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Process-level improvements in CMIP5 models and their impact on tropical variability, the Southern Ocean, and monsoons

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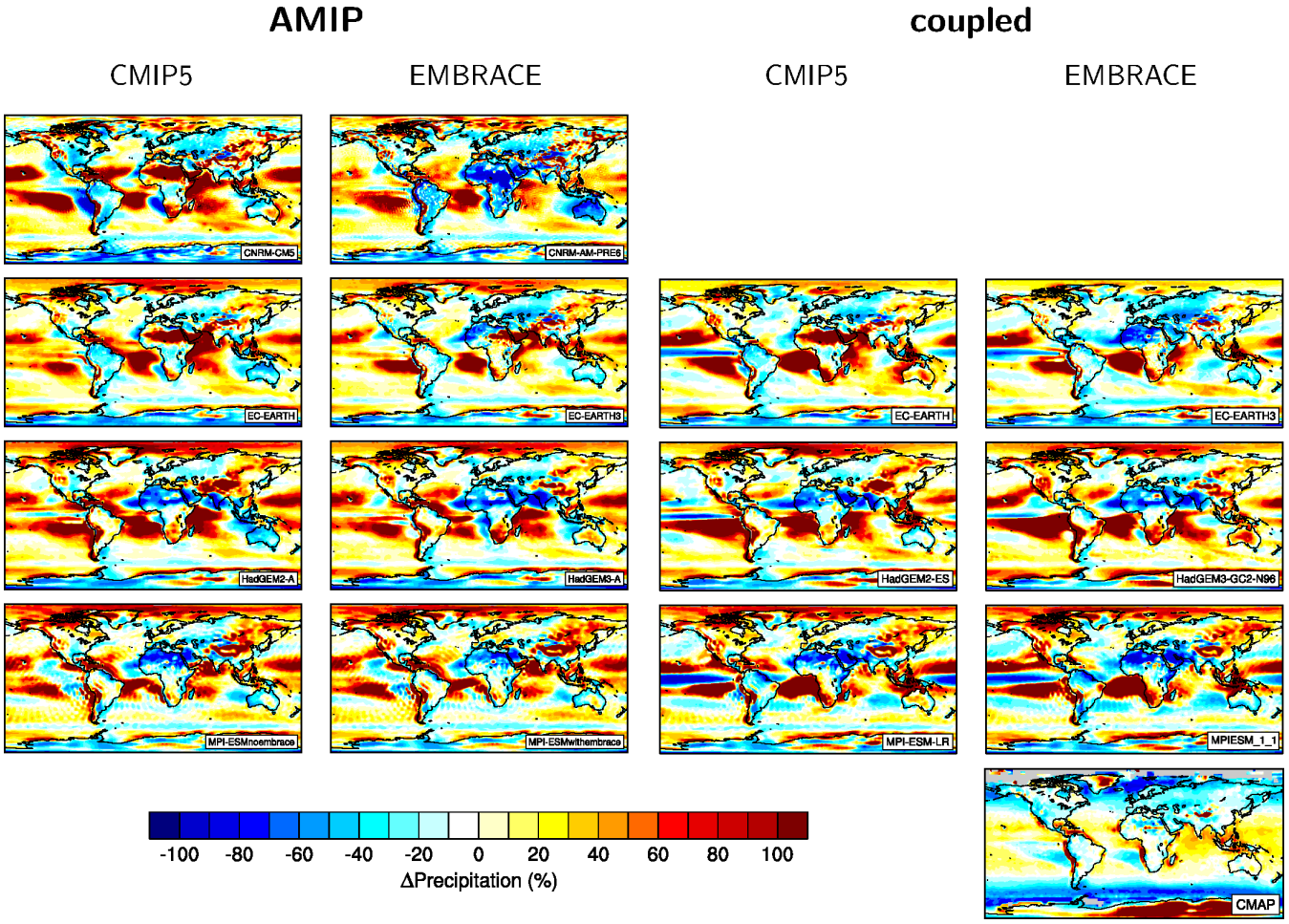

Figure S1 Relative bias in annual mean precipitation rate (%) for the 20-year period 1986-2005 (MPI AMIP models: 1980-1999) compared with the Global Precipitation Climatology Project. From left to right (1) the AMIP simulations from the CMIP5 models (2) the corresponding EMBRACE models (3) the coupled historical simulations from the CMIP5 models, and (4) the corresponding EMBRACE models. Data from CMAP are shown as a second reference data set in the lowermost rightmost panel.

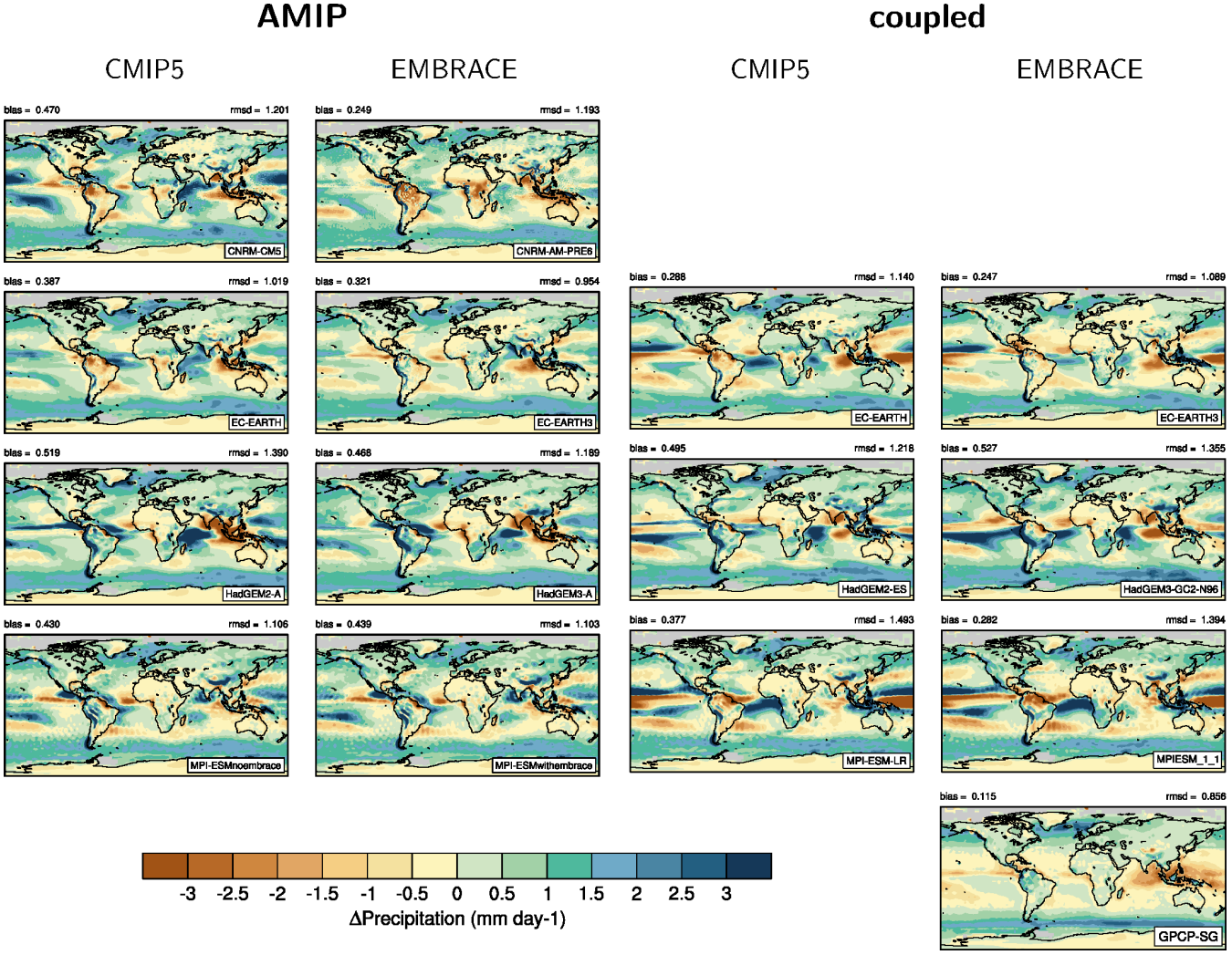

Figure S2 Bias in annual mean precipitation rate (mm day^{-1}) for the 20-year period 1986-2005 (MPI AMIP models: 1980-1999) as the difference between the CMAP data and from left to right (1) the AMIP simulations from the CMIP5 models (2) the corresponding EMBRACE models (3) the coupled historical simulations from the CMIP5 models, and (4) the corresponding EMBRACE models. Data from the Global Precipitation Climatology Project (GPCP) are shown as a second reference data set in the lowermost rightmost panel. The global averaged annual mean bias ("bias") and root mean square deviation ("rmsd") compared with CMAP are given above the individual panels.

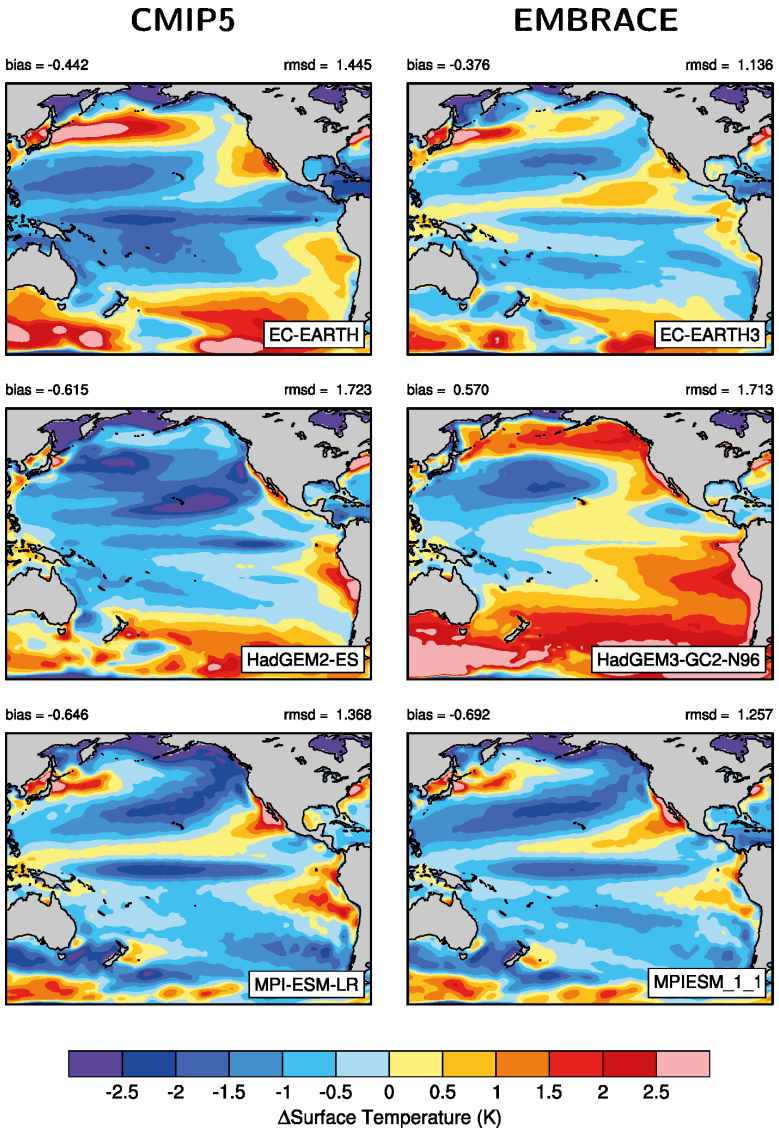

Figure S3 Bias in 20-year annual mean sea surface temperature for the period 1986-2005 (HadGEM models 1986-2004) zoomed in over the Pacific Ocean (120°E-65°W, 65°S-65°N). Shown are the differences between the 20-year climatology from the Hadley Centre Sea Ice and Sea Surface Temperature data set (HadISST, Rayner et al., 2003) and from (left) the coupled historical simulations from the CMIP5 models, and (right) the corresponding EMBRACE models. The domain averaged annual mean bias ("bias") and root mean square deviation ("rmsd") compared with HadISST are given above the individual panels.

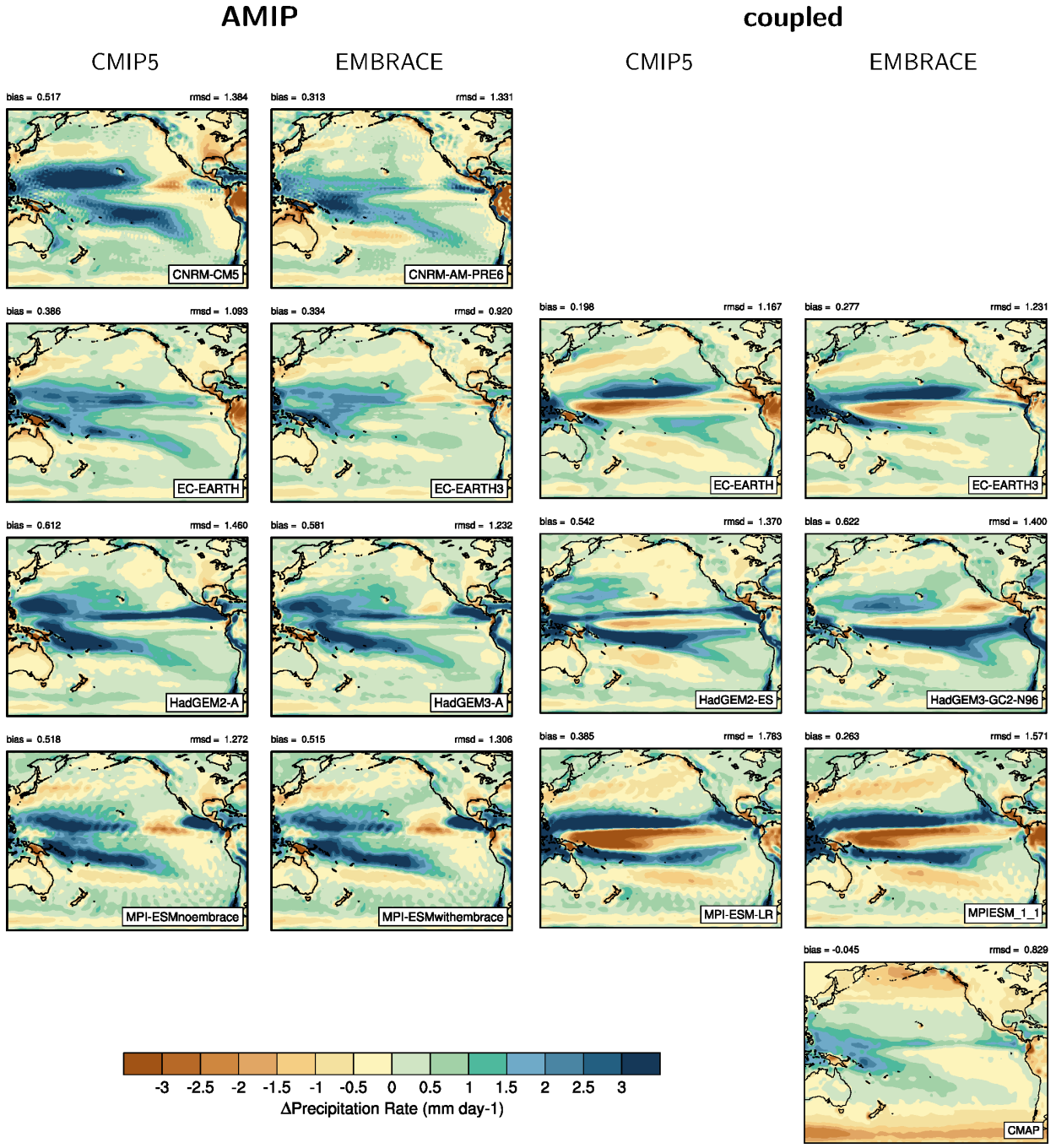

Figure S4 Bias in annual mean precipitation rate (mm day^{-1}) for the 20-year period 1986-2005 (HadGEM models 1986-2004) zoomed in over the Pacific Ocean (120°E-65°W, 65°S-65°N). Shown are the differences between the Global Precipitation Climatology Project (GPCP, Adler et al., 2003) and from left to right (1) the AMIP simulations from the CMIP5 models (2) the corresponding EMBRACE models (3) the coupled historical simulations from the CMIP5 models, and (4) the corresponding EMBRACE models. Data from CMAP (Xie and Arkin, 1997) are shown as a second reference data set in the lowermost rightmost panel. The domain averaged annual mean bias ("bias") and root mean square deviation ("rmsd") compared with GPCP are given above the individual panels.

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