Empirical Mode Decomposition HHT

This Work Uses the GISS Monthly Temperature Data from Above

Because the Array Origin for the rest of this Mathcad worksheet is set to the nominal value of 0 and the HHT works best with the Array Origin set to1,
the EMD HHT was computed in the separate Mathcad Worksheet: "EMD_HHT GISS.xmcd"
Below is a screen shot of this Mathcad Worksheet.

Reference:C:\Users\tom\Documents\$ VXP\www\Pure CSS Version\Climate_Analysis\EMD Extrema.xmcd(R)

Reference:C:\Users\tom\Documents\$ VXP\www\Pure CSS Version\Climate_Analysis\EMD HHT Function.xmcd(R)

Array Origin = 1 GISST := READPRN("GISS-NASA MONTHLY TEMP 1980 to 2022.txt") rows(GISST) = 1709

Extract Yearly Data from Monthly Data

$TSpan := submatrix(GISST, 7, 1687, 1, 2)$ $r := 1, 2 .. 141$ $YR_r := 1 + 12(r - 1)$

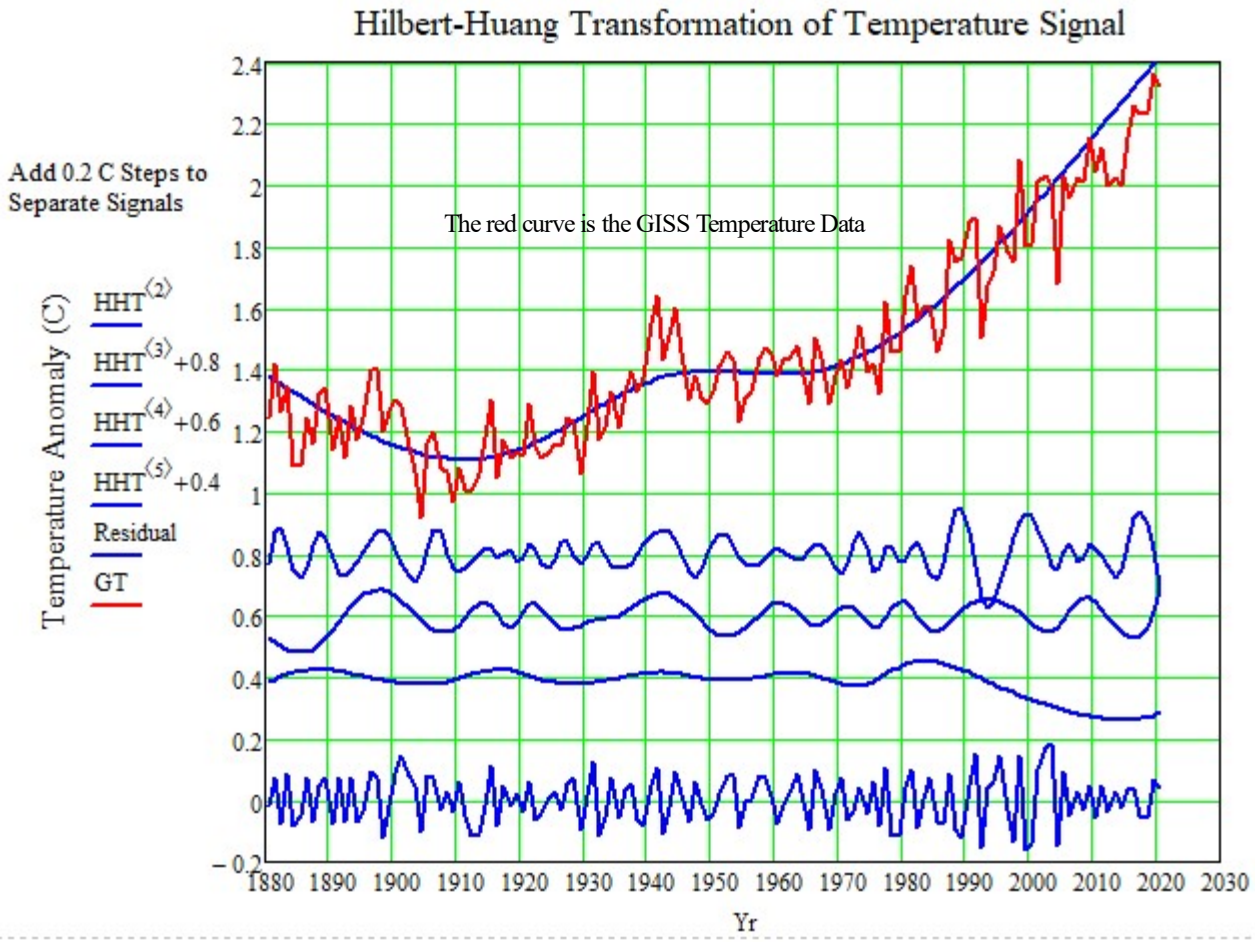
$Yr_r := TSpan_{YR_r, 1}$ $X_r := r$ $GT_r := TSpan_{YR_r, 2}$ $Ext := extrema(GT)$

$HHT := eemd(GT, 0, 1)$ $Residual := HHT^{\langle 6 \rangle} + HHT^{\langle 7 \rangle} + HHT^{\langle 8 \rangle}$ $REext := rows(Ext)$

$spmax := submatrix(Ext, 1, Ext_{REext,2}, 1, 2)$ $spmin := submatrix(Ext, Ext_{REext,2} + 1, REext - 2, 1, 2)$

$up_{sp} := cspline(spmax^{\langle 1 \rangle}, spmax^{\langle 2 \rangle})$ $upper := interp(up_{sp}, spmax^{\langle 1 \rangle}, spmax^{\langle 2 \rangle}, X)$

$low_{sp} := cspline(spmin^{\langle 1 \rangle}, spmin^{\langle 2 \rangle})$ $lower := interp(low_{sp}, spmin^{\langle 1 \rangle}, spmin^{\langle 2 \rangle}, X)$



Note the 140 year low frequency cycle. See also Section IIA. 11

D. Testing the Anthropogenic Greenhouse Gas Global Warming Model
Looking for Unique Fingerprints of AGW

SECTION XIII. Regression Model: Global Temp from CO2 and Natural Forcings

Test #0. Use ENSO, Irradiance, Volcanic Aerosols, & Anthropogenic Effects to Create an Empirical Temp Model

See http://www.leapcad.com/Climate_Analysis/Empirical_Model_ENSO_Solar_VolcAero_Anthro.pdf
Ref: "Some statistical aspects of anthropogenic and natural forced global temperature change", Schonwiese and Bayer, 1995.
Empirical Multivariate Regression Model by Combining ENSO (E), Irradiance (S), Volcanic Aerosols (V), CO_2 Anthropogenic Forcing Effects (A) to generate Multi-Variate regression coefficients of Global Temperature Anomaly data. The resulting model has an R^2 of 0.84, i.e. it **captures 84% of the variation of Global Temperature**. This model is then used to make decadal temperature projections based on predictions for these four climate variables.
Monthly mean surface temperature anomalies ΔT_{MS} are reconstructed as a **Linear Regression Equation**:

$$\Delta T_{MS}(t) = co + c_E \cdot E(t - \Delta t_E) + c_V \cdot V(t - \Delta t_V) + c_S \cdot S(t - t_S) + c_A \cdot A(t - t_A)$$

Where E, V, S and A are a AR(1) time series with **optimized lags** of $\Delta t_E = 7$, $\Delta t_V = 8$, and $\Delta t_S = 2$ months and $\Delta t_A = 17$ years. The lags are chosen to maximize the proportion of global variability that the statistical model captures and are spatially invariant. The fitted coefficients are obtained by multiple linear regression against the instrumental surface temperature record (HadCRUT4). The Temp data was median smooth within a 7 month period.

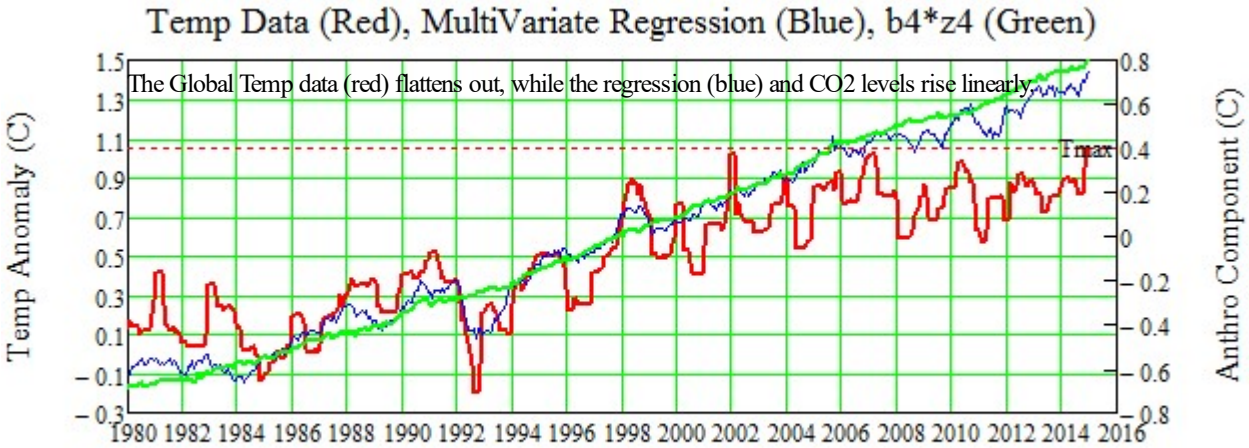
Multiforced regression models based on observational temperature data are able to **reproduce both a major part of natural fluctuations (decadal time scale) & a trend which may be due to GHG forcing**. Moreover, **future extrapolations** of the GHG forced temperature trend show a magnitude which is **similar to Global Climate Model** projections.

Compare Anthropogenic (CO2) Forcing Component - to Temp Data

b4*z4 (Green Line) is the Optimized Match of Effects of CO_2 Forcing to Global Temperature Data

IPCC CO_2 Log Forcing Function used in Regression Model. Co = 340 ppm.

$$Co := 340 \qquad \Delta F_{IPCC}(C) := 6.3 \ln\left(\frac{C}{Co}\right)$$



$corr(Y, \Delta T) = 0.9038$ $\qquad RSquare := corr(Y, \Delta T)^2 = 0.81685$ $\qquad corr(Y, \Delta Ts)^2 = 0.72544$

Correlation to Global Temp between:
Y (ΔTemp) and x1 (ENSO) = - 3.5%
Y (ΔTemp) and x2 (Volcanic Aero) = - 49%
Y (ΔTemp) and x3 (Solar) = - 8.5%
Y (ΔTemp) and x4 (Anthropogenic) = 87%

CO_2 has ten times the correlation than Solar

$$CORR = \begin{pmatrix} 1 & 0.35061 & -0.11702 & -0.23532 & -0.05022 \\ 0.35061 & 1 & 0.01393 & -0.3596 & -0.48887 \\ -0.11702 & 0.01393 & 1 & 0.12867 & 0.08534 \\ -0.23532 & -0.3596 & 0.12867 & 1 & 0.87369 \\ -0.05022 & -0.48887 & 0.08534 & 0.87369 & 1 \end{pmatrix} \begin{pmatrix} x1 \\ x2 \\ x3 \\ x4 \\ y \end{pmatrix} \begin{pmatrix} ENSO \\ Aerosols \\ Solar \\ CO2 \\ \Delta Temp \end{pmatrix}$$