Earth and Space Science

Supporting Information for

The benefits of local regression for quantifying global warming

David C. Clarke[1], Mark Richardson[2,3]

[1]Independent Researcher, Montreal, Quebec, Canada

[2]Jet Propulsion Laboratory, California Institute of Technology, USA [3]Joint Institute for Regional Earth Systems Science and Engineering, University of California, Los Angeles, USA

Contents of this file

Figures S12 to S16

Introduction

- Figures S12 and S13 are supplementary to Section 2.2 and provide additional information and provide further information on LOESS and OLS statistical fit of observational series and model large ensembles.

- Figures S14 explores the sensitivity of observations and model output to distance-limited masking.

- Figure S15 shows performance of $LOESS_{bsln}$ and OLS from 1880 ΔGMST against 20 and 30-year average in Global_3 .

- Figure S16 shows performance of $LOESS_{bsln}$ and 10-year "period" ΔGMST against 30-year average in MPI and CSIRO model ensembles.
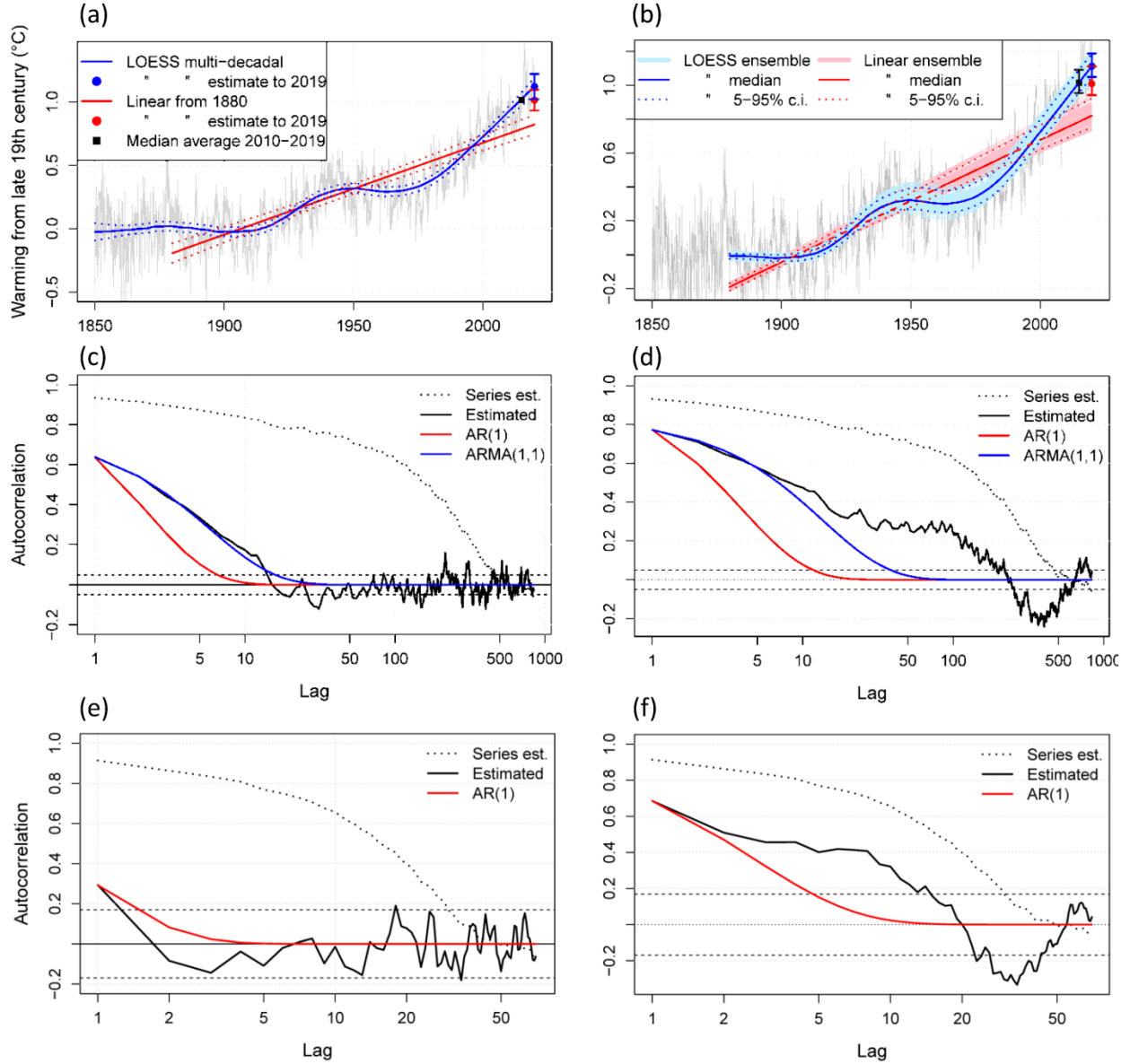
Figure S12: Cowtan-Way ΔGMST to 2019. **Top (a - b)** Cowtan-Way monthly series (light gray) is shown with LOESS$_{bsln}$ (blue) and 2010-2019 average (black square) relative to 1850-1900, along with OLS linear trend over 1880-2019 (red). The OLS linear trend central estimates and uncertainty have been 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.
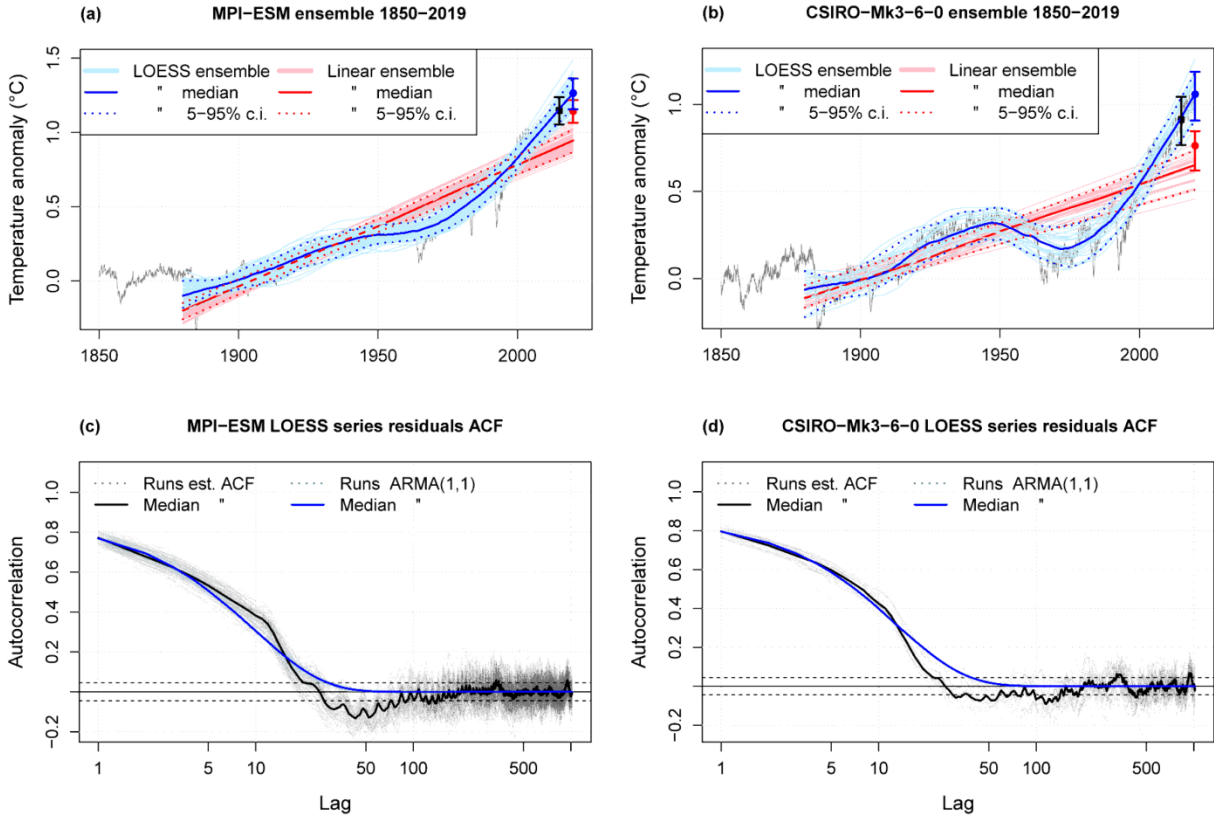
2

Figure S13: MPI and CSIRO Large Ensemble ΔGMST to 2019. **(a)** MPI ensemble median 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. LOESS$_{bsln}$ (thin light blue lines) and OLS trends (thin pink lines) are derived from each ensemble member. **(b)** As in (a), except for CSIRO ensemble. **(c)** Autocorrelation function (ACF) of LOESS statistical fit residuals (black), compared to that estimated with ARMA(1, 1) model (blue) for LOESS trend. **(d)** As in (c), except for CSIRO ensemble.**.**
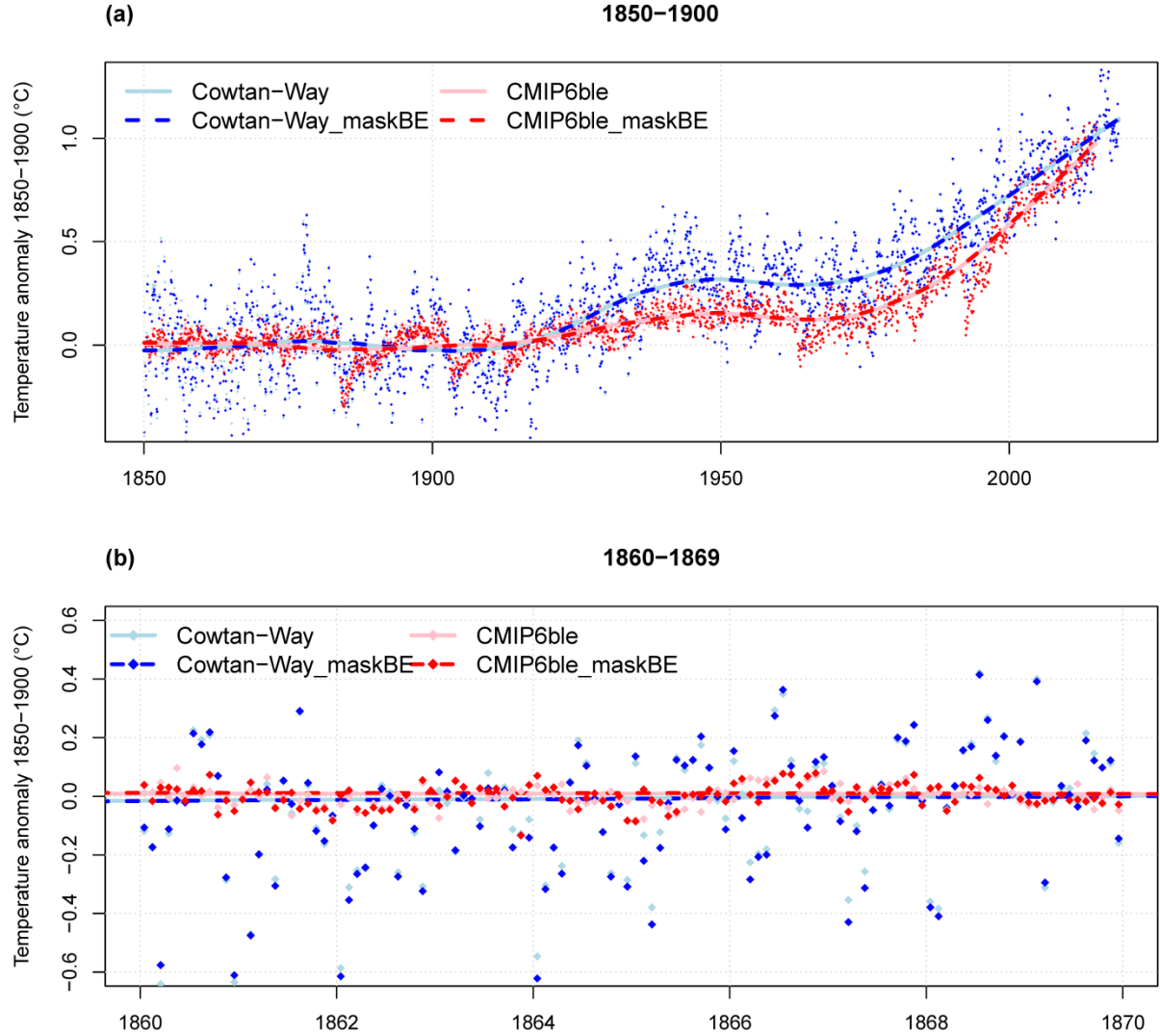
Figure S14: Evaluation of distance-limited interpolation. (a) Shown over 1850-2019 are monthly anomalies (small diamonds) and multi-decadal LOESS trends (full as solid lines, masked as dotted lines) for Cowtan-Way (light blue), Cowtan-Way masked to Berkeley Earth coverage (blue), CMIP6 blended ensemble median (pink) and CMIP6 masked to Berkeley Earth coverage (red). **(b)** As (a), but over 1860-1869.
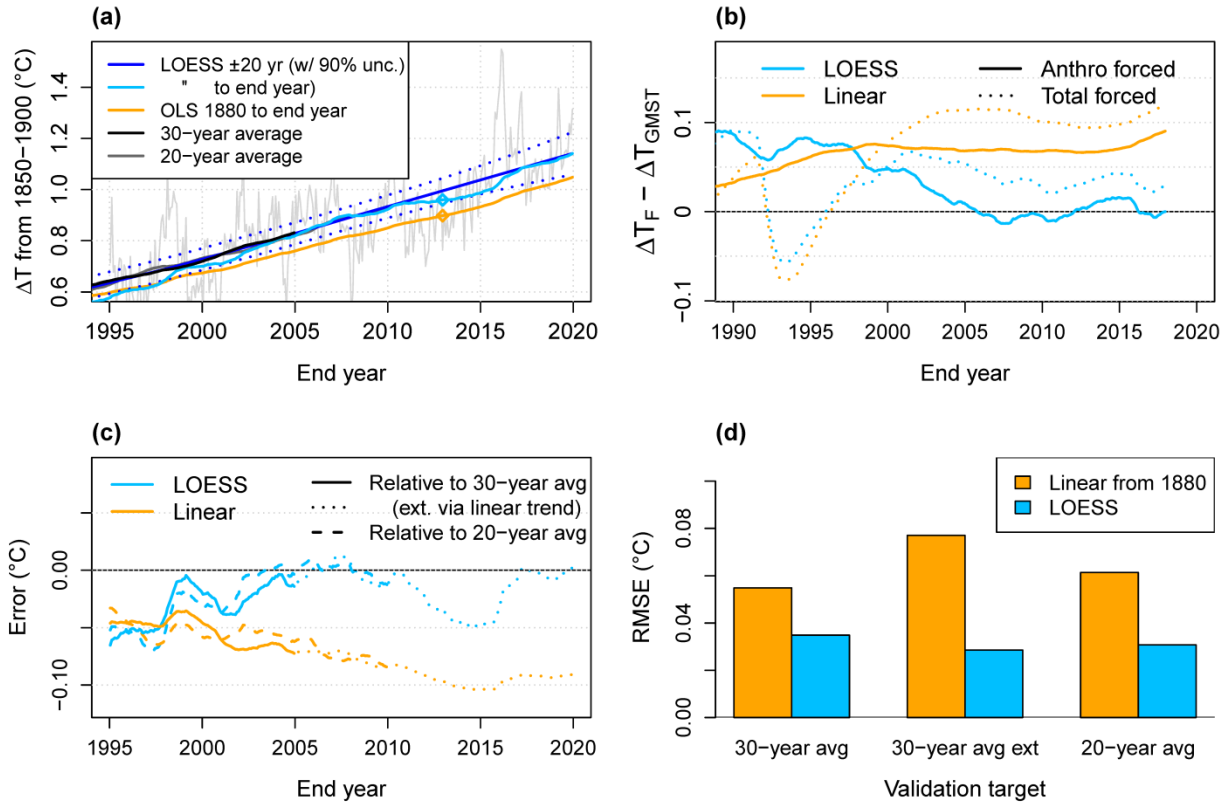
4

Figure S15: ΔGMST estimation method validation based on average of 3 global series. (a) LOESS$_{bsln}$ to 2019 (blue) is shown with LOESS (light blue), OLS from 1880 (orange), 20-year average (light gray) and 30-year average (black). LOESS (light blue) versus OLS (orange) differences are shown with **(b)** forced warming estimates following Haustein et al. (2017) and **(c)** validation targets (30-year average, 30-year average extended with linear trend and 20-year average). **(d)** RMSE is calculated from errors shown in (c).
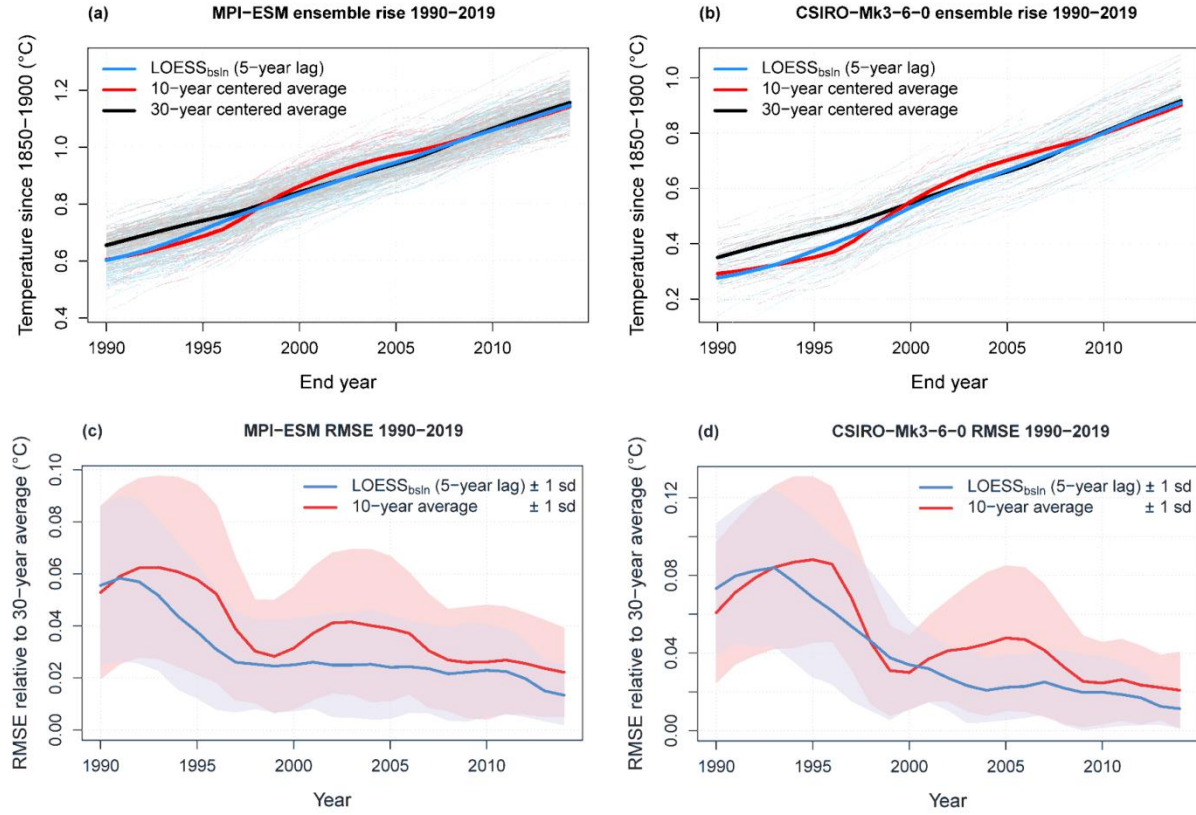
Figure S16: ΔGMST method validation based on large MPI and CSIRO ensembles. **(a)** 5-year lagged LOESS$_{bsln}$ (blue), centered 10-year average (red), and centered 30-year averages (dark gray) are shown from 1850-1900 baseline to indicated end year for each MPI ensemble member (thin lines) and averaged over ensemble (thick lines). The 30-year average is extended from 2004 to 2014, by extending each ensemble member over 2020-2030 with the continuation of its 1990-2019 linear trend. **(b)** As in (a), but for CSIRO ensemble. **(c)** MPI ensemble RMSE is calculated against 30-year average validation target for LOESS$_{bsln}$ (blue) and 10-year average (red). **(d)** As in (c), but for CSIRO ensemble.