

# Climate Science and Economics

Kenneth B. Gregory, P. Eng. March 24, 2019

Anthropogenic (human-caused) climate change is a major issue of our time. There has been a great deal of research on both natural and anthropogenic climate change published in the peer-reviewed scientific literature. Unfortunately, governments and most news media rely on a political organization of the United Nations called the Intergovernmental Panel on Climate Change (IPCC) for information and assessments about climate science and policy options. The IPCC relies on climate models that assume all the warming recorded by instruments was caused by human activity despite the overwhelming evidence of large and rapid warming and cooling events before humans could have had any effect on global temperatures. The sun's activity and intensity has increased through the 20<sup>th</sup> century. Its magnetic flux in the 1990s was the greatest of the last 3000 years.<sup>1</sup> The IPCC falsely attributes natural warming and urban warming to greenhouse gas emission warming. It ignores the compelling evidence of natural climate change before 1950 that correlates well with indicators of solar activity.

Current global temperatures are likely similar to that of the Roman Warm Period (1 – 200 AD) and the Medieval Warm Period (800-1100 AD), but much warmer than the Dark Age Cold Period and the Little Ice Age which ended about 1850. The temperature history shows an obvious millennium cycle, which strongly indicates that a large portion of the warming since 1850 was a natural recovery from the Little Ice Age<sup>2</sup>.

Several studies of urban warming show strong correlations between warming and indicators of economic development. McKittrick and Michaels 2017 estimate that about half of the warming over land since 1980 was due to urban warming.<sup>3,4</sup> This urban heat island effect (UHIE)<sup>5</sup> is caused by several processes, including the direct heating by energy use in our cities, the change in the land cover by replacing natural vegetation with roads and buildings, which retains heat and prevents transpiration. Turbulent mixing the warm air aloft by high buildings with the near-surface air at nighttime which raises nighttime temperatures. These effects must be removed from the instrument temperature record to determine the warming effect of human-caused greenhouse gas (GHG) emissions.

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The IPCC ignores the urban warming component of the temperature indexes they use. The IPCC acknowledges and agrees that there is a strong correlation between warming and economic

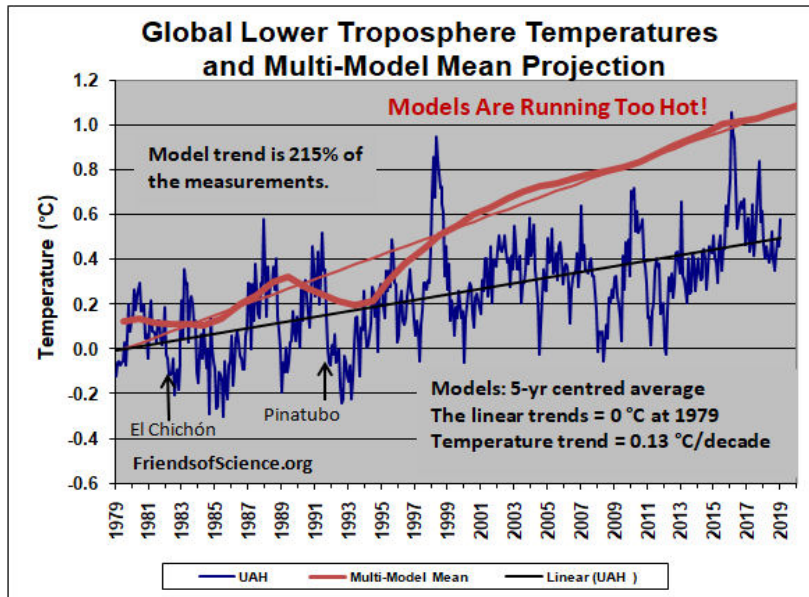
development, but they dismissed the evidence by claiming natural atmospheric circulation changes warmed the cities but not the surrounding country-side, a ludicrous claim.

The most recent energy balance study of climate sensitivity to emissions by Lewis & Curry 2018<sup>6</sup> shows that if all the warming was due to GHG, the expected warming due to all emissions would cause 0.9 °C of warming from 2018 to 2100. Carbon dioxide (CO<sub>2</sub>) causes 90% of GHG warming. This forecast is based on an energy balance calculation that relates the total warming over the last 140 years to the GHG forcing estimates published by the IPCC. However, when the natural warming and the UHIE is accounted for, the effect of CO<sub>2</sub> emissions is projected to cause about 0.6 °C of warming from 2018 to 2100. These estimate assume emissions continue to increase exponentially with no mitigation policies. However, the sun has entered a quiet, less active phase and the natural 65-year ocean cycle is changing to a cooling phase, so the projected CO<sub>2</sub> warming may be fully offset by natural cooling forces for the next 25 years.

The direct radiative warming effect of CO<sub>2</sub> emissions from fossil fuel use is well understood by climate scientists. An increase of CO<sub>2</sub> in the air from 0.041% in 2018 to 0.064% in 2100 is expected to cause about 0.60 °C of warming<sup>7</sup> in that 82-year period assuming no other factors change, such as the amount of water vapor, clouds, snow and ice cover, and natural climate change. The average of the climate models increases this warming to 1.2 °C by assuming water vapour, a strong greenhouse gas, increases in the upper atmosphere and clouds change to enhance warming. But the weather balloon measurements from NOAA show water vapour declining in the upper atmosphere, allowing heat to escape to outer space. News media stories and many official reports rely on a extremely high emissions IPCC scenario called RCP8.5. This scenario assumes coal use increases ten-fold and CO<sub>2</sub> concentrations reach 0.094% (936 ppm) by 2100, which is way above an exponential extrapolation of the recent history. This is an near-impossible emissions scenario. It's not going to happen. It is used only to scare people.

The IPCC ignores natural climate change other than the change in the total solar irradiance (TSI), which is the heat output of the sun. This change is small, but the IPCC ignores the evidence that the sun's impact on climate is much larger than what can be explained by the sun's TSI change. The conduct of the IPCC in this regard is contrary to fundamental scientific principles. Science requires that theory is tested against observational evidence, and where there is disagreement, the theory must be modified.

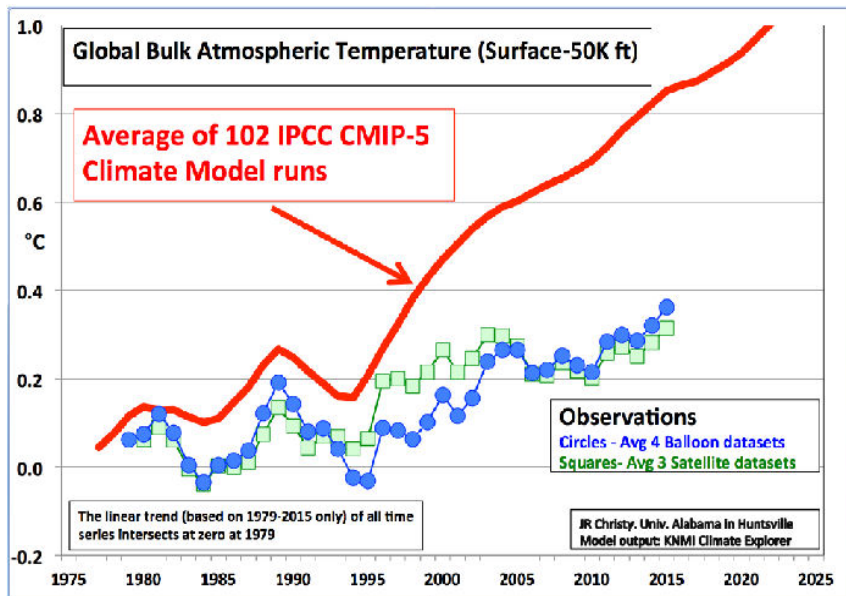
The large solar effect may be due to the sun's changing magnetic field carried by the solar wind which has a significant effect on cloud cover by affecting the creation of tiny aerosol particles that seed cloud formation, and large changes in the ultraviolet radiation that affects stratosphere temperatures, that eventually affects surface temperatures.<sup>8</sup> Natural climate change also includes long-term ocean oscillations, volcanic activity and other processes.



The average of the climate models project a warming trend of the lowest part of the atmosphere from 1979 to 2018 that is 215% of the actual measurements, so the models are wrong. The model trend of the global bulk atmospheric temperature is 250% of the trends of the weather balloon and satellite data. This is because the models are far too sensitive to greenhouse gases. The bulk atmosphere warms

more than the surface in the models because they increase water vapour in the upper atmosphere, while the measurements from weather balloons and satellites show declining

water vapour.



FUND is an economic model that simulates the welfare impacts of greenhouse gas emissions in various regions of the Earth.<sup>9</sup> It forecasts the wealth growth and the economic and social impacts of climate change and CO<sub>2</sub> fertilization of plants. It shows that Canada's personal wealth, or gross domestic product per person (GDP/capita) is

projected to increase from C\$60,550 in 2018 to C\$151,700 in 2100 despite climate change. This is an increase in personal wealth by a factor of 2.5.

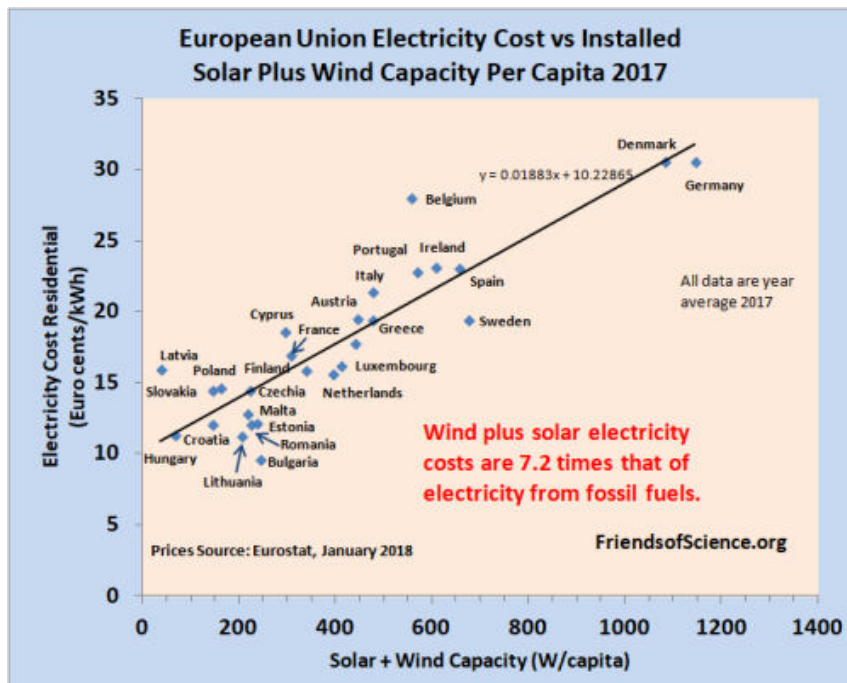
Dr. Richard Tol is an expert in climate economics and co-author of the FUND model. He wrote in his book "Climate Economics" published in 2014 "The impact [in Canada of climate change] is positive throughout the 21<sup>st</sup> century, as are incremental impacts"<sup>10</sup>. He shows the impact continually increases to 1.78% of GDP by 2100, equivalent to over C\$100 billion benefit per

year. The largest benefits for Canada are reduced space heating costs and higher agricultural production.

The Alberta Government relied on a report produced by the US Government to develop their climate plan. That report utilized three economic models to estimate the social cost/benefit of CO<sub>2</sub> emissions (SCC). Two of those models have insignificant benefits of CO<sub>2</sub> fertilization of plants and they fail to account for adaptation. They also assume that all warming is harmful, which clearly is untrue. The FUND model does include CO<sub>2</sub> fertilization and attempt to account for adaptation, but the US Government report authors fudged the SCC higher in the model. They ran all three models using a distribution of possible climate sensitivities to GHG that are far above recent estimates. These factors vastly increases the SCC and makes the results inappropriate for climate policy. Correcting just the climate sensitivity to a recent estimate reduces the calculated SCC from the FUND model by 80%.<sup>11</sup> The Alberta Government projects that their climate plan, which includes shutting down coal-fired power plants and imposing carbon taxes, would reduce atmospheric CO<sub>2</sub> concentrations by 2030 by 0.026 parts per million, thereby reducing global temperatures by 0.00007 °C, which is insignificant.<sup>12</sup>

EDC Associates Ltd. published a study of the potential impact on Alberta's electricity market of Alberta's climate plan. The study finds that the cumulative cost of electricity from 2017 to 2030 is expected to increase by \$3.3 to \$5.9 billion depending on policy choices. The CO<sub>2</sub> reduction would cost \$420/tCO<sub>2</sub>, which is 14 times the current carbon price.<sup>13</sup>

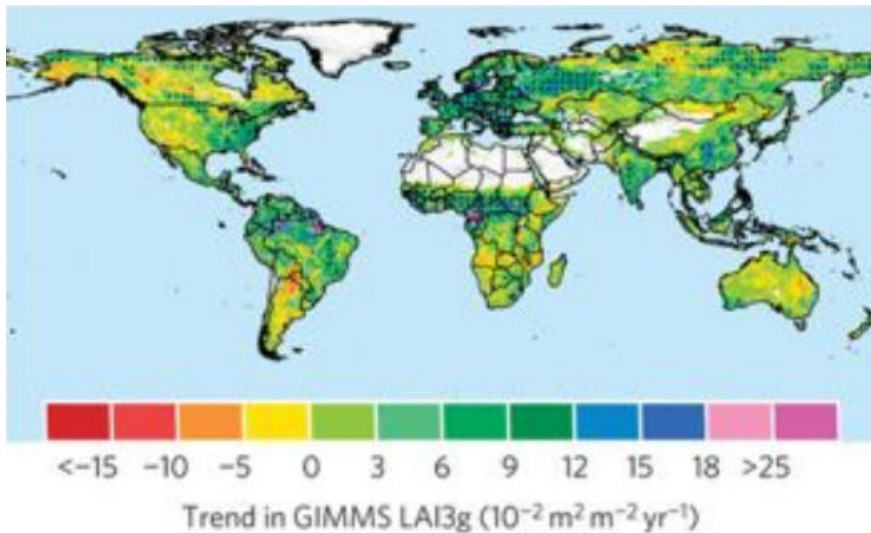
The Alberta government plans to replace inexpensive, reliable and dispatchable electricity from fossil fuels with extremely expensive and unreliable electricity from wind and solar electricity,



which requires near 100% backup with natural gas fired power plants. The extreme variability of renewable power requires the backup power plants to rapidly ramp their power output up and down to offset the variable output of wind and solar power. This enormously increases the cost of the backup power and causes increased CO<sub>2</sub> emissions per unit of electricity produced. In Europe, electricity prices

are highly correlated with the amount of solar and wind on the grid, with prices in Denmark and Germany about 3 times higher than in Hungary, which has little wind and solar power. The relation implies that the cost of wind and solar power in Europe is 7.2 times the cost of power from fossil fuels.

Warming and CO<sub>2</sub> fertilization benefits the agriculture industry as CO<sub>2</sub> is plant food and warming increases the area of arable lands and promotes growth. A study of CO<sub>2</sub> fertilization on crops shows a global economic benefit of over the 50-year period 1961-2011 of US\$4.0 trillion. The annual benefit in 2011 was US\$176 billion (2018 dollars).<sup>14</sup>



Studies of satellite imagery shows that the world has greened due to CO<sub>2</sub> emissions. A study published in 2016 shows a widespread increase of growing-season leaf area, with the CO<sub>2</sub> fertilization effect explaining 70% of the observed greening trend. The greening over 33 years is equivalent to adding a green continent

2/3 times the size of mainland USA.<sup>15</sup>

The Canadian death rate in January is more than 100 deaths/day greater than in August. Similarly, the USA death rate in January and February is more than 1000 deaths per day greater than in July and August.<sup>16</sup> Dr. Peiser wrote “Britain’s leading medical experts have calculated that a rise of the average temperature by two degrees Celsius over the next 50 years would increase heat-related deaths in Britain by about 2,000 – but would reduce cold-related deaths by about 20,000. In other words, the decrease in the number of cold-related deaths would be much more significant (by a factor of 10) than the heat-related deaths due to rising temperatures.” A major study published in 2015 examined 74 million deaths worldwide from 1985 to 2012 and found that the ratio of cold-related to heat-related deaths was a whopping 17 to 1.<sup>17</sup> It appears that much of these health benefits of warming are not included in economic models of climate change.

*The annual global benefit of greenhouse gas emissions may be around US\$3 trillion/year by 2100.*

On a global basis, the FUND model (Julia version) calculates that the net annual benefit of GHG emissions and warming from 1900 is around US\$3 trillion/yr at 2100, or 0.85% of global GDP assuming an equilibrium climate sensitivity of 1.0 °C to a doubling of CO<sub>2</sub> in the atmosphere with 1.3 °C of warming from 2018. That is, global warming to 2100 is likely net beneficial.

So why are we putting a huge burden on ourselves to prevent a benefit to the extremely wealthy people of the future? If the economic forecasts are correct and future Canadians in 2100 will be 2.5 times wealthier than us today, they can afford to pay for adaptation measures if and when temperatures increase to levels that start to cause damages.

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<sup>1</sup> "A 3,000-Year Record of Solar Activity", <http://www.co2science.org/articles/V17/N32/C1.php>

<sup>2</sup> The natural warming is estimated at 0.084 °C/century, however, this is very uncertain.

<sup>3</sup> Quantifying the Influence of the Urban Heat Island Effect, <https://friendsofscience.org/index.php?id=250>

<sup>4</sup> New Study Shows NOAA Overestimate US Warming By 59% due to poor siting of weather stations, <https://friendsofscience.org/index.php?id=2193>

<sup>5</sup> The UHIE is calculated at 0.101 °C over 1980 – 2003.

<sup>6</sup> "The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity" (Lewis&Curry 2018), <https://www.nicholaslewis.org/the-impact-of-recent-forcing-and-ocean-heat-uptake-data-on-estimates-of-climate-sensitivity/>, it determines a best estimate of TCR = 1.2 °C.

<sup>7</sup> Assuming that CO<sub>2</sub> concentrations continues to increase at the same exponential rate as the last 20 years, which was 0.55% per year. Direct ECS = 1.16 °C, direct TCR = 0.93 °C.

<sup>8</sup> "Force Majeure: The Sun's Role in Climate Change, Henrik Svensmark, <https://www.thegwpc.org/content/uploads/2019/03/SvensmarkSolar2019-1.pdf>

<sup>9</sup> FUND - Climate Framework for Uncertainty, Negotiation and Distribution, <http://www.fund-model.org/>

<sup>10</sup> "Climate Economics" by Richard S.J. Tol, Edward Elgar Publishing Limited, 2014, page 89-90.

<sup>11</sup> Empirically-Constrained Climate Sensitivity and the Social Cost of Carbon", Dayaratna et al 2017, [http://www.rossmckitrick.com/uploads/4/8/0/8/4808045/empirical\\_scc\\_cce\\_preprint.pdf](http://www.rossmckitrick.com/uploads/4/8/0/8/4808045/empirical_scc_cce_preprint.pdf)

<sup>12</sup> "Alberta's Climate Plan: A Burden with No Benefit", <https://friendsofscience.org/index.php?id=2230>

<sup>13</sup> "The Economic Impact on the Alberta Electricity Market of the Climate Plan ", <https://friendsofscience.org/index.php?id=2275>

<sup>14</sup> "The Positive Externalities of Carbon Dioxide: Estimating the Monetary Benefits of Rising Atmospheric CO<sub>2</sub> Concentrations on Global Food Production", <http://www.co2science.org/education/reports/co2benefits/co2benefits.php>

<sup>15</sup> "Greening of the Earth and its drivers", <https://www.nature.com/articles/nclimate3004>

<sup>16</sup> "Winters not Summers Increase Mortality and Stress the Economy", [https://friendsofscience.org/assets/documents/Excess\\_Winter\\_Mortality.pdf](https://friendsofscience.org/assets/documents/Excess_Winter_Mortality.pdf)

<sup>17</sup> "Health Effects of Global Warming" <https://www.cato.org/blog/global-science-report-health-effects-global-warming>