Supplement of: Selecting a climate model subset to optimise key ensemble properties

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1 CMIP5 model runs used in this study

Table S1. The CMIP5 model runs used in this study.

Institute ID	Modeling Center (or Group)	Model Name	Ensemble Member
CSIRO-BOM	Commonwealth Scientific and Industrial Research Organization (CSIRO) and Bureau of Meteorology (BOM), Australia	ACCESS1.0	r1i1p1
		ACCESS1.3	r1i1p1
BCC	Beijing Climate Center, China Meteorological Administration	BCC-CSM1.1-m	r1i1p1
		BCC-CSM1.1	r1i1p1
GCESS	College of Global Change and Earth System Science, Beijing Normal University	BNU-ESM	r1i1p1
NCAR	National Center for Atmospheric Research, USA	CCSM4	r1i1p1, r2i1p1, r3i1p1, r4i1p1, r5i1p1, r6i1p1
NSF-DOE-NCAR	National Science Foundation, Department of Energy, NCAR, USA	CESM-BGC	r1i1p1
		CESM1-CAM5	r1i1p1, r2i1p1, r3i1p1
CMCC	Centro Euro-Mediterraneo per I Cambiamenti Climatic, Italy	CMCC-CMS	r1i1p1
		CMCC-CM	r1i1p1
CNRM-CERFACS	Centre National de Recherches Météorologiques / Centre Européen de Recherche et Formation Avancée en Calcul Scientifique, France	CNRM-CM5	r1i1p1
CSIRO-QCCCE	Commonwealth Scientific and Industrial Research Organization in collaboration with Queensland Climate Change Centre of Excellence, Australia	CSIRO-Mk3.6.0	r1i1p1, r2i1p1, r3i1p1, r4i1p1, r5i1p1, r6i1p1, r7i1p1, r8i1p1, r9i1p1, r10i1p1
CCCMA	Canadian Centre for Climate Modelling and Analysis, Canada	CanESM2	r1i1p1, r2i1p1, r3i1p1, r4i1p1, r5i1p1
EC-EARTH	EC-EARTH consortium	EC-EARTH	r2i1p1, r8i1p1, r9i1p1, r12i1p1
LASG-CESS	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences, China	FGOALS-g2	r1i1p1
FIO	The First Institute of Oceanography, SOA, China	FIO-ESM	r1i1p1, r2i1p1, r3i1p1
NOAA GFDL	NOAA Geophysical Fluid Dynamics Laboratory, USA	GFDL-CM3	r1i1p1
		GFDL-ESM2G	r1i1p1
		GFDL-ESM2M	r1i1p1
NASA GISS	NASA Goddard Institute for Space Studies, USA	GISS-E2-H-CC	r1i1p1
		GISS-E2-H	r1i1p1, r1i1p2, r1i1p3, r2i1p1, r2i1p3
		GISS-E2-R-CC	r1i1p1
		GISS-E2-R	r1i1p1, r1i1p2, r1i1p3, r2i1p1, r2i1p3
NIMR/KMA	National Institute of Meteorological Research/ Korea Meteorological Administration, Korea	HadGEM2-AO	r1i1p1
MOHC	Met Office Hadley Centre, UK	HadGEM2-CC	r1i1p1
		HadGEM2-ES	r1i1p1, r2i1p1, r3i1p1, r4i1p1
INM	Institute for Numerical Mathematics, Russia	INM-CM4	r1i1p1
IPSL	Institut Pierre-Simon Laplace, France	IPSL-CM5A-LR	r1i1p1, r2i1p1, r3i1p1, r4i1p1
		IPSL-CM5A-MR	r1i1p1
		IPSL-CM5B-LR	r1i1p1
MIROC	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean Research Institute (The University of Tokyo), and National Institute for Environmental Studies, Japan	MIROC-ESM-CHEM	r1i1p1
		MIROC-ESM	r1i1p1
		MIROC5	r1i1p1, r2i1p1, r3i1p1
MPI-M	Max Planck Institute for Meteorology, Germany	MPI-ESM-LR	r1i1p1, r2i1p1, r3i1p1
		MPI-ESM-MR	r1i1p1
MRI	Meteorological Research Institute, Japan	MRI-CGCM3	r1i1p1
NCC	Norwegian Climate Centre	NorESM1-ME	r1i1p1
		NorESM1-M	r1i1p1

2 Gridded observational products

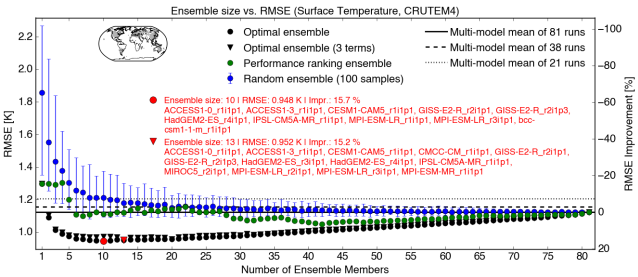
Table S2. Information about the observational and reanalysis products used in this study. tas: Surface air temperature, pr: Total precipitation. The overlapping period 1956–2013 was used for all the products. If two resolutions are given, then the first refers to the resolution the product comes in and the second resolution is the one it is regridded to.

Product Name	Variable	Coverage	Resolution	Link	References
CRUTEM4	tas	land-only	5°	http://www.metoffice.gov.uk/hadobs/crutem4/index.html	Jones, P. D., Lister, D. H., Osborn, T. J., Harpham, C., Salmon, M., and Morice, C. P.: Hemispheric and large-scale land-surface air temperature variations: An extensive revision and an update to 2010, J. Geophys. Res. Atmos., 117(D5), doi:10.1029/2011JD017139, 2012.
Berkeley BEST	tas	land-only and land+ocean	1° / 2.5°	http://berkeleyearth.org/data/	Rohde R., Muller, R. A., Jacobsen, R., Muller, E., Perlmutter, S., Rosenfeld, A., Wurtele, J., Groom, D., and Wickham, C.: A New Estimate of the Average Earth Surface Land Temperature Spanning 1753 to 2011, Geoinformatics and Geostatistics: An Overview, 1(1), doi:10.4172/2327-4581.1000101, 2013. Rohde, R., Muller, R., Jacobsen, R., Perlmutter, S., Rosenfeld, A., Wurtele, J., Curry, J., Wickham, C., and Mosher, S.: Berkeley Earth Temperature Averaging Process, Geoinformatics and Geostatistics: An Overview, 1(2), doi:10.4172/2327-4581.1000103, 2013. Levi, B. G.: Earth's land surface temperature trends: A new approach confirms previous results, Phys. Today, 66(4), 17, doi:10.1063/PT.3.1936, 2013.
CRU TS (v3.23)	tas, pr	land-only	0.5° / 2.5°	https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_3.23/	Harris, I., Jones, P. D., Osborn, T. J. and Lister, D. H.: Updated high-resolution grids of monthly climatic observations — the CRU TS3.10 Dataset, Int. J. Climatol., 34(3), 623–642, doi:10.1002/joc.3711, 2014.
HadCRUT4	tas	land+ocean	5°	http://www.metoffice.gov.uk/hadobs/hadcrut4/	Morice, C. P., Kennedy, J. J., Rayner, N. A., and Jones, P. D.: Quantifying uncertainties in global and regional temperature change using an ensemble of observational estimates: The HadCRUT4 dataset, J. Geophys. Res. Atmos., 117(D8), doi:10.1029/2011JD017187, 2012.
GPCC (v7)	pr	land-only	2.5°	http://www.esrl.noaa.gov/psd/data/gridded/data.gpcc.html	Schneider, U., Becker, A., Finger, P., Meyer-Christoffer, A., Rudolf, B., and Ziese, M.: GPCC Full Data Reanalysis Version 7.0 at 2.5°: Monthly Land-Surface Precipitation from Rain-Gauges built on GTS-based and Historic Data, doi: 10.5676/DWD GPCC/FD_M_V7_250, 2015.
PREC/L	pr	land-only	2.5°	http://www.esrl.noaa.gov/psd/data/gridded/data.precl.html	Chen, M., Xie, P., Janowiak, J. E., and Arkin, P. A.: Global land precipitation: A 50-yr monthly analysis based on gauge observations, J. Hydrometeorol., 3(3), 249–266, doi:0.1175/1525-7541(2002)003<0249:GLPAYM>2.0.CO;2, 2002.

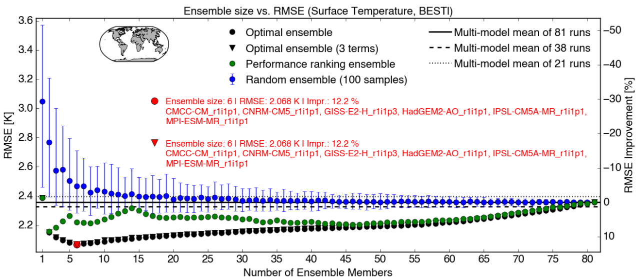
3 Ensemble size vs. RMSE

3.1 For all available runs

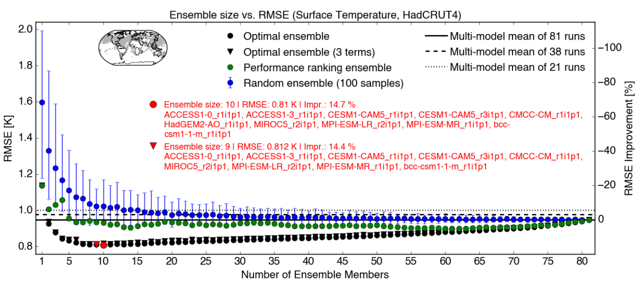
a - CRUTEM4



b - Berkeley BEST, land



c - HadCRUT4



d - Berkeley BEST, global

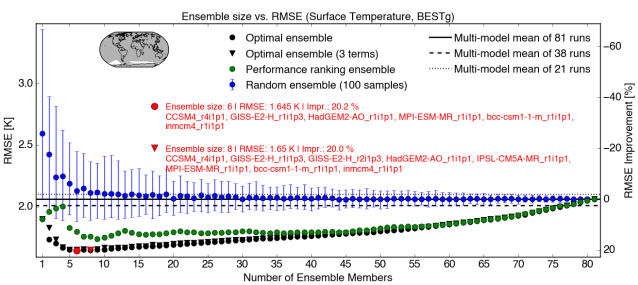
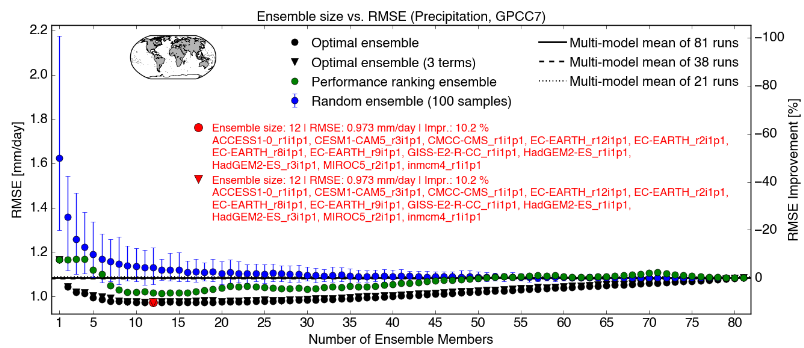


Figure S1. Same as Figure 1 (a) but for different observational products.

a - GPCC7



b - PREC/L

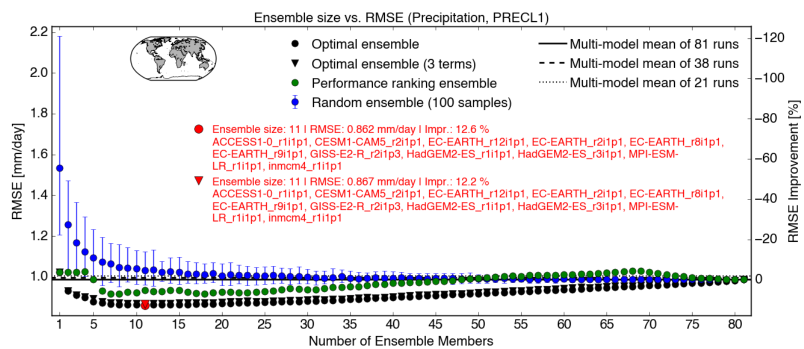
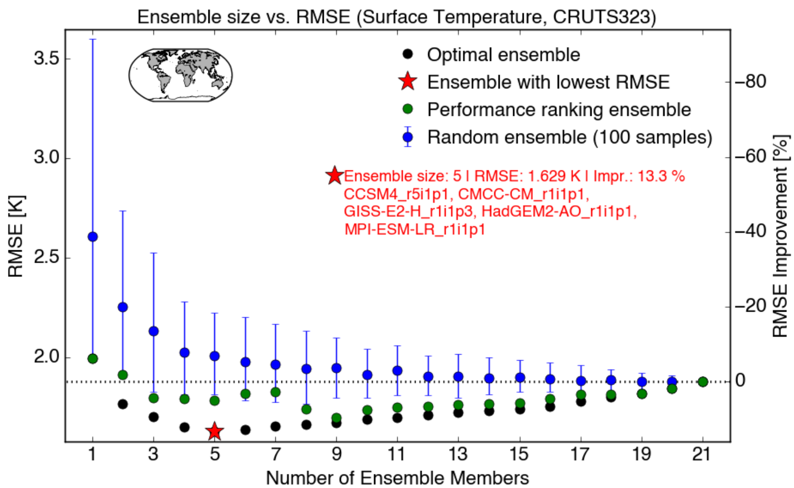


Figure S2. Same as Figure 1 (b) but for different observational products.

3.2 For 1 run per instute

a - Surface Air Temperature



b - Total Precipitation

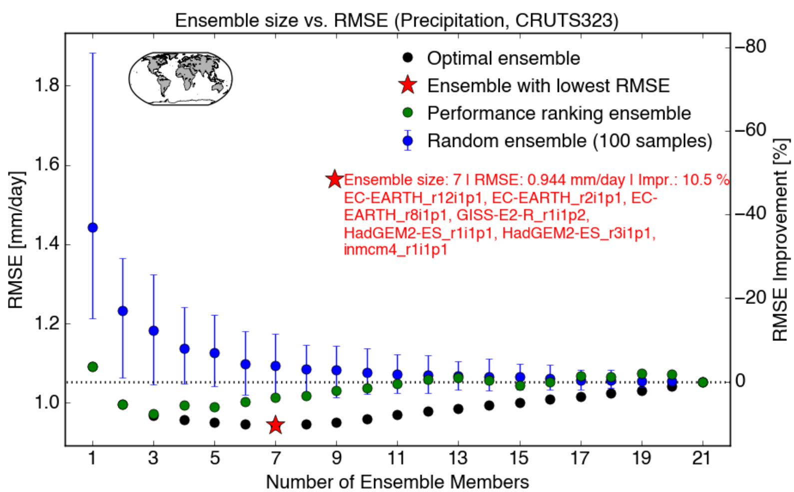


Figure S3. Same as Figure 1 but for 21 model simulations (one simulation per institute to manually remove obvious duplicates) instead of all available model simulations. The horizontal dotted line refers to the multi-model mean of 21 simulations.

4 Performance vs. independence for 1 run per institute

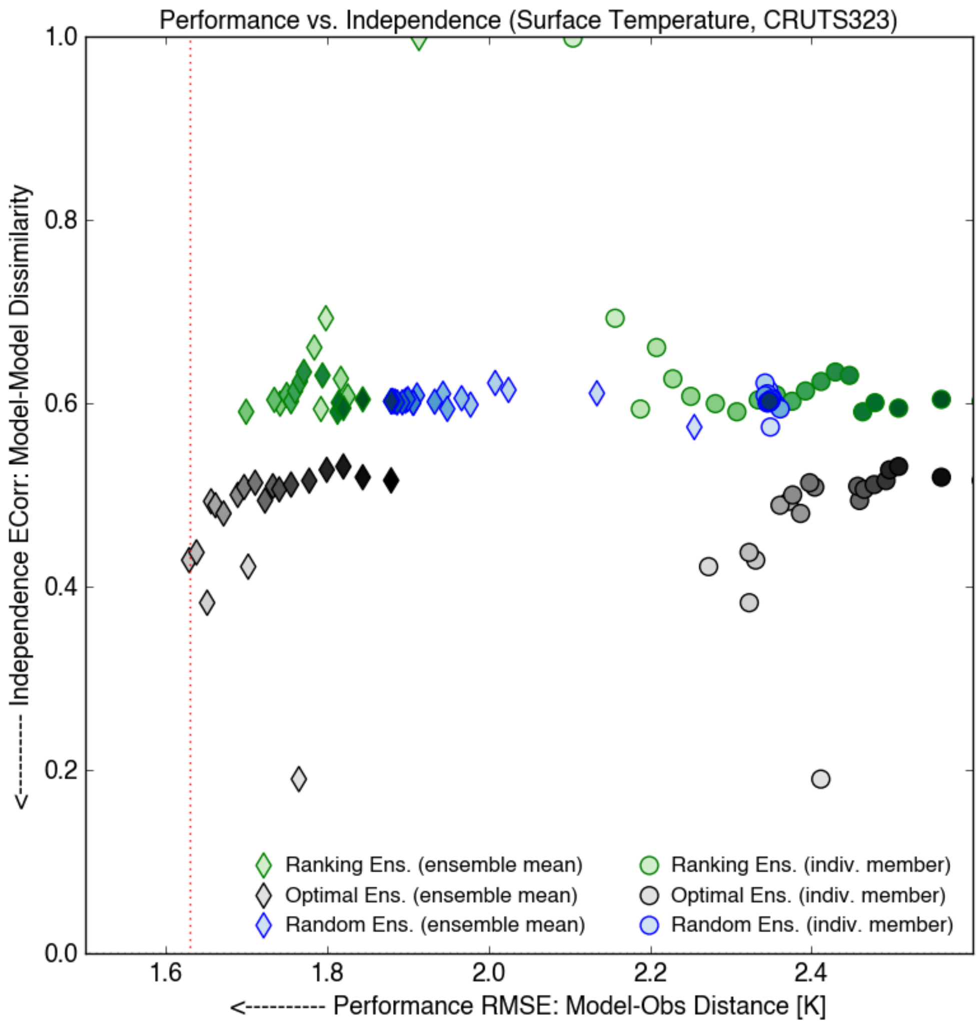


Figure S4. Same as Figure 2 but for one model run per institute.

5 Global mean temperature trends

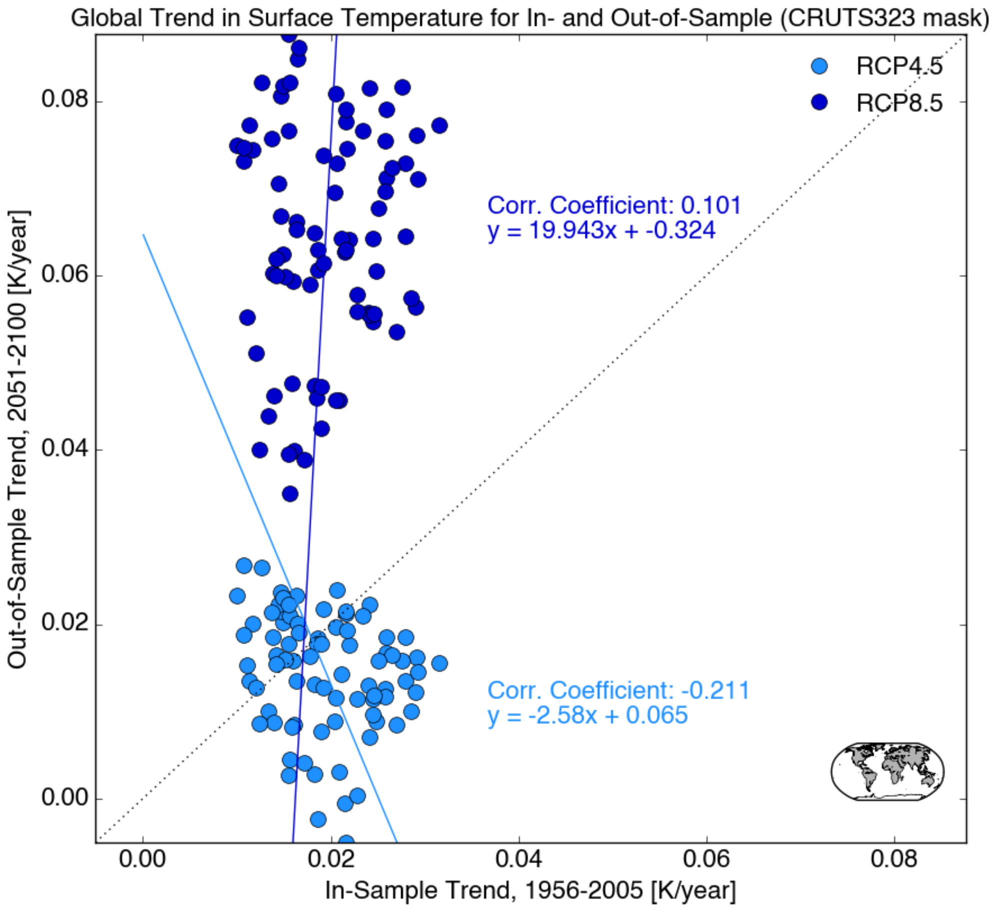


Figure S5. For each of the 81 model simulations, the linear trends in 1956–2005 and 2051–2100 were calculated and plotted against each other. This was done separately for RCP4.5 (light blue) and RCP8.5 (dark blue). The correlation coefficients and regression equations are given on the plot. The trend was calculated based on the data availability of CRUTS3.23 (small map in bottom right corner).

6 Results of the model-as-truth experiments

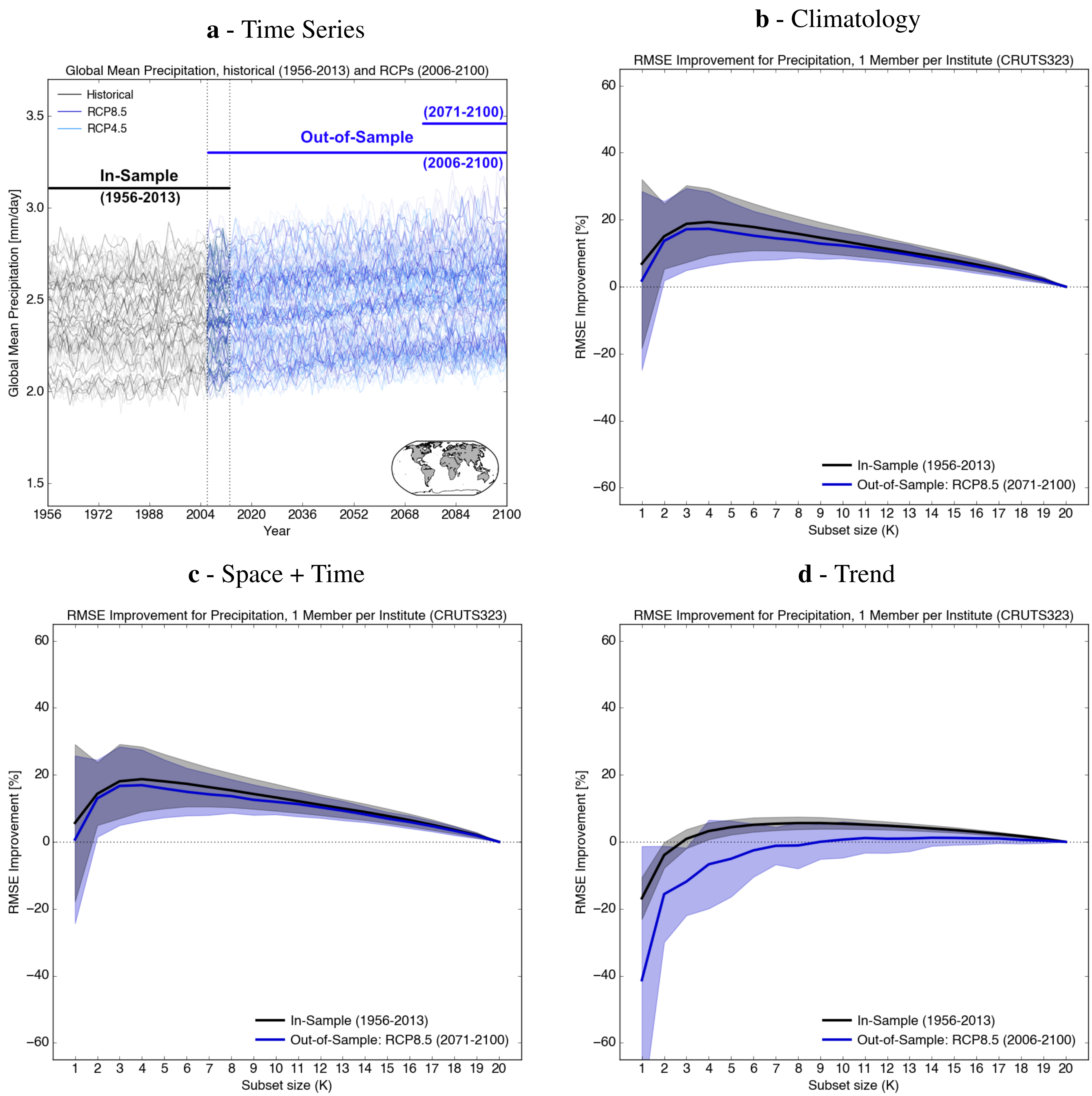


Figure S6. Same as Figure 4 but for precipitation.

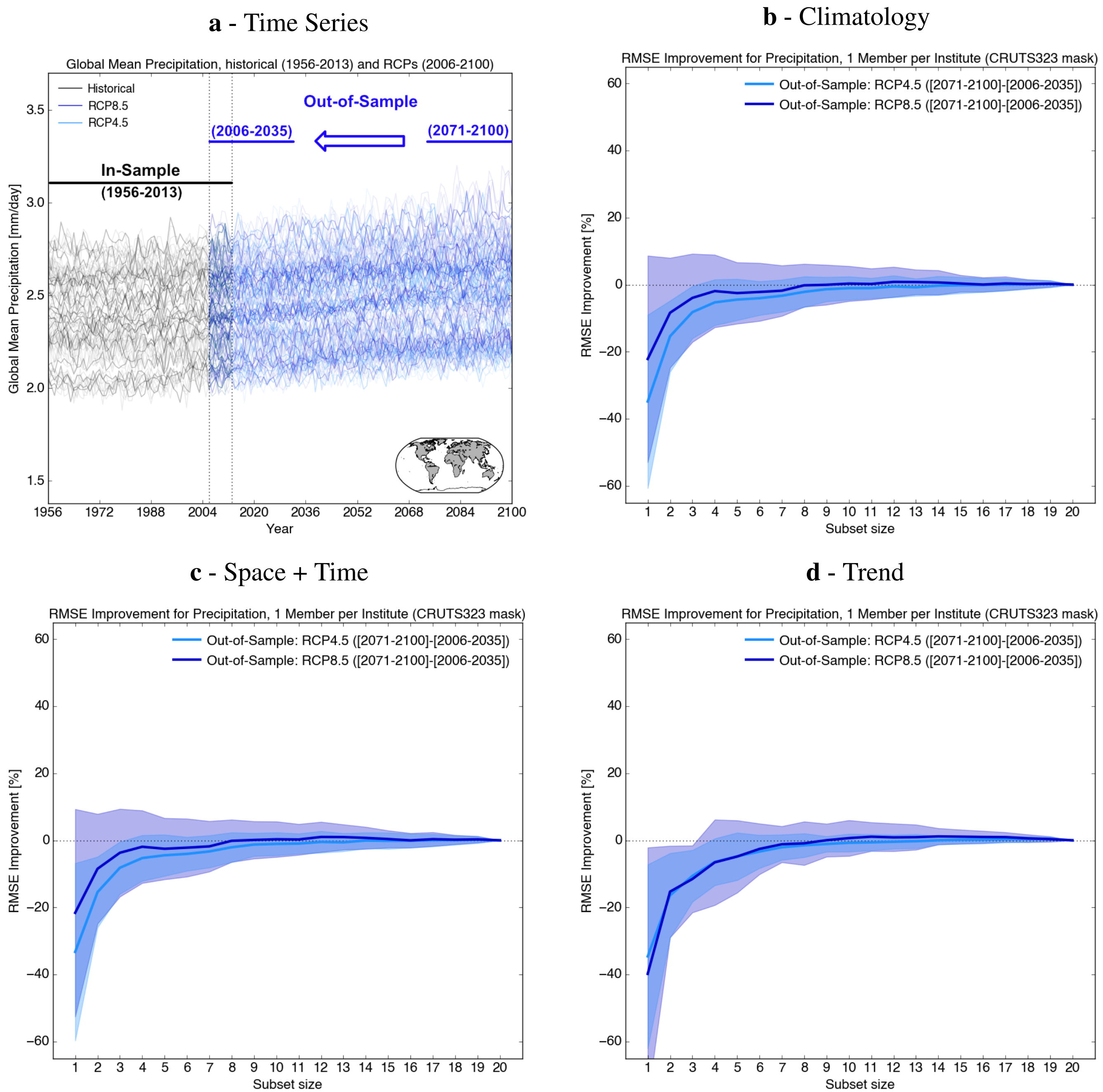
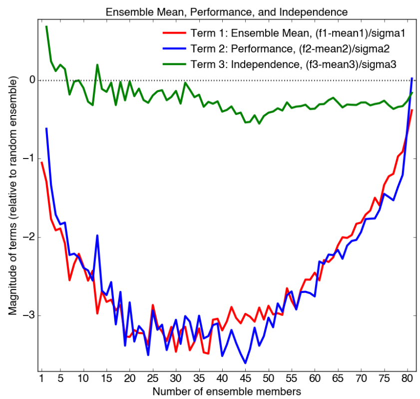
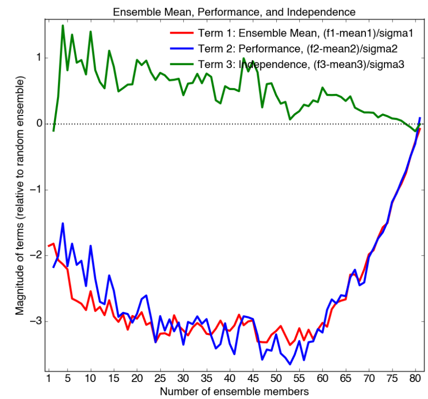


Figure S7. Same as Figure 6 but for precipitation.

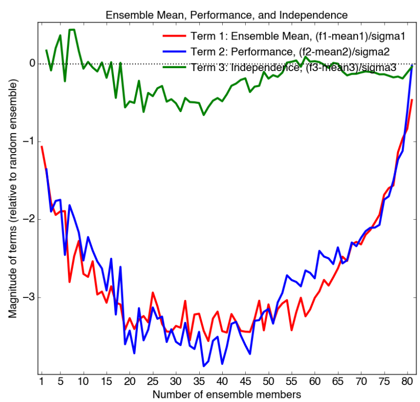
a - CRUTEM4



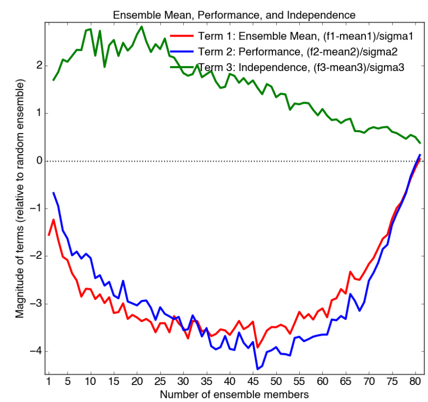
b - Berkeley BEST, land



c - HadCRUT4



d - Berkeley BEST, global



e - CRUTS3.23

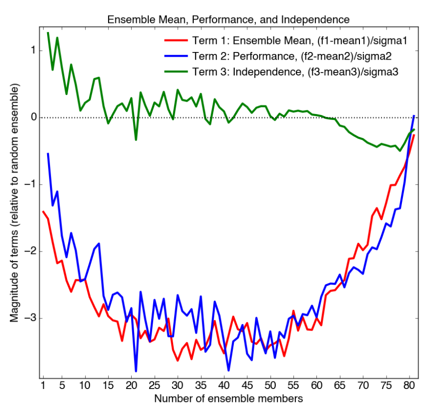
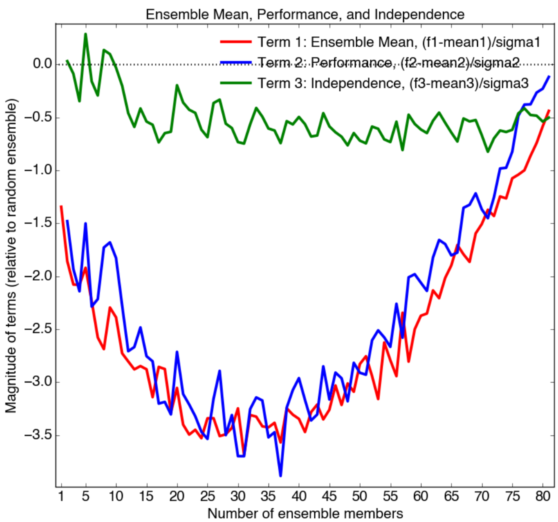
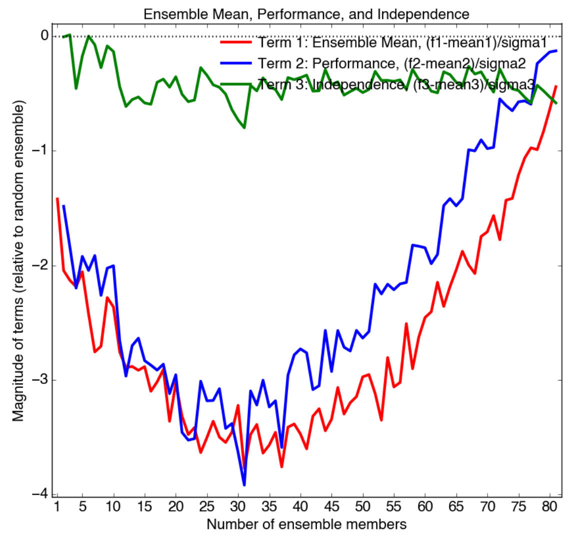


Figure S8. Magnitude of the three terms of the objective function in equation (2). The results for five different observational products of surfae air temperature is shown. The meaning of the terms is described in section 4.1.

a - GPCC7



b - PREC/L



c - CRUTS3.23

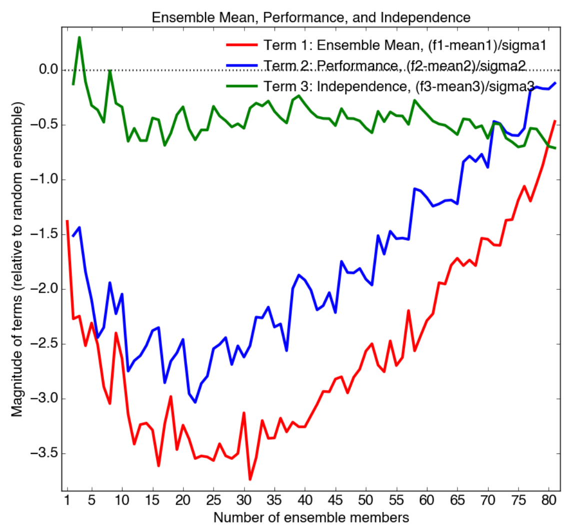


Figure S9. Same as Figure S8, but for total precipitation.