Supplement of Atmos. Chem. Phys., 15, 11571–11592, 2015
http://www.atmos-chem-phys.net/15/11571/2015/
doi:10.5194/acp-15-11571-2015-supplement

Atmospheric Chemistry and Physics Open Access

Supplement of

Granger causality from changes in level of atmospheric CO_2 to global surface temperature and the El Niño–Southern Oscillation, and a candidate mechanism in global photosynthesis

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Results from analyses using a range of data series from raw to those having undergone different methods of seasonal adjustment

To enable comparison of results from analyses using a range of data series from raw to those having undergone different methods of seasonal adjustment, in this Supplement raw and then variously seasonally adjusted data (including by both moving averages and modelling), are both plotted (Figures 1 to 13) and then the core correlational analysis conducted in the paper carried out and statistically tested (Tables 1 to 13).

This analysis shows the results for various forms of adjustment, and in particular carries out (Figures 9 and 10; Tables 9 and 10) seasonal adjustment by modelling as discussed by the referee in the initial review (C10403, 22 December 2014). This seasonal adjustment using modelling is done by means of the TRAMO/SEATS model. It is run using raw monthly data on the levels of atmospheric CO_2.

For comparison, the result from a second, published, seasonal adjustment of atmospheric CO_2 time series by modelling is also presented (NOAA: seasonally adjusted CO2 data series from *ftp://aftp.cmdl.noaa.gov/products/trends/co2/co2_mm_mlo.txt* ; its modelling method is described in Thoning et al. (1989). Results are in Figures 7 and 8 and Tables 7 and 8.

Discussion of the results of the analyses in this section in connection with the referee's comments occur after Table 14: Summary of dynamic regression results.

Abbreviations used in figures and tables: FD - first difference; SD - second difference; HadGL - HadCrut4 global surface temperature; CO2_NOAAseascorr - seasonally corrected CO_2 data published by NOAA; TRAMO: seasonally corrected CO_2 data resulting from TRAMO/SEATS method.

Monthly data, ZFDCO2 no smoothing

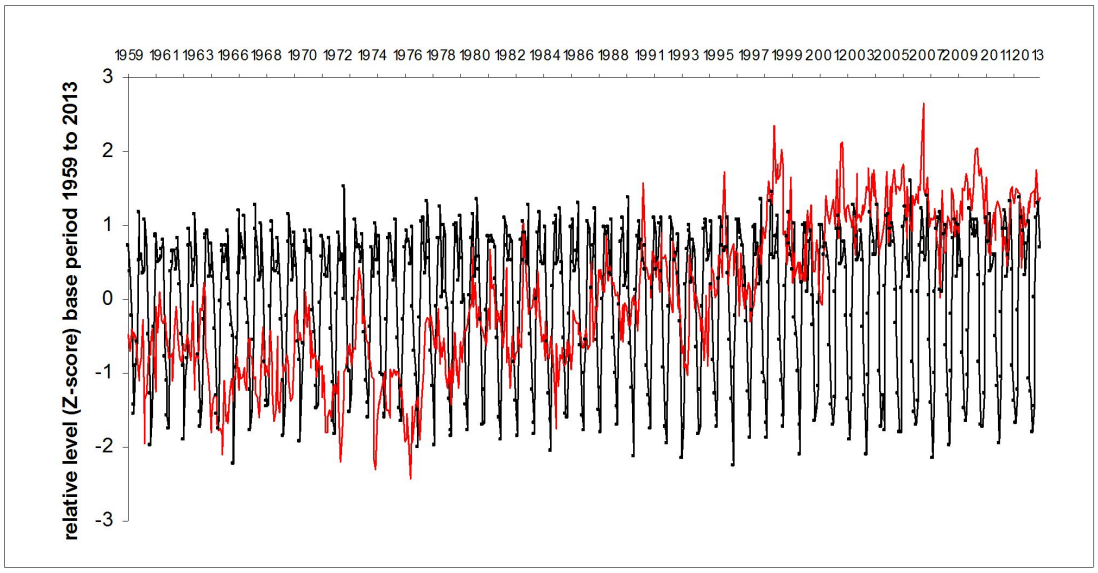


Figure 1. *Z* scored monthly data: First difference atmospheric CO_2 (black dotted curve) compared to global surface temperature (red curve)

Table 1: OLS, using observations 1-654
Dependent variable: ZHad4Gl

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00464901	0.0144919	0.3208	0.74847	
led1mZHad4Gl	0.565413	0.0375822	15.0447	<0.00001	***
Led2mZHad4Gl	0.260223	0.0424148	6.1352	<0.00001	***
led4mZHad4Gl	0.131589	0.0337038	3.9043	0.00010	***
ZFDCO2	0.0265	0.014517	1.8254	0.06839	*

Mean dependent var	−0.006217	S.D. dependent var	0.998938
Sum squared resid	89.08538	S.E. of regression	0.370494
R-squared	0.863285	Adjusted R-squared	0.862442
F(4, 649)	1024.526	P-value(F)	1.0e-278
Log-likelihood	−276.1073	Akaike criterion	562.2147
Schwarz criterion	584.6302	Hannan-Quinn	570.9067
rho	−0.002069	Durbin-Watson	2.004137

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.19088
with p-value = P(F(11,638) > 1.19088) = 0.289543

Monthly data, 13mmaZFDCO2 smooth

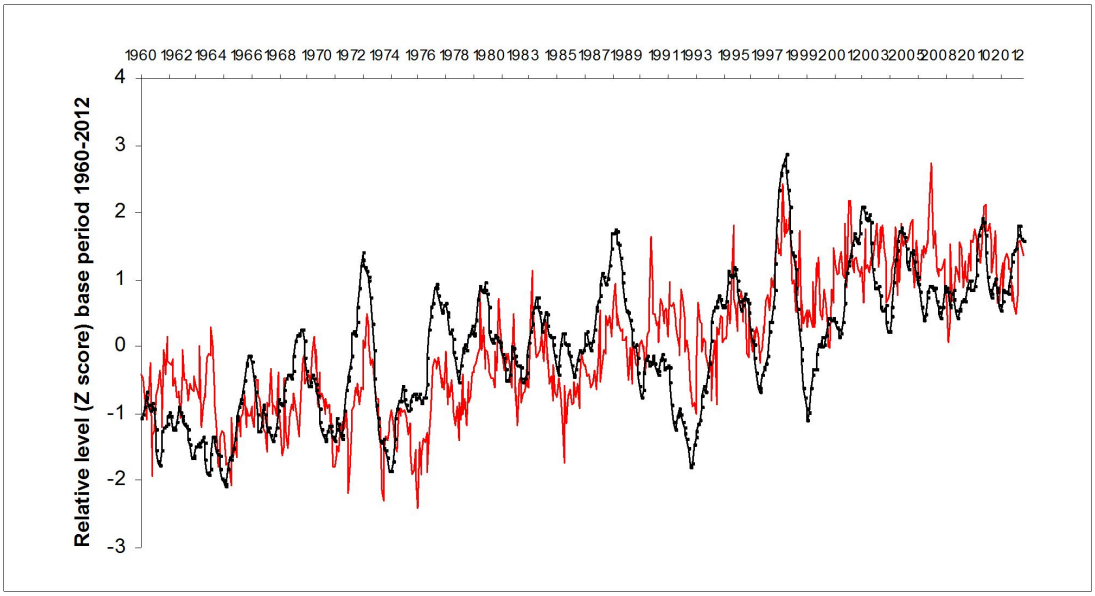


Figure 2. *Z* scored monthly data: First difference atmospheric CO_2 smoothed with two 13-month moving averages (black dotted curve) compared to global surface temperature (red curve)

Table 2: OLS, using observations 1-640
Dependent variable: ZHad4Gl

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00428239	0.0147572	0.2902	0.77177	
led2mZ2x13mFD CO2	0.102015	0.0216835	4.7047	<0.00001	***
Led1mZHad4Gl	0.564726	0.0377431	14.9623	<0.00001	***
led2mZHad4Gl	0.306035	0.0374109	8.1804	<0.00001	***

Mean dependent var	0.003075	S.D. dependent var	1.002326
Sum squared resid	88.63759	S.E. of regression	0.373319
R-squared	0.861930	Adjusted R-squared	0.861279
F(3, 636)	1323.454	P-value(F)	6.7e-273
Log-likelihood	−275.5088	Akaike criterion	559.0175
Schwarz criterion	576.8634	Hannan-Quinn	565.9444
rho	−0.011403	Durbin-Watson	2.022743

LM test for autocorrelation up to order 20 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.1028
with p-value = P(F(20,616) > 1.1028) = 0.34132

Annual data, FDCO2 and Had4Gl

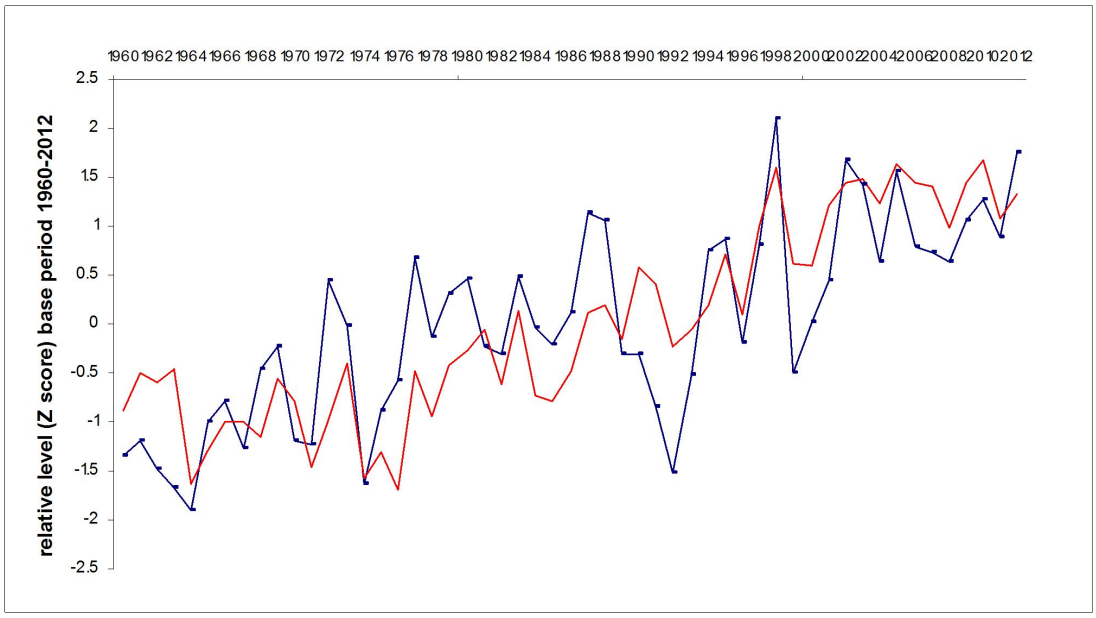


Figure 3. *Z* scored annual data: First difference atmospheric CO_2 smoothed with two 13-month moving averages (black dotted curve) compared to global surface temperature (red curve)

Table 3: OLS, using observations 1-52
Dependent variable: ZAnnHad4Gl

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.0215094	0.0504468	0.4264	0.67170	
ZAnn2x13mFDCO2	0.447195	0.0609389	7.3384	<0.00001	***
led1yZAnnHad4Gl	0.624044	0.0609126	10.2449	<0.00001	***

Mean dependent var	0.017148	S.D. dependent var	1.001857
Sum squared resid	6.465283	S.E. of regression	0.363242
R-squared	0.873699	Adjusted R-squared	0.868544
F(2, 49)	169.4814	P-value(F)	9.65e-23
Log-likelihood	−19.58008	Akaike criterion	45.16017
Schwarz criterion	51.01390	Hannan-Quinn	47.40435
rho	−0.099887	Durbin-Watson	2.147075

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 0.894529
with p-value = P(F(11,38) > 0.894529) = 0.553897

Monthly data: Second difference CO2 and first difference temp, No smoothing

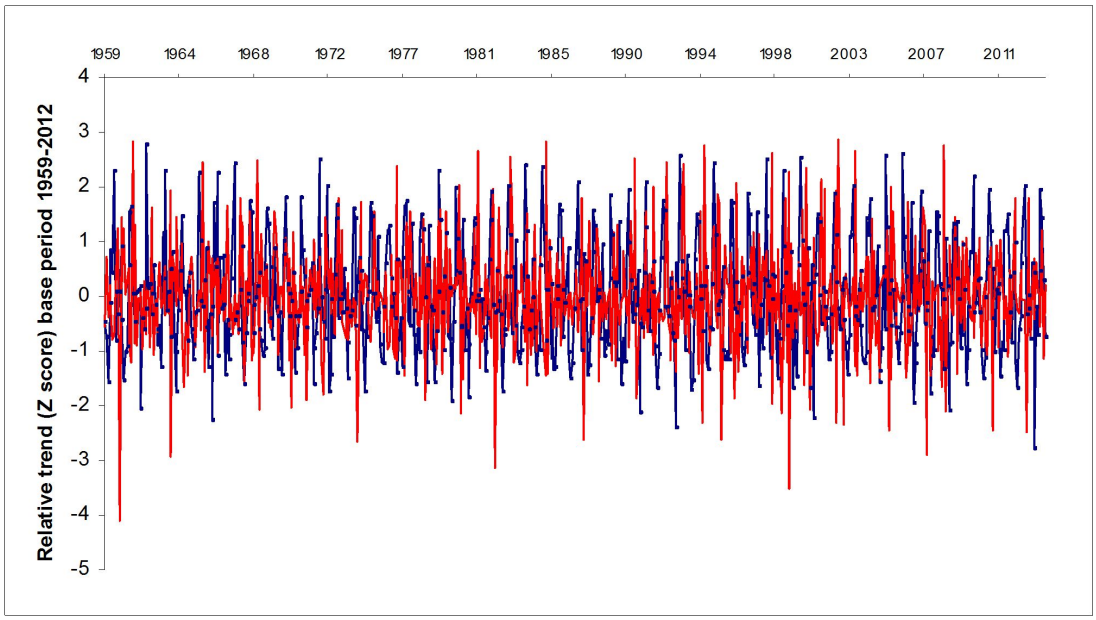


Figure 4. *Z* scored monthly data: second-difference atmospheric CO_2 (black dotted curve) compared to first-difference global surface temperature (red curve)

Table 4: OLS, using observations 1-650
Dependent variable: ZFDHad4GL

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	0.00276484	0.0359273	0.0770	0.93868	
Led3mZSDCO2	0.0986082	0.0359743	2.7411	0.00629	***
Led1mZFDHad4GL	−0.418447	0.0386966	-10.8135	<0.00001	***
Led2mZFDHad4GL	−0.146011	0.0415859	-3.5111	0.00048	***
Led3mZFDHad4GL	−0.140405	0.0387674	-3.6217	0.00032	***

Mean dependent var	0.002485	S.D. dependent var	1.003691
Sum squared resid	541.1463	S.E. of regression	0.915962
R-squared	0.172305	Adjusted R-squared	0.167172
F(4, 645)	33.56815	P-value(F)	1.84e-25
Log-likelihood	−862.7432	Akaike criterion	1735.486
Schwarz criterion	1757.871	Hannan-Quinn	1744.169
rho	−0.010671	Durbin-Watson	2.021077

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.28767
with p-value = P(F(11,634) > 1.28767) = 0.227098

Monthly data: Second difference CO2 and first difference temp, 3x13mma smoothing

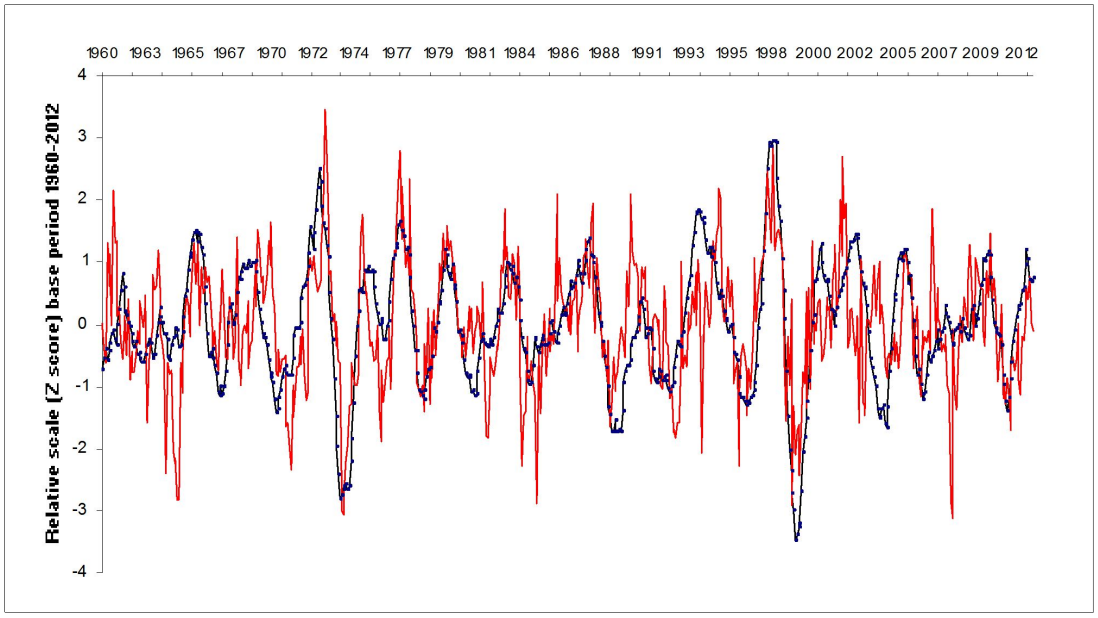


Figure 5. *Z* scored monthly data smoothed by 13-month moving average: second-difference atmospheric CO_2 (black dotted curve) compared to first-difference global surface temperature (red curve)

Table 5: OLS, using observations 1-650
Dependent variable: Z13mmaFDZHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	0.0201245	0.0260442	0.7727	0.43998	
Z13mmaSDZ2x13mCO2	0.166377	0.0299439	5.5563	<0.00001	***
led1mZ13mmaFDZHad4Gl	0.485095	0.038189	12.7025	<0.00001	***
led2mZ13mmaFDZHad4Gl	0.218271	0.0376337	5.7999	<0.00001	***

Mean dependent var	0.061759	S.D. dependent var	1.012336
Sum squared resid	288.7032	S.E. of regression	0.665429
R-squared	0.569909	Adjusted R-squared	0.56793
F(3, 652)	287.9859	P-value(F)	5.40E-119
Log-likelihood	−661.6138	Akaike criterion	1331.228
Schwarz criterion	1349.172	Hannan-Quinn	1338.185
rho	0.013684	Durbin-Watson	1.971948

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.5184
with p-value = P(F(11,641) > 1.5184) = 0.120154

Annual data: Second difference CO_2 and first difference temp

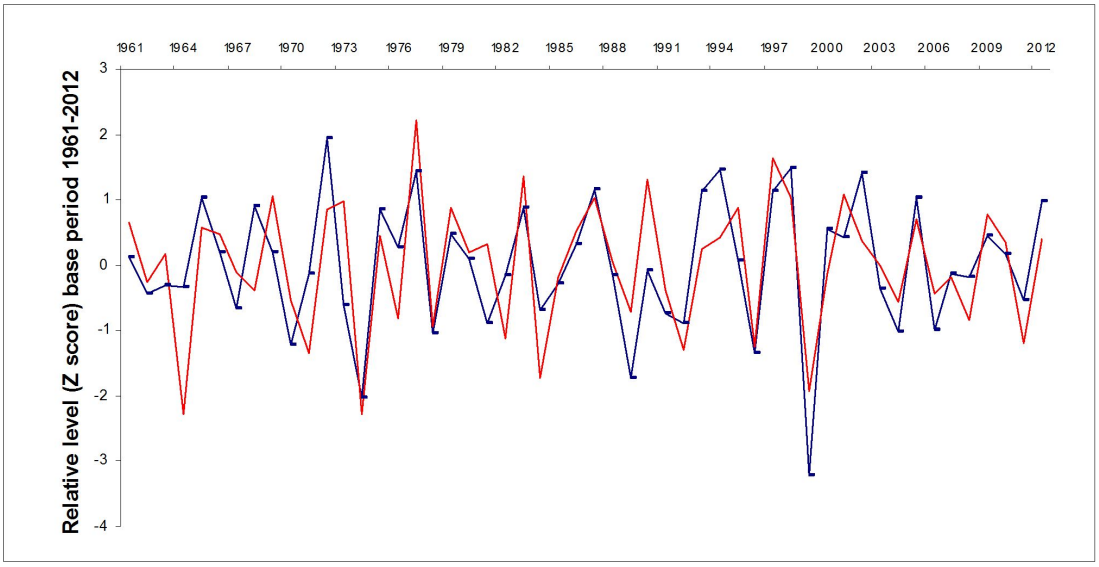


Figure 6. *Z* scored annual data: second-difference atmospheric CO_2 (black dotted curve) compared to first-difference global surface temperature (red curve)

Table 6: OLS, using observations 1-52
Dependent variable: ZFDAnnHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	0	0.100406	0	1	
ZSDAnnCO2	0.697174	0.101385	6.8765	<0.00001	***

Mean dependent var	0	S.D. dependent var	1
Sum squared resid	26.21139	S.E. of regression	0.724036
R-squared	0.486051	Adjusted R-squared	0.475772
F(1, 50)	47.28595	P-value(F)	9.36E-09
Log-likelihood	−55.97351	Akaike criterion	115.947
Schwarz criterion	119.8495	Hannan-Quinn	117.4431
rho	−0.289599	Durbin-Watson	2.561752

LM test for autocorrelation up to order 10 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.83677
with p-value = P(F(10,40) > 1.83677) = 0.0850608

Monthly data, FDCO2 NOAA seascorr, no further smoothing

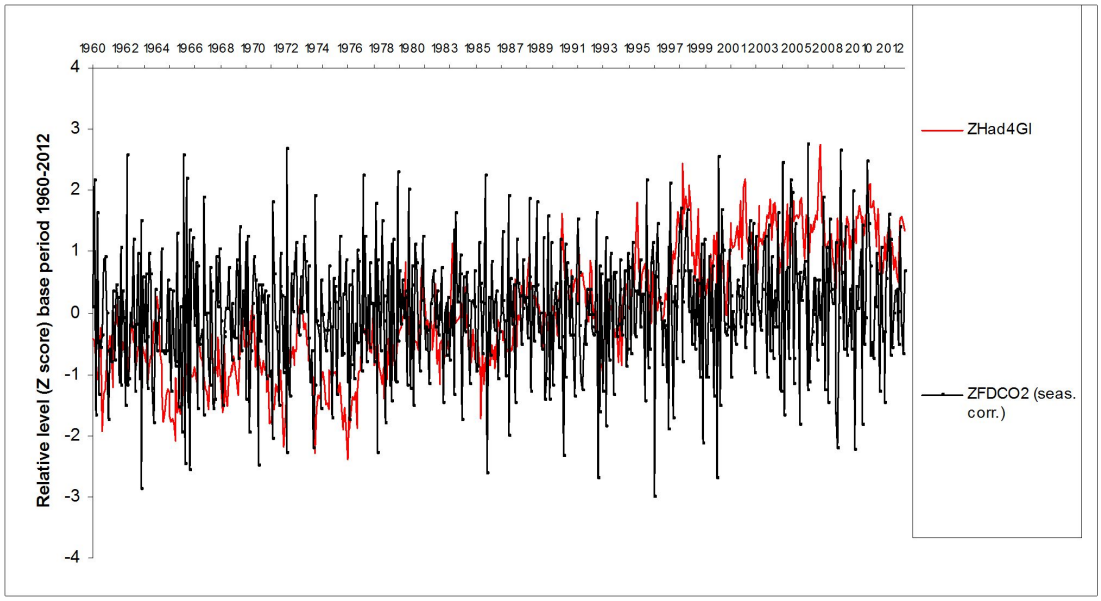


Figure 7. *Z* scored monthly data, : first-difference atmospheric CO_2 (NOAA seasonally corrected) (black dotted curve) compared to level of global surface temperature (red curve)

Table 7: OLS, using observations 1-649
Dependent variable: ZHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	0.00164552	0.0164019	0.1003	0.92012	
Led5mZFDCO2 seascorr	0.0337206	0.0164708	2.0473	0.04103	**
led1mZHad4Gl	0.685278	0.0380884	17.9918	<0.00001	***
Led1mZHad4Gl	0.237719	0.0381737	6.2273	<0.00001	***

Mean dependent var	0.005216	S.D. dependent var	1.006416
Sum squared resid	112.5346	S.E. of regression	0.417699
R-squared	0.828542	Adjusted R-squared	0.827745
F(3, 645)	1038.955	P-value(F)	1.90E-246
Log-likelihood	−352.3114	Akaike criterion	712.6229
Schwarz criterion	730.5246	Hannan-Quinn	719.567
rho	0.009035	Durbin-Watson	1.959372

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 3.38672
with p-value = P(F(11,634) > 3.38672) = 0.000142093

Monthly data, FDCO2seascorr 4x3mma smooth

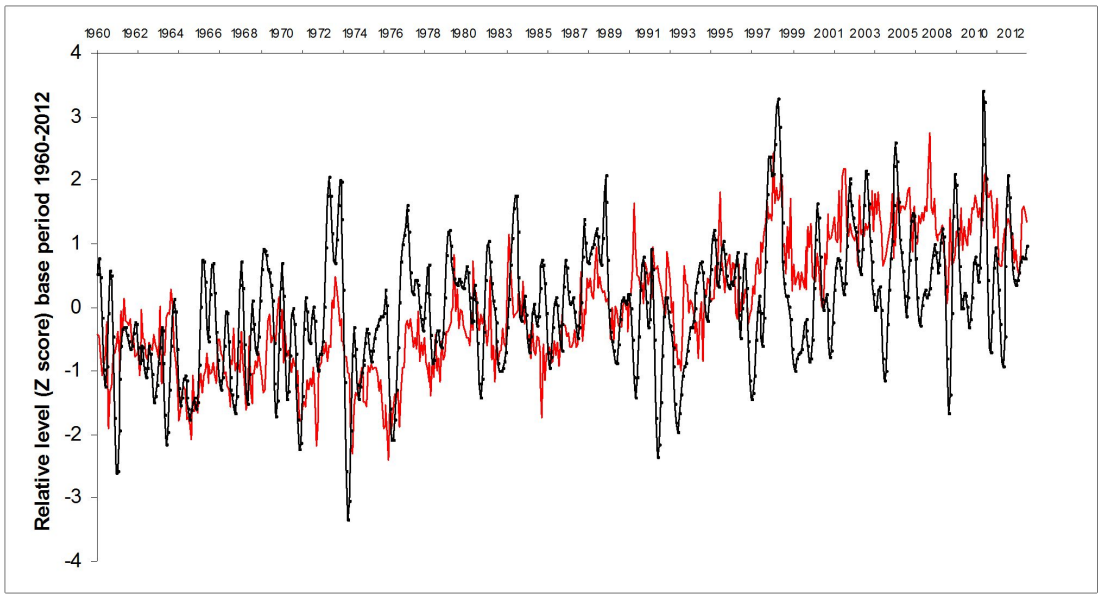


Figure 8. *Z* scored monthly data: first-difference atmospheric CO_2 (NOAA seasonally corrected) smoothed by 4 3month moving averages (black dotted curve) compared to level of global surface temperature (red curve)

Table 8: OLS, using observations 1-632
Dependent variable: ZHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	0.00607628	0.0149984	0.4051	0.68552	
Z4x3mmaFDCO2seascorr	0.0377393	0.0173021	2.1812	0.02954	**
l1ZHad4Gl	0.565126	0.0396178	14.2644	<0.00001	***
l2ZHad4Gl	0.255092	0.0456426	5.5889	<0.00001	***
l3ZHad4Gl	−0.0148978	0.0456096	-0.3266	0.74405	
l4ZHad4Gl	0.130828	0.0394726	3.3144	0.00097	***

Mean dependent var	0.004336	S.D. dependent var	1.001443
Sum squared resid	88.96325	S.E. of regression	0.37698
R-squared	0.859418	Adjusted R-squared	0.858295
F(5, 626)	765.3852	P-value(F)	6.70E-264
Log-likelihood	−277.1987	Akaike criterion	566.3974
Schwarz criterion	593.0907	Hannan-Quinn	576.7643
rho	−0.008269	Durbin-Watson	2.016528

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.38344
with p-value = P(F(11,615) > 1.38344) = 0.176079

Monthly data, FDCO2 TRAMO seasonal adjustment no further smooth

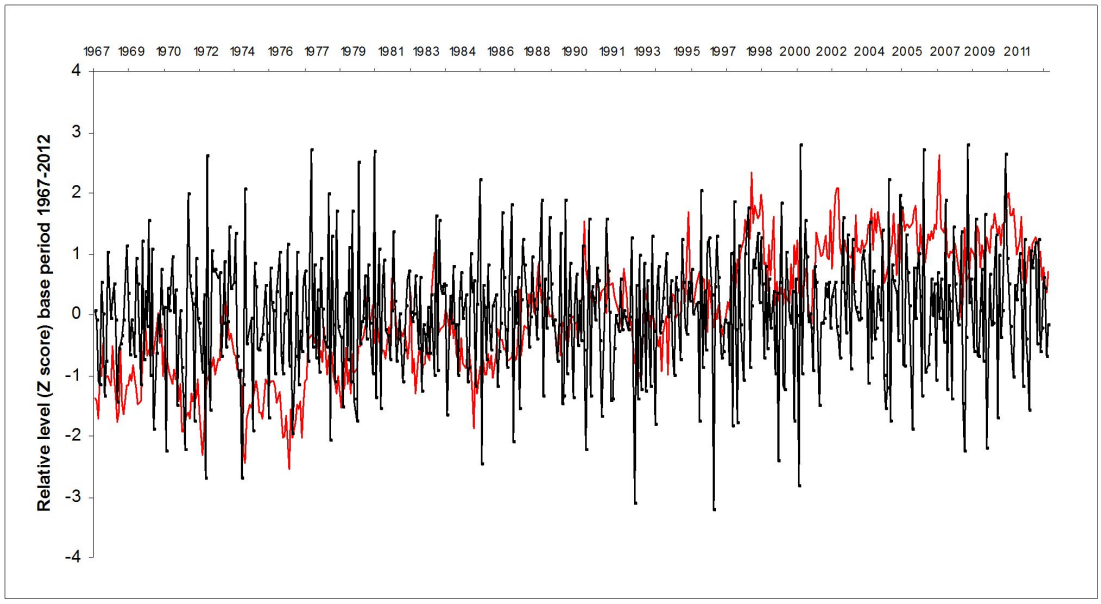


Figure 9. *Z* scored monthly data: first-difference atmospheric CO_2 (TRAMO seasonally corrected) (black dotted curve) compared to level of global surface temperature (red curve)

Table 9: OLS, using observations 1-541
Dependent variable: ZHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	0.00580134	0.0165292	0.351	0.72574	
Led1ZFDCO2_TRAMO	0.0169459	0.016621	1.0195	0.3084	
L1ZHad4Gl	0.594865	0.0405482	14.6706	<0.00001	***
L2ZHad4Gl	0.342522	0.0404153	8.4751	<0.00001	***

Mean dependent var	0.008321	S.D. dependent var	0.996424
Sum squared resid	79.36784	S.E. of regression	0.384446
R-squared	0.851966	Adjusted R-squared	0.851139
F(3, 537)	1030.179	P-value(F)	3.00E-222
Log-likelihood	−248.4681	Akaike criterion	504.9361
Schwarz criterion	522.1098	Hannan-Quinn	511.6522
rho	−0.020425	Durbin-Watson	2.035772

LM test for autocorrelation up to order 11 -
 Null hypothesis: no autocorrelation
 Test statistic: LMF = 1.65967
 with p-value = P(F(11,526) > 1.65967) = 0.0792997

Monthly data, FDCO2 TRAMO seasonal adjustment plus further 4X3mma smoothing

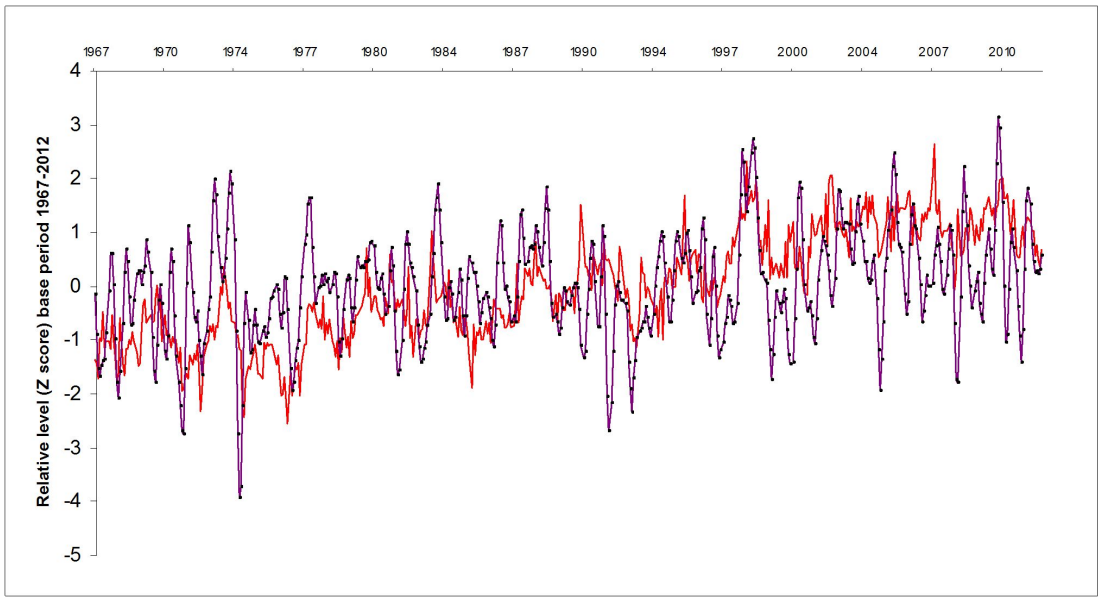


Figure 10. *Z* scored monthly data: first-difference atmospheric CO_2 (TRAMO seasonally corrected) smoothed by three 3-month moving averages (black dotted curve) compared to level of global surface temperature (red curve)

Table 10: OLS, using observations 1-540
Dependent variable: ZHad4Gl

	Coefficient	Std. Error	t-ratio	p-value	
const	−0.0518209	0.0345242	-1.501	0.13394	
Led1m3x3mmaFDCO2_TRAMO	0.50309	0.238916	2.1057	0.03569	**
Led1mZHad4Gl	0.589466	0.040646	14.5024	<0.00001	***
Led2mZHad4Gl	0.333687	0.0404246	8.2545	<0.00001	***

Mean dependent var	0.133697	S.D. dependent var	0.988703
Sum squared resid	77.36309	S.E. of regression	0.379913
R-squared	0.853171	Adjusted R-squared	0.852349
F(3, 536)	1038.164	P-value(F)	8.70E-223
Log-likelihood	−241.6008	Akaike criterion	491.2016
Schwarz criterion	508.3678	Hannan-Quinn	497.9152
rho	−0.021301	Durbin-Watson	2.041103

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.65475
with p-value = P(F(11,525) > 1.65475) = 0.0805097

Monthly data, ZFDHad4Gl and reverse SOI, no smoothing

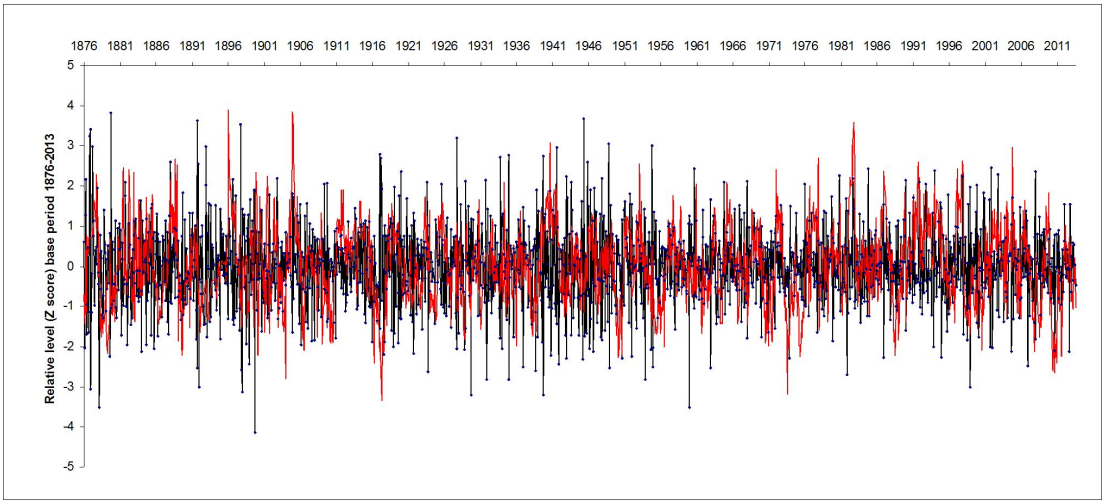


Figure 11. *Z* scored monthly data: first-difference atmospheric CO_2 (TRAMO seasonally corrected) smoothed by three 3-month moving averages (black dotted curve) compared to level of global surface temperature (red curve)

Table 11: OLS, using observations 1-1647
Dependent variable: ZReverseSOI

	Coefficient	Std. Error	t-ratio	p-value	
const	0.000821969	0.0182354	0.0451	0.96405	
ZFDZHad4Gl	0.0551914	0.018288	3.0179	0.00258	***
L1ZReverseSOI	0.47422	0.0244903	19.3636	<0.00001	***
L2ZReverseSOI	0.187349	0.0266996	7.0169	<0.00001	***
L3ZReverseSOI	0.0874809	0.0244789	3.5737	0.00036	***

Mean dependent var	0.002695	S.D. dependent var	1.000409
Sum squared resid	899.2797	S.E. of regression	0.74005
R-squared	0.454104	Adjusted R-squared	0.452774
F(4, 1642)	341.4746	P-value(F)	5.50E-214
Log-likelihood	−1838.678	Akaike criterion	3687.356
Schwarz criterion	3714.39	Hannan-Quinn	3697.38
rho	−0.007240	Durbin-Watson	2.01295

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.69657
with p-value = P(F(11,1631) > 1.69657) = 0.0685144

Monthly data, ZFDHad4Gl smoothed by 13mma, and reverse SOI

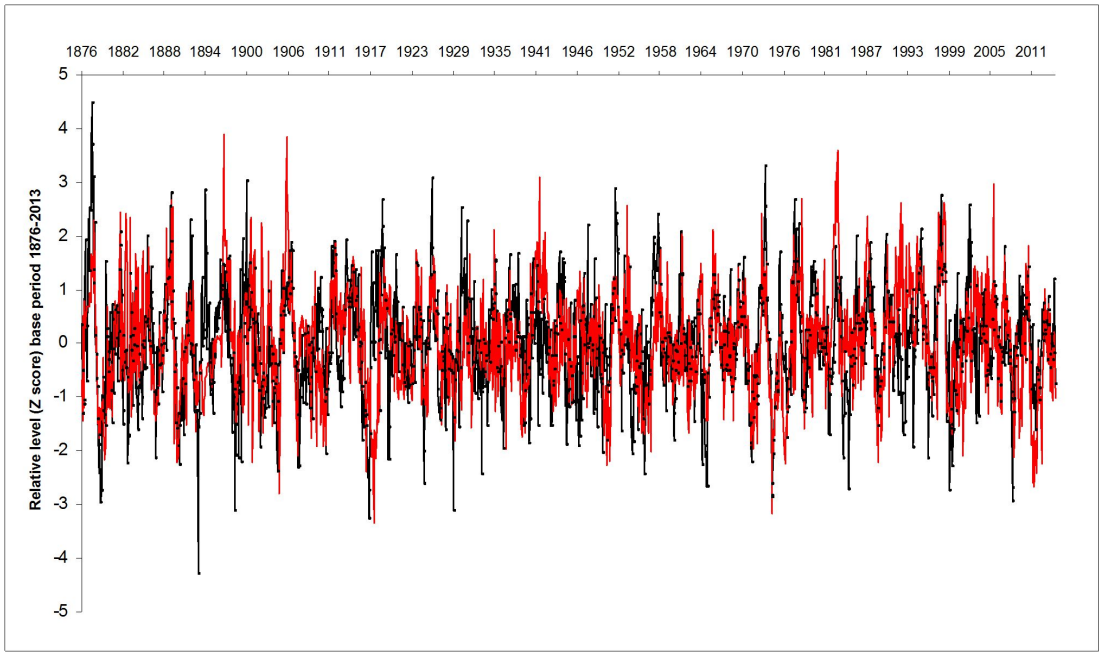


Figure 12. *Z* scored monthly data: led 3 month first-difference global surface temperature smoothed by a 13-month moving average (black dotted curve) compared to level of (reverse) Southern Oscillation Index (red curve)

Table 12 : OLS, using observations 1-1648
Dependent variable: ZReverseSOI

	Coefficient	Std. Error	t-ratio	p-value	
const	0.000305	0.0179903	0.017	0.98646	
Led3mZ13mmaFDHad4Gl	0.14137	0.019169	7.374	<0.00001	***
L1ZReverseSOI	0.442205	0.0245285	18.028	<0.00001	***
L2ZReverseSOI	0.172003	0.0264475	6.5036	<0.00001	***
L3ZReverseSOI	0.0818258	0.0241703	3.3854	0.00073	***

Mean dependent var	0.002074	S.D. dependent var	1.0004
Sum squared resid	876.331	S.E. of regression	0.7303
R-squared	0.468372	Adjusted R-squared	0.4670
F(4, 1643)	361.8771	P-value(F)	1.50E-2
Log-likelihood	−1817.994	Akaike criterion	3645.9
Schwarz criterion	3673.024	Hannan-Quinn	3656.0
rho	−0.006071	Durbin-Watson	2.010102

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 1.15483
with p-value = P(F(11,1632) > 1.15483) = 0.31415

Annual data, ZFDHad4Gl and reverse SOI

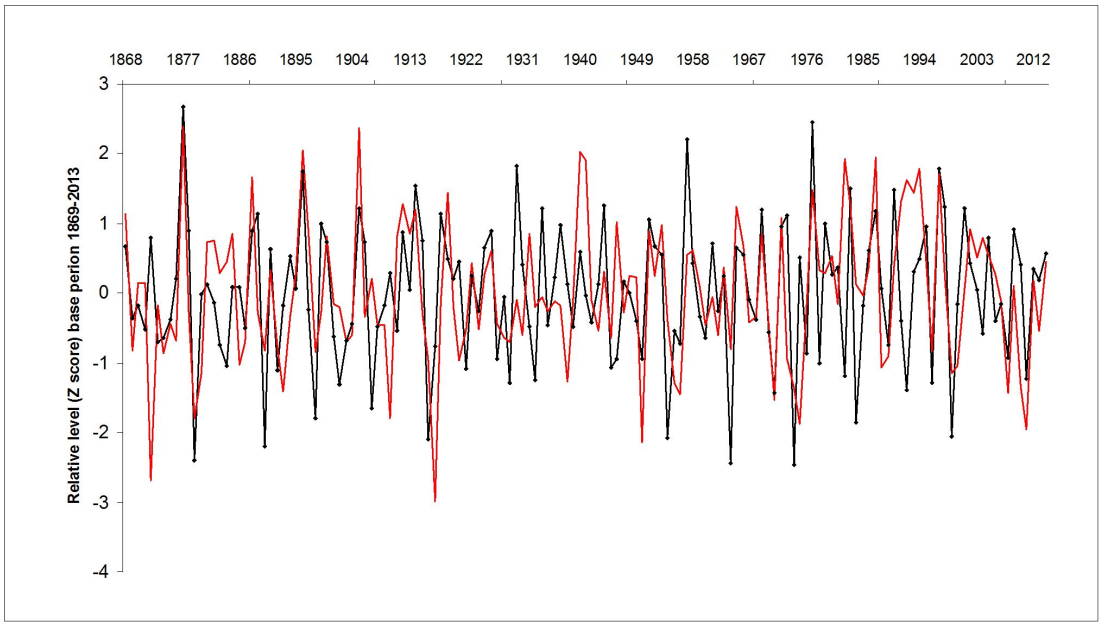


Figure 13. *Z annual* data: first-difference global surface temperature (black dotted curve) compared to level of (reverse) Southern Oscillation Index (red curve)

Table 13: OLS, using observations 1-147
Dependent variable: reverseAnnSOI

	Coefficient	Std. Error	t-ratio	p-value	
const	0	0.0738511	0	1	
FDAnnHad4Gl	0.451394	0.0741036	6.0914	<0.00001	***

Mean dependent var	0	S.D. dependent var	1
Sum squared resid	116.2516	S.E. of regression	0.895397
R-squared	0.203756	Adjusted R-squared	0.198265
F(1, 145)	37.10503	P-value(F)	9.57E-09
Log-likelihood	−191.3353	Akaike criterion	386.6706
Schwarz criterion	392.6514	Hannan-Quinn	389.1007
rho	0.121635	Durbin-Watson	1.750504

LM test for autocorrelation up to order 11 -
Null hypothesis: no autocorrelation
Test statistic: LMF = 0.669798
with p-value = P(F(11,134) > 0.669798) = 0.764953

Table 14: Summary of dynamic regression results

	Condition	FDCO2 or FDHad4GI partial regression coefficient	Significance of independent variable (FDCO2, etc.) partial regression coefficient (p-value)	Adjusted R-square of entire model	LMF p-value (green indicates no significant auto-correlation at order tested)
Monthly: FDCO2 and temperature (Hadcrut4GI)	Monthly, no filter	0.027	0.0684 *	0.862	0.290
	Monthly, filtered (2x13mma)	0.102	<0.00001 ***	0.861	0.341
Monthly: FDCO2_NOAAseascorr and Hadcrut4GI	Monthly, no filter	0.034	0.0410 **	0.828	0.00014
	Monthly, filtered (4x3mma)	0.038	0.02954 **	0.858	0.176
Monthly: FDCO2_TRAMO and Had4GI	Monthly, no filter	0.017	0.308	0.851	0.079
	Monthly, filtered (4x3mma)	0.503	0.0357 **	0.852	0.081
Annual (no seasonality to filter) FDCO2 and Hadcrut4GI		0.447	<0.00001 ***	0.862	0.554
SDCO2 and FDHad4GI	Monthly, no filter	0.099	0.00629 ***	0.167	0.227
	Monthly, filtered (2x13mma)	0.166	<0.00001 ***	0.568	0.120
	Annual (no seasonality to filter)	0.697	<0.00001 ***	0.476	0.085
FD temperature and (reverse) SOI	Monthly, no filter	0.057	0.00189 ***	0.453	0.053
	Monthly, filtered (2x13mma)	0.141	<0.00001 ***	0.466	0.239
	Annual (no seasonality to filter)	0.451	<0.00001 ***	0.198	0.562

Comment:
Thirteen analyses are summarised in the table. In all but one case, models were achieved with no significant autocorrelation remaining. The green highlighting shows results which are both statistically significant and show differenced CO2 correlated with temperature, or differenced temperature correlated with the SOI.
Of the 12 cases without significant autocorrelation, 10 are green highlighted, and one is light green. In other words, most of the approaches assessed above (i) support the findings of the paper, and (ii) the use of its particular seasonal smoothing method.

In more detail, it is seen firstly that, *even using raw data*, in three of the four instances assessed, the findings made in the paper using its smoothed data are supported.

Secondly, the highest partial regression coefficient p-value is seen for the smoothing for first-difference CO_2 used in the paper, 2x13mma.

The question of the best method to use is explored further using cross-correlogram analysis in Table 15 and Figure 15.

Table 15 also enables further assessment of the question of whether first difference CO2 leads or lags global surface temperature. (Re Referee comment Page 2. "…especially for testing sensitive questions such as phase shifts of one or two periods.")

Table 15: Cross-correlogram analyses. Maximum correlation achieved for each analysis is highlighted in green

	Correlation between:					
Lag	**ZFDCO2 and Had4GI**	**ZFDCO2 NOAA seas corr and Had4gl**	**Z4x3mmaFDCO2 NOAA seas corr and had4gl**	**Z2x13mFDCO2 and Had4gl**	**FDCO2_TRAMO and Had4GI**	**4x3mmaFDCO2_TRAMO and Had4GI**
-60	0.017	0.070	0.235	0.420	0.058	0.156
-59	0.011	0.058	0.246	0.434	0.046	0.165
-58	0.013	0.059	0.266	0.449	0.036	0.178
-57	0.015	0.079	0.291	0.466	0.061	0.196
-56	0.005	0.077	0.317	0.483	0.062	0.215
-55	0.002	0.102	0.335	0.501	0.084	0.230
-54	0.004	0.090	0.342	0.517	0.069	0.240
-53	0.021	0.093	0.344	0.534	0.067	0.249
-52	0.037	0.067	0.347	0.548	0.052	0.261
-51	0.053	0.104	0.357	0.560	0.089	0.276
-50	0.042	0.102	0.372	0.567	0.075	0.288
-49	0.024	0.096	0.386	0.571	0.077	0.297
-48	0.020	0.105	0.396	0.574	0.085	0.303
-47	0.023	0.114	0.401	0.576	0.107	0.308
-46	0.024	0.099	0.402	0.576	0.081	0.309
-45	0.026	0.106	0.399	0.575	0.092	0.306
-44	0.018	0.101	0.390	0.570	0.080	0.295
-43	0.007	0.104	0.375	0.564	0.081	0.277
-42	0.009	0.098	0.355	0.556	0.072	0.256
-41	0.020	0.081	0.335	0.552	0.053	0.240
-40	0.034	0.068	0.322	0.549	0.049	0.234
-39	0.051	0.093	0.317	0.545	0.072	0.240
-38	0.038	0.079	0.316	0.537	0.066	0.249
-37	0.022	0.088	0.317	0.528	0.075	0.256
-36	0.014	0.075	0.315	0.520	0.063	0.256

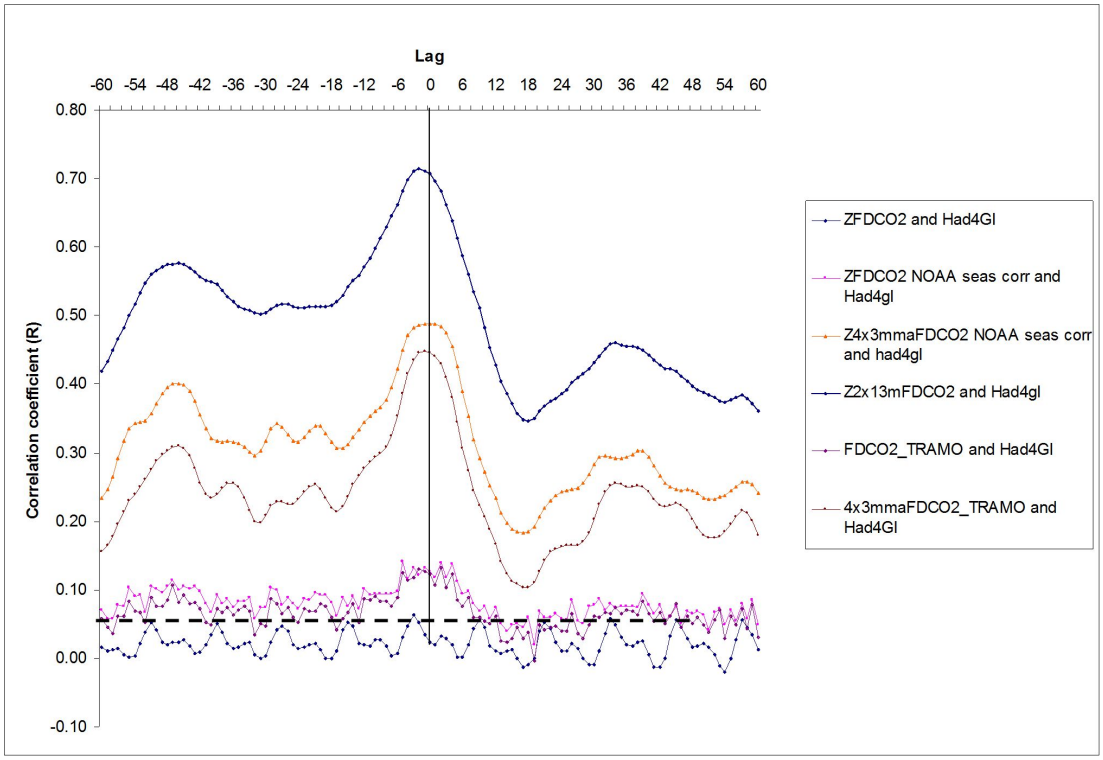
-35	0.016	0.083	0.314	0.514	0.071	0.250
-34	0.021	0.083	0.308	0.510	0.076	0.234
-33	0.024	0.090	0.301	0.507	0.068	0.215
-32	0.006	0.059	0.296	0.504	0.034	0.200
-31	-0.001	0.075	0.302	0.503	0.050	0.198
-30	0.003	0.075	0.318	0.505	0.047	0.209
-29	0.023	0.103	0.335	0.510	0.087	0.223
-28	0.042	0.100	0.342	0.516	0.079	0.229
-27	0.048	0.079	0.338	0.518	0.065	0.228
-26	0.040	0.089	0.327	0.517	0.074	0.224
-25	0.021	0.080	0.318	0.513	0.059	0.225
-24	0.014	0.072	0.316	0.511	0.052	0.232
-23	0.016	0.087	0.323	0.512	0.073	0.242
-22	0.020	0.084	0.333	0.513	0.069	0.250
-21	0.022	0.096	0.340	0.514	0.069	0.253
-20	0.012	0.092	0.338	0.514	0.080	0.247
-19	-0.001	0.092	0.328	0.514	0.077	0.234
-18	-0.001	0.081	0.315	0.515	0.060	0.220
-17	0.011	0.061	0.306	0.521	0.041	0.214
-16	0.041	0.088	0.306	0.531	0.057	0.221
-15	0.052	0.076	0.312	0.542	0.067	0.237
-14	0.047	0.091	0.322	0.552	0.080	0.254
-13	0.022	0.072	0.333	0.559	0.053	0.267
-12	0.019	0.102	0.345	0.571	0.086	0.278
-11	0.019	0.092	0.354	0.584	0.085	0.287
-10	0.026	0.093	0.361	0.598	0.091	0.294
-9	0.028	0.094	0.366	0.614	0.084	0.299
-8	0.018	0.094	0.377	0.629	0.084	0.308
-7	0.004	0.094	0.395	0.646	0.076	0.325
-6	0.008	0.098	0.422	0.662	0.088	0.353
-5	0.030	0.142	0.451	0.681	0.125	0.386
-4	0.047	0.117	0.471	0.698	0.114	0.415
-3	0.064	0.132	0.483	0.711	0.118	0.435
-2	0.052	0.122	0.487	0.715	0.131	0.446
-1	0.034	0.133	0.488	0.712	0.126	0.448
0	0.023	0.127	0.488	0.707	0.123	0.447
1	0.020	0.118	0.487	0.696	0.107	0.440
2	0.032	0.139	0.485	0.682	0.133	0.431
3	0.030	0.118	0.475	0.663	0.103	0.411
4	0.019	0.137	0.456	0.639	0.124	0.381
5	0.002	0.112	0.426	0.612	0.085	0.344
6	0.002	0.093	0.390	0.587	0.076	0.307
7	0.021	0.098	0.353	0.561	0.089	0.273
8	0.044	0.080	0.320	0.536	0.059	0.245
9	0.056	0.068	0.293	0.511	0.060	0.224
10	0.045	0.076	0.271	0.482	0.055	0.207
11	0.019	0.057	0.252	0.453	0.050	0.189
12	0.011	0.075	0.233	0.427	0.061	0.167
13	0.007	0.051	0.213	0.404	0.026	0.142
14	0.010	0.040	0.197	0.386	0.024	0.123
15	0.012	0.049	0.188	0.372	0.029	0.112
16	0.000	0.051	0.184	0.358	0.046	0.108

17	-0.014	0.045	0.182	0.348	0.029	0.103
18	-0.009	0.060	0.185	0.346	0.038	0.103
19	0.000	0.020	0.192	0.350	-0.003	0.110
20	0.039	0.069	0.206	0.361	0.049	0.126
21	0.053	0.059	0.219	0.369	0.041	0.143
22	0.043	0.060	0.230	0.375	0.046	0.155
23	0.024	0.066	0.237	0.380	0.048	0.160
24	0.010	0.058	0.242	0.385	0.040	0.163
25	0.011	0.057	0.245	0.393	0.040	0.164
26	0.022	0.085	0.247	0.402	0.066	0.165
27	0.015	0.055	0.249	0.410	0.036	0.165
28	0.000	0.050	0.256	0.416	0.030	0.170
29	-0.010	0.076	0.268	0.422	0.048	0.183
30	-0.009	0.078	0.283	0.431	0.061	0.204
31	0.011	0.087	0.293	0.441	0.059	0.225
32	0.037	0.070	0.296	0.451	0.068	0.242
33	0.058	0.080	0.294	0.458	0.066	0.252
34	0.049	0.075	0.292	0.460	0.075	0.255
35	0.030	0.075	0.292	0.458	0.065	0.253
36	0.019	0.077	0.294	0.456	0.071	0.250
37	0.019	0.076	0.298	0.455	0.070	0.250
38	0.023	0.074	0.302	0.453	0.063	0.251
39	0.025	0.095	0.302	0.450	0.084	0.250
40	0.005	0.078	0.295	0.443	0.065	0.244
41	-0.013	0.066	0.282	0.435	0.054	0.233
42	-0.013	0.079	0.267	0.428	0.068	0.223
43	0.000	0.057	0.256	0.423	0.050	0.221
44	0.033	0.062	0.250	0.422	0.062	0.224
45	0.057	0.076	0.247	0.419	0.079	0.226
46	0.045	0.051	0.245	0.411	0.046	0.223
47	0.029	0.069	0.247	0.405	0.062	0.215
48	0.016	0.065	0.245	0.397	0.051	0.203
49	0.018	0.069	0.241	0.392	0.059	0.190
50	0.022	0.064	0.235	0.389	0.049	0.180
51	0.016	0.042	0.232	0.385	0.038	0.176
52	0.005	0.067	0.233	0.381	0.057	0.175
53	-0.011	0.073	0.235	0.375	0.070	0.179
54	-0.020	0.049	0.238	0.374	0.029	0.184
55	0.000	0.071	0.244	0.378	0.062	0.196
56	0.027	0.055	0.250	0.382	0.048	0.207
57	0.055	0.080	0.257	0.384	0.073	0.216
58	0.045	0.057	0.257	0.379	0.043	0.212
59	0.034	0.086	0.253	0.371	0.079	0.201
60	0.013	0.049	0.241	0.362	0.030	0.180

Table 15 shows, first, that, while there are some differences in the precise number of periods by which first-difference CO_2 leads temperature, the key point in this aspect of our study is supported - that in none of the six cases assessed does temperature lead first-difference CO_2. Two of these cases are new to the study – NOAA and TRAMO.

Figure 15 plots the data in Table 15.

Figure 15: Cross-correlograms between variously seasonally-adjusted first difference CO_2 time series and the Hadcrut4 global surface temperature time series. The dashed line shows the 0.05 level of statistical significance



The figure shows the following. First, it is of interest that there is very close conjunction between the two (NOAA and TRAMO) model-based methods of seasonal adjustment. Secondly, the 2x13mma FDCO2 series displays the highest correlation with temperature. Thus this observation, along with its displaying the highest statistical significance in the dynamic regression analyses (see Table 14 above) is support for its use as the method of seasonal adjustment in the paper.