



AMS

American Meteorological Society

Supplemental Material

Journal of Climate

A Data Assimilation Approach to Last Millennium Temperature Field Reconstruction Using a Limited High-Sensitivity Proxy Network
<https://doi.org/10.1175/JCLI-D-20-0661.1>

© Copyright 2021 American Meteorological Society (AMS)

For permission to reuse any portion of this work, please contact permissions@ametsoc.org. Any use of material in this work that is determined to be “fair use” under Section 107 of the U.S. Copyright Act (17 USC §107) or that satisfies the conditions specified in Section 108 of the U.S. Copyright Act (17 USC §108) does not require AMS’s permission. Republication, systematic reproduction, posting in electronic form, such as on a website or in a searchable database, or other uses of this material, except as exempted by the above statement, requires written permission or a license from AMS. All AMS journals and monograph publications are registered with the Copyright Clearance Center (<https://www.copyright.com>). Additional details are provided in the AMS Copyright Policy statement, available on the AMS website (<https://www.ametsoc.org/PUBSCopyrightPolicy>).

**Supplemental Information for ‘A data assimilation approach to last
millennium temperature field reconstruction using a limited high-sensitivity
proxy network’**

Jonathan M. King

*Department of Geosciences and Laboratory of Tree-Ring Research, University of Arizona,
Tucson, Arizona*

Kevin J. Anchukaitis

*School of Geography, Development, and Environment and Laboratory of Tree-Ring Research,
University of Arizona, Tucson, Arizona*

Jessica E. Tierney

Department of Geosciences, University of Arizona, Tucson, Arizona

Gregory J. Hakim

Department of Atmospheric Sciences, University of Washington, Seattle, Washington

Julien Emile-Geay and Feng Zhu

Department of Earth Sciences, University of Southern California, Los Angeles, California

Rob Wilson

School of Earth and Environmental Sciences, University of St Andrews, St Andrews, UK

18 **LIST OF TABLES**

19 **Table S1.** Pseudo-proxy localization radii and split-sample validation metrics. As in Table
20 2, but using climate model output as the target field. 3

21 **Table S2.** Skill metrics for pseudo-proxy reconstructions of mean extratropical May-
22 August time series. DA reconstructions use the realistic biased-model, noisy-
23 proxy, time-attrition experimental design. PPR time series and target time series
24 are calculated using only the grid cells for which RE>0 in each reconstructed
25 time step. 4

26 TABLE S1. Pseudo-proxy localization radii and split-sample validation metrics. As in Table 2, but using
 27 climate model output as the target field.

Target	Prior	Localization Radius (km)	Correlation	RMSE (°C)	σ Ratio	Mean Bias (°C)
CESM	CESM	∞	0.73	0.18	0.76	0.02
CESM	MPI	∞	0.72	0.19	0.91	0.02
MPI	CESM	∞	0.74	0.21	0.62	0.09
MPI	MPI	∞	0.75	0.20	0.75	0.07

28 TABLE S2. Skill metrics for pseudo-proxy reconstructions of mean extratropical May-August time series. DA
 29 reconstructions use the realistic biased-model, noisy-proxy, time-attrition experimental design. PPR time series
 30 and target time series are calculated using only the grid cells for which RE>0 in each reconstructed time step.

Target Field	Reconstruction Method	Correlation	RMSE (°C)	σ Ratio	Mean Bias (°C)
CESM	DA, MPI Prior	0.67	0.20	0.84	-0.03
	PPR	0.68	0.25	0.96	0.03
MPI	DA, CESM Prior	0.74	0.41	0.66	0.35
	PPR	0.73	0.46	0.84	0.37

31 **LIST OF FIGURES**

32 **Fig. S1.** As in Figure 2, but for RMSE ($^{\circ}\text{C}$). 6

33 **Fig. S2.** As in Figure 2, but for σ ratios. 7

34 **Fig. S3.** As in Figure 2, but for mean biases ($^{\circ}\text{C}$). 8

35 **Fig. S4.** Extratropical MJJA time series for the pseudo-proxy experiments with a CESM target.
36 Reconstructed temperature anomalies are shown in Celsius (top) for the DA reconstruction
37 (blue) and PPR reconstruction (red) along with the reconstruction target (yellow). The
38 bottom panel displays a 31 year running standard deviation for each time series. A three year
39 moving average has been applied to all time series. 9

40 **Fig. S5.** As in Supplemental Figure 4, but for an MPI target. 10

41 **Fig. S6.** As in Figure 3, but for a MPI target field. Here, the DA reconstructions use a CESM prior. . . . 11

42 **Fig. S7.** Extratropical MJJA time series for the individual DA reconstructions. Each time series shows
43 the results for a particular model prior. A 31 year moving average has been applied to each
44 time series. 12

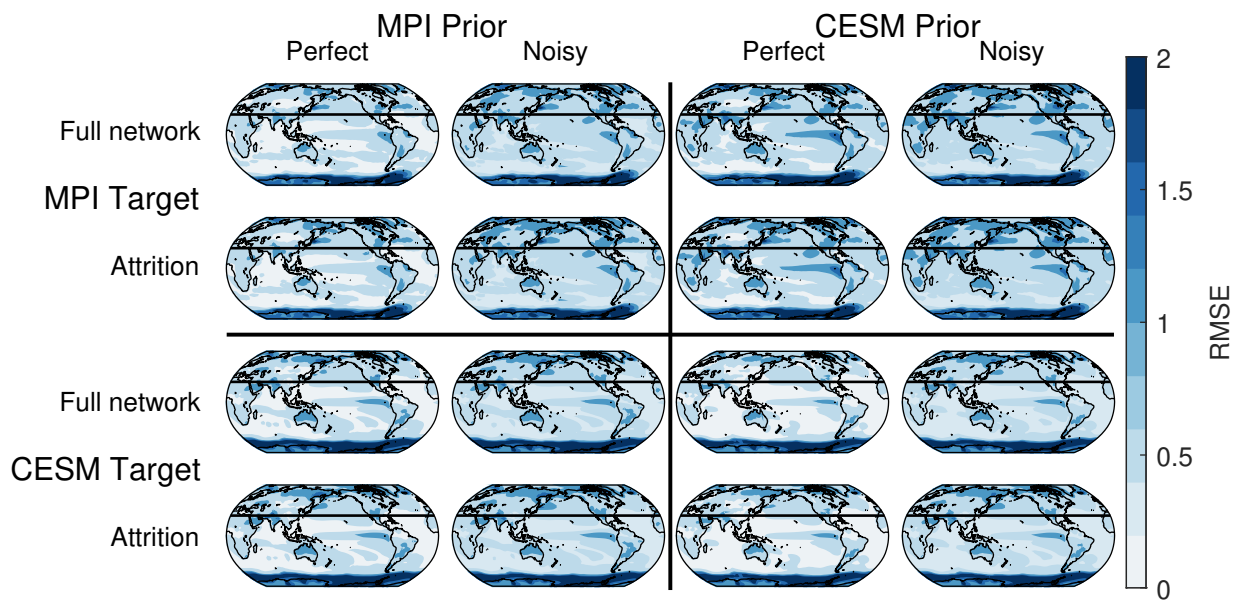


FIG. S1. As in Figure 2, but for RMSE ($^{\circ}\text{C}$).

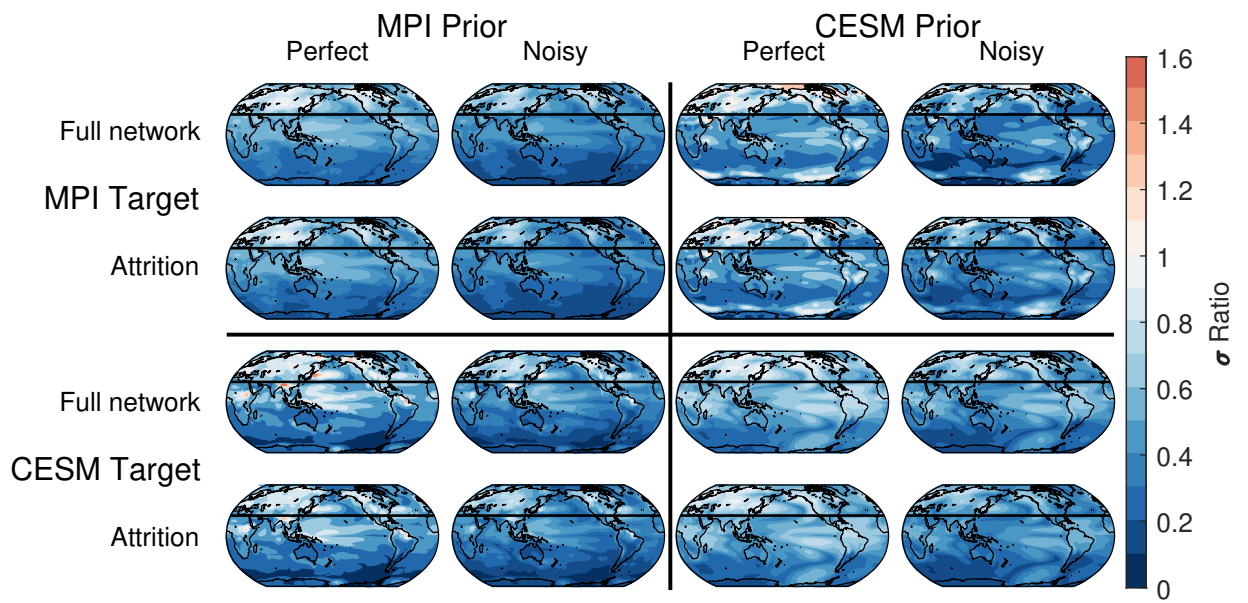


FIG. S2. As in Figure 2, but for σ ratios.

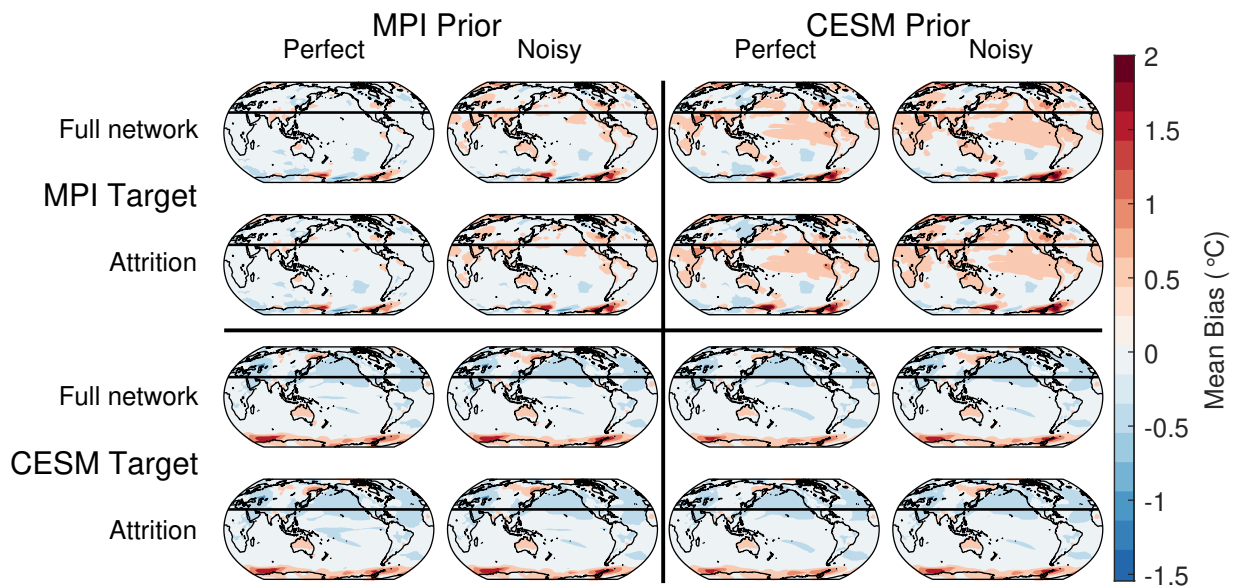
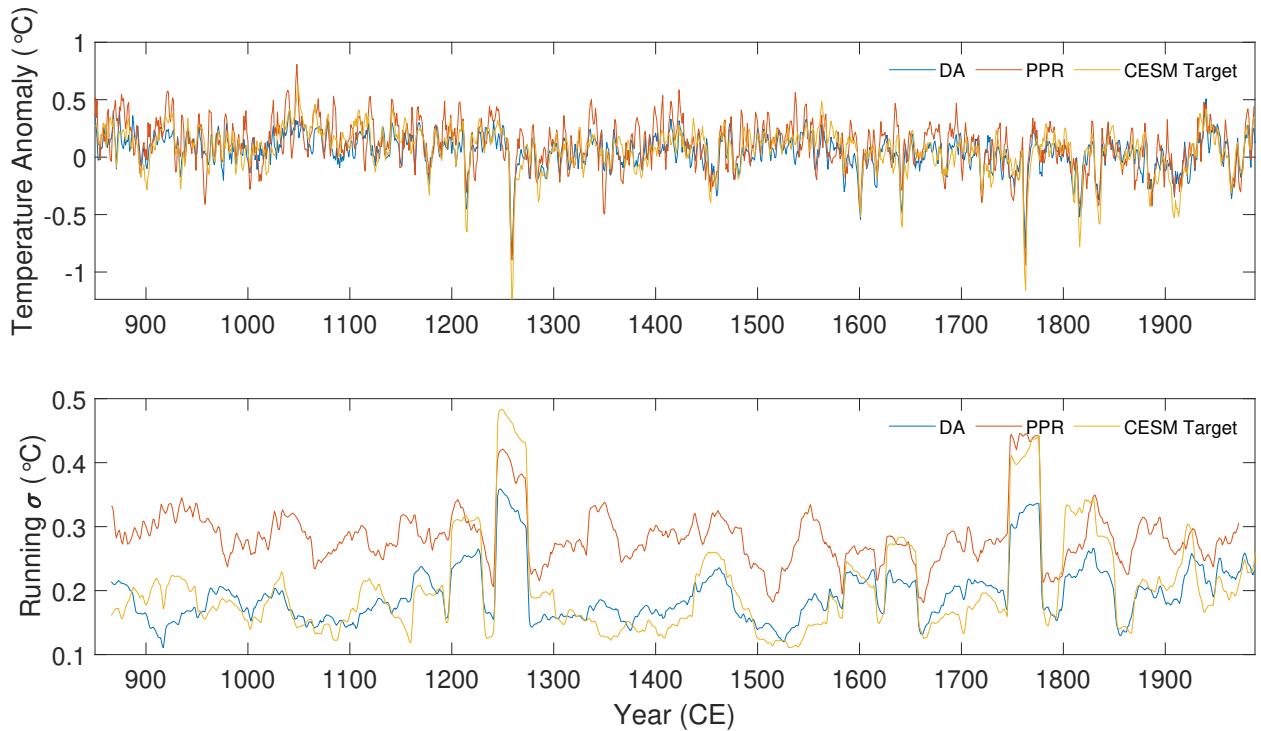


FIG. S3. As in Figure 2, but for mean biases (°C).



45 FIG. S4. Extratropical MJJA time series for the pseudo-proxy experiments with a CESM target. Reconstructed
 46 temperature anomalies are shown in Celsius (top) for the DA reconstruction (blue) and PPR reconstruction (red)
 47 along with the reconstruction target (yellow). The bottom panel displays a 31 year running standard deviation
 48 for each time series. A three year moving average has been applied to all time series.

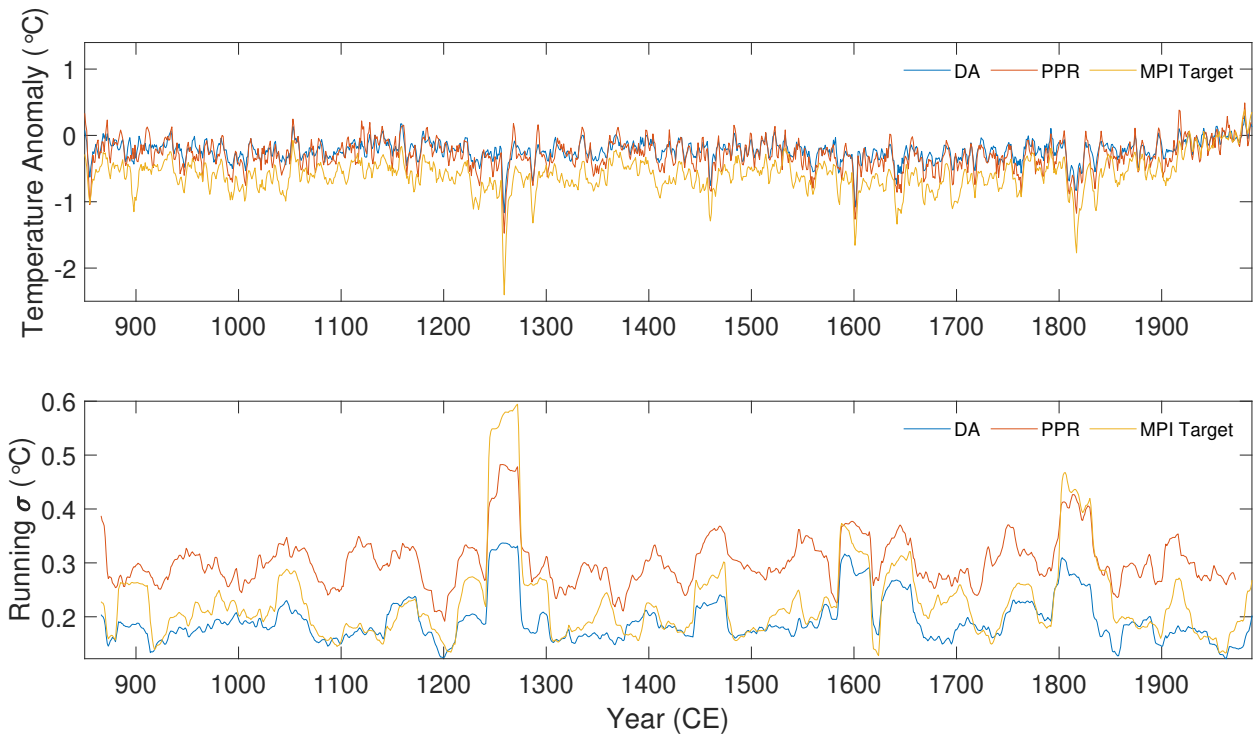


FIG. S5. As in Supplemental Figure 4, but for an MPI target.

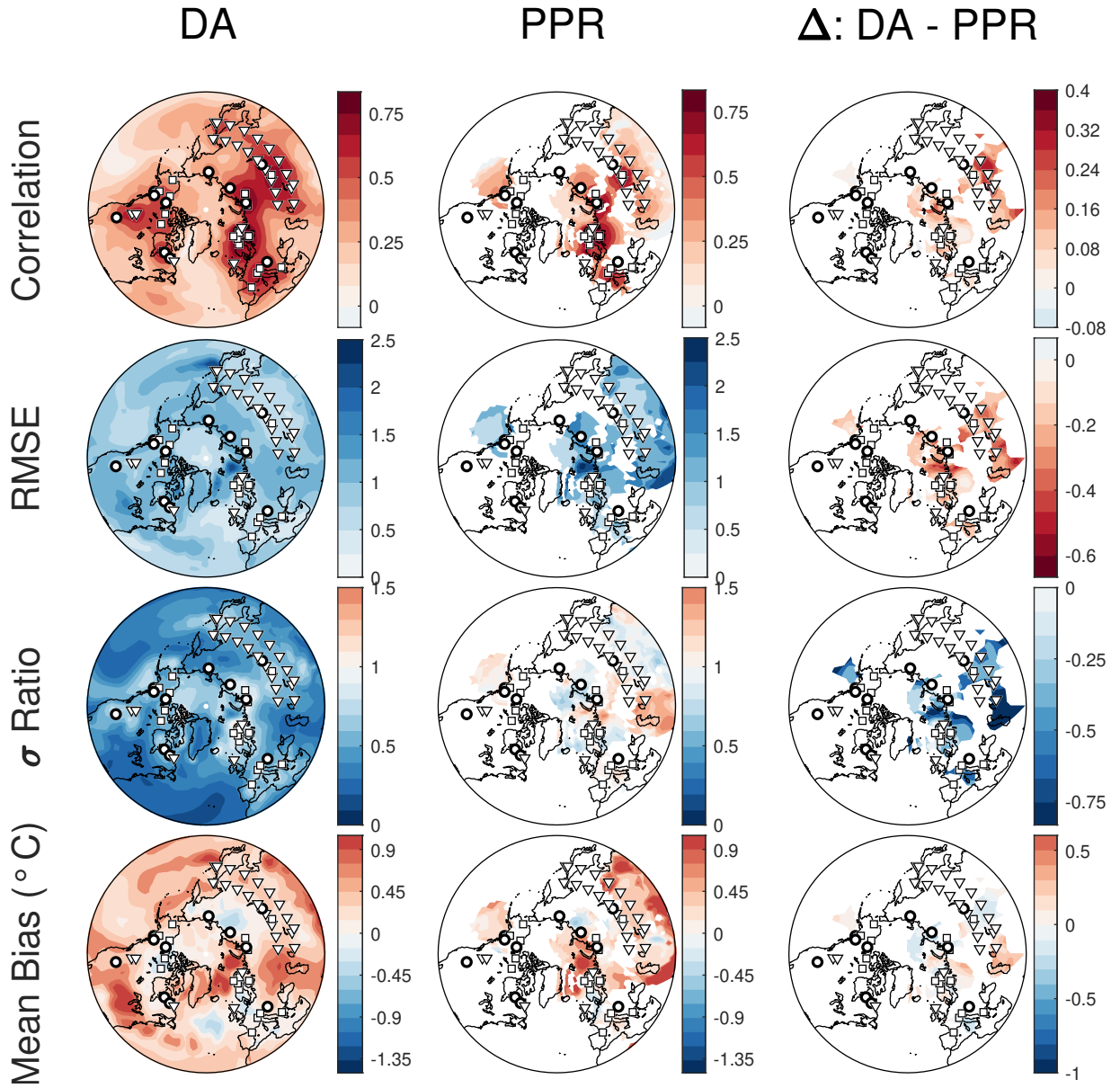
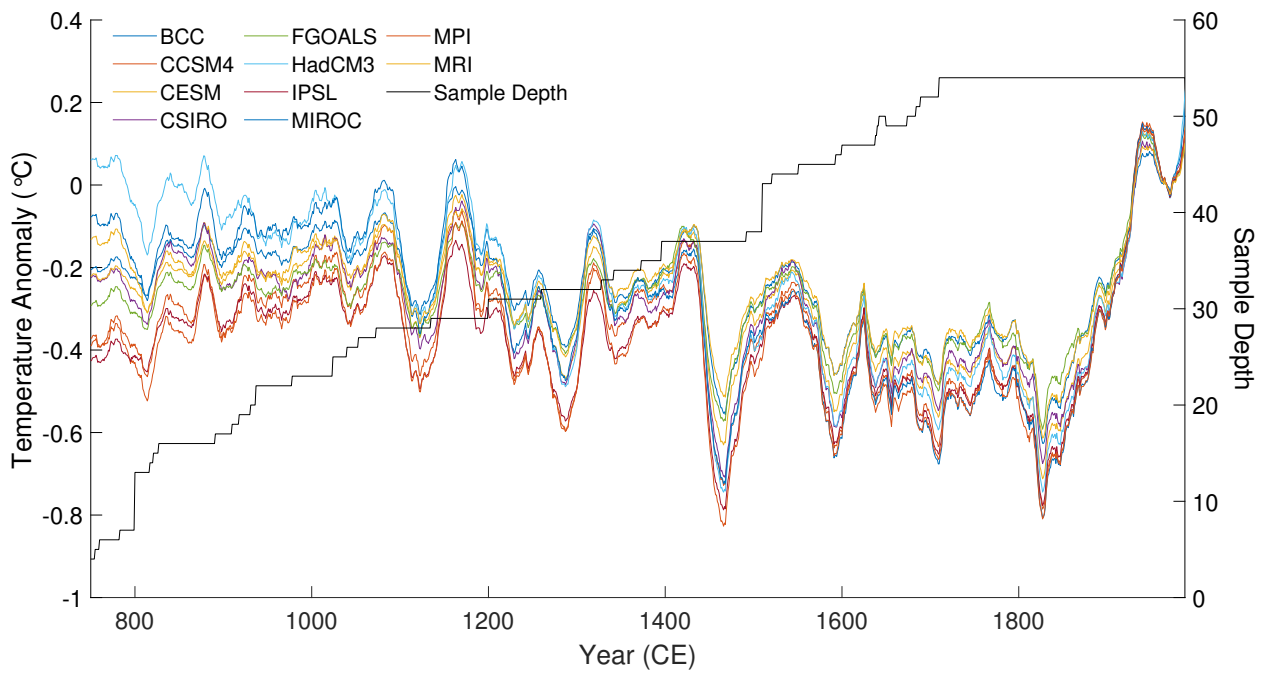


FIG. S6. As in Figure 3, but for a MPI target field. Here, the DA reconstructions use a CESM prior.



49 FIG. S7. Extratropical MJA time series for the individual DA reconstructions. Each time series shows the
 50 results for a particular model prior. A 31 year moving average has been applied to each time series.