AGU PUBLICATIONS

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Supporting Information for

Temperature covariance in tree-ring reconstructions and model simulations over the past millennium

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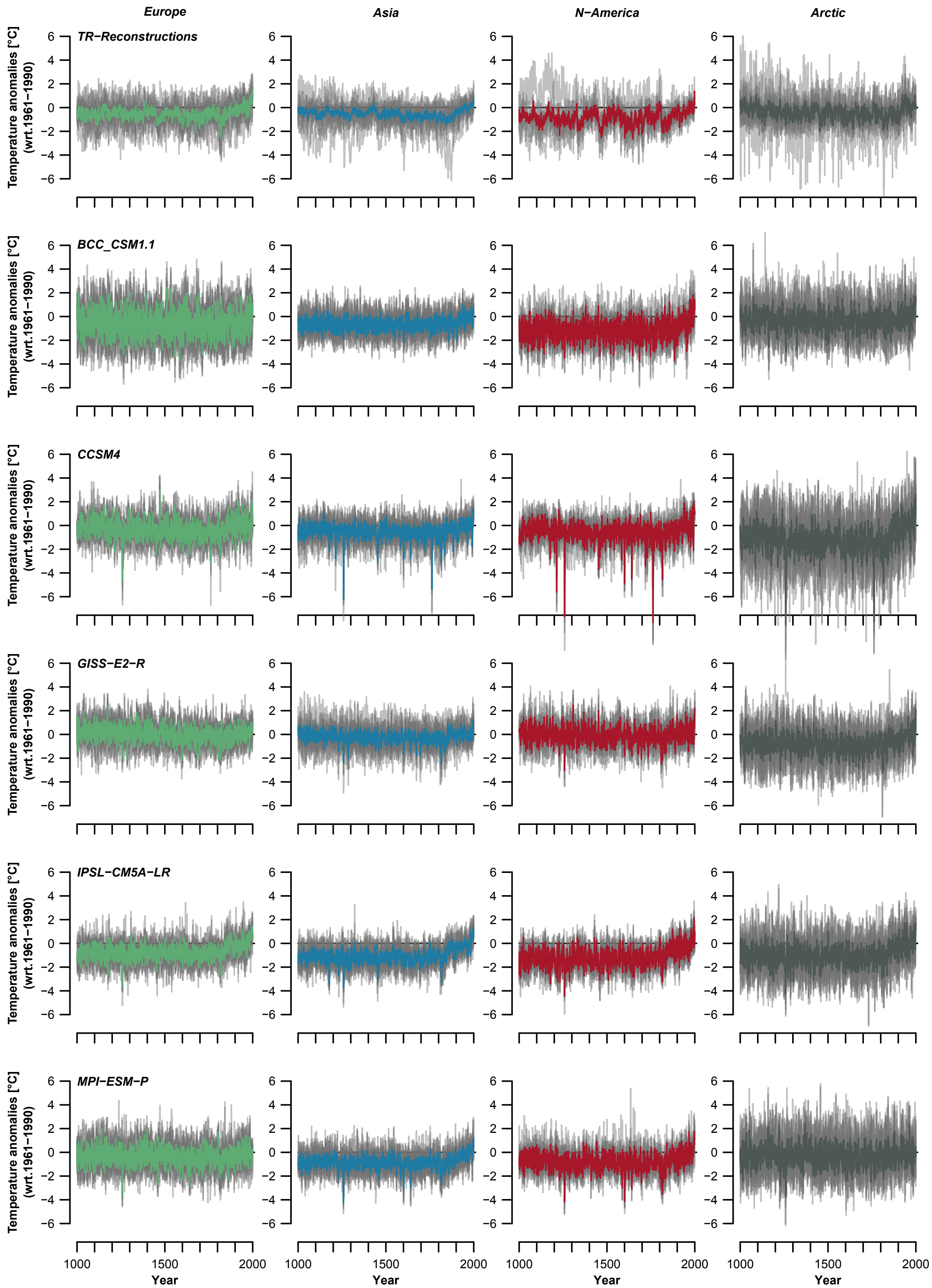

Figure S1. Summer temperature anomalies (wrt. 1961-1990) of the individual tree-ring reconstructions and the corresponding grid cells of the five model simulations. Colored curves are continental arithmetic means.

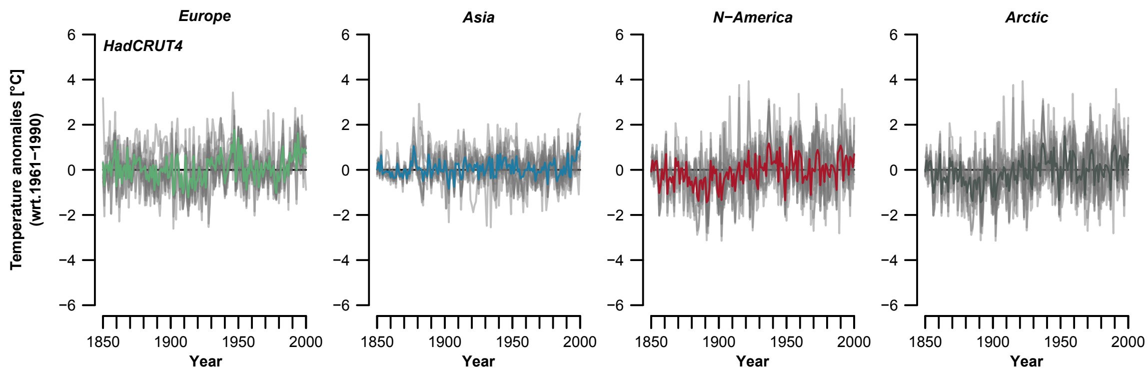

Figure S2. HadCRUT4 summer temperatures of the grid cells corresponding with the reconstruction sites. Colored curves are continental arithmetic means used for further analyses.

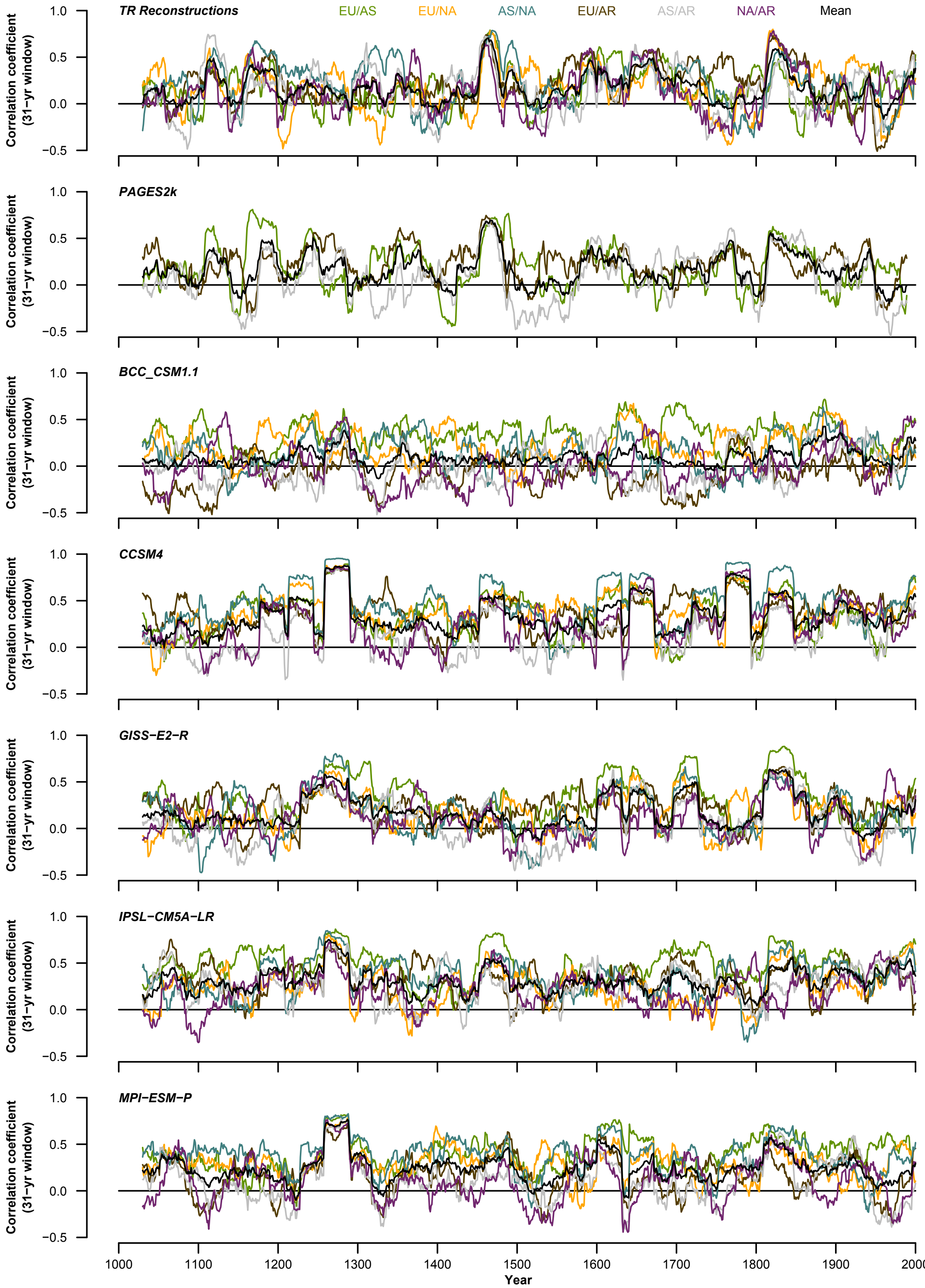

Figure S3. Inter-continental running correlations (31-yr window, left aligned) of reconstructed and modeled temperatures.

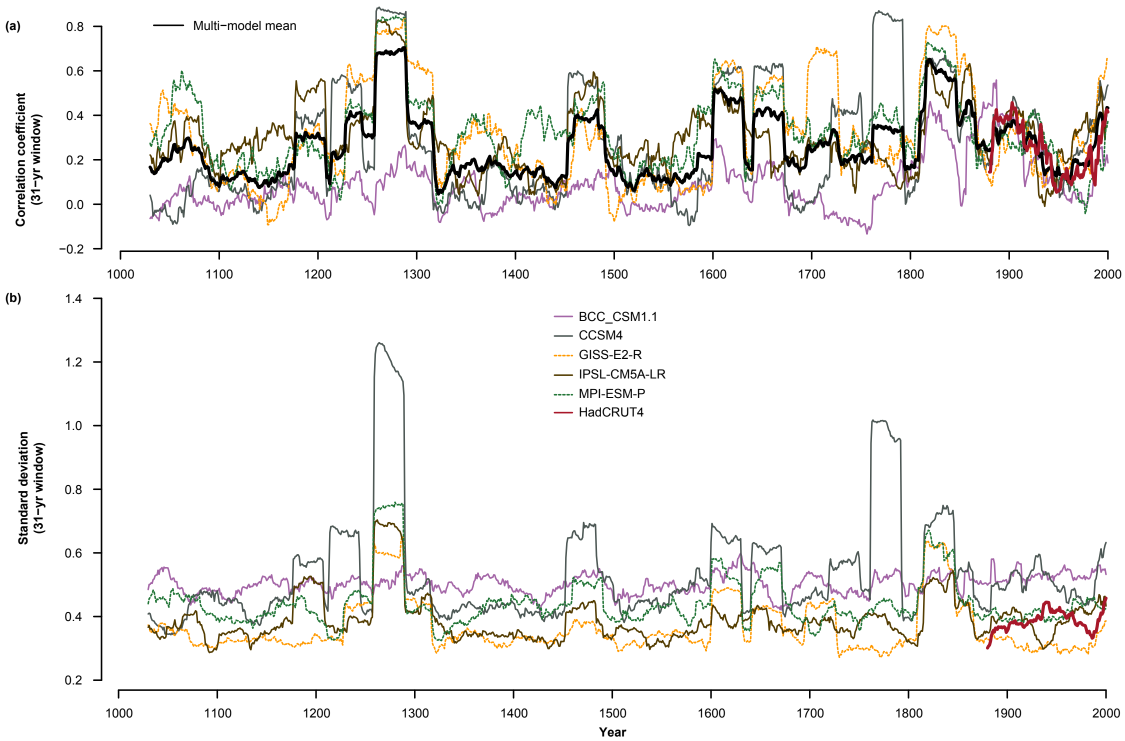

Figure S4. (a) Mean inter-continental running correlations (31-yr window, left aligned) of five model simulations (multi-model mean in black) and instrumental data (red) for full continental means (see Table S2). **(b)** Mean running standard deviation (31-yr window, left aligned) of modelled and instrumental temperature data based on full continental means (see Table S2).

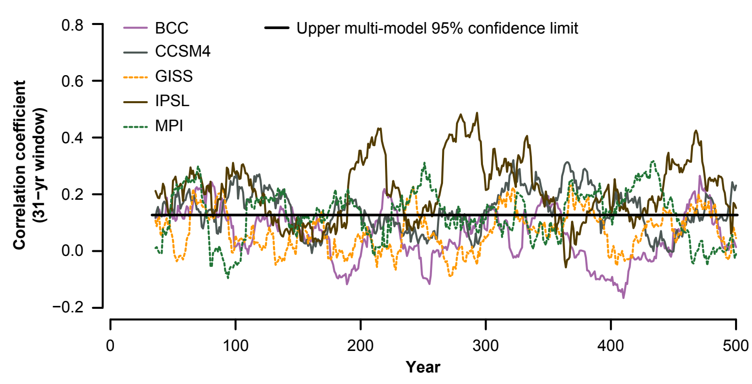

Figure S5. Mean inter-continental running correlations (31-yr window, left aligned) of control runs of five model simulations for the respective last 500 years. Black line denotes the overall upper 95% confidence limit used as covariance baseline.

Continent	Record	Reference	Lat./Lon.	Lat./Lon. Grid cell
Europe	Jämtland	*Linderholm and Gunnarson* [2005]	63.2N 12–13E	62.5N 12.5E
	S-Finland	*Helama et al.* [2014]	61-62N 28-29E	62.5N 27.5E
	Tatra	*Büntgen et al.* [2013]	48-49N 19-21E	47.5N 22.5E
	Swiss/Austrian Alps	*Büntgen et al.* [2005]	46-47N 7-11E	47.5N 12.5E
	Central Alps	*Büntgen et al.* [2011]	46-47N 10-12E	47.5N 17.5E
	Lauenen	*Schweingruber et al.* [1988]	46.4N 7.3E	47.5N 2.5E
	Lötschental	*Büntgen et al.* [2006]	46.3N 7.8E	47.5N 7.5E
	Alps (Larch)	*Büntgen et al.* [2009]	45-47N 6-14E	42.5N 12.5E
	French Alps	*Büntgen et al.* [2012]	44N 7.3E	42.5N 7.5E
Asia	Central Asia	*Davi et al.* [2015]	51.1N 99.7E	52.5N 97.5E
	Mongun	*Myglan, Oidupaa, et al.* [2012]	50.3N 90E	47.5N 92.5E
	Dzhelo	*Myglan, Zharnikova, et al.* [2012]	50N 87.9E	47.5N 87.5E
	Mongolia	*D'Arrigo et al.* [2001]	48.3N 98.9E	47.5N 97.5E
	Tien Shan	*Esper et al.* [2003]	40N 71-72E	42.5N 72.5E
	Qilian	*Zhang et al.* [2014]	38.7N 99.7E	37.5N 102.5E
	Wulan	*Zhu et al.* [2008]	37N 98.7E	37.5N 92.5E
	Dulan	*Liu et al.* [2009]	36N 98-99E	37.5N 97.5E
	Karakorum	*Esper et al.* [2002]	35-36N 74-75E	37.5N 72.5E
	W-Himalaya	*Yadav et al.* [2011]	32-33N 76-77E	32.5N 77.5E
	Qamdo	*Wang et al.* [2014]	31.1N 97.2E	32.5N 97.5E
N-America	E-Canada	*Gennaretti et al.* [2014]	54-55N 70-72W	52.5N 72.5W
	Icefield	*Luckman and Wilson* [2005]	51-53N 117-119W	52.5N 117.5W
	Great Basin	*Salzer et al.* [2014]	37-40N 114-118W	42.5N 112.5W
	Crabtree	*Graumlich* [1993]	36.5N 118.3W	37.5N 117.5W
	Boreal Plateau	*Lloyd and Graumlich* [1997]	36.3N 118.5W	42.5N 117.5W
	Upper Wright	*Lloyd and Graumlich* [1997]	36.3N 118.3W	37.5N 107.5W
	Southern Colorado	*Salzer and Kipfmueller* [2005]	35.3N 111.7W	37.5N 112.5W
Arctic	Tornetraesk (MXD)	*Melvin et al.* [2013]	68.2N 19.5E	67.5N 17.5E
	Tornetraesk (TRW)	*Melvin et al.* [2013]	68.2N 19.5E	67.5N 22.5E
	N-Scan	*Esper et al.* [2012]	67-69N 20-28E	67.5N 27.5E
	Finland	*Helama et al.* [2010]	67-69N 20-28E	67.5N 32.5E
	Taimyr	*Briffa et al.* [2008]	70-72N 95-105E	72.5N 102.5E
	Indigirka	*Sidorova et al.* [2006]	70N 148E	67.5N 147.5E
	Yamal	*Briffa et al.* [2013]	67-68N 69-71E	67.5N 72.5E
	Polar Ural	*Briffa et al.* [2013]	66.8N 65.6E	67.5N 67.5E
	Gulf of Alaska	*Wiles et al.* [2014]	58-61N 134-149W	62.5N 142.5W

Table S1. Millennium-length tree-ring based temperature reconstructions from the Northern Hemisphere. Lat./Lon. Grid cell refers to the simulated and instrumental temperature data used for calculating continental means.

Model	Expanded Model Name	Modeling center	Volcanic forcing	Run number	Reference
BCC_CSM1.1	BCC, Climate system Model, version 1.1	Beijing Climate Center (BCC), China Meteorological Administration	*Gao et al.* [2008]	r1i1p1	*Wu et al.* [2010]
CCSM4	Community Climate System Model, version 4	National Center for Atmospheric Research (NCAR)	*Gao et al.* [2008]	r1i1p1	*Landrum et al.* [2013]
GISS-E2-R	GISS Model E2, coupled with the Russell ocean model	National Aeronautics and Space Administration (NASA) Goddard Institute for Space Studies (GISS)	*Crowley and Unterman* [2013]	r1i1p124	*Schmidt et al.* [2014]
IPSL-CM5A-LR	IPSL Coupled Model, version 5A, low resolution	L'Institut Pierre-Simon Laplace (IPSL)	*Ammann et al.* [2007]	r1i1p1	*Dufresne et al.* [2012]
MPI-ESM-P	MPI Earth System Model, paleoclimate versions	Max Planck Institute (MPI) for Meteorology	*Crowley and Unterman* [2013]	r1i1p1	*Jungclaus et al.* [2014]

Table S2. Employed PMIP3/CMIP5 climate models and their associated volcanic forcing used in the last-millennium simulations.

Continent	Latitude	Longitude
Europe	37.5-62.5N	2.5-37.5E
Asia	32.5-57.5N	62.5-117.5E
N-America	32.5-57.5N	77.5-117.5W
Arctic	62.5-87.5N	2.5-357.5E

Table S3. Delimitation of regions for processing full continental mean temperatures of simulated and instrumental data.

1000-2000	TR-Recons	BCC	CCSM4	GISS	IPSL	MPI	Pages2k
EU/AS	0,49****	0,34****	0,49****	0,40****	0,67****	0,45****	0,31****
EU/NA	0,42****	0,24****	0,52****	0,23****	0,47****	0,36****	
AS/NA	0,47****	0,27****	0,67****	0,28****	0,60****	0,53****	
EU/AR	0,38****	-0,03	0,48****	0,27****	0,49****	0,22****	0,35****
AS/AR	0,43****	0,09****	0,41****	0,24****	0,51****	0,19****	0,27****
NA/AR	0,32****	0,09	0,47****	0,20****	0,43****	0,18****	

1850-2000	TR-Recons	BCC	CCSM4	GISS	IPSL	MPI	Had CRUT4	Pages2k
EU/AS	0,58****	0,39****	0,42****	0,28***	0,64****	0,46****	0,20*	0,19*
EU/NA	0,47****	0,32****	0,48****	0,19*	0,47****	0,28***	0,19*	
AS/NA	0,55****	0,43****	0,60****	0,13	0,55****	0,49****	0,17*	
EU/AR	0,32****	0,12	0,45****	0,25**	0,39****	0,17*	0,36****	0,41****
AS/AR	0,51****	0,32****	0,43****	0,14	0,50****	0,13	0,19*	0,34****
NA/AR	0,25**	0,32****	0,49****	0,23**	0,42****	0,11	0,32****	

Table S4. Inter-continental correlation of summer temperature anomalies derived from tree-ring and PAGES2k reconstructions and five different model simulations for the 1000-2000 and 1850-2000 periods. **** = $p<0.0001$, *** = $p<0.001$, ** = $p<0.01$, * = $p<0.05$.

	BCC	CCSM	GISS	IPSL	MPI	PAGES2k
TR-Recons	-0,01	0,16	0,31	0,19	0,22	0,57
BCC		0,43	0,26	0,22	0,36	0,09
CCSM			0,40	0,43	0,50	0,31
GISS				0,45	0,63	0,28
IPSL					0,43	0,31
MPI						0,29

Table S5. Relationship of running correlation timeseries among the different data sets.