Earth and Space Science

Supporting Information for

The benefits of local regression for quantifying global warming

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Introduction

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- Table S2 compares $LOESS_{bsln}$ and OLS $\Delta GMST$ s over 1880-2010, 151-2019 and 1979-2019.

- Table S3 presents combined $\Delta GMST$ and $\Delta GSAT$ uncertainties.

- Table S4 shows impact of incorporating HadCRUT5 and HadSST4 on $LOESS_{bsln}$ $\Delta GMST$ and $\Delta GSAT$

Table S1: CMIP6 model ensemble. CMIP6 model runs employed in this study are listed, along with a preliminary evaluation of ECS assessed by $4xCO_2$ abrupt experiments, with the resulting ECS_{lk} flag (set to "Y" if ECS is within the CMIP5 5-95% range of 1.9-4.5°C). The SSP ext column lists Shared Scenario Pathway continuations of interest that were available in February, 2020.

CAMS	CAMS-CSM1-0	r1i1p1f1	2.3	Y	245, 370
CAS	FGOALS-F3-L	r1i1p1f1	4.7	Y	245, 370
CCCma	CanESM5	r1i1p1f1	5.6	N	245, 370
CNRM-CERFACS	CNRM-CM6-1	r1i1p1f2	4.8	N	245, 370
CNRM-CERFACS	CNRM-ESM2-1	r1i1p1f2	4.7	N	245, 370
CISRO	ACCESS-ESM1-5	r1i1p1f1	3.5	Y	245, 370
IPSL	IPSL-CM6A-LR	r1i1p1f1	4.8	N	245, 370
MIROC	MIROC6	r1i1p1f1	2.6	Y	245, 370
MIROC	MIROC-ES2L	r1i1p1f2	2.7	Y	245, 370
MOHC	HadGEM3-GC31-LL	r1i1p1f3	5.5	N	245, 370
MOHC	UKESM1-0-LL	r1i1p1f2	5.4	N	245, 370
MPI-M	MPI-ESM1-2-LR	r1i1p1f1	2.8	Y	245, 370
MRI	MRI-ESM2-0	r1i1p1f1	3.1	Y	245, 370
NASA-GISS	GISS-E2-1-G	r1i1p1f1	2.7	Y	
NASA-GISS	GISS-E2-1-G-CC	r1i1p1f1	*3.2*	Y	
NASA-GISS	GISS-E2-1-H	r1i1p1f1	*3*	Y	
NCAR	CESM2	r1i1p1f1	5.2	N	245, 370
NCAR	CESM2-WACCM	r1i1p1f1	4.7	N	245, 370
NCC	NORCPM1	r1i1p1f1	*3*	Y	
NCC	NorESM2-LM	r1i1p1f1	*2.9*	Y	
NOAA-GFDL	GFDL-CM4	r1i1p1f1	3.9	Y	245
NOAA-GFDL	GFDL-ESM4	r1i1p1f1	3.2	Y	245
NUIST	NESM3	r1i1p1f1	4.7	N	245
SNU	SAM0-UNICON	r1i1p1f1	3.8	Y	

Figure S12: Cowtan-Way ΔGMST to 2019. Top (a - b) Cowtan-Way monthly series (light gray) is shown with $LOESS_{bsln}$ (blue) and 2010-2019 average (black square) relative to 1850-1900, along with OLS linear trend over 1880-2019 (red). The OLS linear trend central estimates and uncertainty have been shifted upward to provide direct comparison to the other two estimates. **(a)** Trends are given with ARMA(1,1) corrected 5%-95% confidence interval (dotted lines). **(b)** $LOESS_{md}$ (thin light blue lines) and OLS (thin pink lines) trends are derived from Cowtan and Way 100-member ensemble. **Middle (c)** Autocorrelation function (ACF) of $LOESS_{md}$ statistical fit residuals (black), compared to that estimated with ARMA(1, 1) model (blue) and AR(1) model (red) for LOESS trend. **(d)** As in (c), except for OLS linear trend. **Bottom (e)** ACF for $LOESS_{md}$ fit residuals for Cowtan-Way annual series, compared to AR(1) model (red) for LOESS trend. **(f)** As in e), except for OLS linear trend.

Table S2: Observed increase in GMST (°C) **in datasets and dataset groupings.** Numbers in square brackets correspond to 5–95% statistical trend fit uncertainty ranges, accounting for autocorrelation in fit residuals. Round brackets denote 5–95% observational parametric uncertainty where available (HadCRUT4, Cowtan-Way). Best estimates from 3 full global (NASA GISTEMP, Cowtan-Way and Berkeley Earth series are denoted by *.

Period: / Series:	1880 - 2019		1951 - 2019		1979 - 2019	
	LOESS$_{md}$	Linear	LOESS$_{md}$	Linear	LOESS$_{md}$	Linear
HadCRUT4	0.99 [0.88 - 1.11] (0.94 – 1.04)	0.96 [0.82 - 1.10] (0.92 – 1.03)	0.75 [0.63 - 0.87] (0.67 – 0.76)	0.84 [0.69 - 1.00] (0.76 – 0.88)	0.70 [0.58 - 0.81] (0.64 – 0.71)	0.70 [0.59 - 0.82] (0.65 – 0.72)
NOAA GlobalTemp	1.06 [0.93 - 1.18]	1.04 [0.89 - 1.19]	0.87 [0.75 - 0.99]	0.97 [0.83 - 1.10]	0.74 [0.62 - 0.85]	0.71 [0.58 - 0.84]
NASA GISTEMP	1.09 [0.98 - 1.21]	1.04 [0.88 - 1.20]	0.94 [0.83 - 1.04]	1.03 [0.90 - 1.15]	0.79 [0.69 - 0.89]	0.77 [0.65 - 0.88]
Cowtan & Way	1.14 [1.03 - 1.25] (1.08 – 1.21)	1.02 [0.88 - 1.15] (0.94 – 1.09)	0.81 [0.70 - 0.91] (0.75 – 0.87)	0.88 [0.73 - 1.04] (0.83 – 0.94)	0.75 [0.65 - 0.86] (0.70 – 0.79)	0.77 [0.66 - 0.88] (0.74 – 0.81)
Berkeley Earth	1.20 [1.09 - 1.31]	1.09 [0.96 - 1.22]	0.85 [0.74 - 0.95]	0.92 [0.78 - 1.06]	0.77 [0.67 - 0.86]	0.78 [0.67 - 0.88]
All Operational	**1.10** **[0.88 - 1.31]**	**1.03** **[0.82 - 1.22]**	**0.84** **[0.63 – 1.04]**	**0.93** **[0.69 - 1.15]**	**0.75** **[0.58 - 0.89]**	**0.75** **[0.58 - 0.88]**
Near Global (3 series) *	**1.14 *** **[0.98 - 1.31]**	**1.05** **[0.88 - 1.22]**	**0.83 *** **[0.70 – 1.04]**	**0.91** **[0.70- 1.12]**	**0.74 *** **[0.65 - 0.89]**	**0.74** **[0.65 - 0.88]**

Table S3: Combined GMST and GSAT changes and uncertainty ranges for each dataset, group and combination of uncertainties. As described in main manuscript: individual dataset ΔGMST combine in quadrature Cowtan & Way ensemble uncertainty and either statistical error ("stat") or CSIRO ensemble standard deviation ("CSIRO"). ΔGSAT combines fractional ΔGMST and A_{blend} uncertainties in quadrature. We justify quadrature combinations as the Shapiro-Wilks test does not reject normality in any case: for Cowtan & Way ensemble (p 0.27), the CSIRO ensemble (p=0.48) or CMIP6 ensemble A_{blend} (p=0.17). Group_3 uncertainty ranges are lowest minimum percentile to highest maximum percentile from across the datasets. This means that the 5—95 % and 17—83 % are not consistent according to any standard formal PDF distribution.

		Mean	Statistical σ		CSIRO ensemble σ	
			17—83 %	5—95 %	17—83 %	5—95 %
ΔGMST [°C]	CowtanWay	1.12	1.06—1.18	1.02—1.23	1.02—1.22	0.95—1.30
	GISTEMP	1.12	1.05—1.18	1.01—1.22	1.01—1.22	0.94—1.29
	Berkeley	1.19	1.12—1.25	1.08—1.29	1.08—1.29	1.01—1.36
	Group_3	1.14	1.05—1.25	1.01—1.29	1.01—1.29	0.94—1.36
ΔGSAT [°C]	CowtanWay	1.19	1.12—1.25	1.07—1.30	1.08—1.30	1.00—1.38
	GISTEMP	1.18	1.11—1.25	1.07—1.30	1.07—1.29	0.99—1.37
	Berkeley	1.25	1.19—1.32	1.14—1.37	1.14—1.36	1.06—1.44
		1.21	1.11—1.32	1.07—1.37	1.07—1.36	0.99—1.44

Table S4: Impact of HadSST4 and HadCRUT5 on observational ΔGMST and ΔGSAT in °C.
The Cowtan-Way/HadSST4 and HadCRUT5 datasets have been extended to the end of 2019, by assuming the same monthly temperature innovations as observed over 2019 as in the published Cowtan-Way (with HadSST3) dataset. Berkeley Earth/HadSST4 LOESS$_{bsln}$ ΔGMST$_{LOESS}$ is estimated by applying the difference between Cowtan-Way/HadSST4 and Cowtan-Way/HadSST3 ΔGMST$_{LOESS}$ to BerkeleyEarth/HadSST3 ΔGMST$_{LOESS}$. Numbers in square brackets correspond to 5–95% statistical trend fit uncertainty ranges, accounting for autocorrelation in fit residuals.

Period/metric: Series:	LOESS$_{bsln}$ w/HadSST3 (*) 1850-1900 to 2019		LOESS$_{bsln}$ w/HadSST4 (**) 1850-1900 to 2019	
	ΔGMST	ΔGSAT	ΔGMST	ΔGSAT
NASA GISTEMP	1.12 [1.02 - 1.22]	1.18	1.12 [1.02 - 1.22]	1.18
Cowtan-Way	1.12 * [1.04 - 1.21]	1.19 *	1.19 ** [1.08 - 1.30]	1.26 **
Berkeley Earth	1.19 * [1.10 - 1.27]	1.26 *	1.26 ** [1.17 - 1.34]	1.33 **
Full Global (3 series)	**1.14 * [1.02 – 1.27]**	**1.21 ***	**1.19 ** [1.02 – 1.34]**	**1.26 ***
HadCRUT5	N/A	N/A	1.20 ** [1.09 - 1.32]	1.27 **
Full Global (4 series)	**N/A**	**N/A**	**1.19 ** [1.02 – 1.34]**	**1.26 ***