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SUPPLEMENTARY INFORMATION

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Robustness and uncertainties in the new CMIP5 climate model projections

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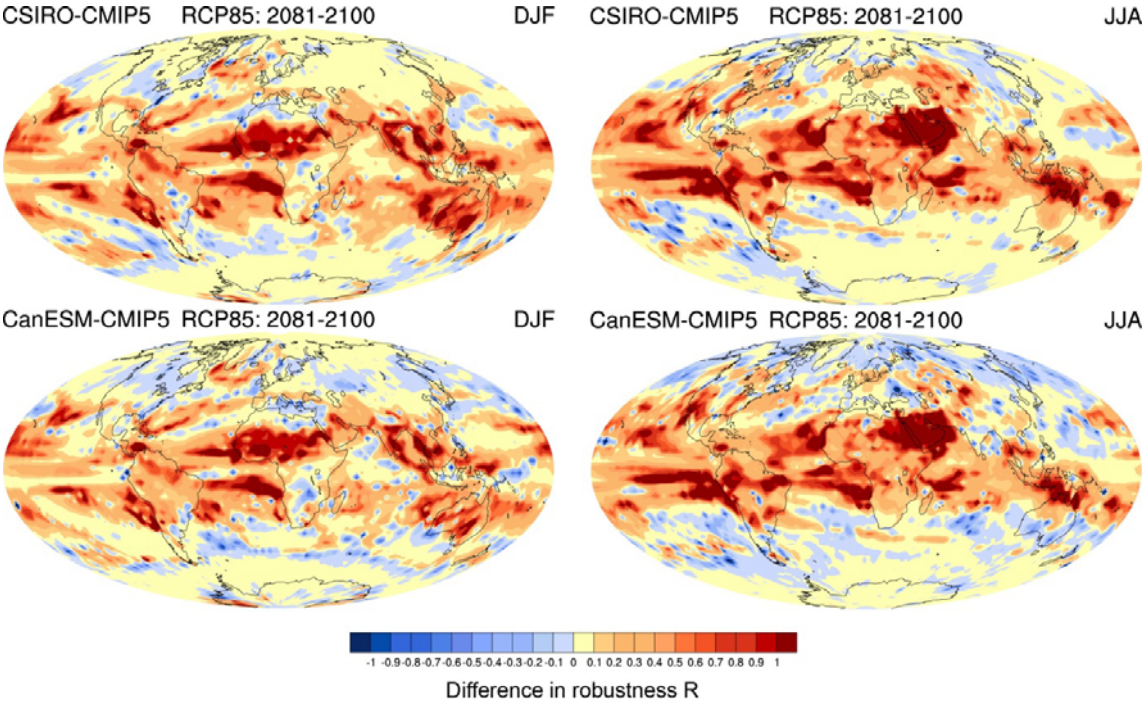
Supplementary figures



Supplementary figure S1: Difference in robustness *R* between the CSIRO initial condition ensemble and CMIP5 (top), and between the CanESM2 ensemble and CMIP5 (bottom), for December to February (DJF) and June to August (JJA) precipitation. Red colors in the Tropics indicate where the initial condition ensemble has a higher robustness than the multi model ensemble.

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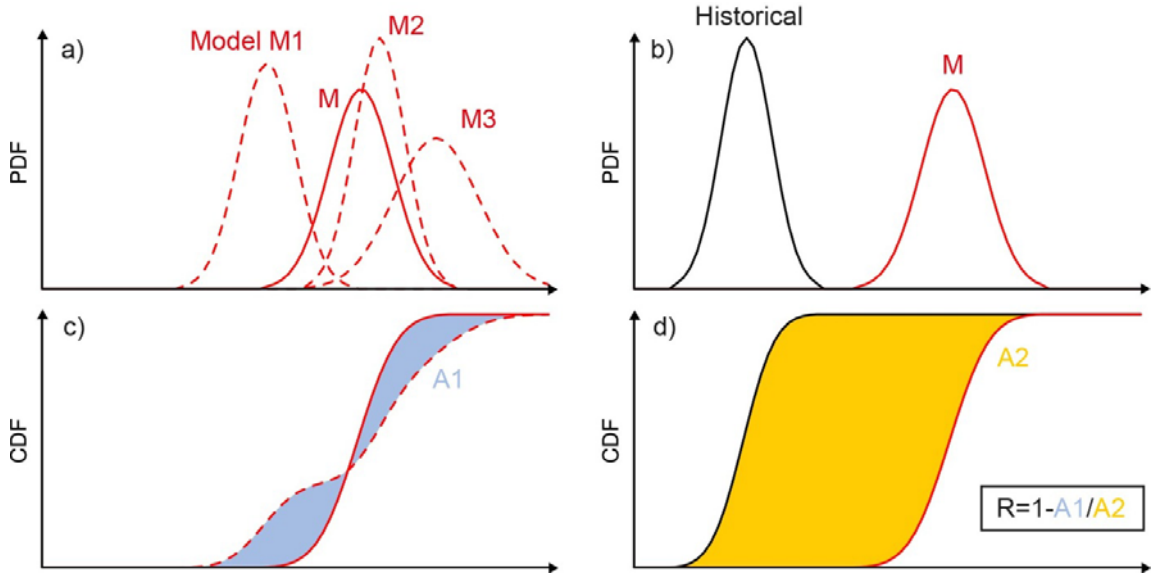
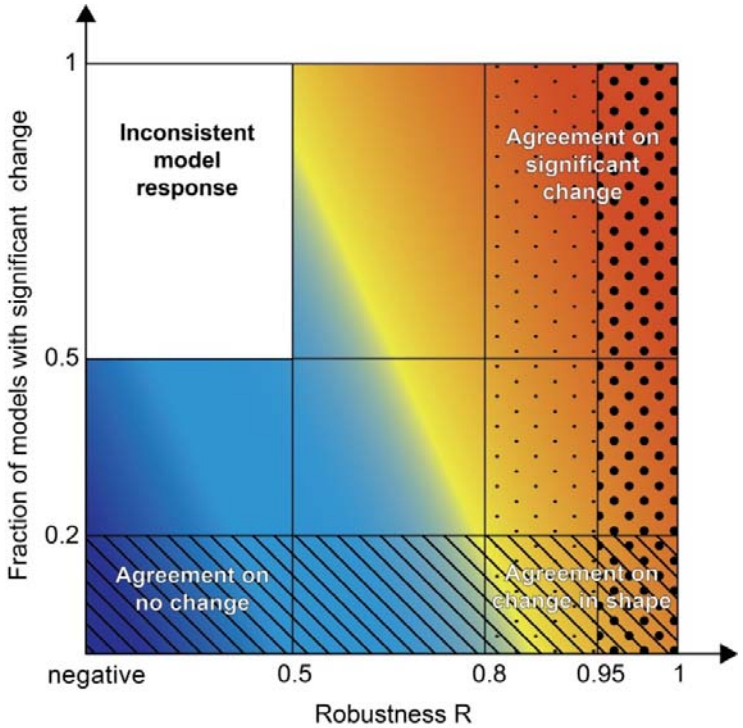


Supplementary figure S2: The robustness *R* illustrated in an example. a) Probability density function (PDF) of projected changes from three illustrative models (red dashed) and the multi model mean (red solid), b) PDF of historical (black solid) and future multi model mean (red solid), c) the cumulative density functions (CDF) from panel a, d) CDFs from panel b. PDFs are calculated from a seasonal average in each year of the 20yr period. PDFs are assumed to be Gaussian. The robustness is defined as *R=1-A1/A2*, where A1 is defined as the integral of the squared area (blue) between two cumulative density functions (CDF) characterizing the individual model projections (panel c, red dashed) and the multi model mean projection (panel c, red solid), and A2 the integral of the squared area (orange) between two CDFs characterizing the multi model projection (panel d, red solid) and the historical climate (panel d, black solid). R=1 implies perfect agreement, R close to zero a case where the model spread is comparable to the signal, and negative R a case where the spread is much larger than the signal.



Supplementary figure S3: Schematic illustration of criteria used for maps. For the temperature and precipitation maps in Fig. 2/3, colored contours show the multi model mean values. Significance of change and model agreement can be interpreted as two orthogonal criteria. High agreement (R>0.8) is marked by small dots stippling, very high agreement (R>0.95) by large dots stippling (see Methods and Fig. S1 for the definition of R). Hatching marks areas where less than 20% of the models show a significant change. White marks areas with inconsistent model response, defined as at least half of the models indicating significant change but low robustness (R<0.5). Colors without stippling and hatching can be interpreted as regions with limited evidence for change in the indicated direction. Note that the choice of particular thresholds is subjective and depends on the application.

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Supplementary Table 1: Models used in the analysis. Note that one or two models are missing in some figure panels due to incomplete availability of data. Models used in the subset analysis are marked by an asterisk.

CMIP5 models
ACCESS1-0
ACCESS1-3
CCSM4
CESM1-BGC
CESM1-CAM5*
CMCC-CM
CNRM-CM5*
CSIRO-Mk3-6-0*
CanESM2*
FGOALS-g2
FGOALS-s2
FIO-ESM
GFDL-CM3*
GFDL-ESM2G
GFDL-ESM2M
GISS-E2-R*
HadGEM2-AO
HadGEM2-CC
HadGEM2-ES*
IPSL-CM5A-LR
IPSL-CM5A-MR*
MIROC-ESM-CHEM
MIROC-ESM
MIROC5*
MPI-ESM-LR
MPI-ESM-MR*
MRI-CGCM3*
NorESM1-M
bcc-csm1-1
inmcm4

CMIP3
bccr_bcm2_0
cccma_cgcm3_1*
cnrm_cm3*
csiro_mk3_0*
csiro_mk3_5
gfdl_cm2_0
gfdl_cm2_1*
giss_model_e_r*
ingv_echam4
inmcm3_0
ipsl_cm4*
miroc3_2_medres*
miub_echo_g
mpi_echam5*
mri_cgcm2_3_2a*
ncar_ccsm3_0*
ncar_pcm1
ukmo_hadcm3
ukmo_hadgem1*