GLOBAL WARMING MODELS USING WORLD EMISSION DATA ; NOT LINEARIZING T^4 IN TDFD EQUATION, CO2 FORCING SATURATION, & NORMALIZING CO_2 TO PPM CIRVE

CONSTANTS PW=CTC0618&1944

Stephen Boltzmann Constant per degree Kelvin $\sigma := 5.6704\cdot10^{-8}\cdot\frac{watt}{m^2\cdot K^4}$

Earth albedo $\alpha := 0.32956$

Radius of Earth $R_E := 6371\cdot km$

Temperature of Sun (Kelvin): $T_{sun} := 5770\cdot K$

Radius of Sun: $R_{sun} := 7\cdot10^8\cdot m$

Average Distance from Sun to Earth: $R_{SE} := 1.5\cdot10^{11}\cdot m$

BLACK BODY FLUX FROM THE SUN:

$F_{sun} := \sigma\cdot T_{sun}^{\ 4} = 62851688.365\cdot\frac{W}{m^2}$

Specific Heat Capacity of Earth:

$C_e := 2.08\cdot10^8\cdot\frac{J}{K\cdot m^2}$

Solar Luniosity (constant power output of sun):

$L_{sun} := F_{sun}\cdot4\cdot\pi\cdot R_{sun}^{\ 2} = 387010628769123350000000000\ W$

AVERAGE SUN'S FLUX AT THE EARTH IS GIVINE BY:

$F_{earth} := \frac{L_{sun}}{4\cdot\pi\cdot R_{SE}^{\ 2}} = 1.36877\times10^3\cdot\frac{watt}{m^2}$

The Accepted value for theSolar Constant: $S := 1370\cdot\frac{watt}{m^2}$

Include Emissivity since earth is not a black body $\varepsilon := 0.6062$

Average Global Temperature 1950-1980: $T_o := 14.0\ °C$

Define Gigatons: $Gt := 10^9\cdot tonne$

CONSTANTS PW=CTC0618&1944

WORLD TEMPERATURE DATA

MEASURED_ANOMALY := WORLD MONTHLY TEMPERATURE VS DATE.xlsx

rows(MEASURED_ANOMALY) = 1739

n := 12 .. rows(MEASURED_ANOMALY) − 2

MEASURED_ANOMALY := submatrix(MEASURED_ANOMALY , 1 , rows(MEASURED_ANOMALY) − 1 , 0 , 5)

$SurfaceAnomaly := MEASURED\_ANOMALY^{\langle 5\rangle}$

$Date := MEASURED\_ANOMALY^{\langle 4\rangle}$

SurfaceAnomaly =

	0
0	-0.2
1	-0.26
2	-0.09
3	-0.17
4	-0.1
5	-0.22
6	-0.2
7	...

Date =

	0
0	1880
1	1880.0833
2	1880.1667
3	1880.25
4	1880.3333
5	1880.4167
6	1880.5
7	...

MOVING AVERAGE

$$SurfaceAvg_n := \frac{\sum_{j=n-12}^{n} SurfaceAnomaly_j}{12}$$

WORLD TEMPERATURE DATA

UAH SATELLITE DATA

SATDATA := UAH DATA WORKING NEW.xlsx

rows(SATDATA) = 550

	0	1	2	3
0	"Year"	"Mo"	"Globe"	"YEAR INCL MO /12"
1	1979	1	-0.48	1979

SATDATA =

2	1979	2	-0.44	1979.0833
3	1979	3	-0.39	1979.1667
4	1979	4	-0.41	1979.25
5	1979	5	-0.4	1979.3333
6	1979	6	-0.4	...

SATDATA1 := submatrix(SATDATA, 1, rows(SATDATA) − 1, 0, 3)   rows(SATDATA1) = 549

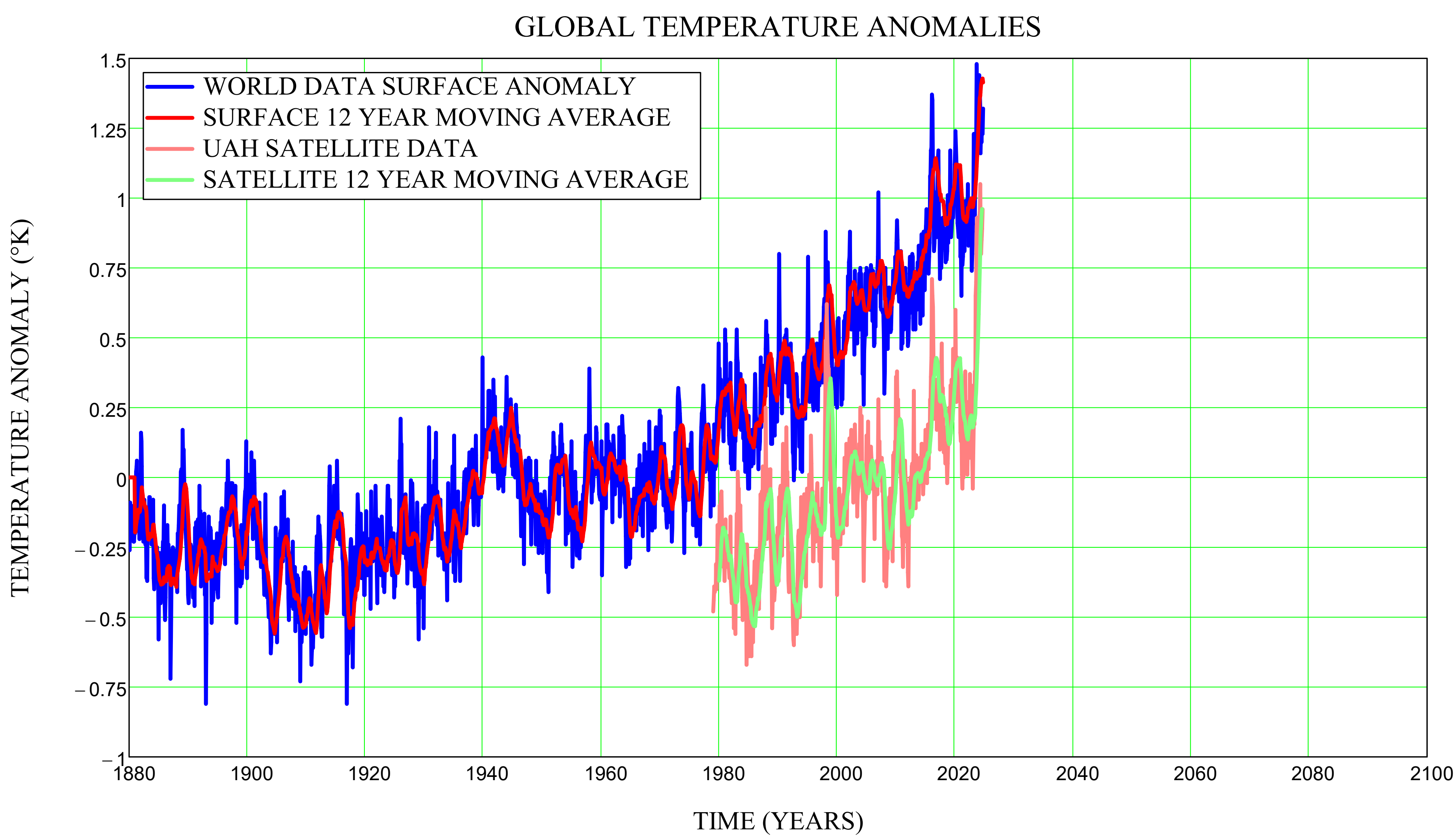
ns := 12 .. rows(SATDATA1) − 2

$SatelliteAnomaly := SATDATA1^{\langle 2 \rangle}$ $DateSat := SATDATA1^{\langle 3 \rangle}$ rows(DateSat) = 549

$$SatelliteAvg_{ns} := \frac{\sum_{j = ns-12}^{ns} SatelliteAnomaly_j}{12}$$

$SatelliteAvg_{ns} := if(SatelliteAvg_{ns} = 0, SatelliteAvg_{12}, SatelliteAvg_{ns})$

UAH SATELLITE DATA



REDEFINE FINE DATA TO 12-YEAR MOVING AVERAGES

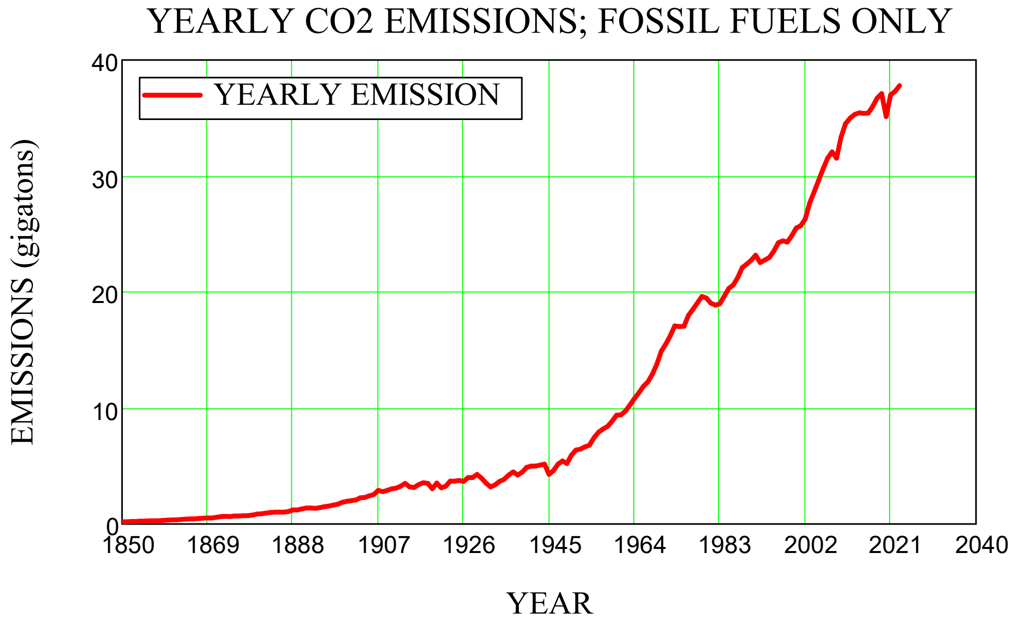
SurfaceAnomaly := SurfaceAvg $SatelliteAnomaly_{ns} := SatelliteAvg_{ns}$

WORLD EMISSION DATA

EMISSION := WORLD EMISSION DATA VS DATE.xlsx

EMISSION := submatrix(EMISSION, 1, 174, 0, 1)

$$EMISSION^{\langle 1 \rangle} := \frac{EMISSION^{\langle 1 \rangle}}{10^9}$$



EMISSION =

	0	1
0	$1.85 \cdot 10^3$	$1.9685 \cdot 10^{-1}$
1	$1.851 \cdot 10^3$	$1.9878 \cdot 10^{-1}$
2	$1.852 \cdot 10^3$	$2.076 \cdot 10^{-1}$
3	$1.853 \cdot 10^3$	$2.1724 \cdot 10^{-1}$
4	$1.854 \cdot 10^3$	$2.5504 \cdot 10^{-1}$
5	$1.855 \cdot 10^3$	$2.6026 \cdot 10^{-1}$
6	$1.856 \cdot 10^3$	$2.7825 \cdot 10^{-1}$
7	$1.857 \cdot 10^3$	$2.8118 \cdot 10^{-1}$
8	$1.858 \cdot 10^3$	$2.8555 \cdot 10^{-1}$
9	$1.859 \cdot 10^3$	$3.0257 \cdot 10^{-1}$
10	$1.86 \cdot 10^3$	...

$j := 0 .. 173$ $\quad CumEm_j := \sum_{n=0}^{j} \left(EMISSION^{\langle 1 \rangle}\right)_n$ $\quad max(CumEm) = 1807.7833$

WORLDCUMULATIVE := CUMULATIVE CO2 EMISS... WORLD DATA 2023.xlsx

CO2CUMULATIVE := submatrix(WORLDCUMULATIVE , 1 , rows(WORLDCUMULATIVE) – 1 , 1 , 2)

n := 0 .. rows(WORLDCUMULATIVE) – 1

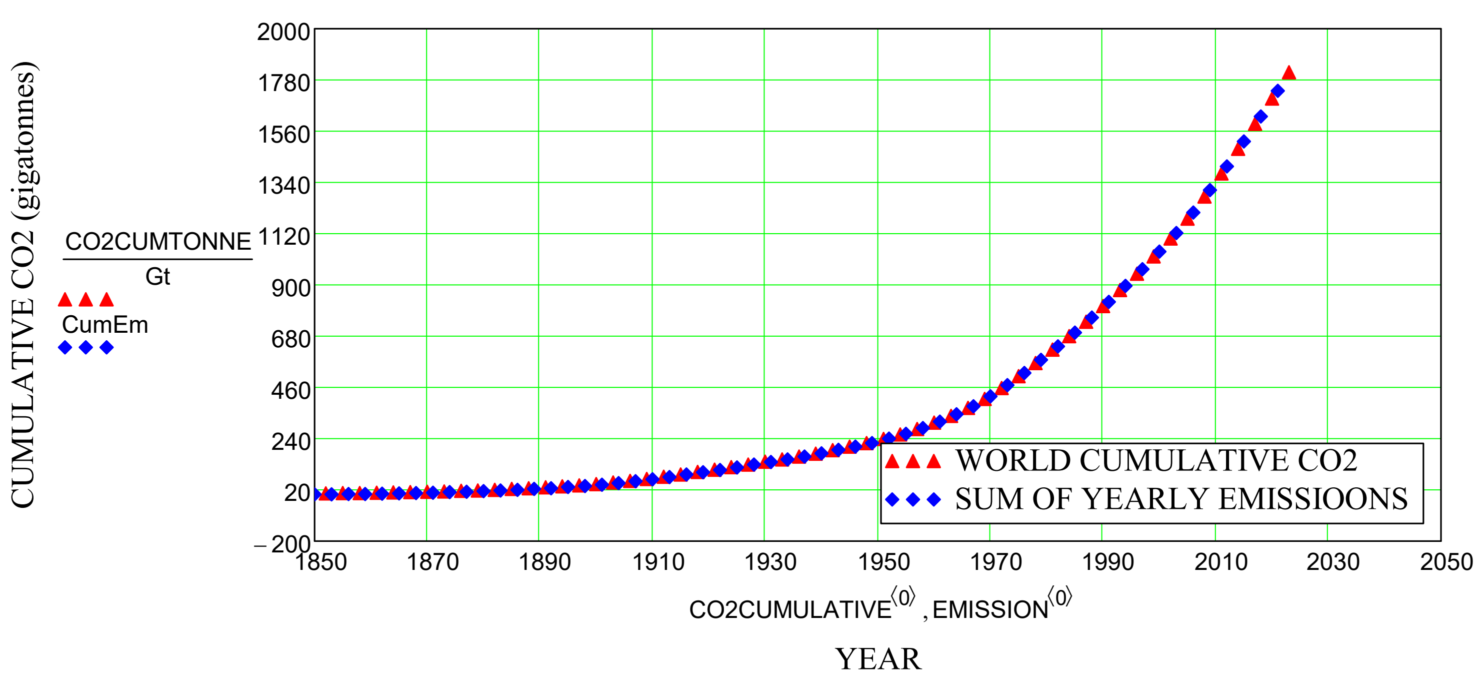
CO2CUMULATIVE =

	0	1
0	$1.75 \cdot 10^3$	$9.3059 \cdot 10^6$
1	$1.751 \cdot 10^3$	$1.8713 \cdot 10^7$
2	$1.752 \cdot 10^3$	$2.8218 \cdot 10^7$
3	$1.753 \cdot 10^3$	$3.7829 \cdot 10^7$
4	$1.754 \cdot 10^3$	$4.7562 \cdot 10^7$
5	$1.755 \cdot 10^3$	$5.7356 \cdot 10^7$
6	$1.756 \cdot 10^3$	...

tonne = 1000 kg

ton = 907.1847 kg

$CO2CUMTONNE := CO2CUMULATIVE^{\langle 1 \rangle} \cdot tonne$



WORLD EMISSION DATA

NOW LET'S FIT THE EMISSION CURVE WITH AN EXPONENTIAL REGRESSIONFIT FUNCTION

FIT EMISSION DATA WITH EXPONENTIALS

$z := 1850 .. 1900$

$V := augment\left(EMISSION^{\langle 0 \rangle}, EMISSION^{\langle 1 \rangle}\right)$

$V1 := submatrix(V, 0, 125, 0, 1)$

$V2 := submatrix(V, 125, rows(V) - 1, 0, 1)$

V =

	0	1
0	1850	0.1968
1	1851	0.1988
2	1852	0.2076
3	1853	0.2172
4	1854	0.255
5	1855	0.2603
6	1856	...

$Guess := \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$ $\quad expc1 := expfit\left(V1^{\langle 0 \rangle}, V1^{\langle 1 \rangle}, Guess\right)$

$expc1 = \begin{pmatrix} 0 \times 10^{0} \\ 4.0161 \times 10^{-2} \\ 7.3778 \times 10^{-1} \end{pmatrix}$

$Guess := \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$ $\quad expc2 := expfit\left(V2^{\langle 0 \rangle}, V2^{\langle 1 \rangle}, Guess\right)$

$expc2 = \begin{pmatrix} 1.6781 \times 10^{-9} \\ 1.1933 \times 10^{-2} \\ -1.2015 \times 10^{1} \end{pmatrix}$

$i := \min(V1^{\langle 0 \rangle}) .. \max(V1^{\langle 0 \rangle})$ $X_i := i \cdot 1$ $rows(X) = 1976$

$X := submatrix(X, 1850, 1975, 0, 0)$

$FITemiss := expc1_0 \cdot \exp(expc1_1 \cdot X) + expc1_2$

$rows(FITemiss) = 126$

$FITemiss := augment(V1^{\langle 0 \rangle}, FITemiss)$

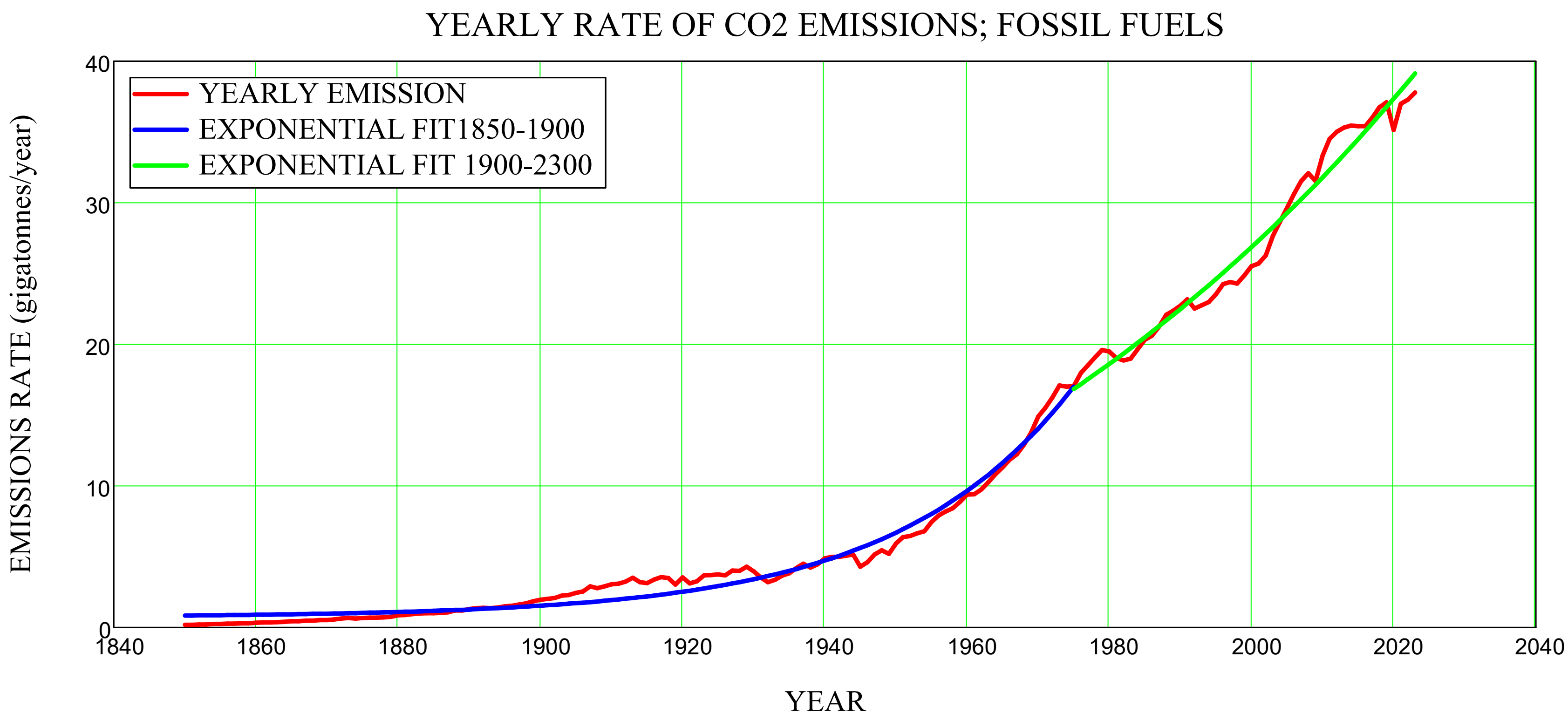
$i := \min(V2^{\langle 0 \rangle}) .. \max(V2^{\langle 0 \rangle})$ $X2_i := i \cdot 1$ $rows(X2) = 2024$

$X2 := submatrix(X2, 1975, 2023, 0, 0)$

$FITemiss2 := expc2_0 \cdot \exp(expc2_1 \cdot X2) + expc2_2$

$rows(FITemiss2) = 49$

$FITemiss2 := augment(V2^{\langle 0 \rangle}, FITemiss2)$



FIT EMISSION DATA WITH EXPONENTIALS

Now solve the differential equation to get the sum over time for cumulative emission.

FIT EMISSION DATA FROM 2014 TO 2400

FIT EMISSION DATA 2014-2400

V =

	0	1
0	1850	0.1968
1	1851	0.1988
2	1852	0.2076
3	1853	0.2172
4	1854	0.255
5	1855	...

$Vsub := submatrix(V, 164, rows(V) - 1, 0, 1)$

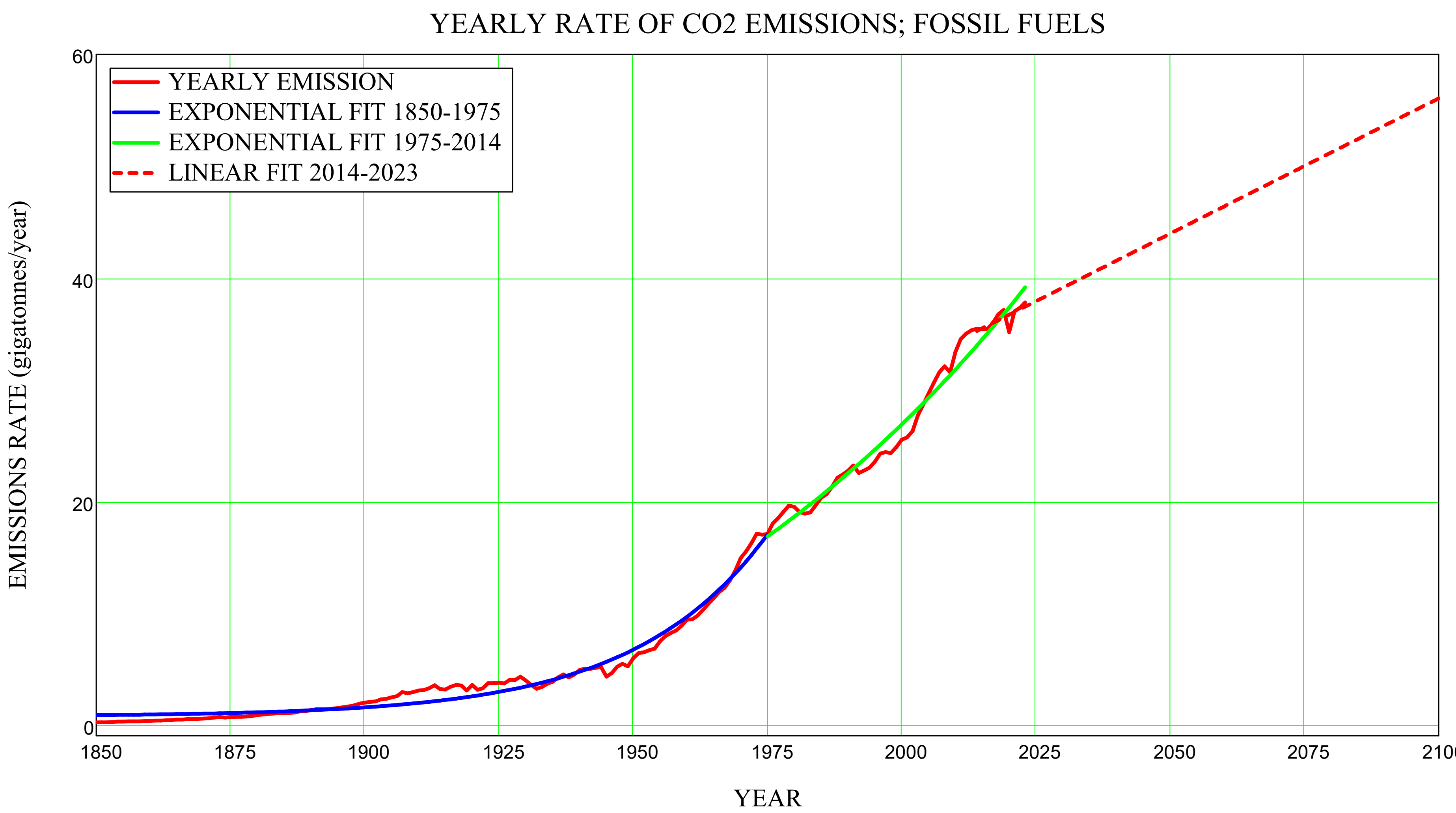
$z := 2014 .. 2300$

$AA := line(Vsub^{\langle 0 \rangle}, Vsub^{\langle 1 \rangle}) = \begin{pmatrix} -452.4521 \\ 0.2422 \end{pmatrix}$

$fitsub_z := AA_0 + AA_1 \cdot z$

Vsub =

	0	1
0	2014	35.4501
1	2015	35.4049
2	2016	35.4167
3	2017	35.9899
4	2018	36.7304
5	2019	37.1043
6	2020	35.1265
7	2021	36.9917
8	2022	37.2938
9	2023	37.7916



FIT EMISSION DATA 2014-2400

ANALYTIC SOLUTION TO ODE

$ENDDATE := 2700$ $z := 1850 .. ENDDATE$

$maxjj := ENDDATE - 1850 = 850$

$jj := 0 .. maxjj$ $x_{jj} := 1850 + jj$

$a1 := expc1_0$ $b1 := expc1_1$ $c1 := expc1_2$ $\tau := 300$ $\lambda := \frac{1}{\tau}$

$a2 := expc2_0$ $b2 := expc2_1$ $c2 := expc2_2$

$t_o := 1975$ $t_1 := 2021$

$Q(t) = a1 \cdot e^{b1 \cdot t} + c1$ $a1 = 0 \times 10^{0}$ $b1 = 0.0402$ $c1 = 0.7378$

$Q2(t) = a2 \cdot e^{b2 \cdot t} + c2$ $a2 = 1.6781 \times 10^{-9}$ $b2 = 0.0119$ $c2 = -12.0145$

$Q1(z) := a1 \cdot e^{b1 \cdot z} + c1$ $Q2(z) := a2 \cdot e^{b2 \cdot z} + c2$ $Q3(z) := AA_0 + AA_1 \cdot z$

$$Y := \left[\begin{array}{l} \text{for } z \in 1850 .. ENDDATE \\ \quad Y_z \leftarrow e^{-\lambda \cdot z} \cdot \int_0^z e^{\lambda \cdot z} \cdot Q1(z)\, dz \ \text{ if } z \le t_o \\ \quad Y_z \leftarrow e^{-\lambda \cdot z} \cdot \left(\int_{t_o}^z e^{\lambda \cdot z} \cdot Q2(z)\, dz \right) + Y_{t_o} \ \text{ if } t_o \le z \le t_1 \\ \quad Y_z \leftarrow e^{-\lambda \cdot z} \cdot \left(\int_{t_1}^z e^{\lambda \cdot z} \cdot Q3(z)\, dz \right) + Y_{t_1} \ \text{ if } z > t_1 \\ Y \end{array} \right]$$

$t_o = 1975$ $t_1 := 2014$

$Y := submatrix(Y, 1850, rows(Y) - 1, 0, 0)$

x =

	0
0	1850
1	1851
2	1852
3	1853
4	1854
5	1855
6	1856
7	1857
8	1858
9	1859
10	1860
11	1861
12	1862
13	...

z =

1850
1851
1852
1853
1854
1855
1856
1857
1858
1859
1860
1861
1862
...

Y =

	0
0	223.3415
1	223.4443
2	223.5512
3	223.6625

x =

	0
0	1850
1	1851
2	1852
3	1853

4	223.7782
5	223.8986
6	...

4	1854
5	1855
6	...

ANALYTIC SOLUTION TO ODE

NORMALIZE ODE TO WORLD DATA

UPDATE TO WORLD CONCENTRATION IN PPM

WORLDPPM := WORLD CO2 ppm UPDATE.xlsx

rows(WORLDPPM) = 131

WORLDPPM := submatrix(WORLDPPM, 1, rows(WORLDPPM) − 1, 1, 2)

$WORLDGT^{\langle 1 \rangle} := WORLDPPM^{\langle 1 \rangle} \cdot 7.8$

$WORLDGT := augment\left(WORLDPPM^{\langle 0 \rangle}, WORLDGT^{\langle 1 \rangle}\right)$

WORLDGT =

	0	1
0	1850	2215.2129
1	1851	2239.5992
2	1854	2246.8246
3	1855	2227.4115
4	1857	2208.6644
5	1859	2235.7382
6	1862	...

WORLDPPM =

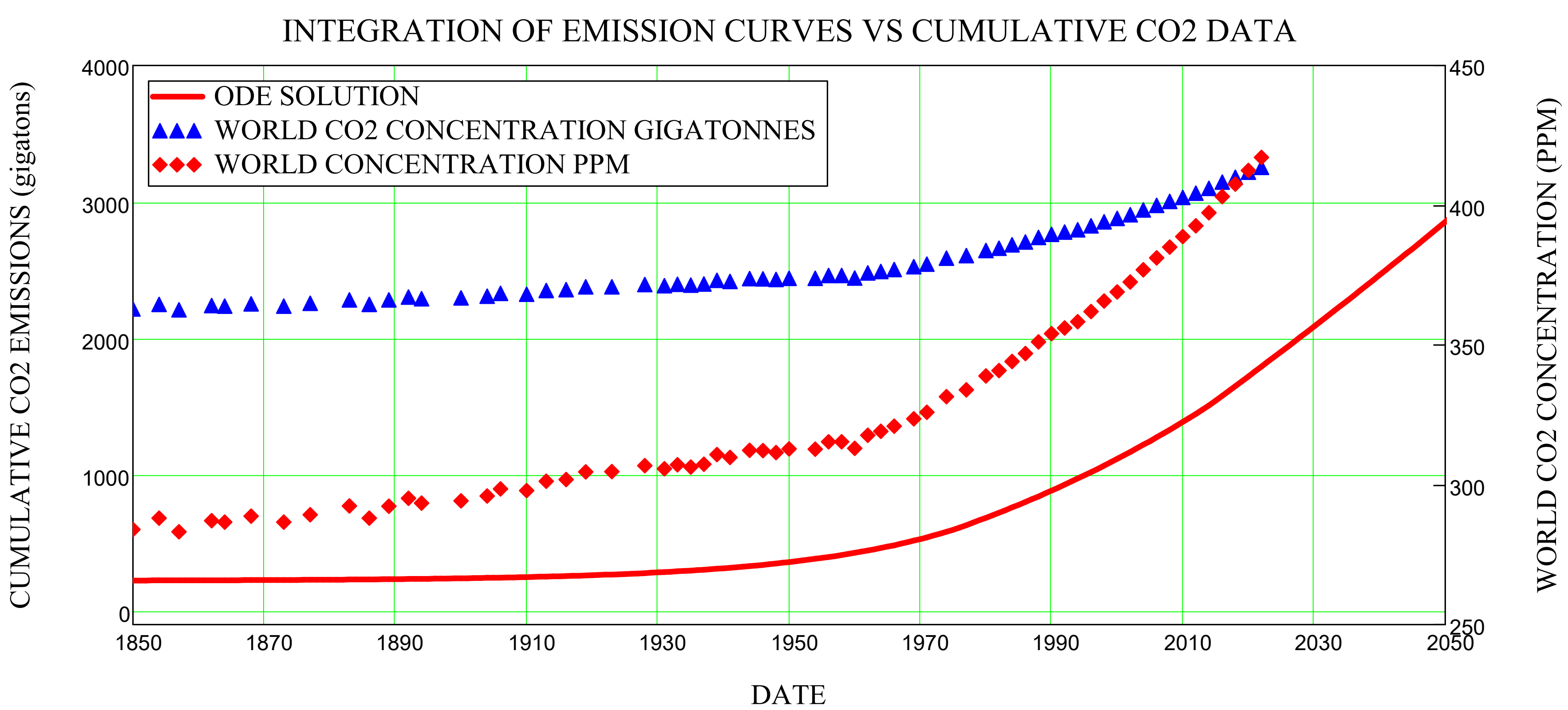
	0	1
0	1850	284.0016
1	1851	287.1281
2	1854	288.0544
3	1855	285.5656
4	1857	283.1621
5	1859	...

$PPM := WORLDPPM^{\langle 1 \rangle}$

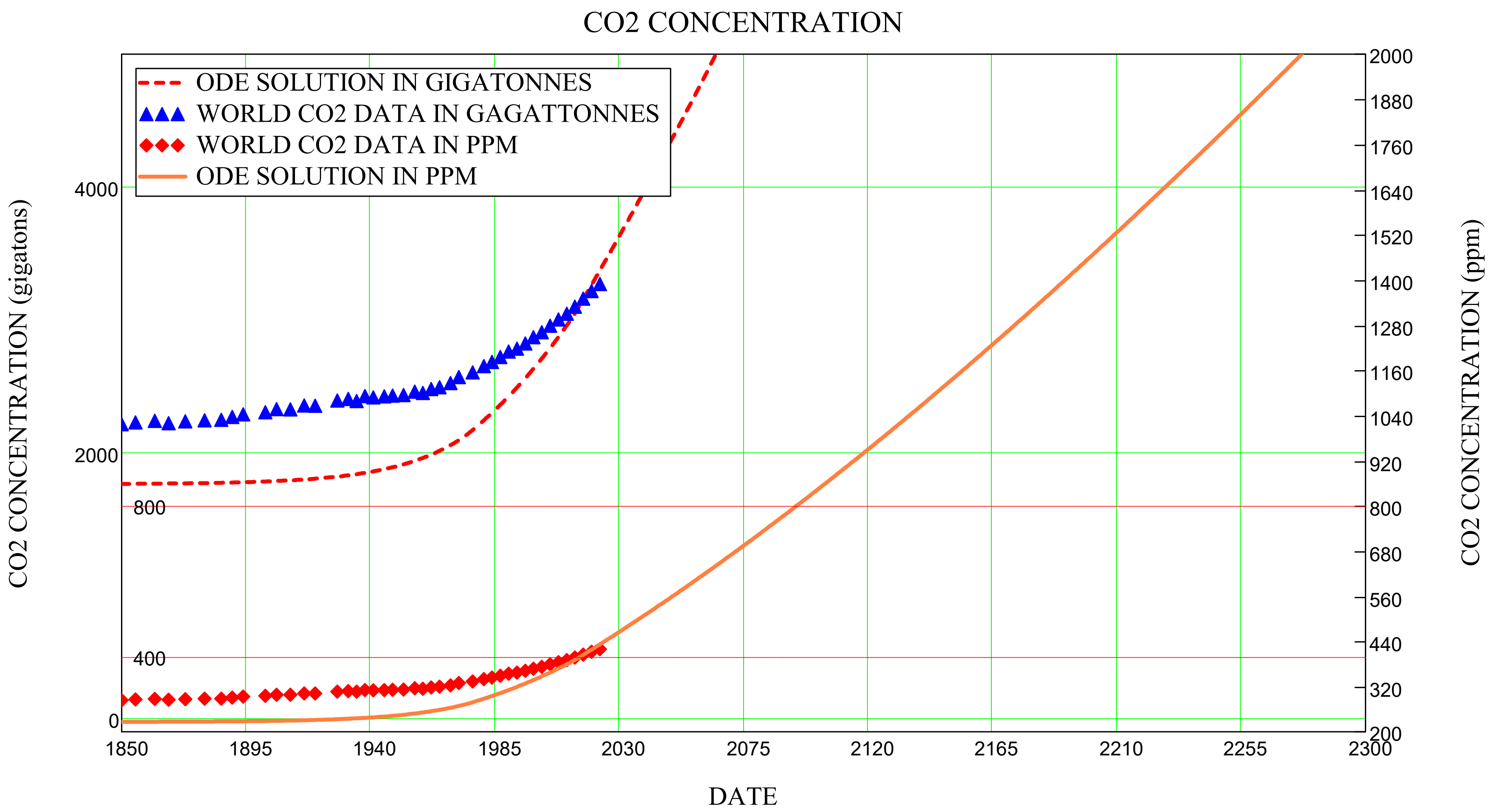
$PPM := augment\left(WORLDPPM^{\langle 0 \rangle}, PPM\right)$

k := jj

NORMALIZE CUMULATIVE DATE TO WORLD DATA DOWNLOAD IN PPM

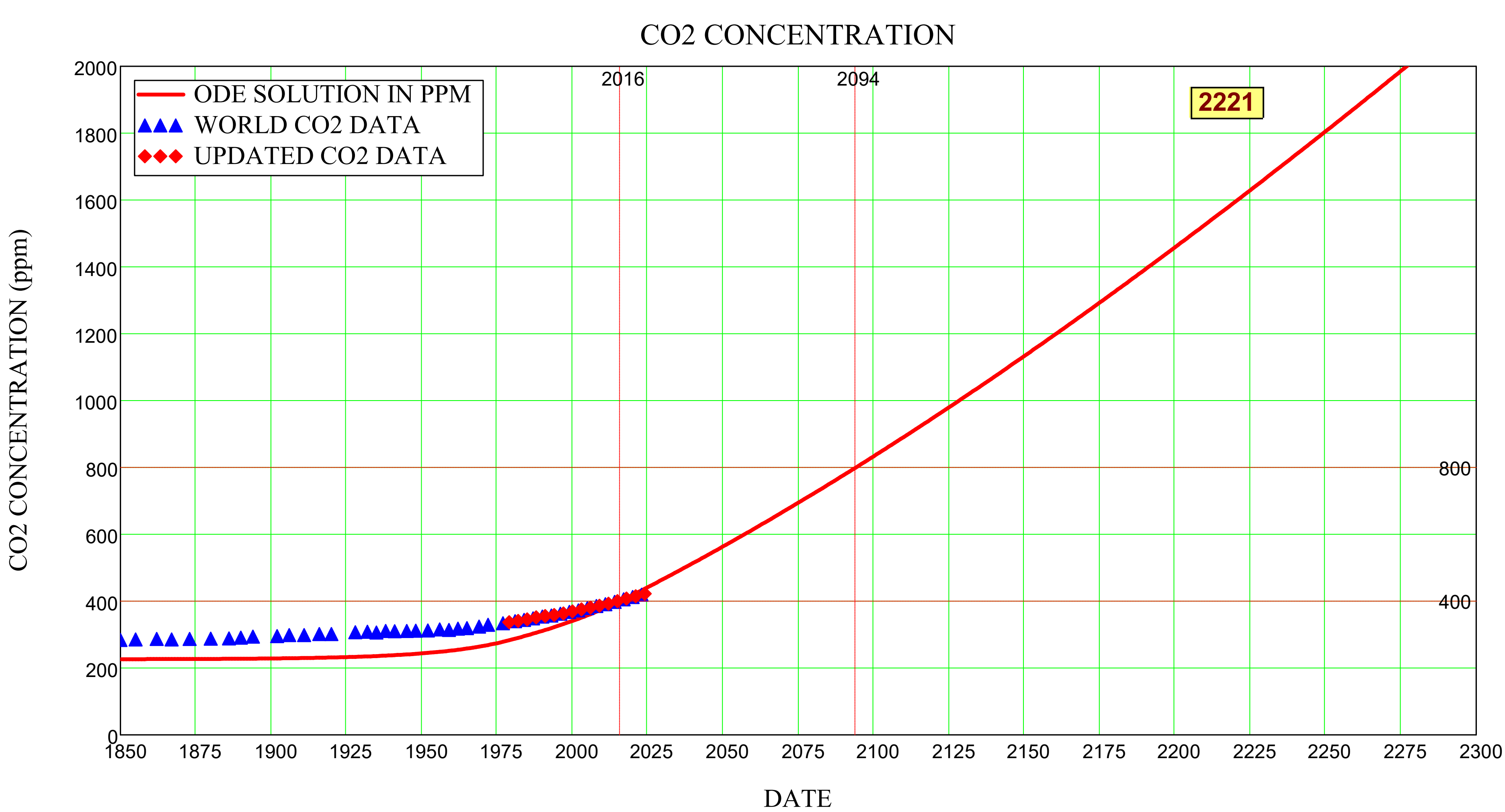


$Y := Y + (3371 - 1828.3)$ $\qquad$ $3308.1 \cdot 2 = 6616.2$ $\qquad$ $YPPM := augment\left(x, \frac{Y}{7.8}\right)$



NEWPPM := WORLD YEARLY CONCENTRATION PPM.xlsx

NEWPPM := submatrix(NEWPPM , 1 , rows(NEWPPM) – 1 , 0 , 1)



NORMALIZE ODE TO WORLD DATA

NOW GET THE TEMPERATURE ANOMALY DUE CO_2 EMISSION DATA

TDFD FOR TEMPERATURE ANOMALY CO2 FORCING SATURATION STUDY

$CO2_{jj} := \left(YPPM^{\langle 1 \rangle}\right)_{jj}$ max(CO2) = 5487.4591 $CO2Initial := \left(YPPM^{\langle 1 \rangle}\right)_0$ $T_o = 14 \cdot °C$ k := jj $x_{223} = 2073$

$\Delta FCO2_k := 5.35 \cdot \ln\left[\frac{(CO2)_k + CO2Initial}{CO2Initial}\right] \cdot \frac{watt}{m^2}$

CO2Initial = 226.4156

$x_{169} = 2019$ $CO2_{169} = 413.664$

$x_{243} = 2093$ $CO2_{243} = 793.5731$

$T3_0 := T_o = 287.15K$ $\Delta t := 1 \cdot yr$

$x_{355} = 2205$ $CO2_{355} = 1492.2246$

$$T3_{k+1} := \frac{1}{C_e} \cdot \left[\frac{(1-\alpha) \cdot S}{4} + \Delta FCO2_k - \left[\varepsilon \cdot \sigma \cdot (T3_k)^4 \right] \right] \cdot \Delta t + T3_k$$

$rows(T3) = 852$

$T3 := submatrix(T3, 1, rows(T3) - 1, 0, 0)$

$T3_{emiss} := \frac{T3}{K}$ $T3_{emiss} := augment(x, T3_{emiss})$

$\frac{T_o}{K} = 287.15$ $T3_{emiss}^{\langle 1 \rangle} := T3_{emiss}^{\langle 1 \rangle} - \frac{T_o}{K}$

$last\left(T3_{emiss}^{\langle 1 \rangle}\right) = 850$

CO2 =

	0
0	226.4156
1	226.4288
2	226.4425
3	226.4567
4	226.4716
5	226.487
6	...

x =

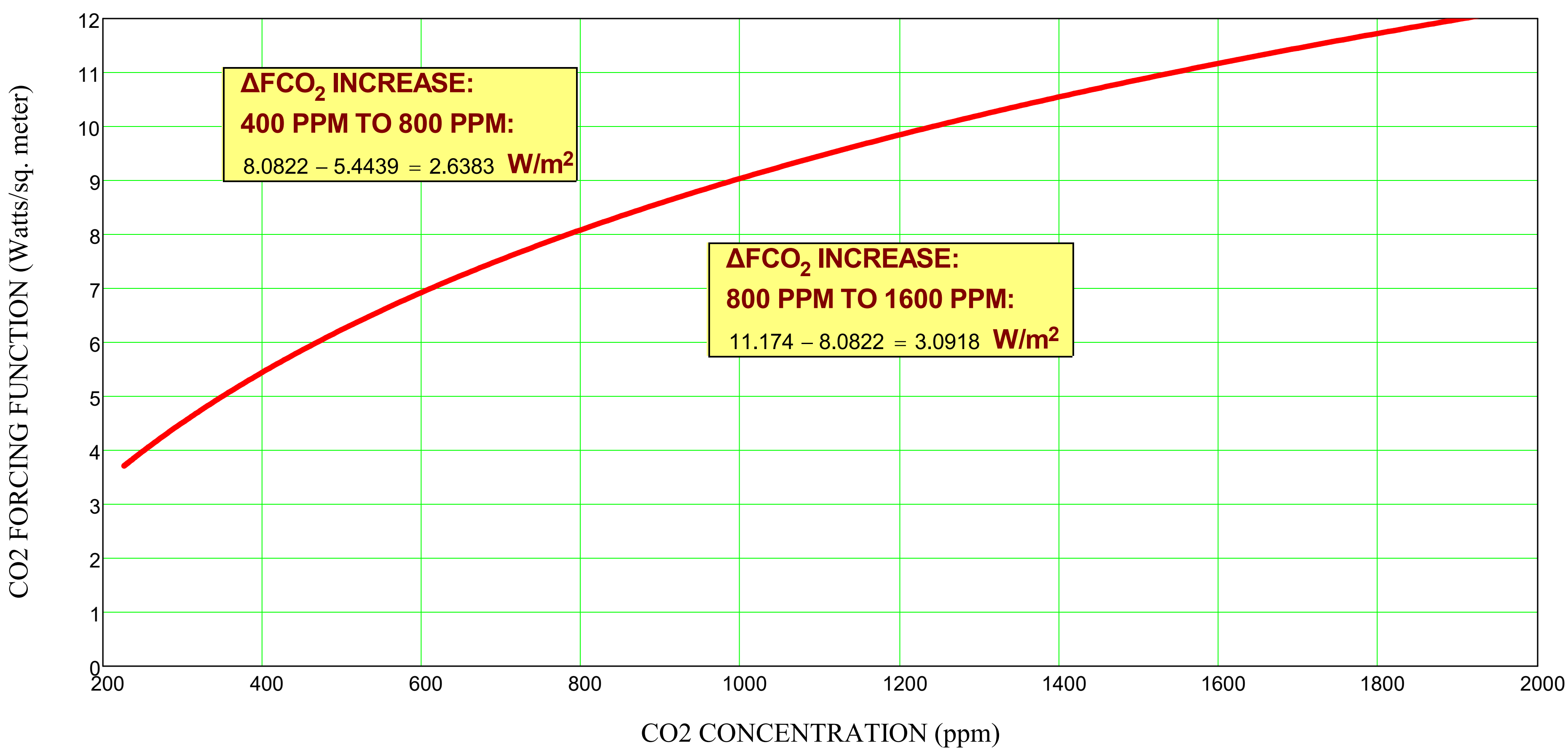
	0
0	1850
1	1851
2	1852
3	1853
4	1854
5	1855
6	...

ΔFCO2 =

	0
0	3.7083
1	3.7085
2	3.7087
3	3.7088
4	3.709
5	3.7092
6	...

$\cdot \frac{watt}{m^2}$

CO2 FORCING VERSUS CO2 CONCENTRATION



$\Delta F1 := 8.0822 - 5.4439 = 2.6383$

$\Delta F2 := 11.174 - 8.0822 = 3.0918$

TDFD FOR TEMPERATURE ANOMALY CO2 FORCING SATURATION STUDY

LINEAR REGRESSION ANALYSIS OF SURFACE AND SATELLITE DATA

WORLD SURFACE DATA

$X := Date$ $Y := SurfaceAnomaly$ $Date_{1188} = 1979$

$X := submatrix(X, 1188, rows(X) - 1, 0, 0)$ $Y := submatrix(Y, 1188, rows(Y) - 1, 0, 0)$

$xsurf := 1979 .. 2180$

$b := slope(X, Y) = 0.0214$ $a := intercept(X, Y) = -42.261$ $fit_{xsurf} := a + b \cdot xsurf$

$X_0 = 1979$

Date =

	0
0	1880
1	1880.0833
2	1880.1667
3	1880.25
4	1880.3333
5	1880.4167
6	1880.5
7	...

X =

	0
0	1979
1	1979.0833
2	1979.1667
3	1979.25
4	1979.3333
5	1979.4167
6	...

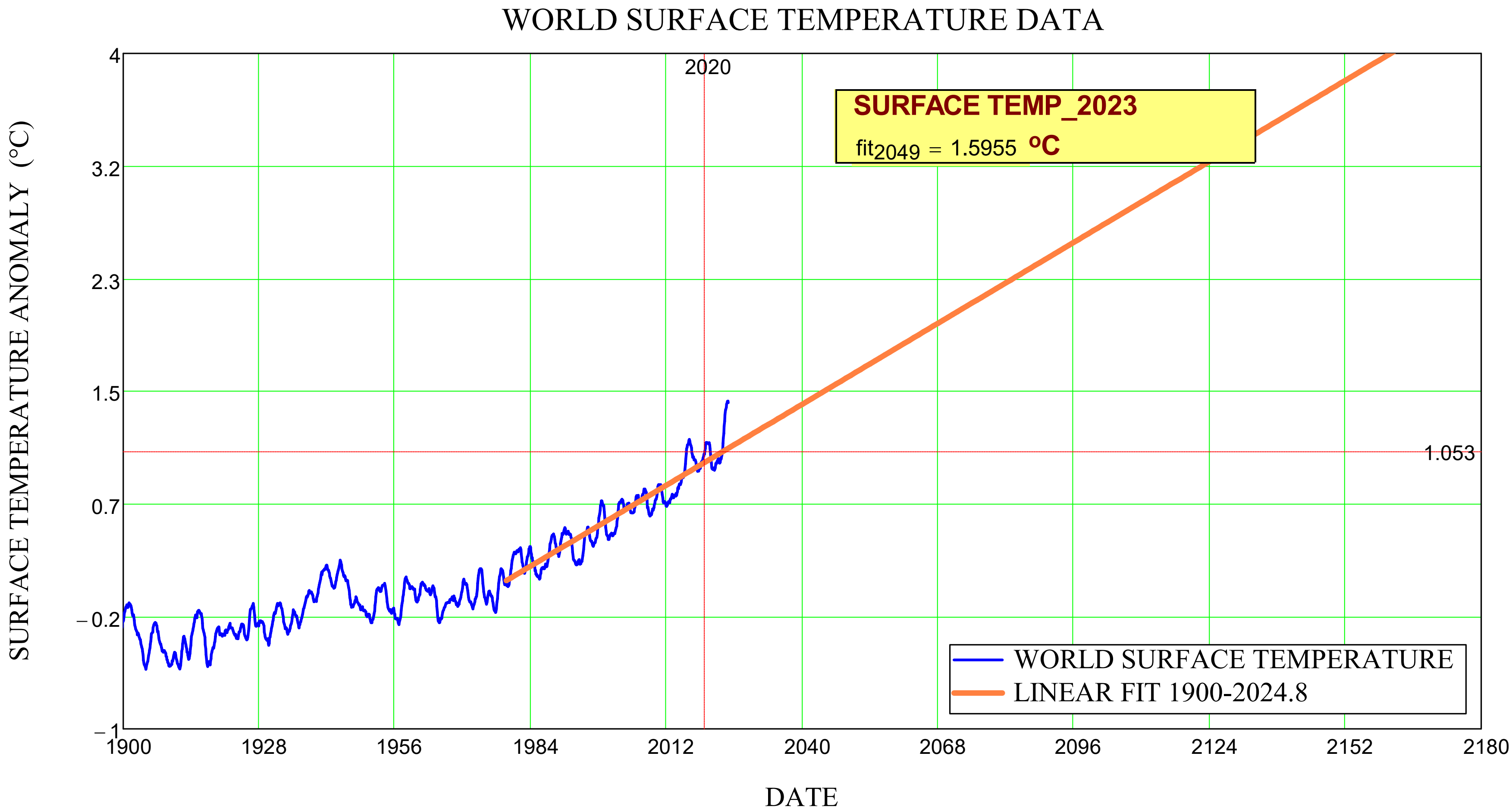
$XSurf := submatrix(X, 0, rows(X) - 1, 0, 0)$ $YSurf := submatrix(Y, 0, rows(Y) - 1, 0, 0)$

$median(XSurf) = 2001.875$

$mean(XSurf) = 2001.875$

$median(YSurf) = 0.5987$

mean(YSurf) = 0.5869



WORLD SURFACE DATA

UAH SATELLITE DATA

xx := 1979 .. 2180

X := DateSat

Y := SatelliteAnomaly

mean(SatelliteAnomaly) = −0.0559

b := slope(X , Y) = 0.0159   a := intercept(X , Y) = −31.9146 $SATFIT_{xx} := a + b \cdot xx$

mean(DateSat) = 2001.8333

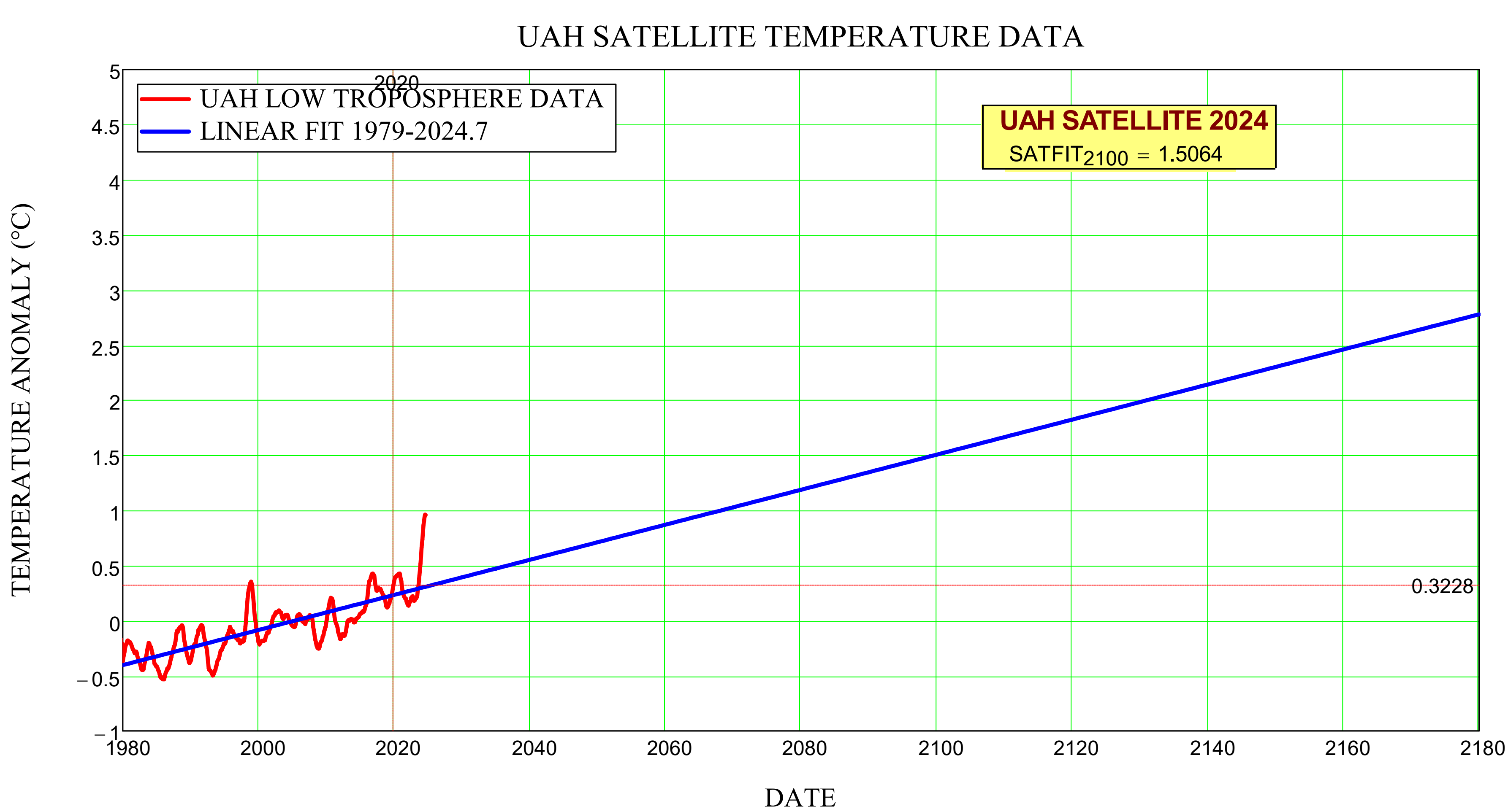
$DateSat_0 = 1979$

XSat := DateSat   YSat := SatelliteAnomaly

XSat := submatrix(XSat , 0 , rows(XSat) − 1 , 0 , 0)   YSat := submatrix(YSat , 0 , rows(YSat) − 1 , 0 , 0)

mean(XSat) = 2001.8333

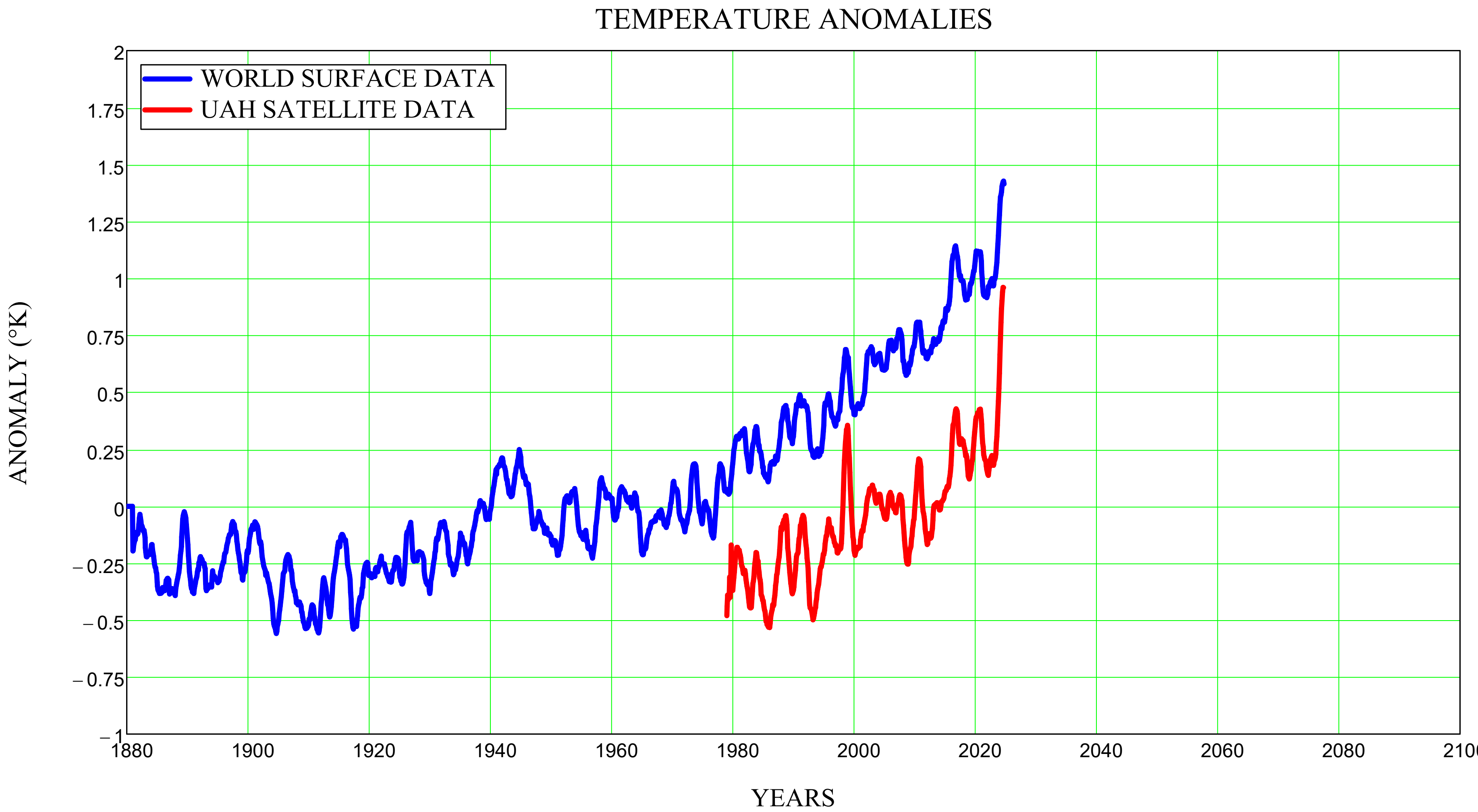
mean(YSat) = −0.0559



UAH SATELLITE DATA

FINAL MODEL PLOT WITH MOVING 12 YEAR AVERAGES FOR DATA

DATA PLOT--12 YEAR MOVING AVERAGE



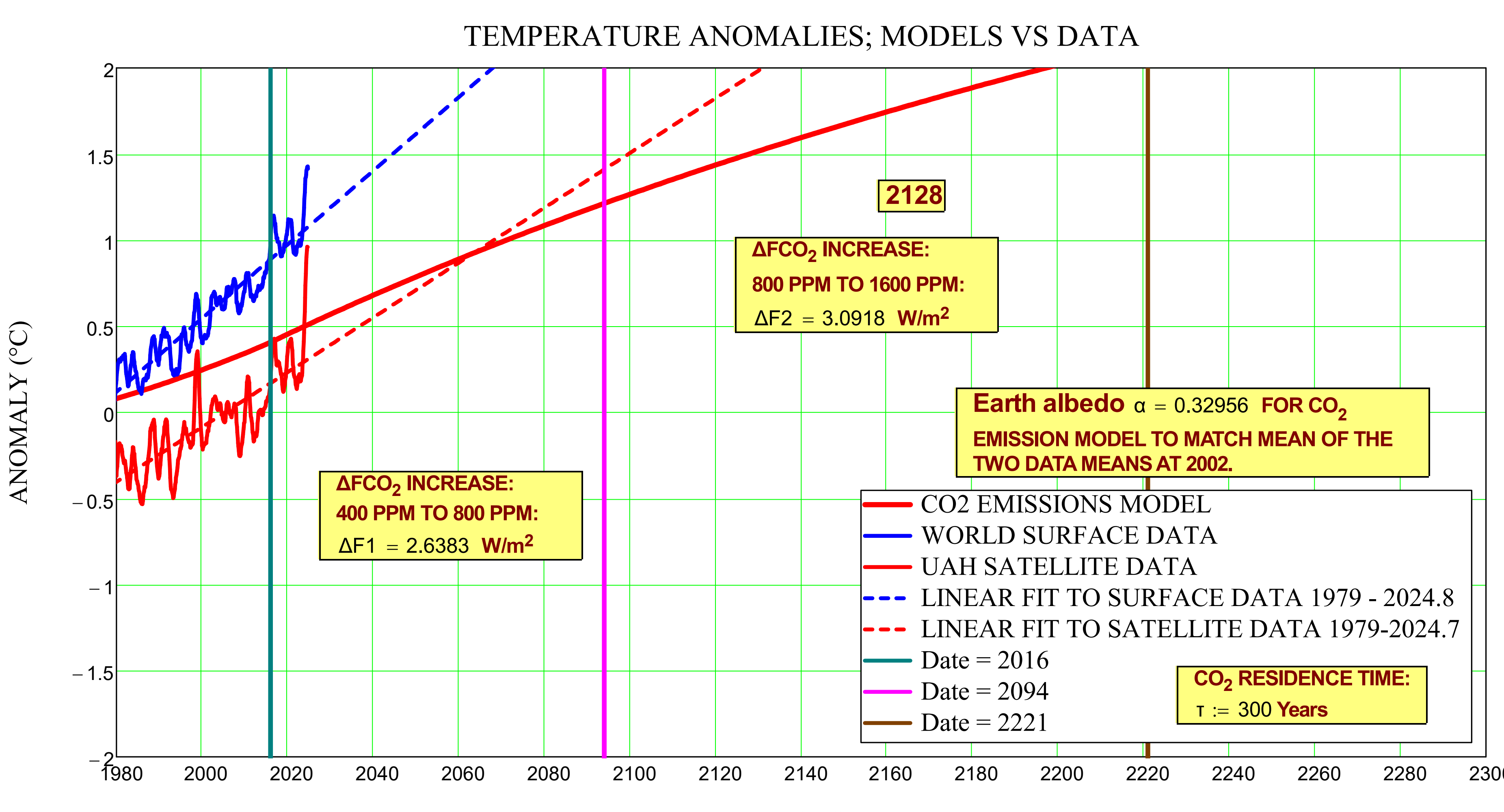
DATA PLOT--12 YEAR MOVING AVERAGE

$Date2016_k := -1000$ $Date2016_{166} := 5$ $Date2094_k := -1000$ $Date2094_{244} := 5$

$Date2221_k := -1000$ $Date2221_{371} := 5$

x =

	0
0	1850
1	1851
2	1852
3	1853
4	1854
5	...



meansurface := mean(YSurf) meansat := mean(YSat)

$$\frac{mean(XSurf) + mean(XSat)}{2} = 2001.8542$$

$$MEANOFMEANS := \frac{meansurface + meansat}{2} = 0.2655$$

$$\left(T3_{emiss}^{\langle 1 \rangle}\right)_{152} = 0.2654$$

END OF SPREADSHEEET

DateSat =

	0
0	1979
1	1979.0833
2	1979.1667
3	1979.25
4	1979.3333
5	1979.4167
6	1979.5
7	1979.5833
8	1979.6667
9	1979.75
10	1979.8333
11	1979.9167
12	1980
13	...

mean(X) = 2001.8333