Global Temperature Due to Carbon-Dioxide and Methane Emissions

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Introduction

The main contributors to Global Warming are the concentrations of carbon dioxide and methane in the atmosphere. The incremental addition to the global temperature due to these two molecules is:

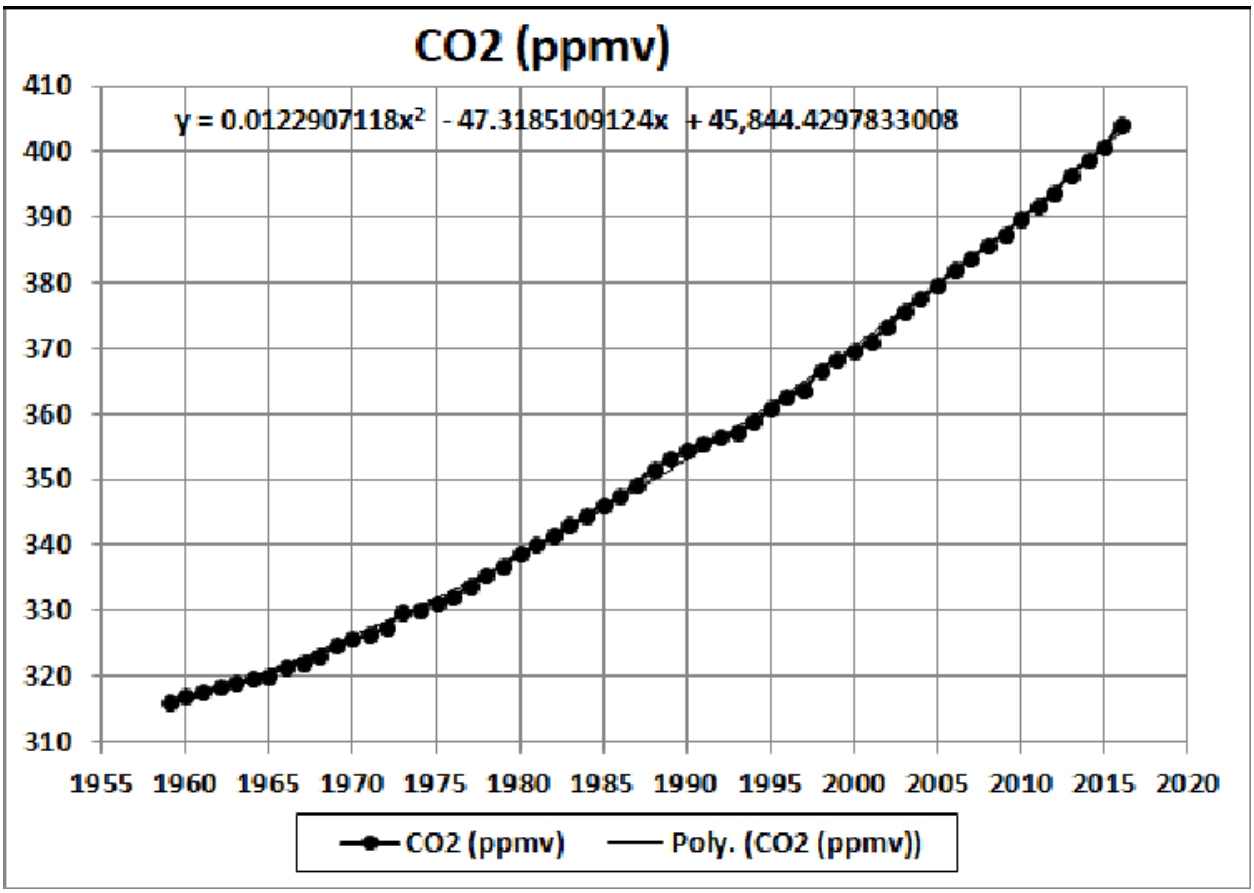
$$\boxed{dT = S_C \ln\left(C_f / C_i\right) / \ln(2) + S_M \ln(M_f / M_i) / \ln(2)} \text{ where}$$

$S_C =$ climate sensitivity for carbon dioxide concentration (C) in the atmosphere and

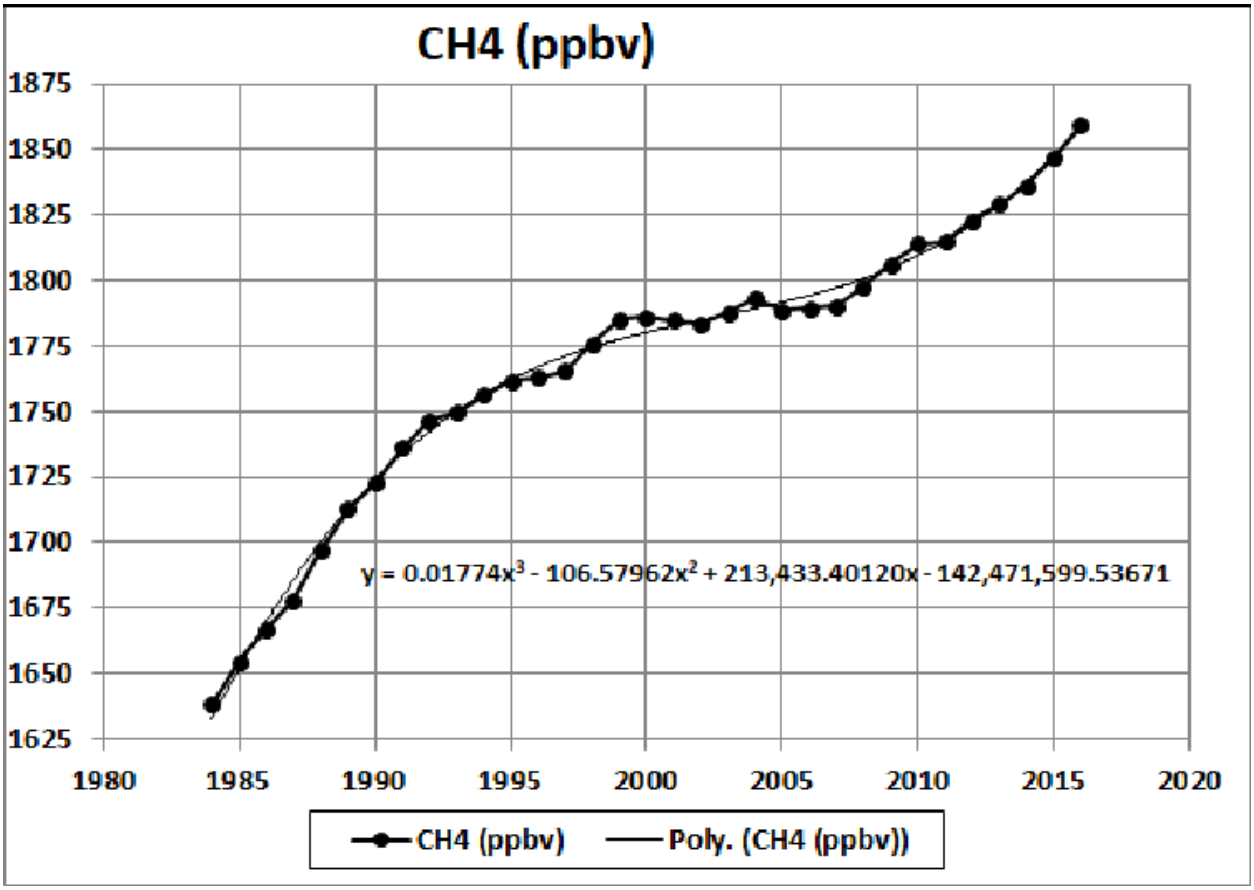
$S_M =$ climate sensitivity for methane concentration (M) in the atmosphere.

Climate sensitivity is the amount the global temperature changes when the concentration of a gas in the atmosphere doubles.

The stratospheric (lower atmosphere) concentrations of carbon dioxide and methane have been measures at the Mauna Loa Observatory in Hawaii.



The equation is a quadratic fit to the data.

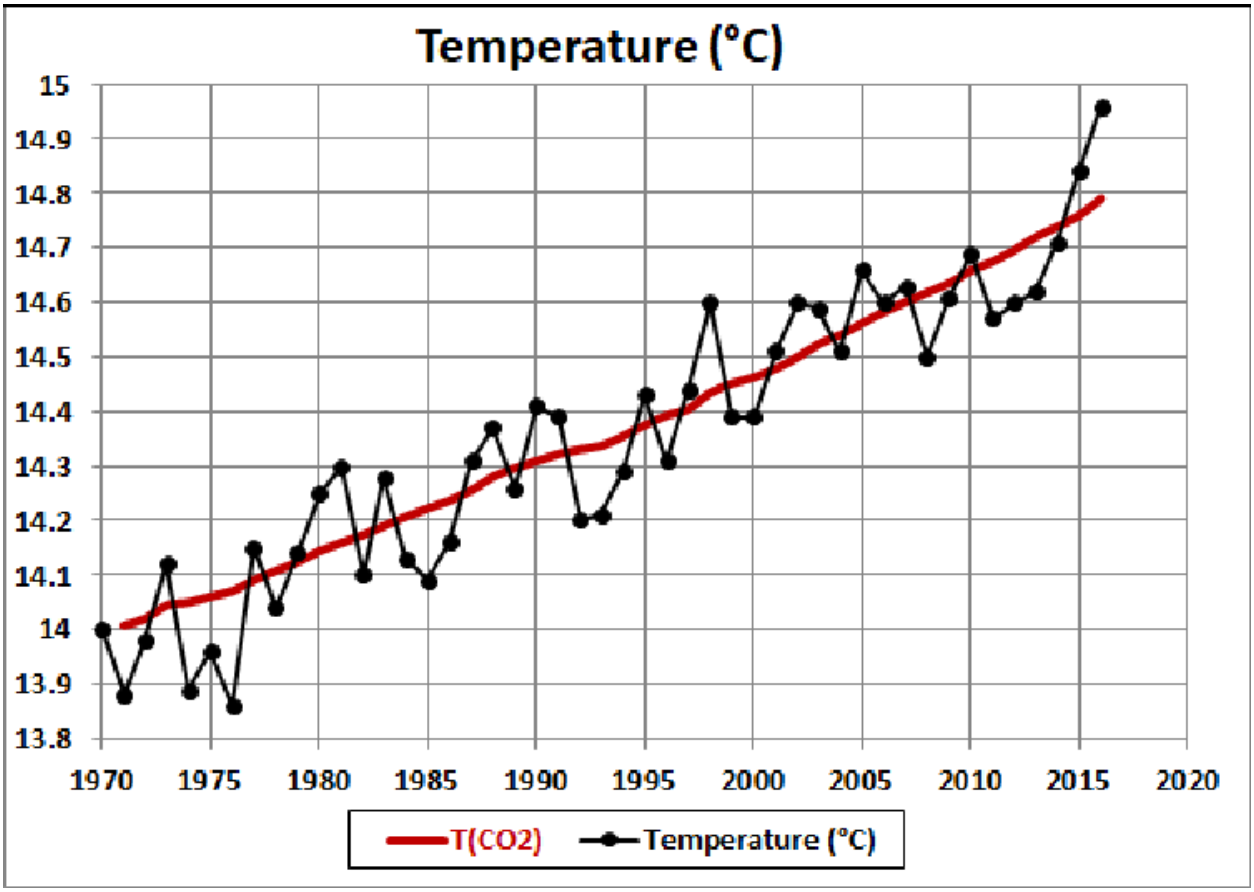


The equation is a cubit fit to the data.

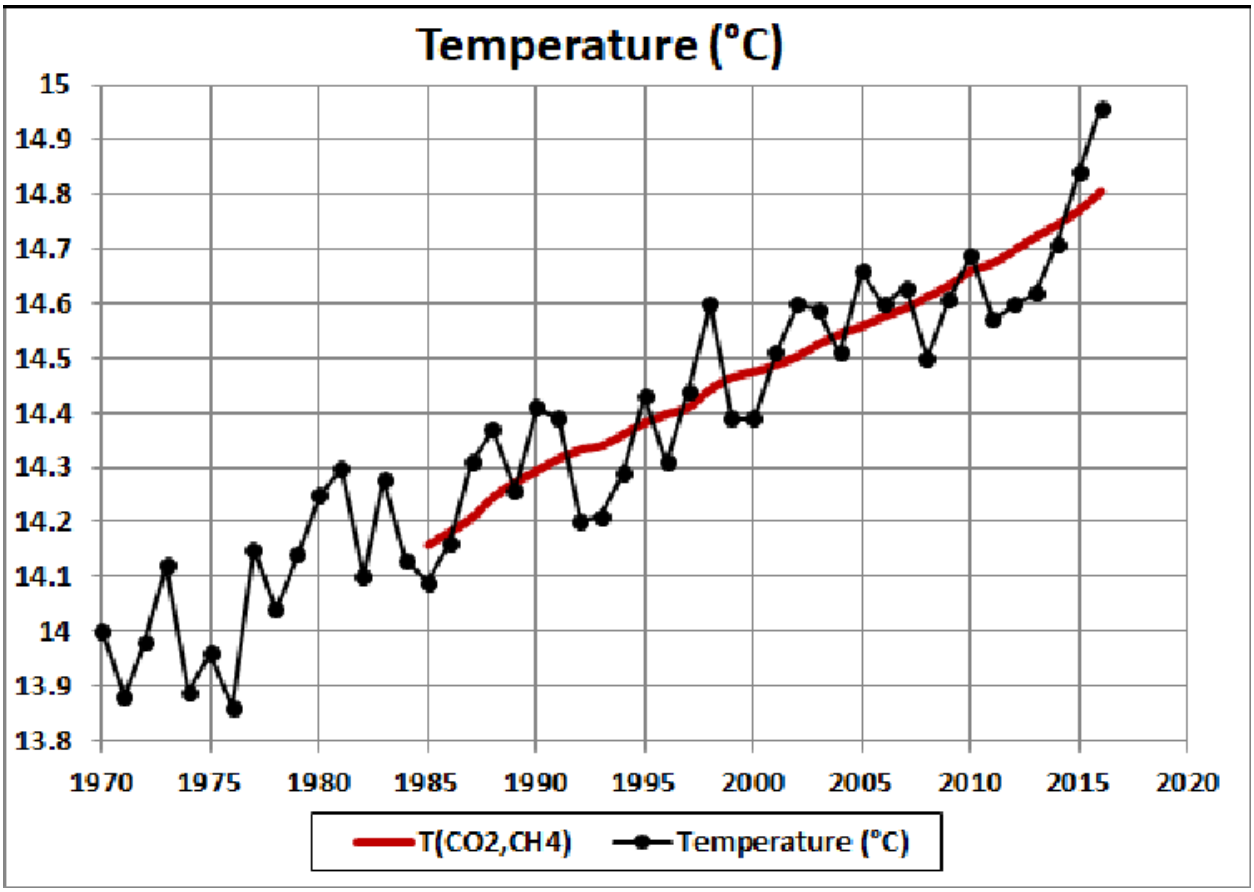
The recent rise in CH4 concentration is probably mostly due to leaks at fracked wells and pipelines and methane emissions from defrosting Arctic permafrost and methane clathrates on northern continental shelves.

Calculating Global Temperature Due to Carbon in the Atmosphere

Since the main contribution to global temperature is the concentration of carbon dioxide in the atmosphere, a fit was done to the global-temperature data using only carbon dioxide ($S_M = 0$). The result is $S_C = 2.536$ and the curve is:

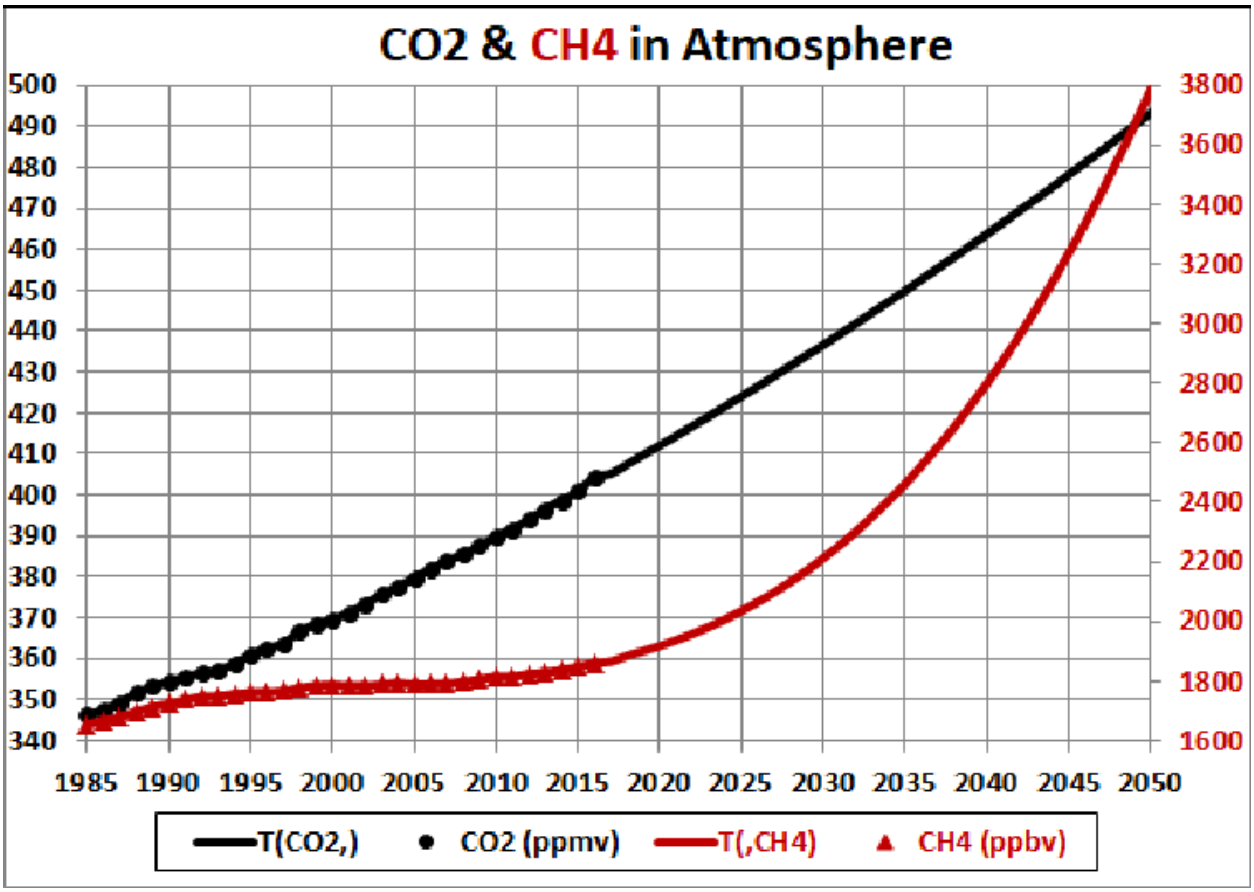


A slightly better fit is obtained by allow S_M to vary with the result S_C = 2.071 and S_M = 1.097:

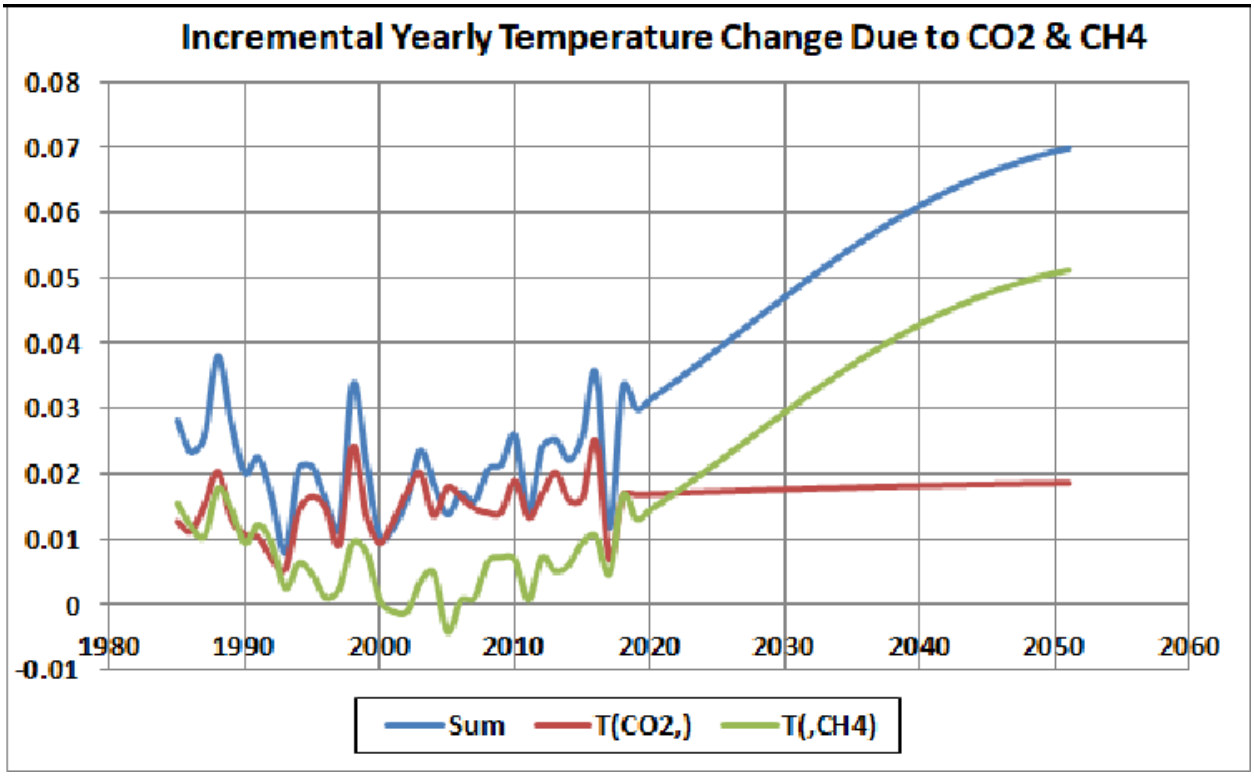


Global-Temperature projection to Year 2050

The quadratic fit to carbon-dioxide concentration and the cubic fit to methane concentration projected to year 2050 are:

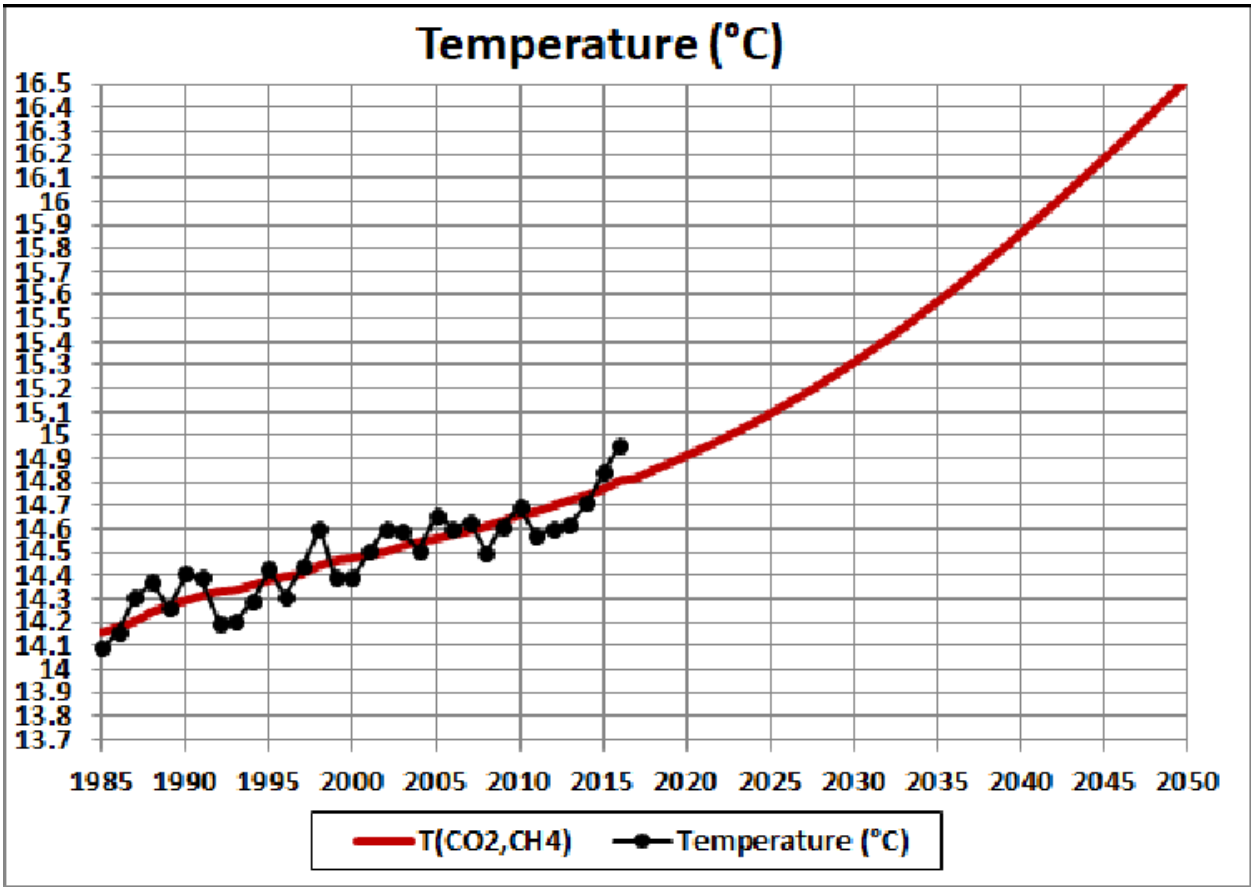


The yearly incremental global-temperature changes due to CO2 and CH4 are:



Thus, although carbon-dioxide has been the dominant driver for global-temperature increase, after ~2020 methane may be the dominant driver!

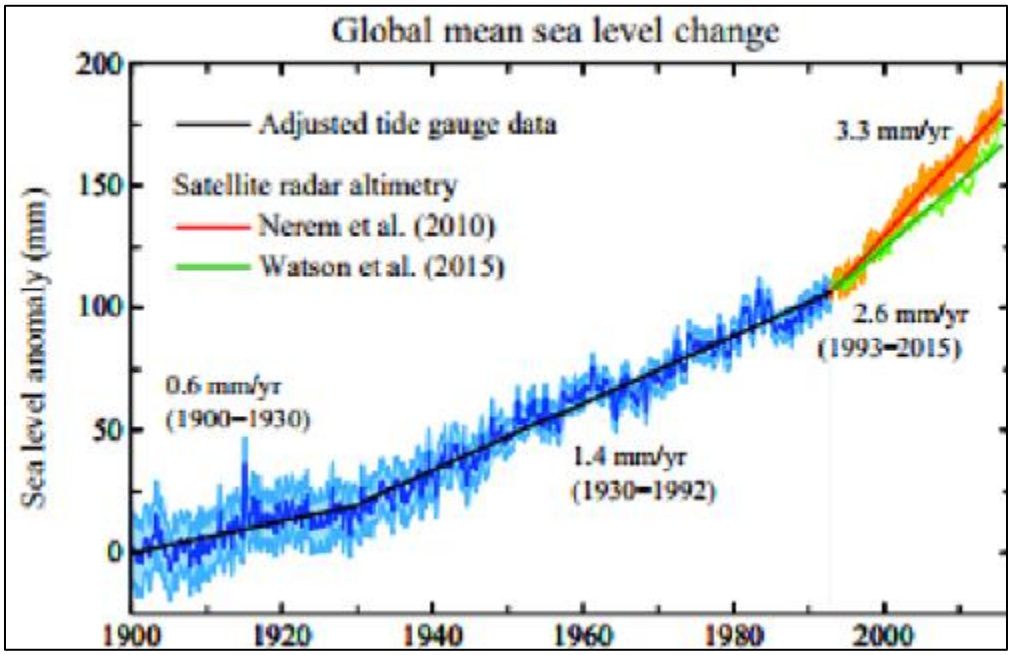
The projected global temperatures are:



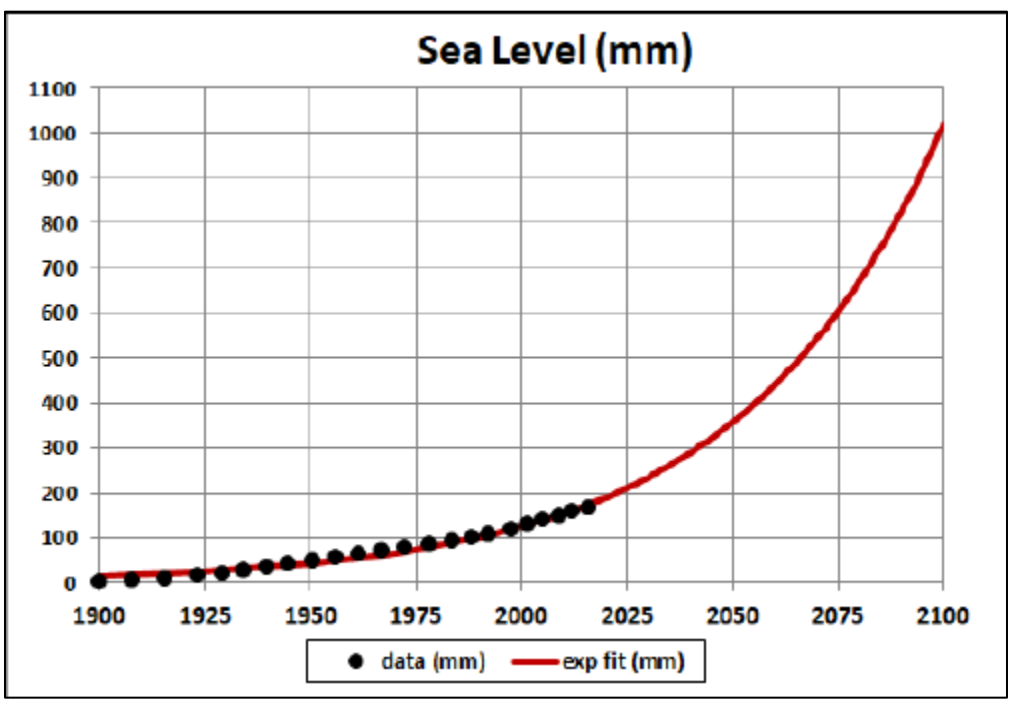
Environmental Changes Due to Temperature Rise

Sea-Level Rise

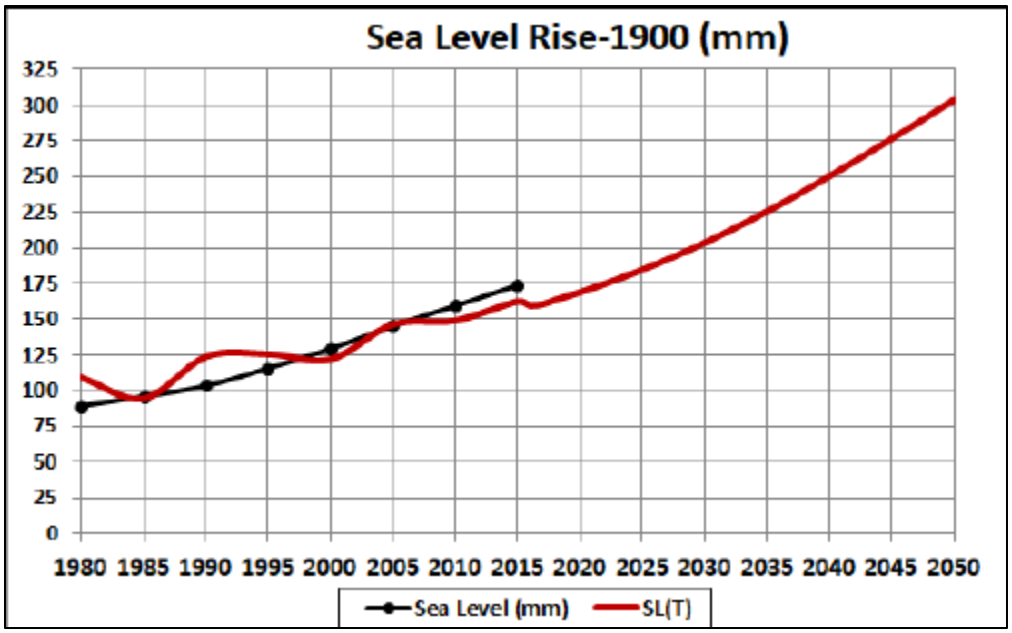
The web page https://www.atmos-chem-phys.net/16/3761/2016/acp-16-3761-2016.pdf has the graph, which is sea-level rise relative to year 1900:



An exponential fit to this curve extrapolated to year 2100 is:



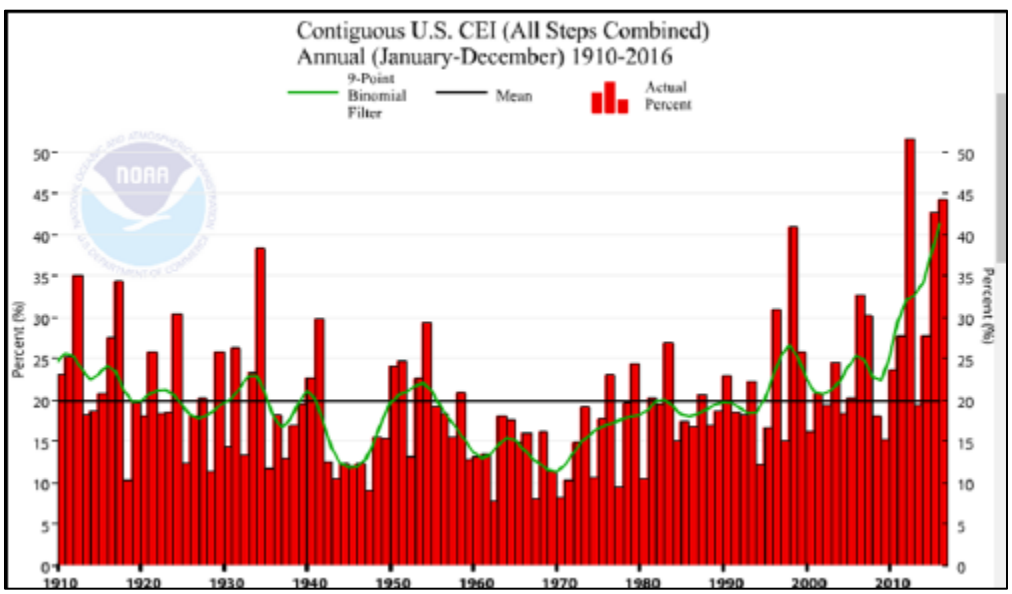
Using the extrapolated global temperature to year 2050 given above and the equation $dL = L \ln(T_f/T_i)/\ln(2)$, where dL is the sea-level rise since 1900, yields for L = 910.5:



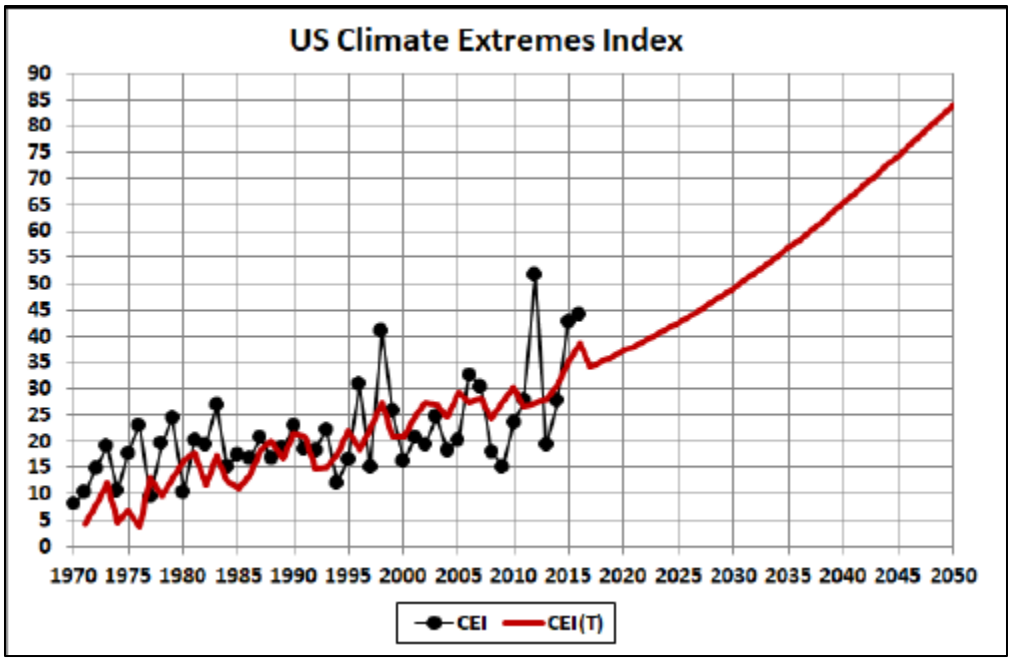
Thus, for a doubling of global temperature the prediction is that the sea level rise will be 910 mm, almost a meter. This fit is not very good.

U.S. Climate Extremes Index

The web page https://www.ncdc.noaa.gov/extremes/cei/graph/cei/01-12 has the graph for the Climate Extremes Index:



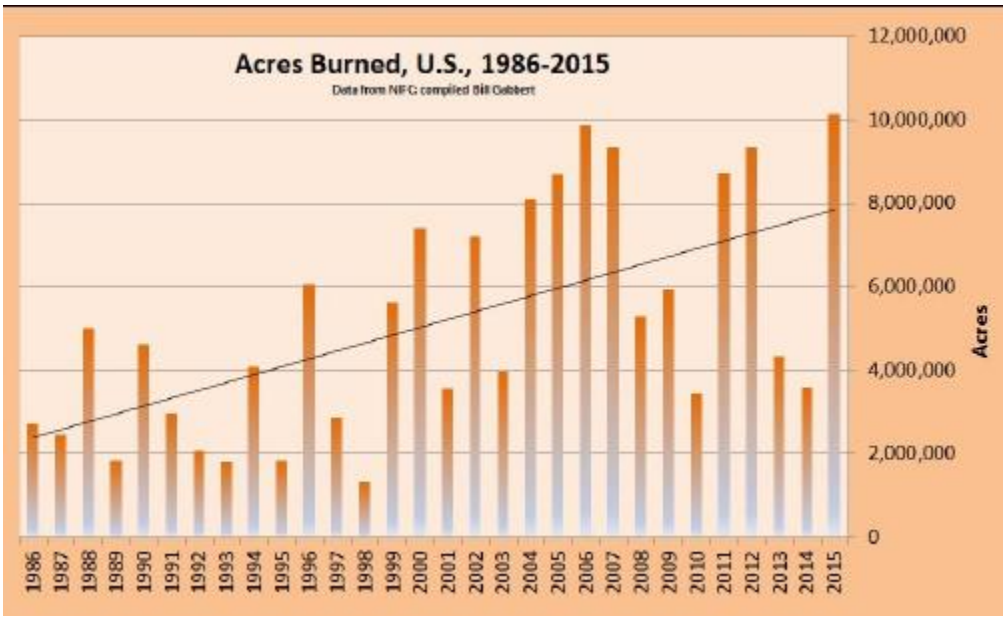
Using the extrapolated global temperature to year 2050 given above and the equation $dE = E \ln(T_f/T_i)/\ln(2)$, where dE is the Climate Extremes Index (CEI) since 1970, yields for E = 316.6:



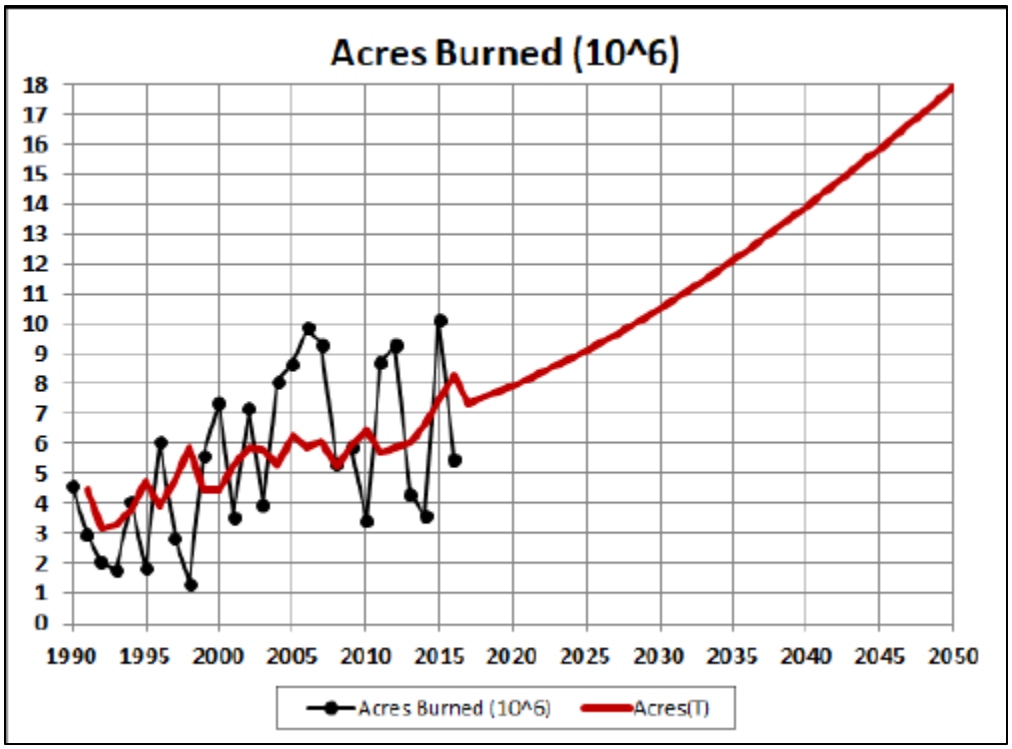
Thus, for a doubling of global temperature the prediction is that the CEI increase will be 317.

U.S. Forest Fires

The web page http://wildfiretoday.com/tag/statistics/has the graph:



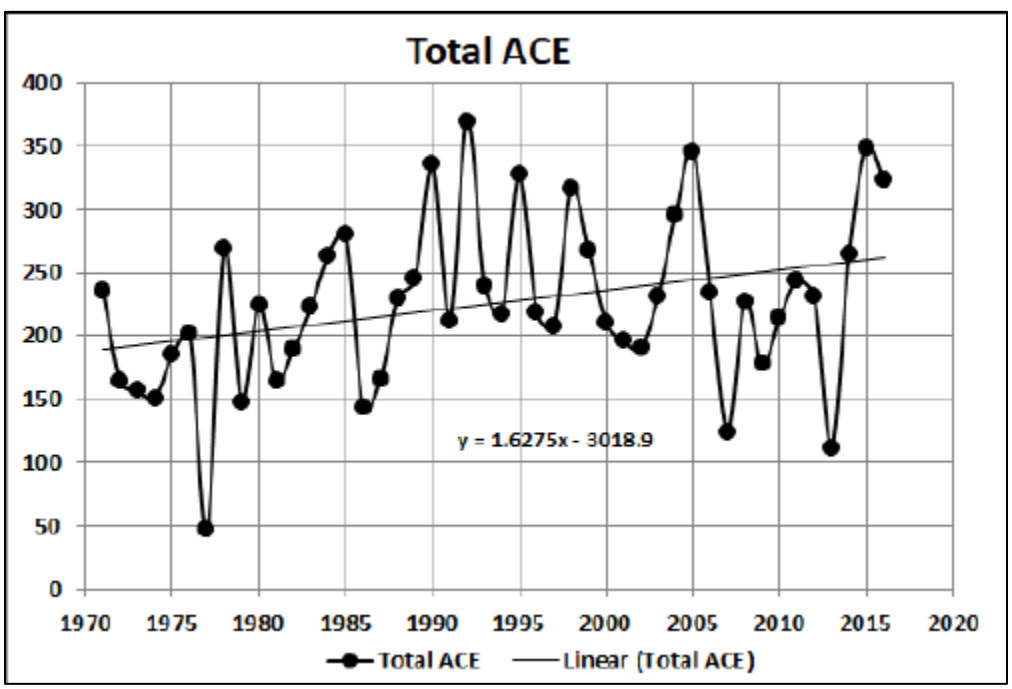
Using the extrapolated global temperature to year 2050 given above and the equation $dF = F \ln(T_f/T_i)/\ln(2)$, where dF is the acres burned per year since 1990, yields for F = 65.21:



Thus, for a doubling of global temperature the prediction is that the acres/year increase will be 65×10^6.

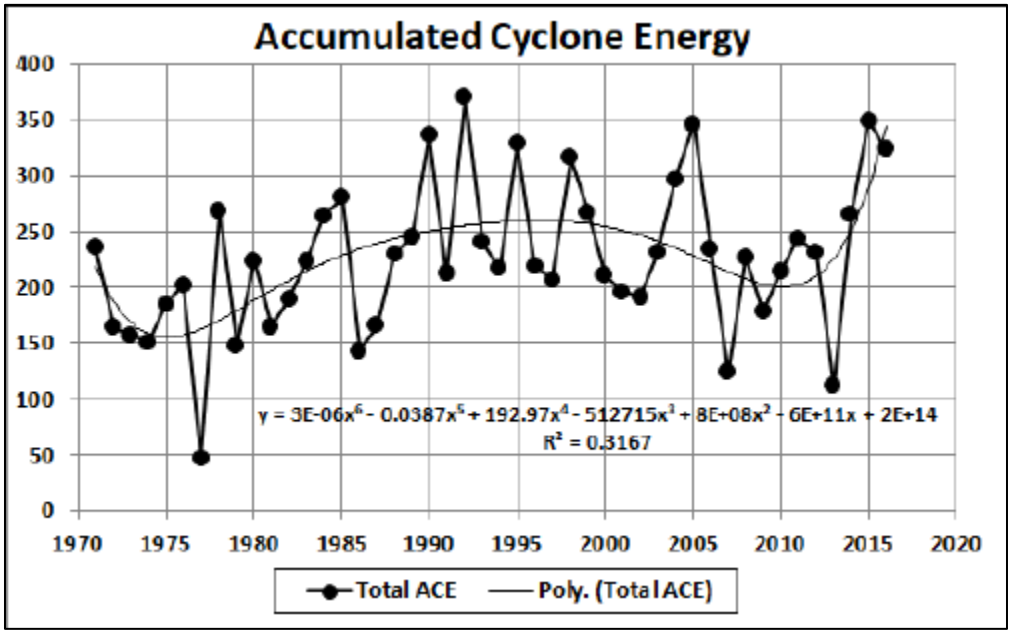
Atlantic and Pacific Hurricanes/Cyclones

The web page https://en.wikipedia.org/wiki/Accumulated_cyclone_energy lists the Accumulated Cyclone Energy (ACE) for Atlantic-Ocean and Pacific-Ocean hurricanes/cyclones/typhoons. I will use the term "cyclone" for hurricane/cyclone/typhoon. The sum for both oceans is:



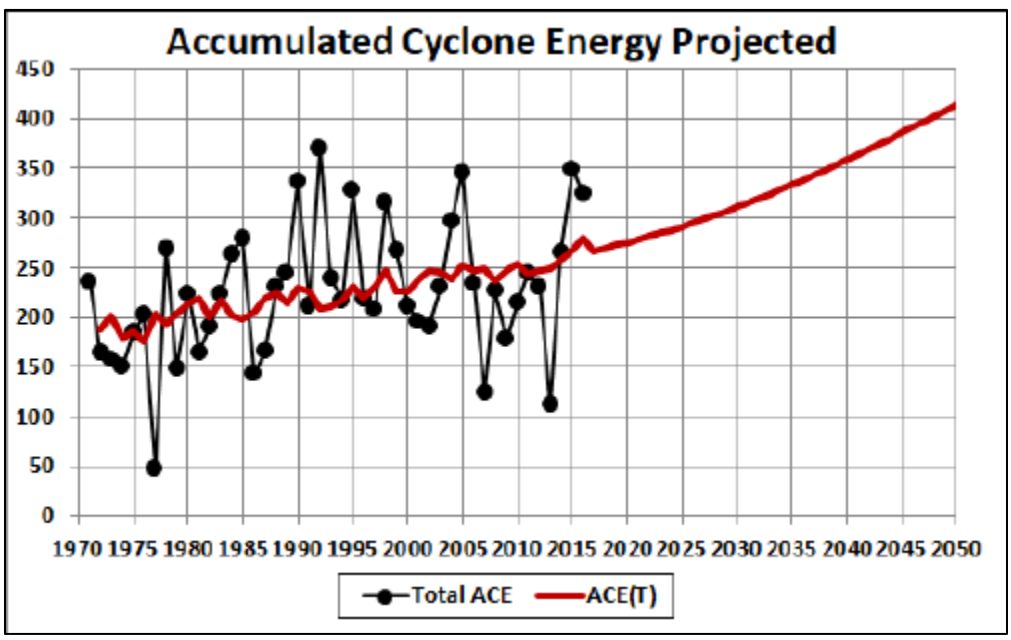
From 1970 through 2016 there is a strong linear increase in cyclone energy.

A better fit is a 6th-order polynomial:



Although there is a linear increase in hurricane/cyclone increase from 1970 through 2016, there is an underlying complicated oscillatory variation.

Using the extrapolated global temperature to year 2050 given above and the equation $dH = H \ln(T_f/T_i)/\ln(2)$, where dH is the Accumulated Cyclone Energy (ACE) since 1970, yields for H = 935.6:

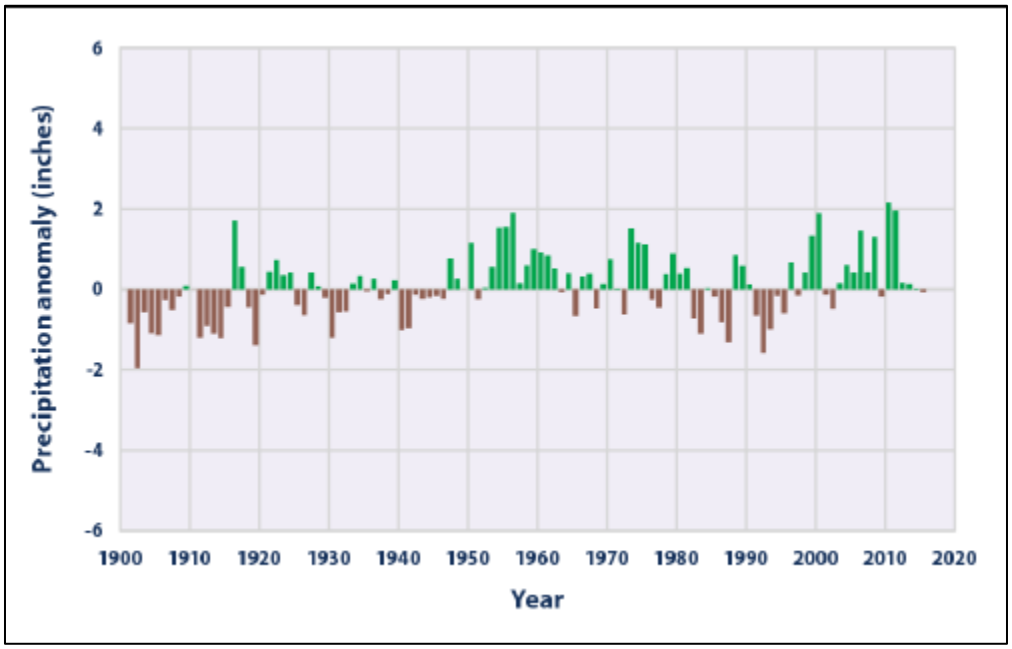


Thus, for a doubling of global temperature the prediction is that the ACE/year increase will be 936.

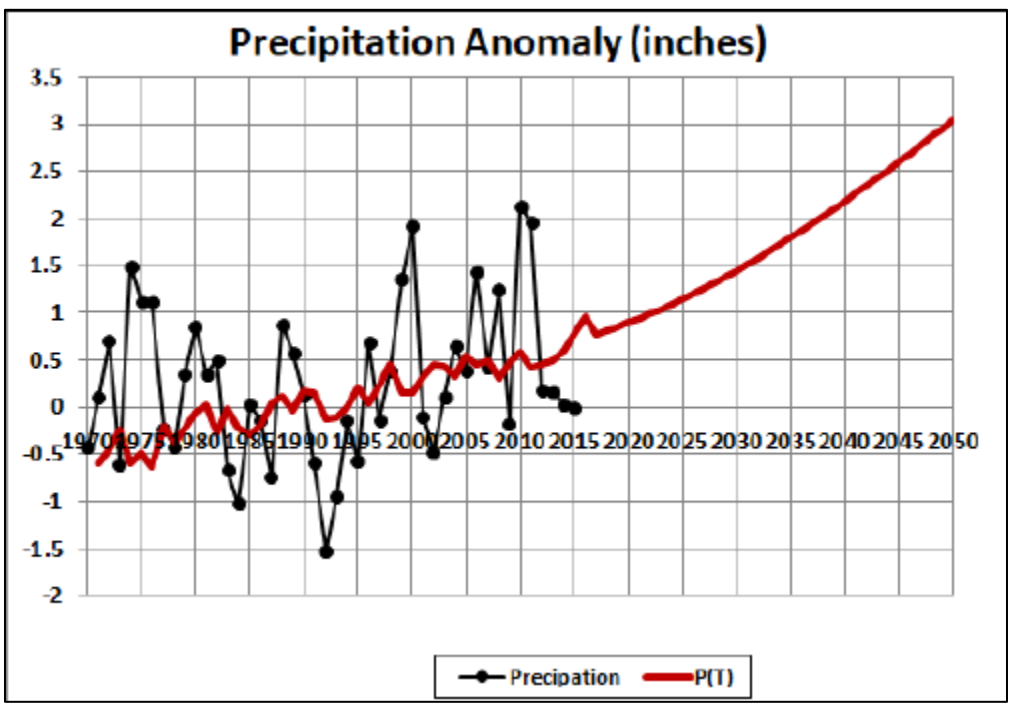
For more details about cyclones see http:/www.roperld.com/science/HurricanesEnergy.pdf.

Global Precipitation

The web page https://www.epa.gov/climate-indicators/climate-change-indicators-us-and-global-precipitation has this graph of global land precipitation relative to the 1901-2000 average:



Using the extrapolated global temperature to year 2050 given above and the equation $dP = P \ln(T_f/T_i)/\ln(2)$, where dP is the precipitation anomaly per year since 1990, yields for P = 14.47:



Thus, for a doubling of global temperature the prediction is that the global average precipitation/year increase will be 15 inches.

Because of mathematics I had to add 2” to the anomaly to do the projection and then subtract 2” from the result.