Supplementary figures

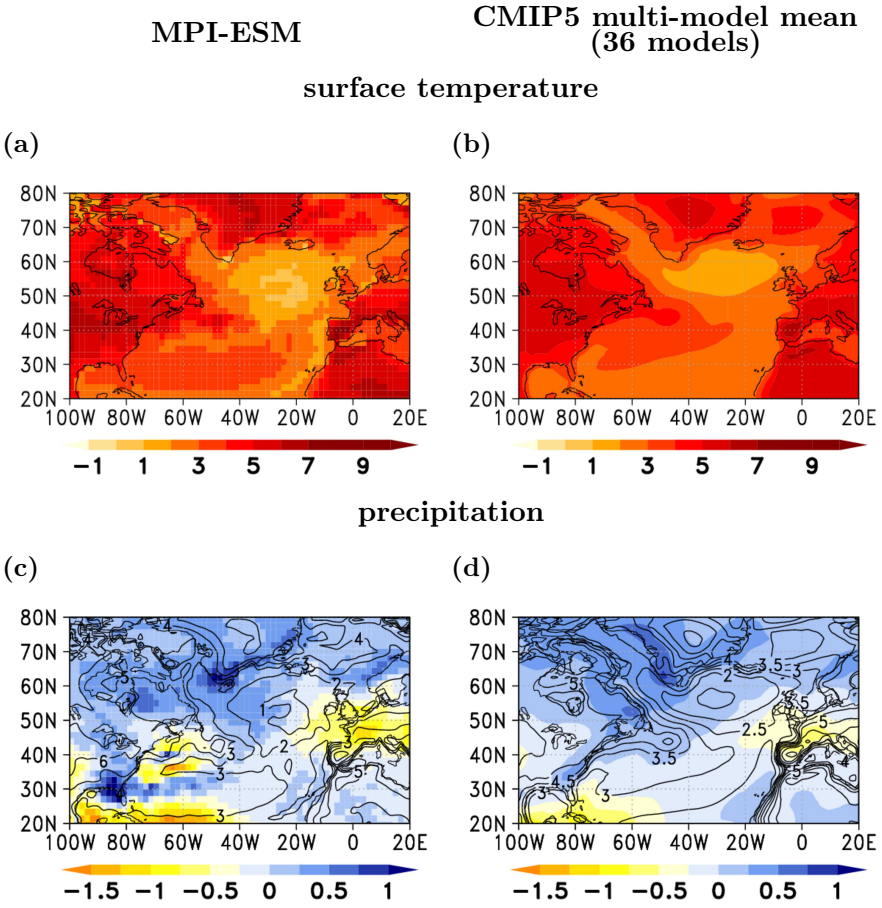


Fig. S.1: Summer-time (JJA) surface temperature response (top, in K) and precipitation response (bottom, in mm/day) to the RCP 8.5 scenario for MPI-ESM (left column) and the CMIP5 multi-model ensemble mean (right column). Climatological differences between the periods from 2050 to 2100 and 1850 to 2005. In panels (c) and (d) contours repeat the surface temperature change.

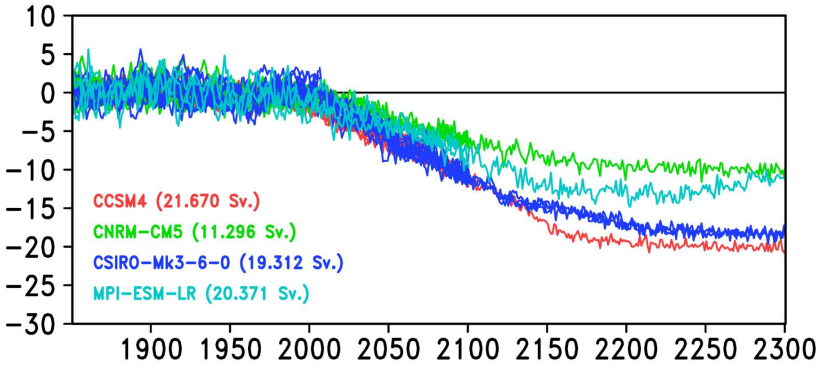


Fig. S.2: Atlantic Meridional Overturning Circulation (as the absolute value of the meridional overturning stream funtion at 45 °N in 1000 m depth, in Sv) for different CMIP5 models as indicated by the color index in the lower left corner of the plot. To account for differences in the mean AMOC of the individual models, for every model the time averaged ensemble mean of the historical runs (the value in brackets in the color index) of the according model was removed from the time series.

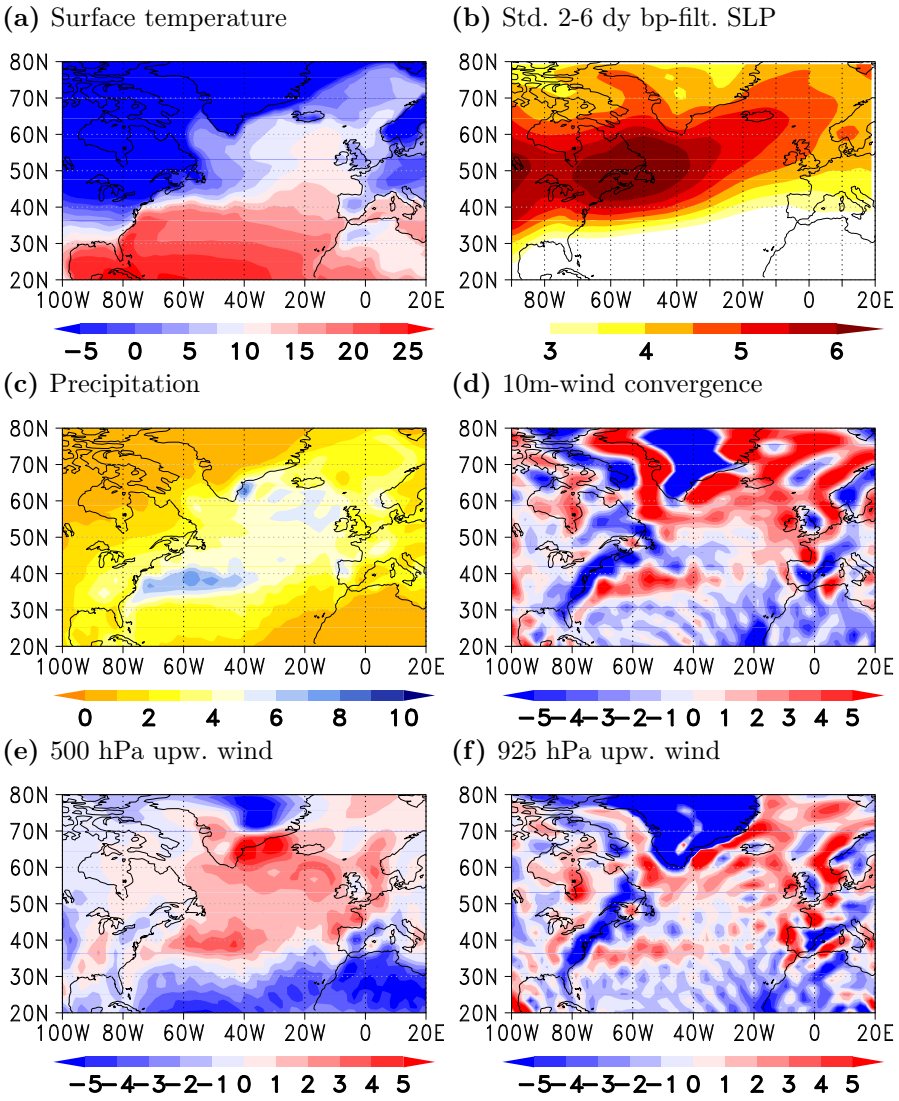


Fig. S.3: Winter-time (DJF) climatologies of different atmosperic quantities in the historical run. (a) Surface temperature (in °C), (b) standard deviation of 2-6 day bandpass-filtered SLP anomalies (in hPa), (c) total precipitation (in mm/day), (d) 10m-wind convergence (in 10^{-6} s^{-1}), and (e,f) upward wind (in Pa/s) for 500 hPa (e) and 925 hPa (f). According observations/reanalysis for comparison can be found in suppl. Fig. S.4

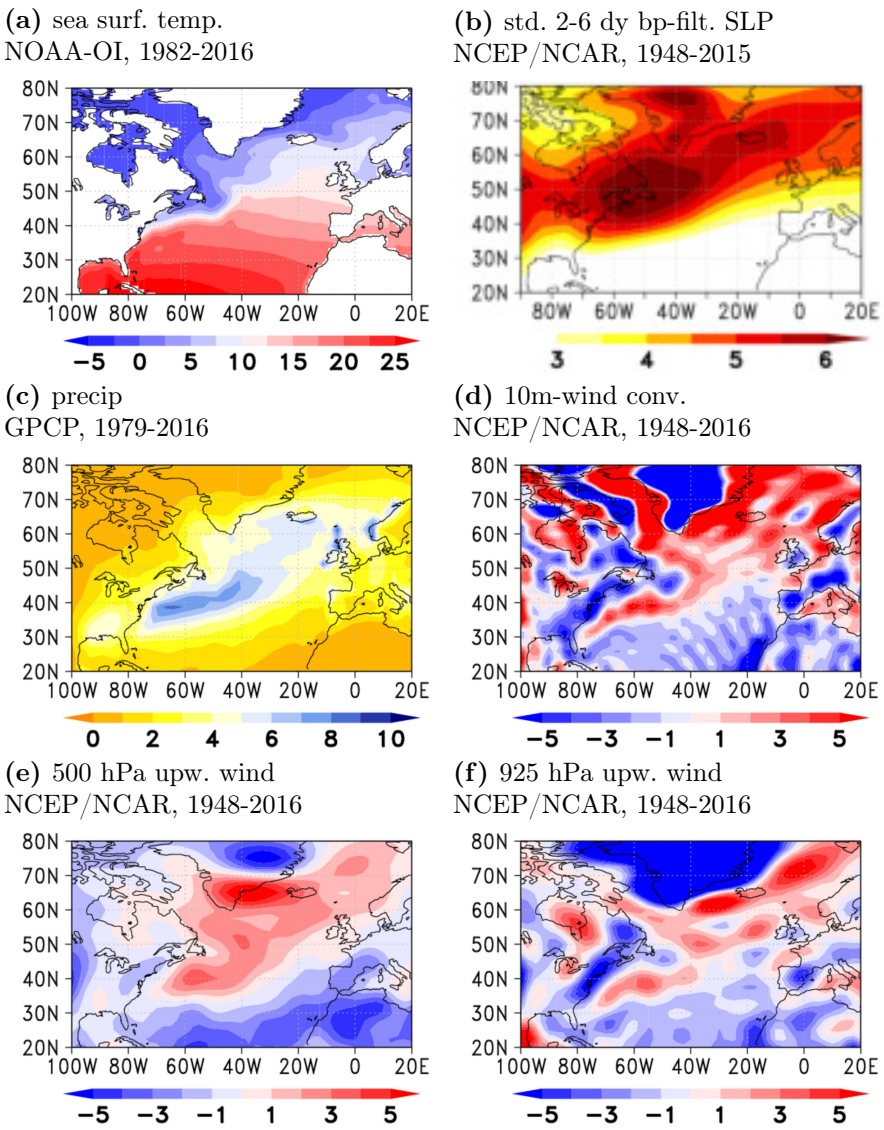


Fig. S.4: Winter-time (DJF) climatologies of different atmosperic quantities in the NOAA Optimum Interpolation [Reynolds et al., 2002] and Global Precipitation Climatology Project (GPCP) [Adler et al., 2003] observations and the NCEP-NCAR reanalysis products [Kalnay et al., 1996]. (a) Sea surface temperature (in °C) (b) standard deviation of 2-6 day bandpass-filtered SLP anomalies (in hPa), (c) total precipitation (in mm/day), (d) 10m-wind convergence (in 10^{-6} s^{-1}), and (e,f) upward wind (in Pa/s) for 500 hPa (e) and 925 hPa (f). Note that due to the limited availability of suitable long-term observations and reanalysis data, the period (mentioned in the subcaption vor the individual subfigures) differs to that used in Fig. S.3.

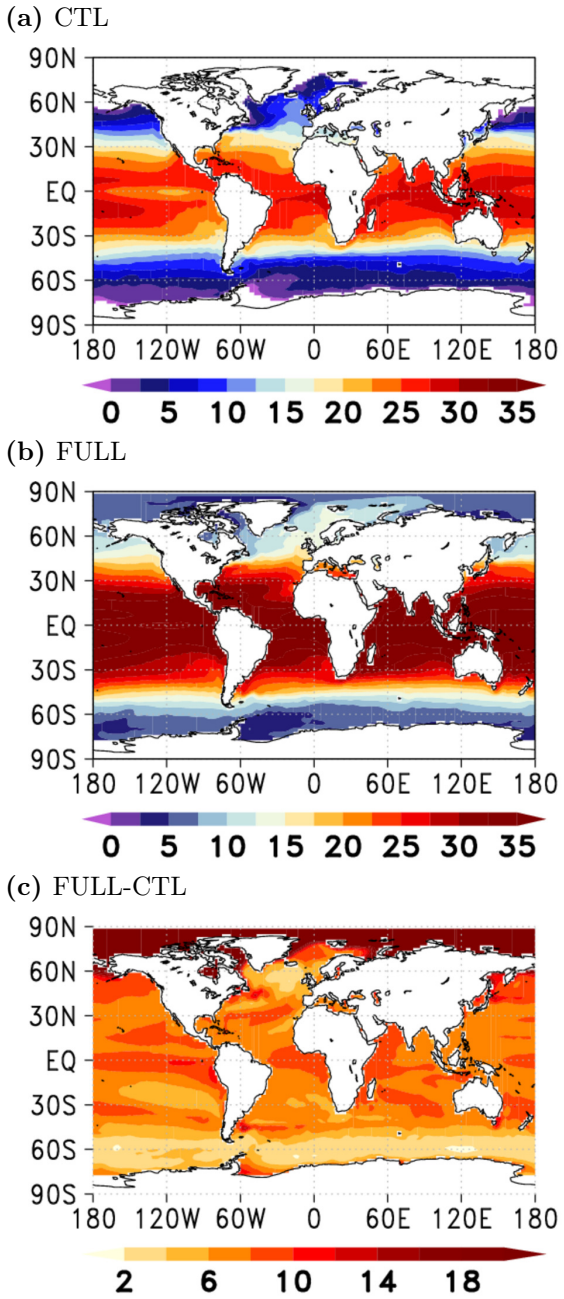


Fig. S.5: Winter-time (DJF) SST forcing for the sensitivity experiment. Absolute SSTs (in °C) for CTL (a) and FULL (b) and the difference FULL-CTL (c). Outside the North Atlantic the forcing for CTLPNA is the same as for CTL (inside the North Atlantic it is modified according to Fig. 2c). Furthermore, outside the North Atlantic the forcing for FULLMNA is the same as for FULL (inside the North Atlantic it is modified according to Fig. 2d). In (a) and (b) white areas over the ocean indicate sea ice.

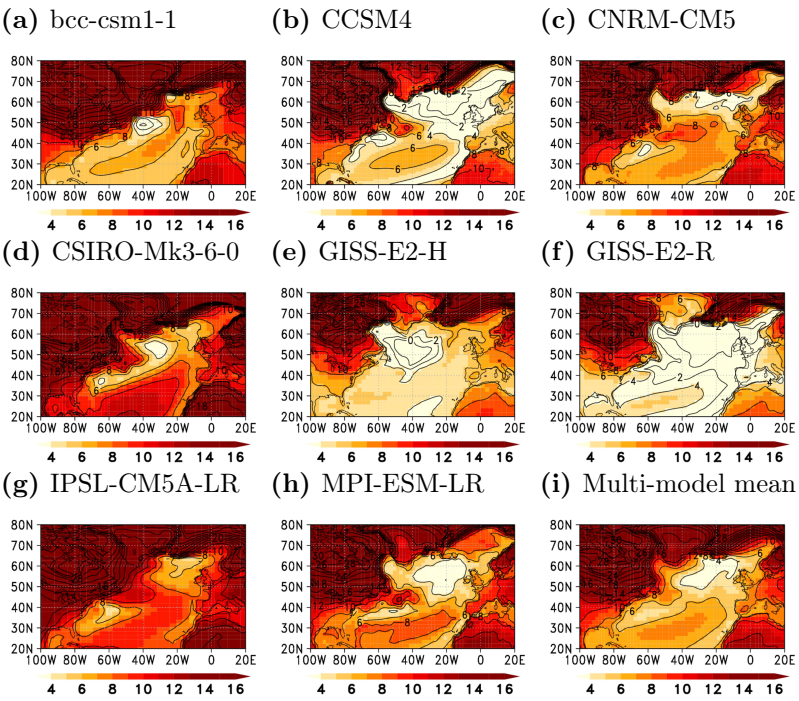
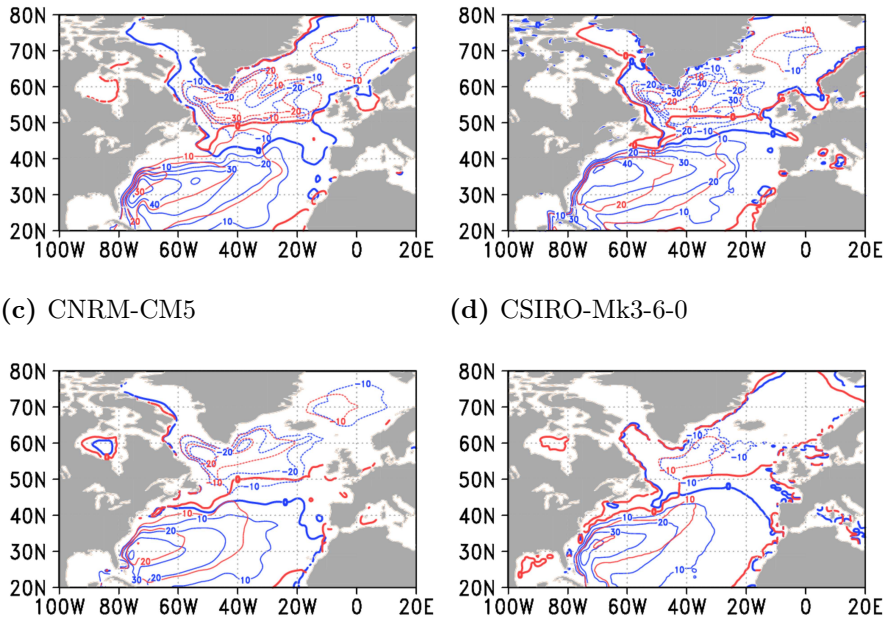


Fig. S.6: Surface temperature response (bottom, in K) to the RCP 8.5 scenario for winter for different CMIP5 models (a-h) the multi-model ensemble mean (i). Climatological differences between the periods from 2200 to 2300 and 1850 to 2005. For those models, where more than one realization was available for the period from 2200 to 2300, the ensemble mean is shown.

(a) MPI-ESM-LR **(b)** CCSM4



(c) CNRM-CM5 **(d)** CSIRO-Mk3-6-0

Fig. S.7: Ocean barotropic stramfunction (in Sv) for the historical simulations (averaged for the winters from 1850 to 2005, blue) and the RCP 8.5 scenario (averaged for the winters from 2200 to 2300, red) for different CMIP5 models. For those models, where more than one realization was available for the period from 2200 to 2300, the ensemble mean is shown.

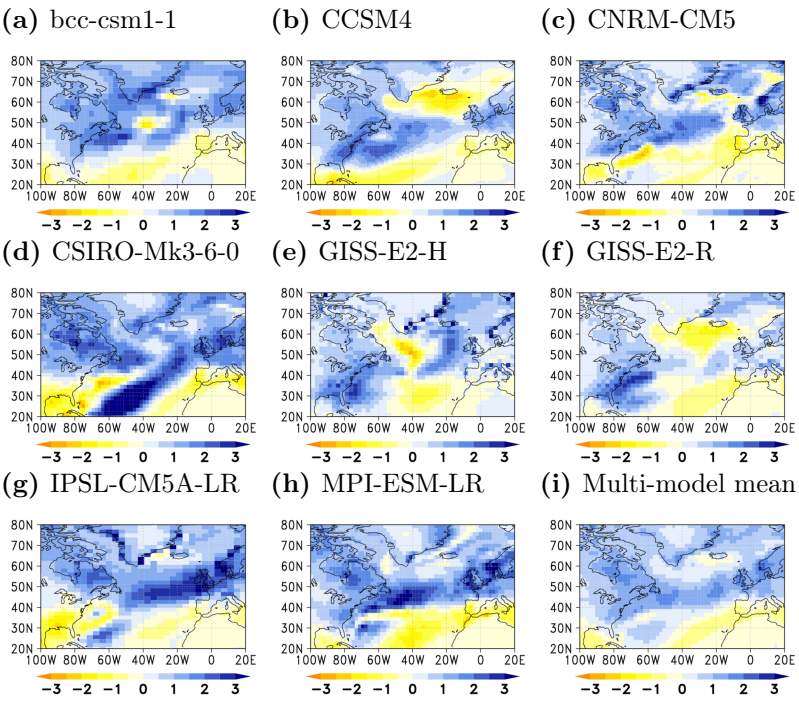


Fig. S.8: Same as Fig. S.6, but for the precipitation response (in mm/day).

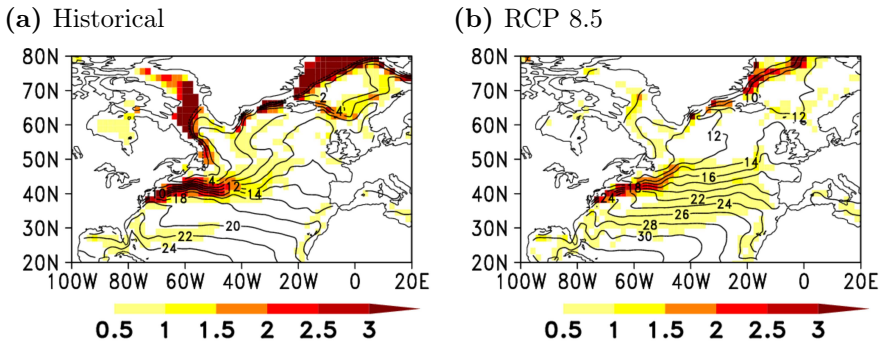


Fig. S.9: Winter-time (DJF) SST gradient (in K/100km) averaged for the periods from 1850 to 2005 in the historical run (a) and from 2200 to 2300 in the RCP 8.5 scenario run (b). Underlying contours show the climatological seasonal mean SSTs for the according period.

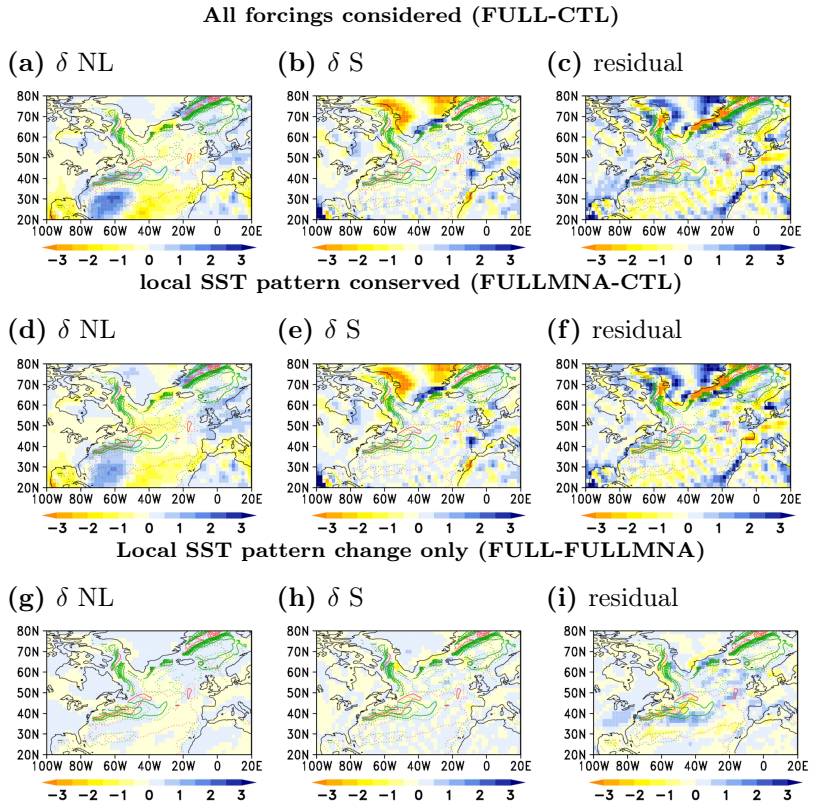
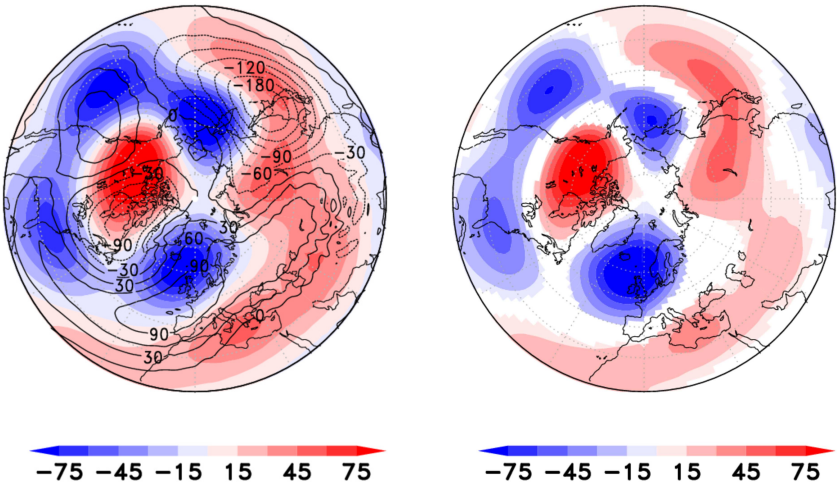


Fig. S.10: Climatological winter-time difference for the non-linear term (shadings, in mm/day), the surface term and the residual of the moisture budget analysis. Green (red) contours indicate the SST gradient (in K/100km) in CTL (FULL). Response to all forcings (FULL-CTL, a-c), all forcings except local SST pattern changes (FULLMNA-CTL, d-f) and local SST pattern change only (FULL-FULLMNA, g-i).

(a) Coupled experiment (RCP 8.5-historical)

(b) Climate change, incl. local SST pattern change (FULL-CTL)



(c) Climate change, local SST pattern conserved (FULLMNA-CTL)

(d) No climate change, local SST pattern change only (FULL-FULLMNA)

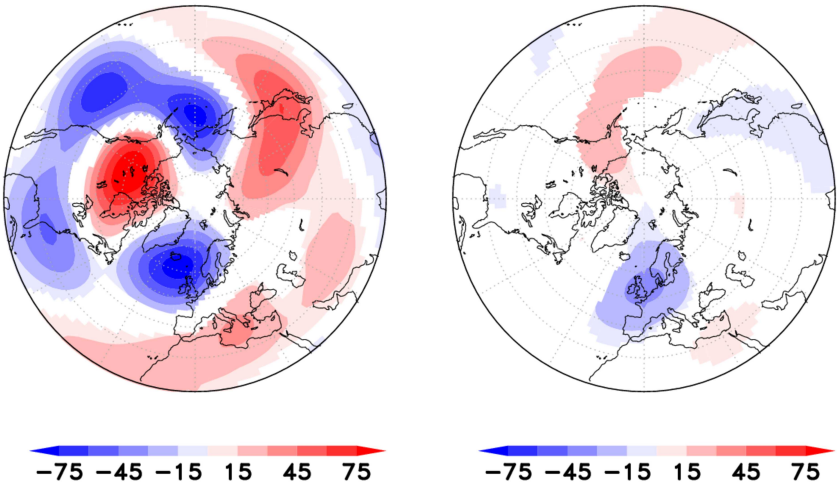


Fig. S.11: Stationary wave response, as indicated by the climatological wintertime (DJF) 500 hPa geopotential height anomalies (in gpm) with the zonal mean response removed. (a) Difference between the RCP 8.5 coupled run (averaged for the period 2200 to 2300) and the historical run (averaged and averaged for the period 1850 to 2005). (b-e) Same as (a), but for the sensitivity experiment: (b) difference between FULL and CTL (i.e.the response to all forcing changes), (c) between FULLMNA and CTL (i.e.the response to all forcing changes except local SST pattern change) and (d) between FULL and FULLMNA (i.e. the effect of local SST pattern changes only). In (a) the contours show the climatological values from the historical run, in (b) to (d) values that are not significant at the 95% level (using a bootstrapping test) are masked out.