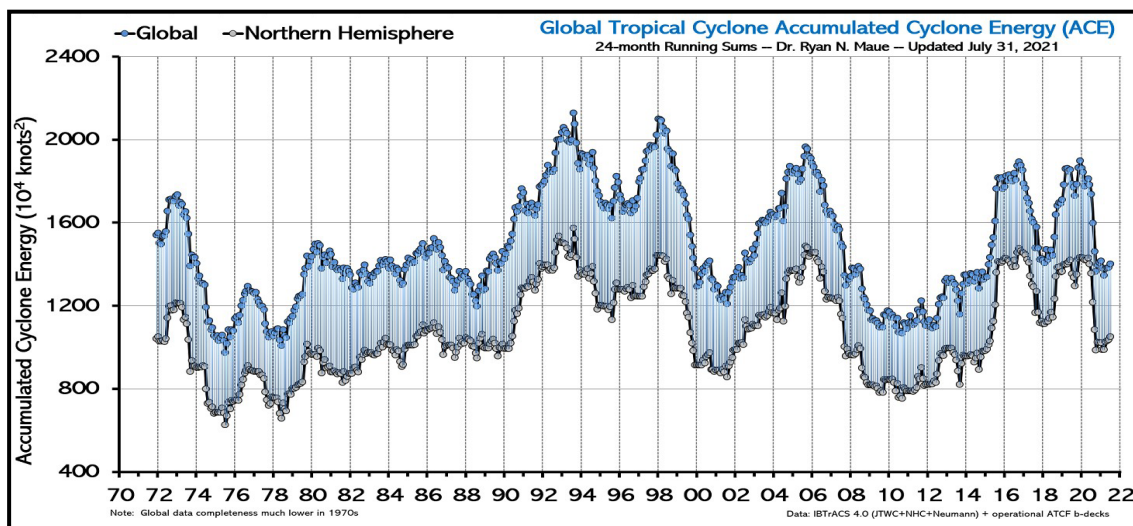


Figure 17 - Annual ACE index back to when satellite coverage becomes universal.

Top figure: Global; Bottom: Northern Hemisphere; Area between: Southern Hemisphere.<sup>21</sup>

Records of landfalling hurricanes in the United States clearly show a decline in these dangerous storms, rather than the increase that is claimed to be occurring.



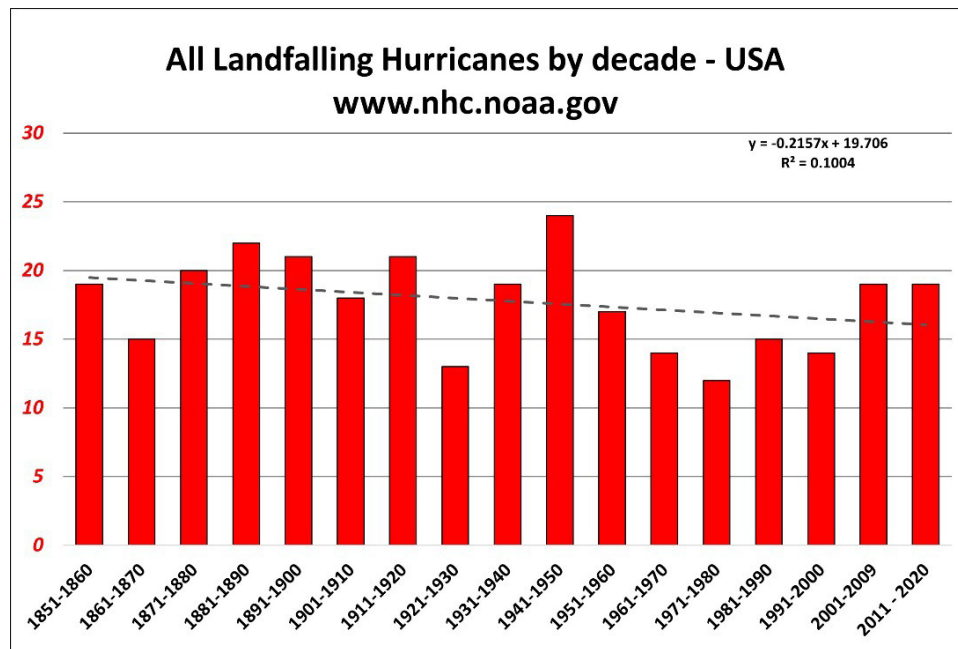


Figure 18 –NOAA National Hurricane Center –  
Decline in USA landfalling hurricanes<sup>22</sup>

As figures 17 and 18 make obvious, there's no relationship between tropical cyclones and global temperature.

### Regional Sea-Level Rise

The longest and most consistent direct measurements of local sea level come from long-term tide gauges in onshore environments. In our region there are three, which are Sewell's Point (tidewater Virginia), Solomon's Island (Maryland portion of Chesapeake Bay) and Washington, D.C.

Global average sea-level rise is determined by a combination of the thermal expansion of water accompanying the approximately one-degree (C) rise in surface temperature and ice-melt from land-based glaciers. Local sea-level rise can have a strong geological component, as is the case in coastal Virginia, where the rise is amplified by the well-documented isostatic rebound along the eastern seaboard responding to glacial melt at the end of the last ice advance. Land-subsidence rates in the mid- and northeast Atlantic coastal regions are between two and five mm/year<sup>21</sup>, which yields 21<sup>st</sup>-century sea level rises of 7.8 to 19.7 inches *from non-climatic processes that cannot be arrested*.

All the tide gauge data from the coterminous U.S. show strongly linear trends. In other words, despite increasing temperatures, *there is no acceleration in sea level rise in the tide gauge records*. Satellite-based findings of an acceleration in sea level rise data are contaminated by sensor changes (different satellites) and

challenged by the behavior of the very large number of independent sensors which are the tide gauges<sup>23</sup>.

Here we show the behavior of the gauge record with the lowest regional rise (Washington, D.C.; 1.13 ft/100 years) as well as the largest (Sewell's Point, VA; 1.55 ft/100 years)<sup>23</sup>.

These two records, which are both nearly 100 years long, show that the rate of warming established at their beginning (the late 1920s) is the same as it is now, despite atmospheric concentrations of CO<sub>2</sub> in the 1920s being only 7% above the 1850 background (compared to 45% today). Virginians have easily adapted to and prospered with rises in sea level of up to 1.55 feet per century.

It should be noted that the most extreme projections of global sea level rise this century (of 8.2 feet)<sup>24</sup> are based upon a single reference (DeConto and Pollard, 2016)<sup>25</sup> that has been roundly criticized because its temperature model has Antarctica warming at several *times* its observed value.<sup>25</sup>

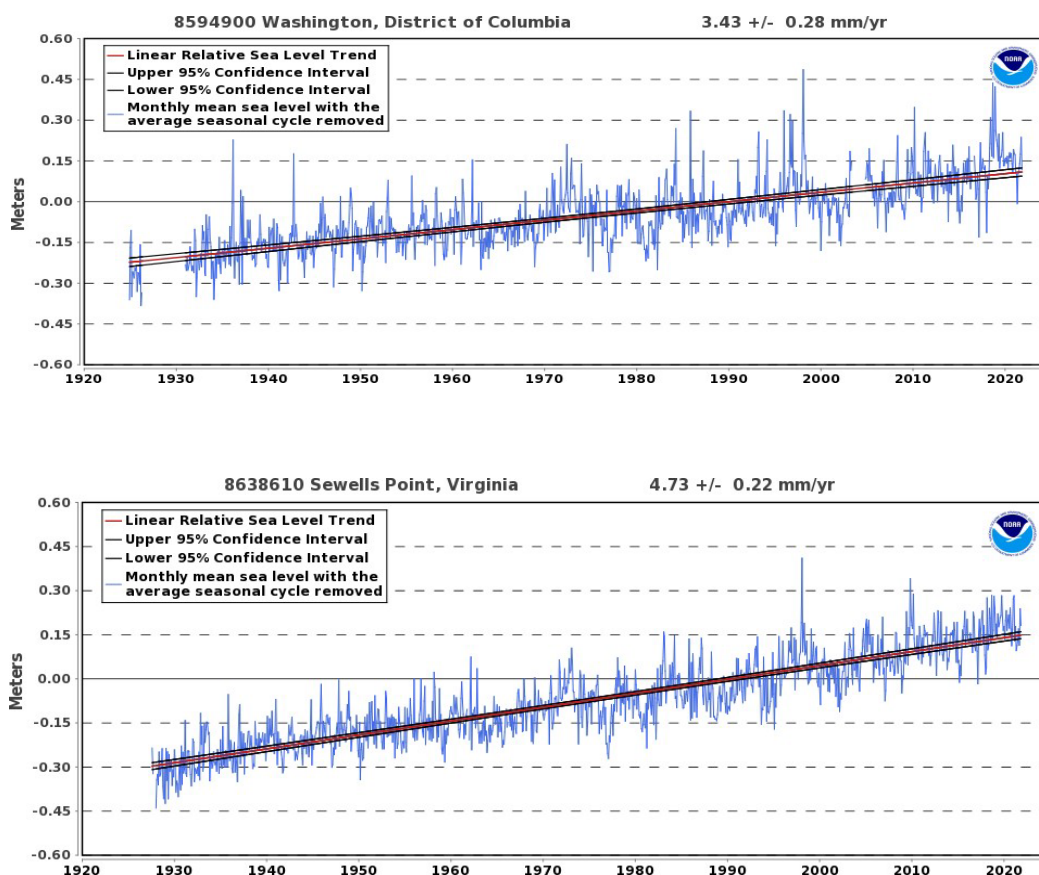


Figure 19 - NOAA tide gauge records from Washington, D.C., (top) and Sewell's Point, VA, are the longest in the region, and show absolutely no acceleration in sea-level rise.

Within this document, we examined several commonly cited reasons for stringent regulation of GHGs relevant to Virginia: the overall proposition that “extreme” weather events are increasing, the facile proposition, spurred by recent stories about the Kentucky tornado outbreak, that climate change is responsible for increases in these storms, the notion of increasing frequency of heat waves, and finally, the proposition that hurricanes will (and are) increasing in power and frequency because of global warming and that sea levels are rising at increasing rates.

None of these are supported by data or science. Virginia policies that claim a basis in these “realities” are in fact not scientifically founded and should be revisited.

### **The climatic futility of Virginia’s proposed emission reductions**

The proposed reductions in GHG emissions in Virginia do nothing measurable concerning climate change, and therefore Virginia’s participation is meaningless. The near-zero effect of the Commonwealth’s emission reductions needs to be assessed in the context of the rapid expansion of global emissions from the developing nations, in particular India, China, Russia and Brazil.

EPA’s standard model to assess the climate implications of policy is the Model for the Assessment of Greenhouse Gas Induced Climate Change (MAGICC). It assumes a varying equilibrium climate sensitivity from 1.5 to 4.5°C (the amount of equilibrium warming from a doubling of atmospheric CO<sub>2</sub>).

MAGICC calculates that if *all* carbon dioxide emissions from the U.S. were set to zero in 2010, and kept at zero until 2100, the amount of global warming “mitigated” (using a climate sensitivity of 2.0) would be 0.104°C. At the same time, it appears that India and China are determined to increase their coal-fired electricity production and, hence their emissions are expected to continue increasing for the next several decades. While they are currently well over twice those of the U.S., they will be around three times our current emissions by the end of the century. Put simply, the U.S. is rapidly on the way to being a minor player in global carbon dioxide emissions.

Looking only at Virginia emissions, the MAGICC simulations (using 2.0 sensitivity) project that a complete elimination of the Commonwealth’s emissions would only avert 0.0021°C by the year 2100. This is far less than the difference in temperature that humans experience every few seconds in a “constant” environment and far below our ability to even measure, a change that is scarcely different from zero. According to MAGICC, Virginia’s attempts to reduce the planet’s atmospheric temperature are climatically meaningless.

<b>Model for the Assessment of Greenhouse-gas Induced Climate Change</b>						
<b>How much temperature rise will be averted by 100% reduction in CO2 emissions?</b>						
<u>Jurisdiction</u>	<u>CO2 emissions by state (2016)*</u>	<u>% of US emissions</u>	<u>Temperature rise averted by decreasing CO2 by 100%</u> (Climate sensitivity of 2.0°C)			
			by 2050 (°C)	by 2050 (°F)	by 2100 (°C)	by 2100 (°F)
United States	5,161.00	100.0%	0.041	0.0738	0.1040	0.1872
Virginia	104.2	2.0%	0.0008	0.0015	0.0021	0.0038

\*Carbon dioxide emission data from U.S. Energy Information Administration

*Figure 20 – Estimated temperature rise averted by complete elimination of CO2 emissions in the United States and Virginia using a climate sensitivity of 2.0°C.*

## Conclusion

This detailed analysis of climate change and its alleged impact on Virginia finds the following to be true and supported by voluminous governmental and peer-reviewed studies concerning the Commonwealth:

- There is no unusual or unprecedented warming
- Heat waves have been declining
- Severe weather is not increasing
- Crop and forest growth are increasing
- Droughts are in decline
- There is no increase in hurricanes
- Complete elimination of carbon dioxide emissions within Virginia will have an impact that is so close to zero that it is meaningless

In short, there is no climate crisis and any attempts to eliminate CO<sub>2</sub> via regulation or taxation are simply “solutions in search of a problem.

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