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SUPPLEMENTARY INFORMATION

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Disentangling greenhouse warming and aerosol cooling to reveal Earth's climate sensitivity

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1 Overview

This Supplement provides tabulated results of regression estimates and tests described in the Online Methods Section (OMS) to Storelvmo et al. (2016). The 5 tables given below detail findings obtained from the following tests and estimation procedures. References, variable notation, and tests, including acronyms, are as given in the OMS document.

1. Table S1 provides results of unit root tests designed to assess evidence for the presence of stochastic trends in the variables used in the panel regressions in the main paper. Both unit root null and stationary null hypotheses are tested, as described in the OMS.

2. Table S2 provides results of residual based tests for cointegration among the global variables in the system.

3. Table S3 reports estimation and confidence interval results for a model extension that allows for parameter differentiation across latitudes into four spatial regions. Details are provided in the OMS.

4. Table S4 provides the results of a stationarity test for the time specific effect in the model, which serves as a long run equilibrium error effect in global energy balance.

5. Table S5 reports alternative estimates of the global level variable coefficients obtained by dynamic ordinary least squares regression (rather than panel least squares regression), an estimation method that accommodates nonstationarity and cointegrating links among the variables.

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2 Tables

Table S1: Test results for the presence of a unit root using ADF, PP coefficient, and KPSS tests. The ADF and PP results allow for a fitted intercept. Similar results were obtained in ADF and PP regression tests with a deterministic trend with the exception of T_t, where the null of a unit root with drift was rejected in favor of trend stationarity (p value 0.001).

Test	Variable	p value	Unit Root
Tests with a null of stochastic trend			
ADF	T_t	0.17	Y
PP	T_t	0.17	Y
ADF	R_t	0.31	Y
PP	R_t	0.31	Y
ADF	$CO_{2,eq}$	0.87	Y
PP	$CO_{2,eq}$	0.87	Y
Tests with a null of trend stationarity			
KPSS	T_t	0.06	Y*
KPSS	R_t	0.01	Y***
KPSS	$CO_{2,eq}$	0.01	Y***

Table S2: Test results for the presence of cointegration between temperature, radiation and $CO_{2,eq}$ using Phillips-Ouliaris (1990) residual based coefficient (z) and t ratio (τ) tests with an intercept in the regression. Similar results were obtained from the same residual based tests with a deterministic trend in the regression.

Test Statistic	Variables: T_t and	Stat Value	p value	Cointegration
z	R_t	-18.660	0.013	Y
τ	R_t	-3.378	0.014	Y
z	$CO_{2,eq}$	-37.621	0.001	Y
τ	$CO_{2,eq}$	-5.511	0.001	Y
z	R_t and $CO_{2,eq}$	-6.584	0.000	Y
τ	R_t and $CO_{2,eq}$	-46.436	0.000	Y

Table S3: Results of the first model extension described in the OMS, in which we estimate new parameter values for four separate latitude bands. The number of surface stations in each latitude band were 127 (SH), 192 (Tr), 556 (NHs) and 374 (NHh).

Parameter	Region	Value	Std.Error	95% Conf. Interval	Variable	Number of stations
β_1	SH	0.9639	0.0072	$(0.9498, 0.9779)$	T_i	127
β_1	Tr	0.9583	0.0070	$(0.9447, 0.9719)$	T_i	192
β_1	NHs	0.9181	0.0049	$(0.9085, 0.9277)$	T_i	556
β_1	NHh	0.9680	0.0046	$(0.9590, 0.9769)$	T_i	374
β_2	SH	0.0079	0.0021	$(0.0038, 0.0121)$	R_i	127
β_2	Tr	0.0029	0.0013	$(0.0003, 0.0055)$	R_i	192
β_2	NHs	0.0093	0.0011	$(0.0072, 0.0114)$	R_i	556
β_2	NHh	0.0012	0.0017	$(-0.002, 0.0045)$	R_i	374
γ_1	SH	-1.027	0.153	$(-1.33, -0.72)$	T	127
γ_1	Tr	-0.945	0.16	$(-1.26, -0.62)$	T	192
γ_1	NHs	-0.818	0.158	$(-1.13, -0.50)$	T	556
γ_1	NHh	-0.838	0.158	$(-1.16, -0.52)$	T	374
γ_2	SH	-0.009	0.0023	$(-0.014, -0.005)$	R	127
γ_2	Tr	-0.008	0.0031	$(-0.014, -0.0014)$	R	192
γ_2	NHs	-0.0028	0.007	$(-0.011, 0.017)$	R	556
γ_2	NHh	0.0048	0.0076	$(-0.011, 0.020)$	R	374
γ_3	SH	3.26	0.527	$(2.197, 3.324)$	$CO_{2,eq}$	127
γ_3	Tr	2.362	0.601	$(1.151, 3.574)$	$CO_{2,eq}$	192
γ_3	NHs	3.948	0.838	$(2.257, 5.638)$	$CO_{2,eq}$	556
γ_3	NHh	3.197	0.686	$(1.814, 5.580)$	$CO_{2,eq}$	374

Table S4: Test results for the presence of a unit root in λ_t using ADF, PP coefficient, and KPSS tests. The ADF and PP results allow for a fitted intercept.

Test	Variable	p value	Unit Root
Tests with a null of stochastic trend			
ADF	λ_t	0.000	N
PP	λ_t	0.000	N
Tests with a null of trend stationarity			
KPSS	λ_t	> 0.1	N

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Table S5: Estimated global forcing parameters in equation (3) of OMS for λ_t using DOLS regression allowing for lead and lag differences in variables R and $CO_{2,eq}$.

Parameter	Variable	Value	Std.Error	t	$P > \|t\|$	95% Conf. Interval
γ_1	T_t	-0.883	0.165	-5.34	0	(-1.217, -0.548)
γ_2	R_t	0.0072	0.011	0.65	0.518	(-0.0152, 0.0296)
γ_{2b}	ΔR_{t-1}	0.0056	0.012	0.47	0.638	(-0.018, 0.029)
γ_{2c}	ΔR_{t+1}	0.0173	0.012	1.44	0.159	(-0.007, 0.042)
γ_3	$CO_{2,eq}$	4.782	1.155	4.14	0	(2.44, 7.12)
γ_{3b}	$\Delta(CO_{2,eq})_{t-1}$	-11.98	7.965	-1.5	0.141	(-28.12, 4.16)
γ_{3c}	$\Delta(CO_{2,eq})_{t+1}$	8.36	7.97	1.05	0.301	(-7.79, 24.51)
γ_0	Constant	0.199	0.093	2.13	0.039	(0.0101, 0.388)