Supplement of

Simulating the mid-Holocene, Last Interglacial and mid-Pliocene climate with EC-Earth3-LR

Qiong Zhang et al.

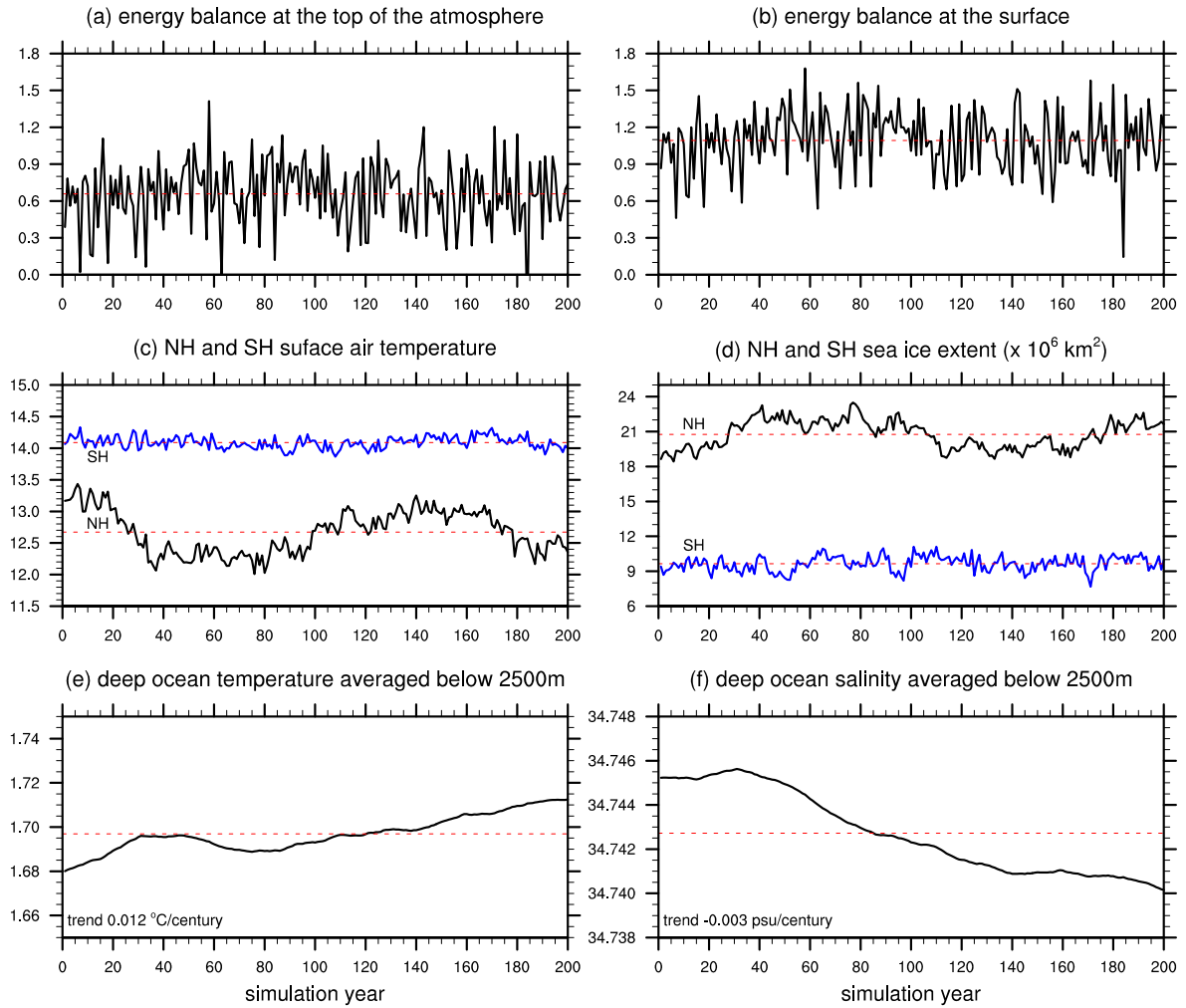Correspondence to: Qiong Zhang (qiong.zhang@natgeo.su.se)

PI

Figure S1. The evolution during the 200 years spin-up period for the *piControl* simulation using annual mean data. (a) global mean energy balance at the top of the atmosphere (W m-2), (b) global mean energy balance at the surface (W m-2), (c) NH and SH average surface air temperature (°C), (d) NH and SH average sea ice extent (10₆ km2), (e) global mean deep ocean temperature averaged below 2500 m (°C), and (f) global mean deep ocean salinity averaged below 2500 m (PSU). The 200 years mean value is indicated with a red dash line.

MH

(a) energy balance at the top of the atmosphere

(b) energy balance at the surface

(c) NH and SH suface air temperature

(d) NH and SH sea ice extent (x 10^6 km^2)

(e) deep ocean temperature averaged below 2500m

trend 0.017 ^{o}C/century

(f) deep ocean salinity averaged below 2500m

trend -0.002 psu/century

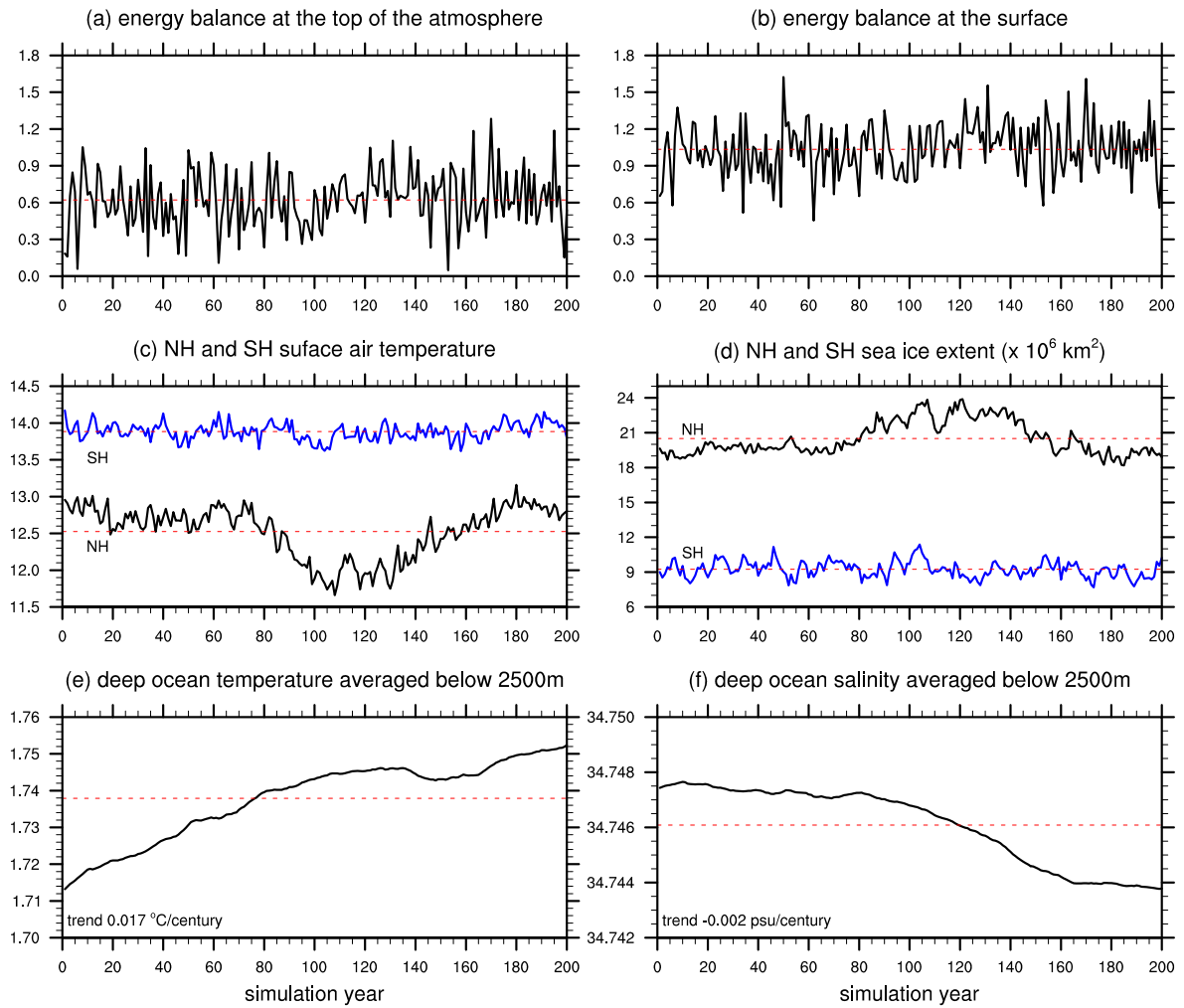simulation year

simulation year

Figure S2. The evolution during the 200 years spin-up period for the *midHolocene* simulation using annual mean data. (a) global mean energy balance at the top of the atmosphere (W m-2), (b) global mean energy balance at the surface (W m-2), (c) NH and SH average surface air temperature (°C), (d) NH and SH average sea ice extent (10_6 km2), (e) global mean deep ocean temperature averaged below 2500 m (°C), and (f) global mean deep ocean salinity averaged below 2500 m (PSU). The 200 years mean value is indicated with a red dash line.
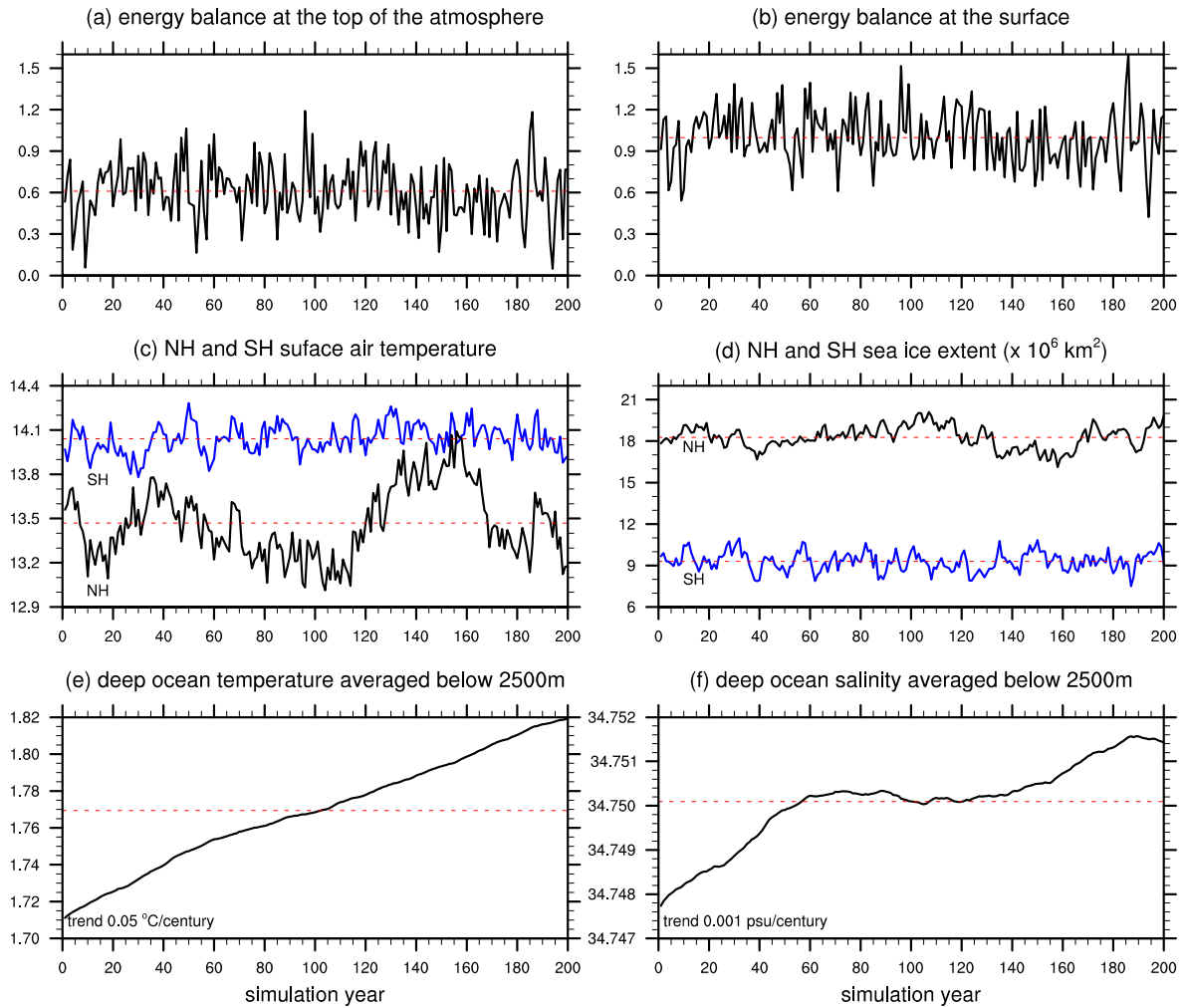
LIG

Figure S3. The evolution during the 200 years spin-up period for the *lig127k* simulation using annual mean data. (a) global mean energy balance at the top of the atmosphere (W m-2), (b) global mean energy balance at the surface (W m-2), (c) NH and SH average surface air temperature (°C), (d) NH and SH average sea ice extent (10₆ km2), (e) global mean deep ocean temperature averaged below 2500 m (°C), and (f) global mean deep ocean salinity averaged below 2500 m (PSU). The 200 years mean value is indicated with a red dash line.
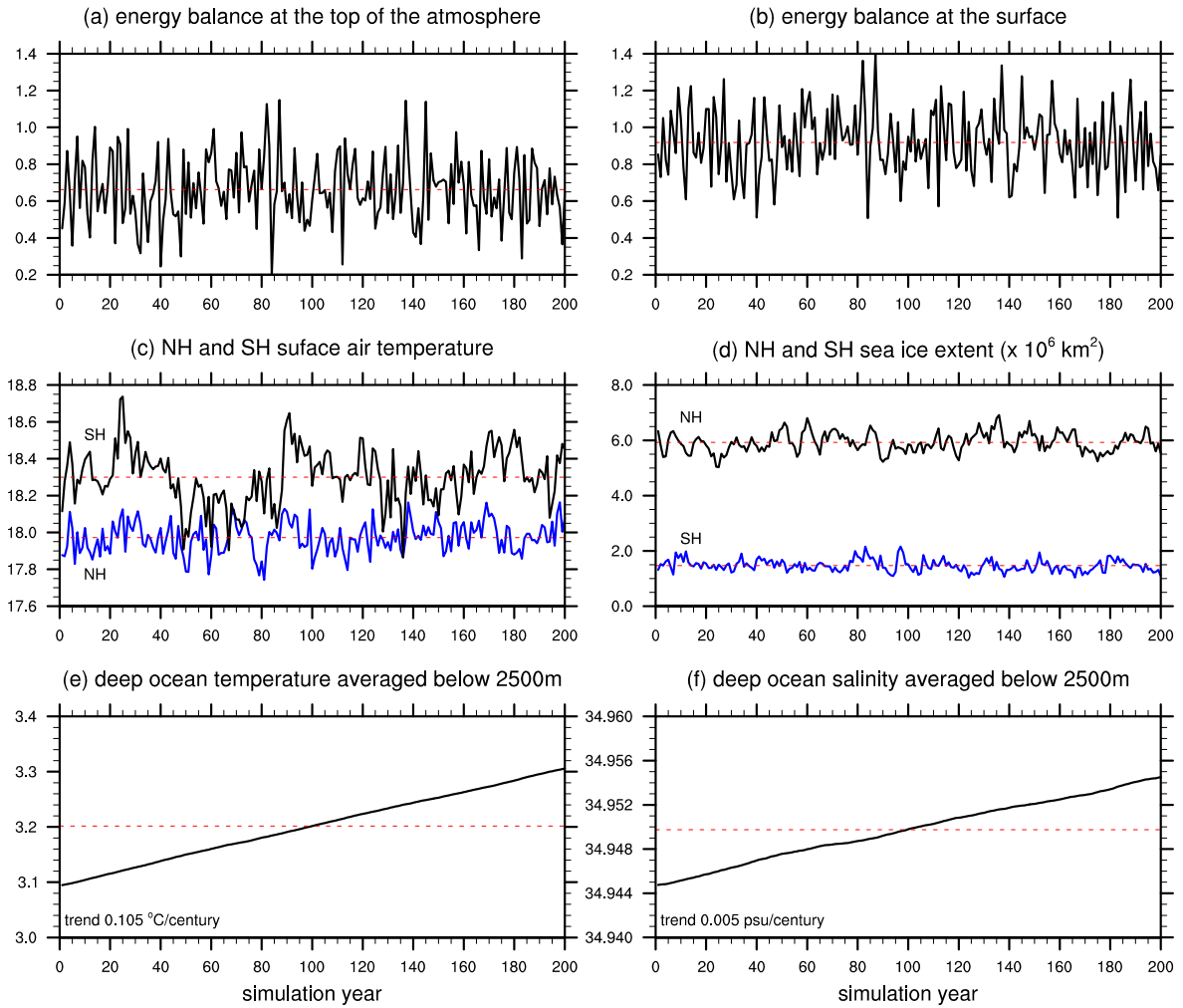
MP

Figure S4. The evolution during the 200 years spin-up period for the *midPliocene* simulation using annual mean data. (a) global mean energy balance at the top of the atmosphere (W m-2), (b) global mean energy balance at the surface (W m-2), (c) NH and SH average surface air temperature (°C), (d) NH and SH average sea ice extent (106 km2), (e) global mean deep ocean temperature averaged below 2500 m (°C), and (f) global mean deep ocean salinity averaged below 2500 m (PSU). The 200 years mean value is indicated with a red dash line.
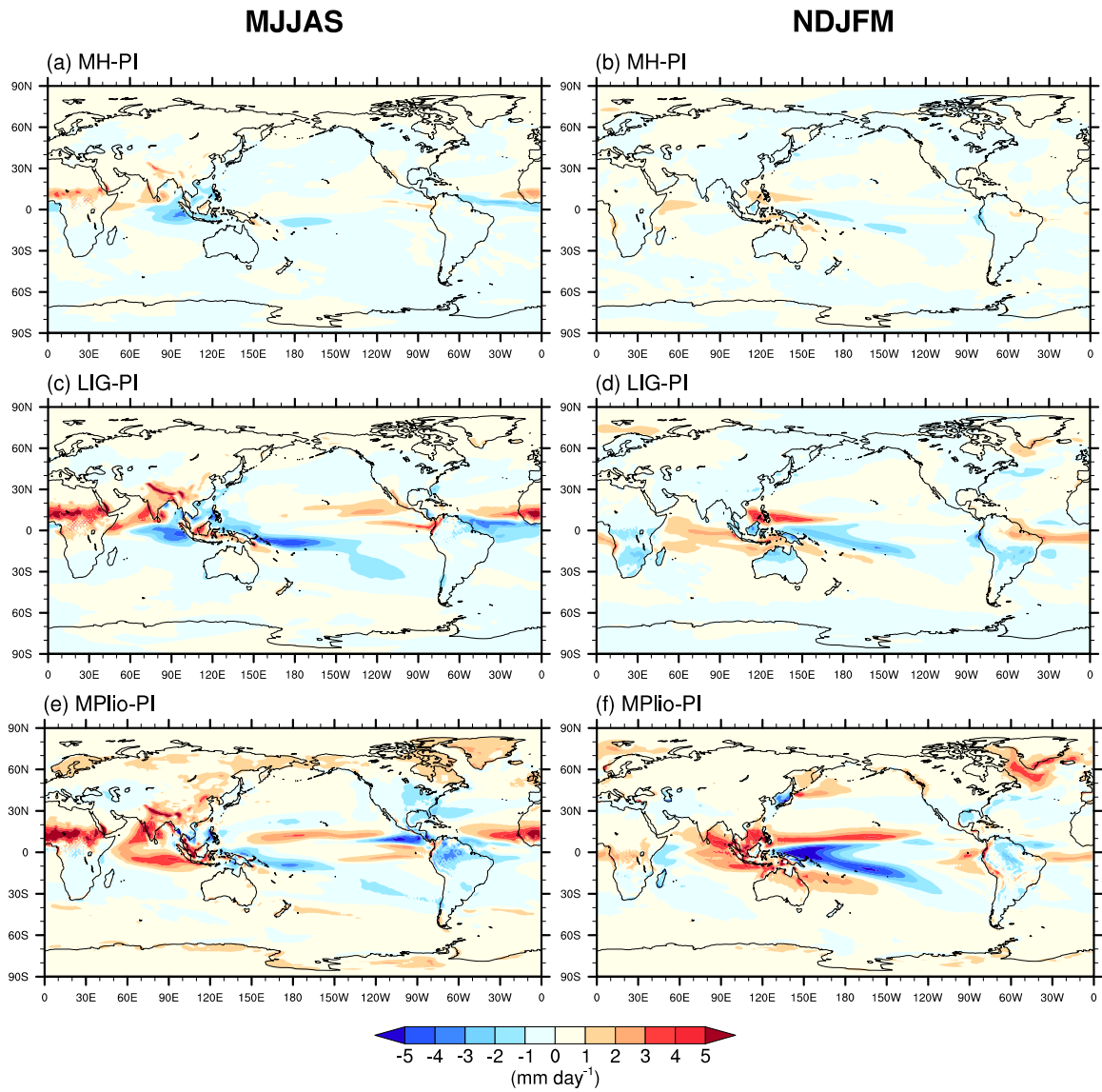
MJJAS **NDJFM**

Figure S5. Boreal (MJJAS, left panel) and austral (NDJFM, right panel) summer precipitation anomalies in the *midHolocene* (a, b), the *lig127k* (c, d) and the *midPliocene* (e, f) compared to the *piControl*.
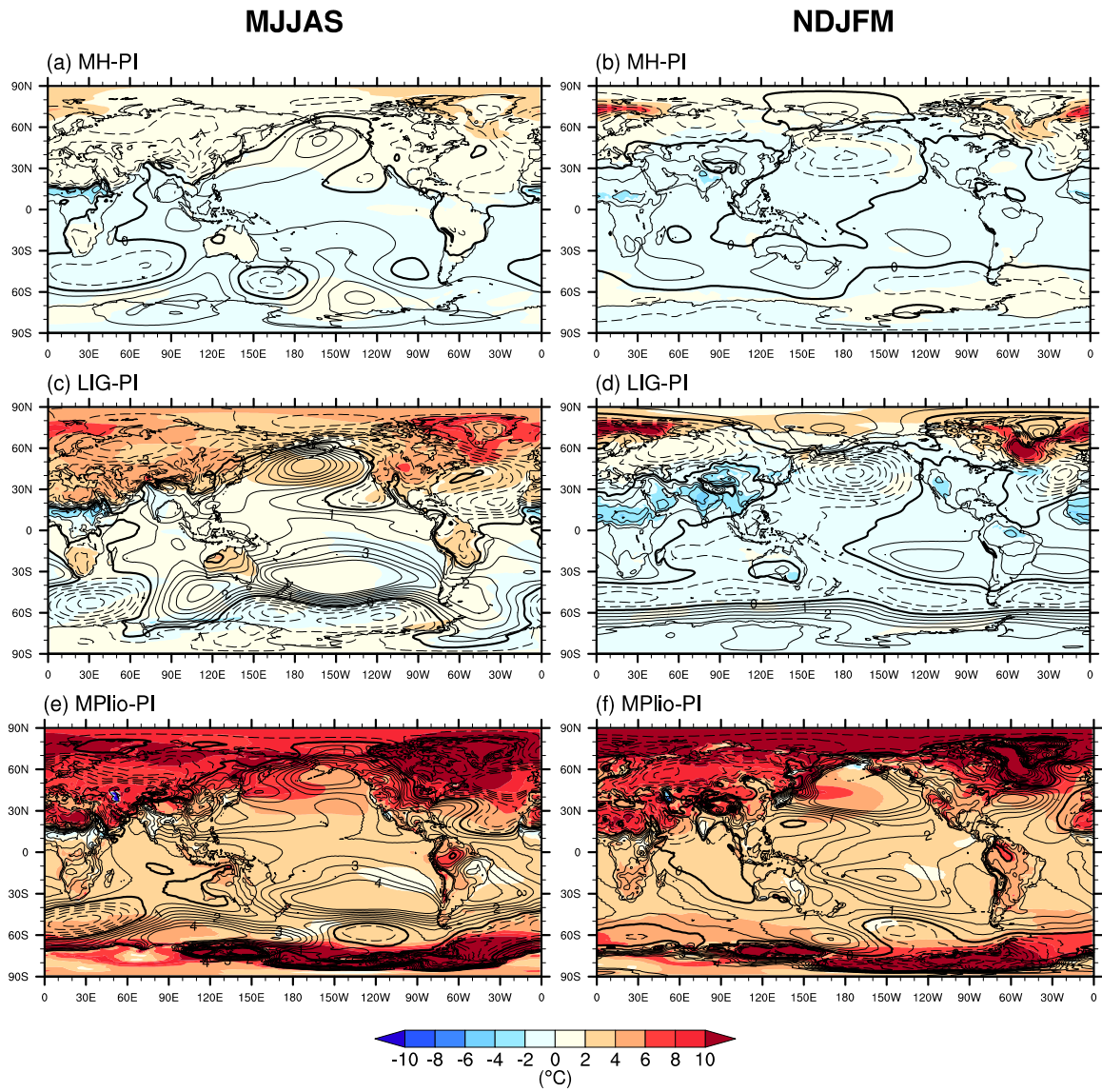
Figure S6. Boreal (MJJAS, left panel) and austral (NDJFM, right panel) summer SAT (shading) and mean sea level pressure (contours, the negative anomalies are shown as dashed and the positive are shown as solid) anomalies in the *midHolocene* (a, b), the *lig127k* (c, d) and the *midPliocene* (e, f) respect to the *piControl*.
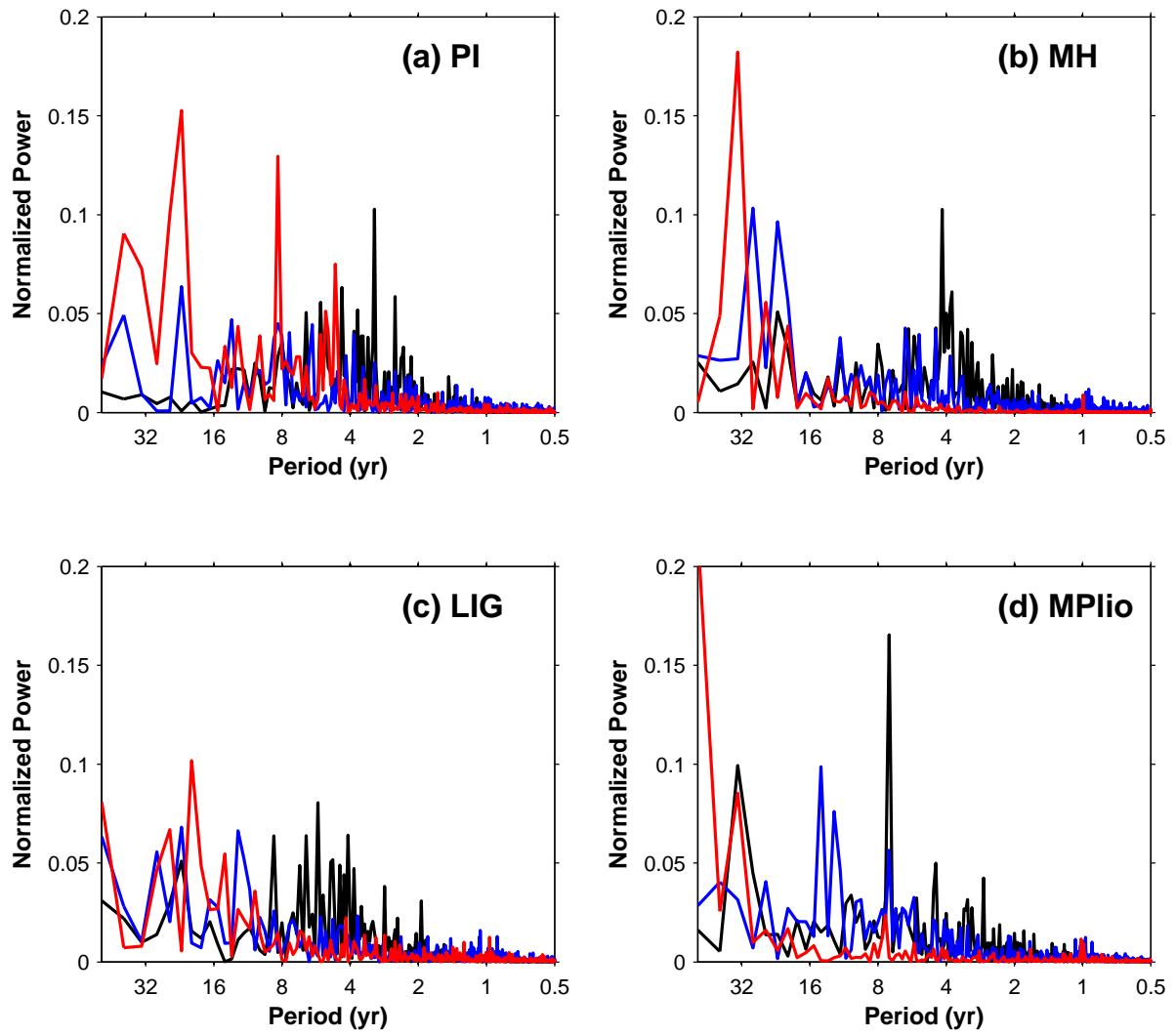
Figure S7. Power spectra (normalized) of simulated climate variability using EOF PC1 time series of ENSO (black), PDO (blue) and AMO (red) in the four simulations.