The Canadian Climate Model's Epic Failure

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The Canadian Centre for Climate Modeling and Analysis located at the University of Victoria in British Columbia submitted five runs of its climate model CanESM2 for use in the fifth assessment report of the International Panel on Climate Change (IPCC). The climate model produces one of the most extreme warming projections of all the 30 models evaluated by the IPCC. (See Note 1.) The model badly fails to match the surface and atmosphere temperature observations, both globally, regionally, as presented in six graphs. This is an update of a report dated May 2014 to include 2015 annual data.

Global Trends

The graph below compares the near-surface global temperatures to the model runs.

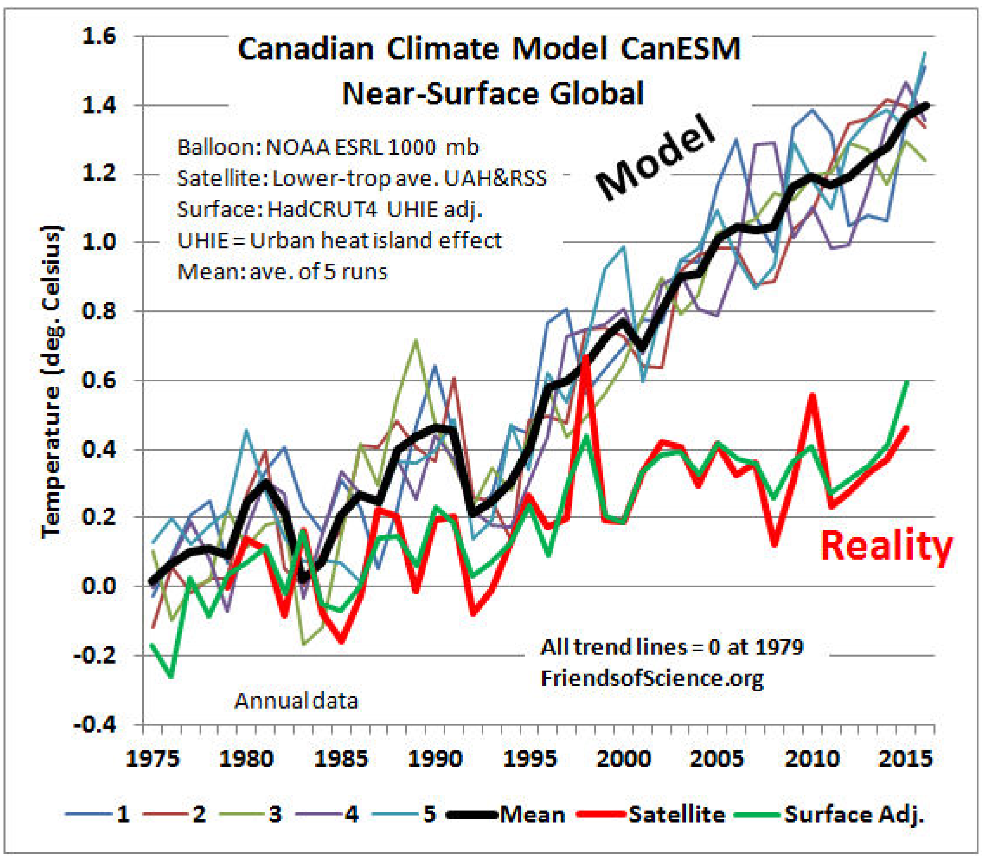

Figure 1. Canadian climate model simulations of near-surface global temperatures and two datasets of observations; surface weather stations adjusted for urban warming, and lower troposphere temperatures from satellite data.

The five thin lines are the climate model runs. The thick black line is the average (mean) of the five runs. The satellite data in red is the average of two analysis of lower troposphere temperature; from the University of Alabama in Huntsville and Remote Sensing Systems. The surface data is the HadCRUT4.5 dataset, adjusted by an urban heat island (UHI) adjustment of 0.042 °C/decade starting in 1981. (See Note 2 for the data sources. See Note 3 for the UHI adjustment.) The best fit linear trend lines (not shown) of the model mean and all datasets are set to zero at 1979, which is the first year of the satellite data. We believe this is the best method for comparing model results to observations. All trends are 1979 to 2015.

Any computer model that is used to forecast future conditions should reproduce known historical data. A computer climate models that fails to produce a good match to historical temperature data cannot be expected to give useful projections.

Figure 1 shows that the computer model simulation produces too much warming compared to the observations. The discrepancy between the model and the observation increase dramatically after 1995 as there has been no global near-surface warming from 1997 through 2014. An El Nino started in 2015 causing a temperature uptick. Most El Ninos are followed by a cooling La Nina, and it remains to be seen if one develops in 2017. With the model and observation trends set to zero in 1979, the discrepancy between the model mean trend of the near-surface global temperatures and the surface observations trend by 2015 was 0.86 °C. This discrepancy is larger than the 0.8 °C estimated global warming during the 20th century. The model temperature warming trend as determined by the best fit linear line from 1979 to 2015 through the model mean is 0.360 °C/decade, and the average trend of the two observational datasets is 0.121 °C/decade. Therefore, the model temperature warming rate is 297% of the observations.

The large errors are primarily due to incorrect assumptions about water vapor and cloud changes. The climate model assumes that water vapor, the most important greenhouse gas, would increase in the upper atmosphere in response to the small warming effect from CO_2 emissions. A percentage change in water vapor has over five times the effect on temperatures as the same percentage change of CO_2. Contrary to the model assumptions, radiosonde humidity data show declining water vapor in the upper atmosphere as shown in this graph.

The individual runs of the model are produced by slightly changing the initial conditions of several parameters. These tiny changes cause large changes of the annual temperatures between runs due to the chaotic weather processes simulated in the model. The mean of the five runs cancels out most of the weather noise because these short term temperature changes are random.

The climate model assumes that almost all of the temperature changes are due to anthropogenic greenhouse gas emissions and includes insignificant natural causes of climate change. The simulated weather noise includes the effects of ENSO (El Niño and La Niña), but does not include multi-decadal temperature changes due to natural ocean oscillations or solar-induced natural climate change other than the small changes in the total solar irradiance. The historical record includes the effects of large volcanoes that can last for three years. The projections assumes no large future volcanoes. There has been no significant volcanoes since 1992 that could have affected temperatures as shown in this graph of volcanic aerosols.

The model fails to match the temperature record because the model over estimates the effects of increasing greenhouse gases and it does not include most natural causes of climate change.

Figure 2 compares the mid-troposphere global temperatures at the 400 millibar pressure level, about 7 km altitude, to the model. (mb = millibar. 1 mbar = 1 hPa = 0.1 kPa.)

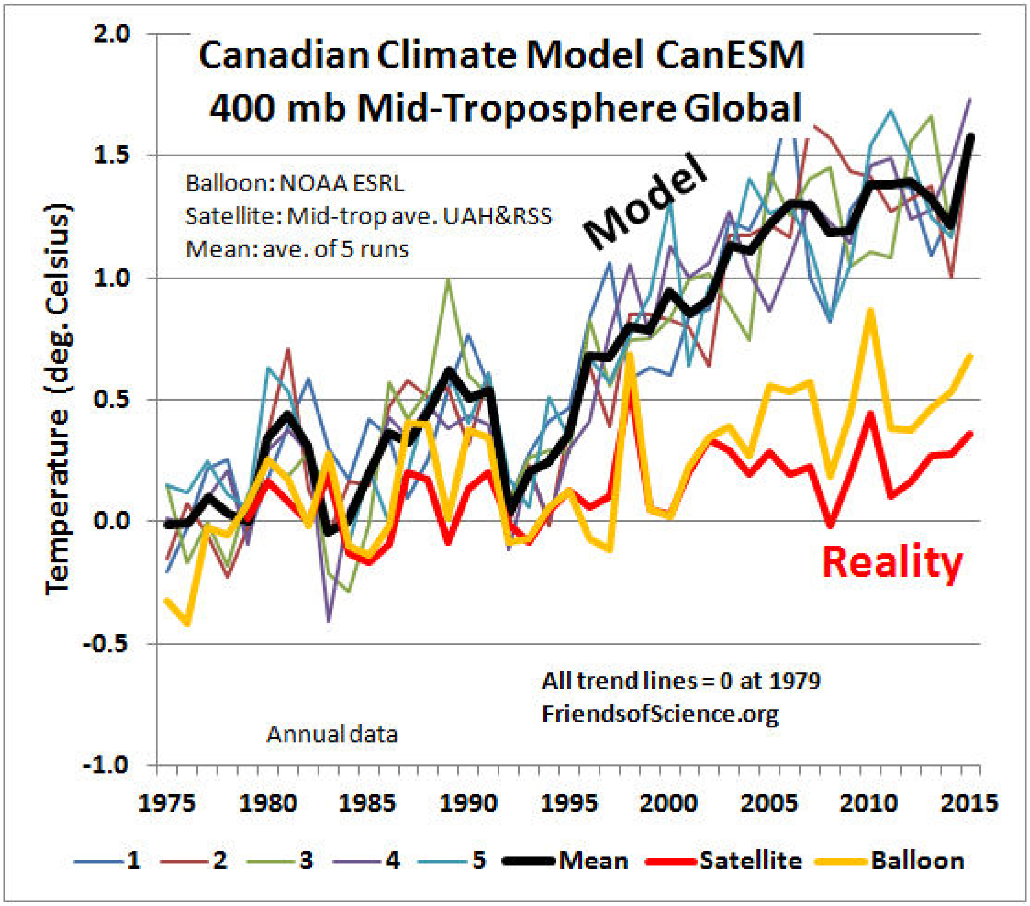

Figure 2. Canadian climate model simulations of mid-troposphere global temperatures and two datasets of observations. The weather balloon data and the model simulations are at the 400 mbar pressure level, about 7 km altitude.

The discrepancy in 2015 between the model mean trend of the global mid-troposphere temperatures and the satellite and weather balloon observation trends were 1.20 °C and 0.96 °C, respectively. The model temperature trend is 532% of the satellite trend, and 373% of the average of the satellite and weather balloon trends.

The satellites measure the temperature of a thick layer of the atmosphere. The satellite temperature weighting function describes the relative contributions that each atmospheric layer makes to the total satellite signal. We compared the balloon trends weighted by the lower troposphere satellite temperature weighting functions to the near-surface observed trends for global and tropical data. Similar comparisons were made for the mid-troposphere. The weighted thick layer balloon trends for the lower and mid-troposphere were similar to the near-surface and 400 mbar balloon trends, respectively. We conclude that the satellite lower-troposphere and mid-troposphere temperature trends are approximately representative of the near-surface and 400 mbar temperature trends, respectively. (See Notes 4 for further information.)

Tropical Trends

Figure 3 compares the near-surface temperatures in the tropics from 20 degrees North to 20 degrees South latitude to the climate model simulations. The model temperature trend is 262% of the average of the three observational trends.

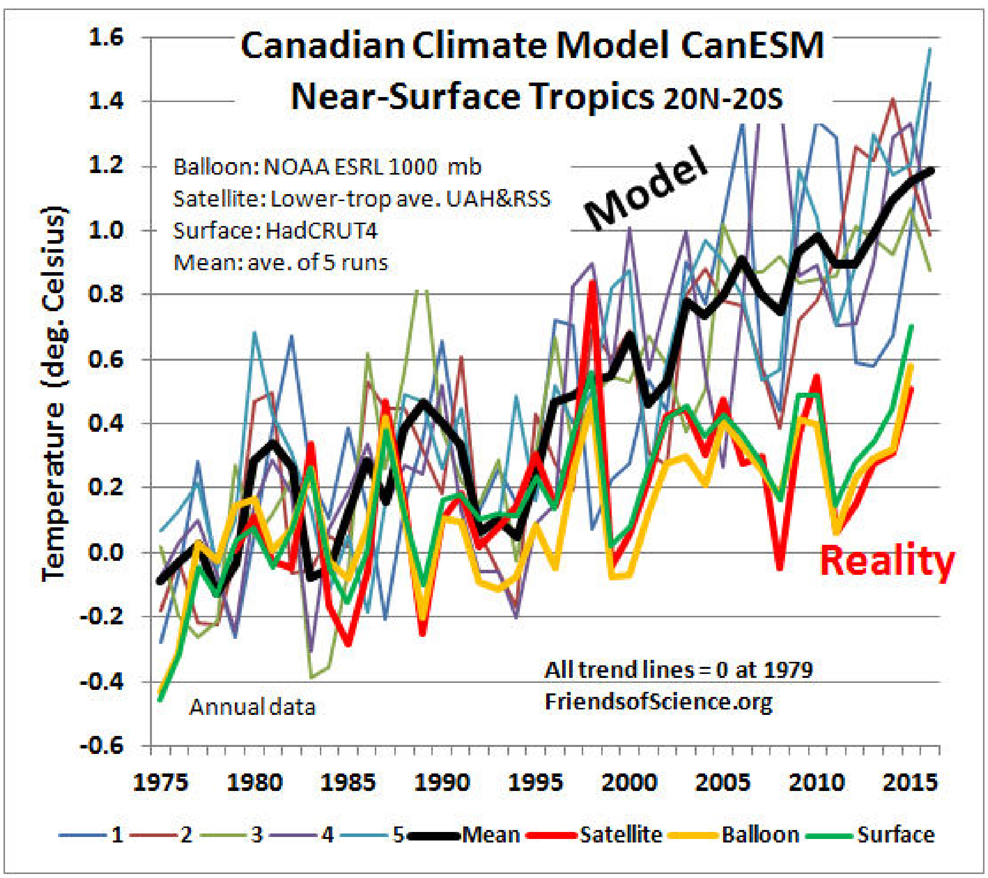

Figure 3. Canadian climate model simulations of near-surface tropical temperatures and three datasets of observations; satellite lower troposphere, 1000 mb weather balloon and surface station data.

No UHI adjustment was applied to the HadCRUT4.5 surface temperature trend as urban development is less than in the global average. The weather balloon data is at the 1000 mb pressure level. The satellite data is of the lower troposphere.

The average temperature trend of the three datasets is 0.106 °C/decade, which is less than the trend of 0.121 °C/decade of the global temperature observations.

Figure 4 compares the warming trend in the tropical mid-troposphere to the observations. The increasing tropical mid-troposphere water vapor in the models makes the warming trend at the 400 mbar pressure level 52% greater than the modeled surface trend.

The discrepancy in 2015 between the model mean trend of the mid-troposphere tropical temperatures and the average of the satellite and weather balloon trends is 1.28 °C. The model temperature trend is 527% of the satellite temperature trend and is 447% of the average of the two observational trends.

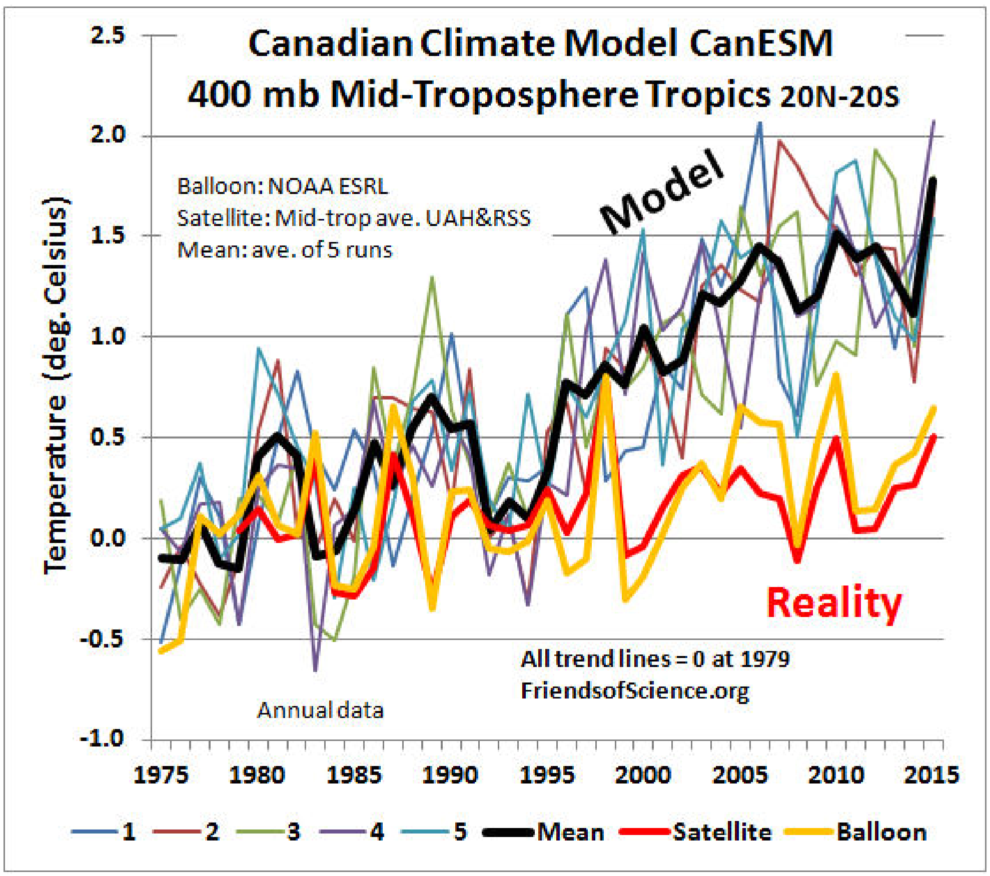

Figure 4. Canadian climate model simulations of mid-troposphere 400 mbar tropical temperatures (about 7 km altitude) and two datasets of observations.

The discrepancy is nearly as large at the 300 mbar pressure level, which is at about 9 km altitude.

Figure 5 compares the model to the balloon temperatures at the 300 mbar pressure level in the tropics. The tropical warming trend at 300 mbar in the model is 369% the model surface trend. In contrast, the temperature trend of the balloon data at 300 mbar is only 19% greater than the surface station trend. The discrepancy in 2015 between the model mean trend of the mid-troposphere tropical temperatures at the 300 mbar level and the balloon observations is 1.44 °C.

The temperature trends (1979 to 2015) of the tropical atmosphere at 7 km and 9 km altitude are an astonishing 389% and 369% of radiosonde balloon data. These are huge errors in the history match!

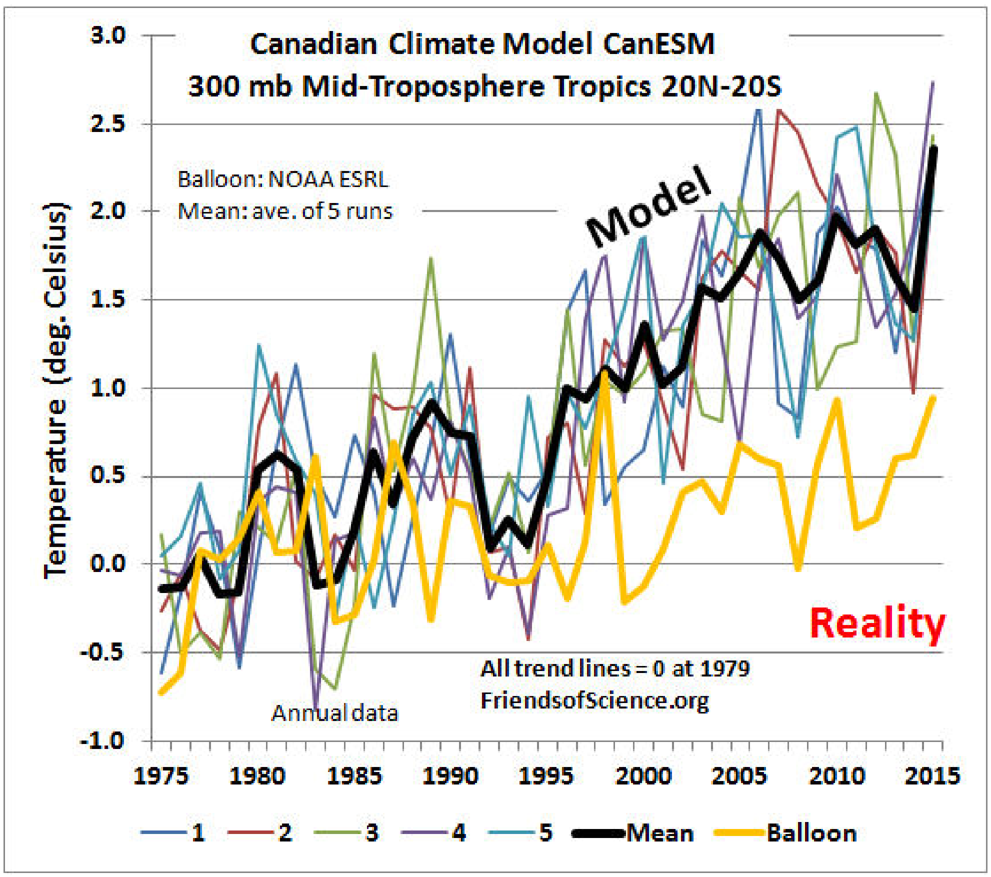

Figure 5. Canadian climate model simulations of mid-troposphere 300 mbar (about 9 km altitude) tropical temperatures and weather balloon observations.

South Trends

In the far south, the near-surface modeled temperature tend is in the opposite direction from the observations. The figure 6 compares the model near-surface temperatures from 50 degrees South to 75 degrees South latitude to the observations. The modeled temperatures from 1979 are increasing at 0.368 °C/decade while the surface temperatures are decreasing -0.063 °C/decade.

Temperatures over most of Antarctica (except the Antarctic Peninsula) have been falling over the last 30 years. The Antarctic sea ice extent linear trend from 2001 through 2015 is increasing 560,000 km^2/decade, see graph here. The sea ice annual extent has been greater than the 1979 to 2008 mean for all of 2012 through 2015 despite rising CO_2 levels in the atmosphere.

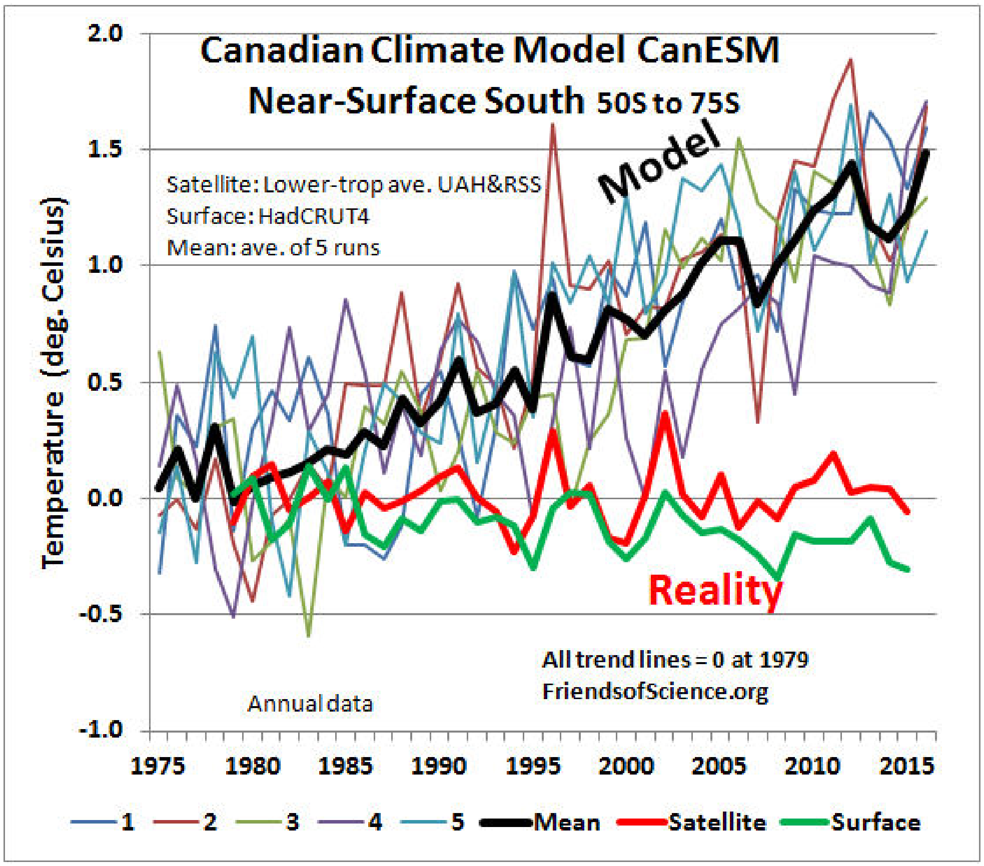

Figure 6. Canadian climate model simulations of near-surface southern temperatures (50 S to 75 S latitude) and two datasets of observations.

Summary of Trend Errors

The table below summarizes the model trend to observation trend ratios.

	Model Trend to Observations Ratios (1979 to 2015)		
	Model/Satellite	Model/Balloon	Model/Surface
Global Surface	305%		290%
Global 400 mb	532%	287%	
Tropics Surface	264%	315%	222%
Tropics 400 mb	527%	389%	
Tropics 300 mb		369%	
South Surface	5723%		-583%

The table shows that discrepancies between the model and observations are larger in the tropics than in the global average. The ratio of the modeled tropical mid-troposphere 300 mbar warming rate to the surface warming rate is 200%, and is a fingerprint of the theoretical water vapor feedback. This enhanced warming rate over the tropics, named the "hot spot", is responsible for 2/3 of the warming in the models. The weather balloon temperature trends at 300 mbar and 400 mbar are 3% and 40% greater than the average surface temperature trend, indicating that there is little positive water vapor feedback, so the projected warming rates are grossly exaggerated.

Model results with large history match errors should not be used for formulating public policy. A model without a good history match is useless and there can be no confidence in its projections. The lack of a history match in the Canadian model output shows that the modeling team have ignored a fundamental requirement of computer modeling.

A global map of the near-surface air temperature from the model for April 2013 is here.

Anti-Information

Patrick Michaels and Paul "Chip" Knappenberger compared the model output to actual 20th century temperature data to determine what portion of the actual data can be explained by the model. They wrote, "One standard method used to determine the utility of a model is to compare the “residuals”, or the differences between what is predicted and what is observed, to the original data. Specifically, if the variability of the residuals is less than that of the raw data, then the model has explained a portion of the behavior of the raw data."

In an article here, they wrote "The differences between the predictions and the observed temperatures were significantly greater (by a factor of two) than what one would get just applying random numbers." They explained that a series of random numbers contain no information. The Canadian climate model produces results that are much worse than no information, which the authors call "anti-information".

The Canadian Model Contributes to Fuel Poverty

The results from the Canadian climate model were used in a U.S. Global Change Research Program report provided to the US Environmental Protection Agency to justify regulating CO_2. The authors of that report were told that the Canadian climate model produces only anti-information. They confirmed this fact, but published their report unchanged. The Canadian government has indicated it will follow the lead of the U.S.A. in regulating CO_2 emissions.

The Canadian climate model is also used by the IPCC to justify predictions of extreme anthropogenic warming despite the fact that the model bears no resemblance to reality. As does the climate model, the IPCC ignores most natural causes of climate change and misattributes natural climate change to greenhouse gas emissions. Here is a list of 123 peer-reviewed papers published from 2008 to 2012 on the solar influence on climate that were ignored by the IPCC in the fifth assessment report. Another 231 papers published from 2014 to the first half of 2016 show the sun-climate link, see here.

Climate alarmism based on climate models that don't work has so far cost the world US$2.7 trillion from 2004 to 2015 in a misguided and ineffective effort to reduce greenhouse gas emissions, here. These efforts have caused electricity prices to increase dramatically in Europe causing fuel poverty and putting poor people at risk. High fuel costs and cold winter weather are blamed for 30,000 excess deaths in Britain in 2013. Germany's household electricity costs have increased from 139.4 to 291.3 Euros/MWh from 2000 to 2014, an astonishing 109% increase, chart here. The Canadian climate model failures has contributed to this misery.

Canadian politicians and taxpayers need to ask why we continue to fund a climate model that can't replicate the historical record and produce no useful information.

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Notes:

1. The Canadian Earth System Model CanESM2 combines the CanCM4 model and the Canadian Terrestrial Ecosystem Model which models the land-atmosphere carbon exchange. Table 9.5 of the IPCC Fifth Assessment Report Climate Change 2013 shows that the CanESM2 transient

climate sensitivity is 2.4 °C (for double CO_2). The 30 model mean transient climate sensitivity is 1.8 °C with a 90% certainty range of 1.2 °C to 2.4 °C.

2. The Canadian climate model CanESM monthly data was obtained from the KNMI Climate Explorer here. The satellite data was obtained from the University of Alabama in Huntsville here (LT) and here (MT), and from Remote Sensing Systems here (LT) and here (MT). The radiosonde weather balloon data was obtained from the NOAA Earth System Research Laboratory here. The global surface data is from the HadCRUT4.5 dataset prepared by the U.K. Met Office Hadley Centre and the Climate Research Unit of the University of East Anglia, here. The HadCRUT4 tropical data (20 N to 20 S) was obtained from KNMI Climate Explorer. An Excel spreadsheet containing all the data, calculations and graphs is here.
3. The HadCRUT4.5 data needs to be corrected for the urban heat island effect. Numerous studies show that the surface station measurements are warmed by the effects of urbanization. We use a study by McKitrick and Michaels 2007 that found that warming is strongly correlated with indicators of economic development and urbanization. Correcting the HadCRUT temperature index trend for the urban warming effect from 1980 to 2002 over land would reduce the trend from 0.27 °C/decade to 0.13 °C/decade. The UHIE over land is about 0.14 °C/decade, or 0.042 °C/decade on a global basis from 1980. See page 11 here.
4. The average global weather balloon trends of all pressure levels from 1000 mbar to 300 mbar weighted by the LT satellite temperature weighting functions is only 4% greater than the balloon trend at 1000 mbar, confirming that the LT satellite trends is representative of the near-surface temperature trend. The weighted average tropical weather balloon trends are 6% greater than the average of the 1000 mbar balloon trend and the surface station trend. The temperature weighting functions for land and oceans were obtained from the Remote Sensing Systems website. The average global and tropical balloon trends of all pressure levels weighted by the mid-troposphere (MT) satellite temperature weighting functions are 15% and 7% greater than the balloon trends at 400 mbar. If the MT satellite trends were adjusted by these factors to correspond to the 400 mbar pressure level, the global and tropical satellite trend adjustments would be -0.008 °C/decade and -0.004 °C/decade, respectively. Since the MT satellite trends are already less than the 400 mbar balloon trends, no adjustments were applied.

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