Supporting Information for "SPEAR – the next generation GFDL modeling system for seasonal to multidecadal prediction and projection" by Delworth et al.,

doi:10.1029/2019MS001895

In this section we present basic aspects of the time-mean climate and variability from extended simulations of the SPEAR_LO and SPEAR_MED simulations. Since this is a newly developed model it is useful to have some broad perspective on the ability of the model to simulate aspects of the Earth's climate. Unless noted otherwise, figures showing model output are calculated based on time-means over years 21-100 of a control simulation forced with atmospheric composition corresponding to calendar year 2010.

List of figures

Annual mean precipitation (mm day^{-1})

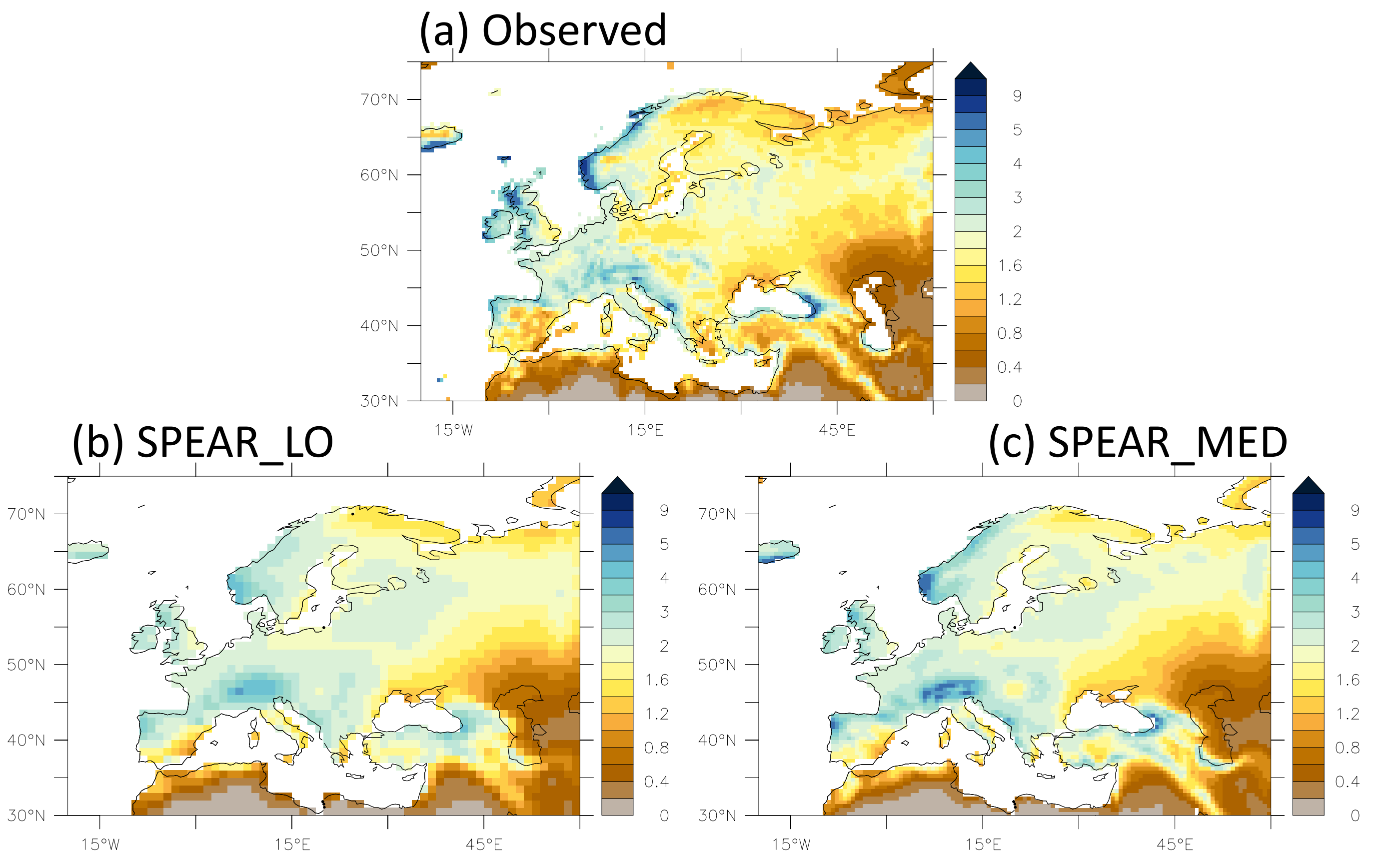

Figure S1: Time mean, annual mean precipitation (units are mm day^{-1}). (a) Observations from the Global Precipitation Climatology Centre (GPCC, Schneider et al., 2017), calculated as the mean from 1981-2010. (b) Results from SPEAR_LO (c) Results from SPEAR_MED.

Annual mean precipitation (mm day^{-1})

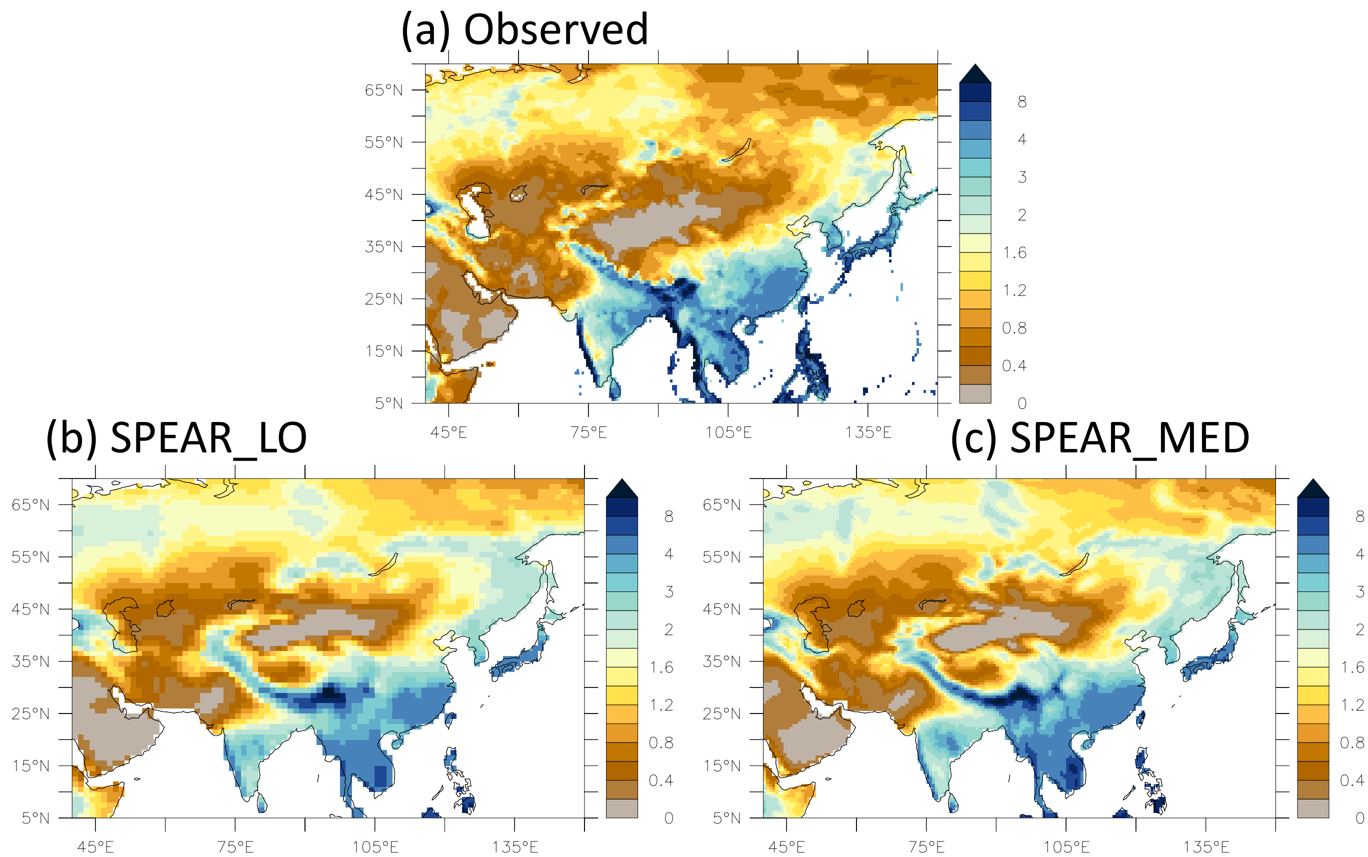

Figure S2: Time mean, annual mean precipitation (units are mm day^{-1}). (a) Observations from the Global Precipitation Climatology Centre (GPCC, Schneider et al., 2017), calculated as the mean from 1981-2010. (b) Results from SPEAR_LO (c) Results from SPEAR_MED.

Annual mean precipitation (mm day^{-1})

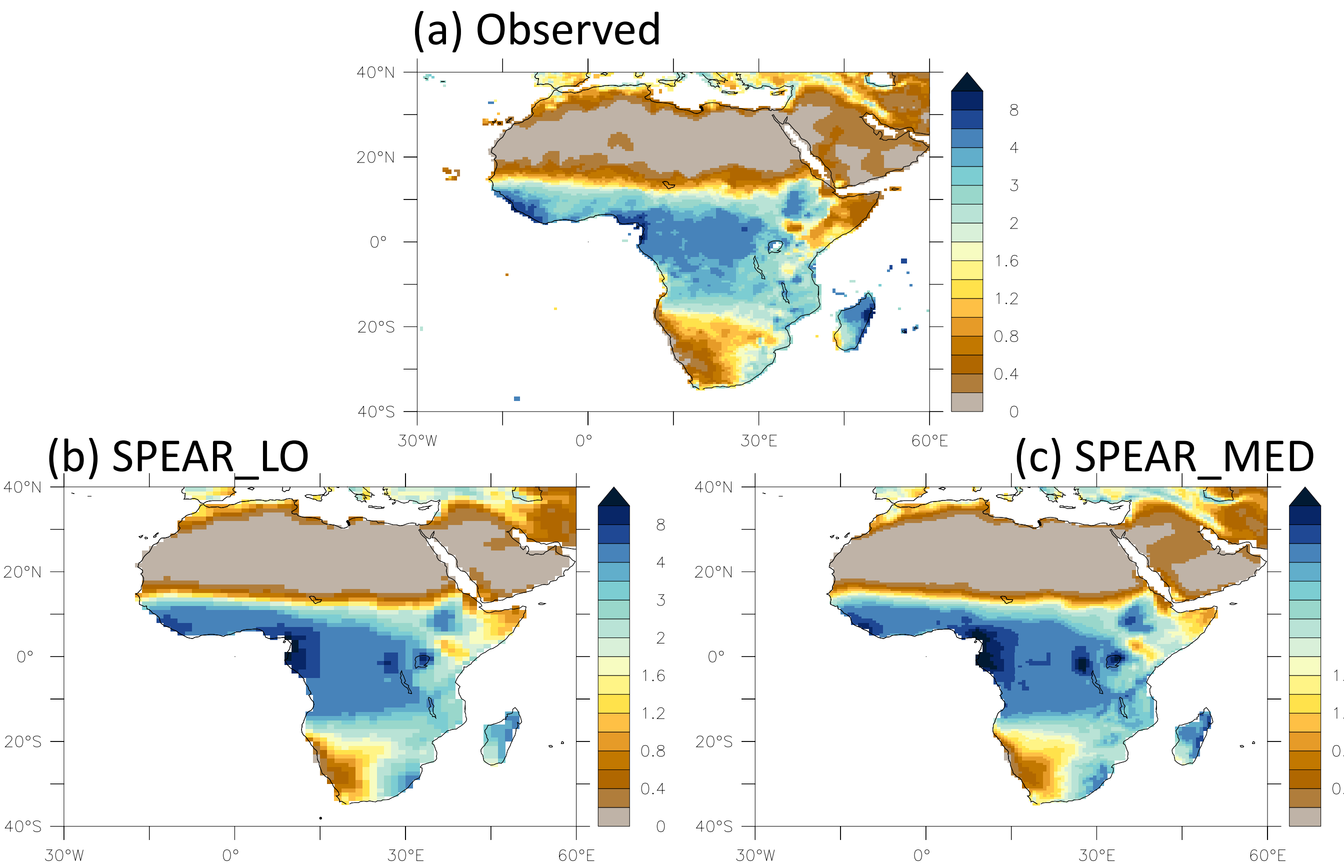

Figure S3: Time mean, annual mean precipitation (units are mm day^{-1}). (a) Observations from the Global Precipitation Climatology Centre (GPCC, Schneider et al., 2017), calculated as the mean from 1981-2010. (b) Results from SPEAR_LO (c) Results from SPEAR_MED.

Annual mean precipitation (mm day^{-1})

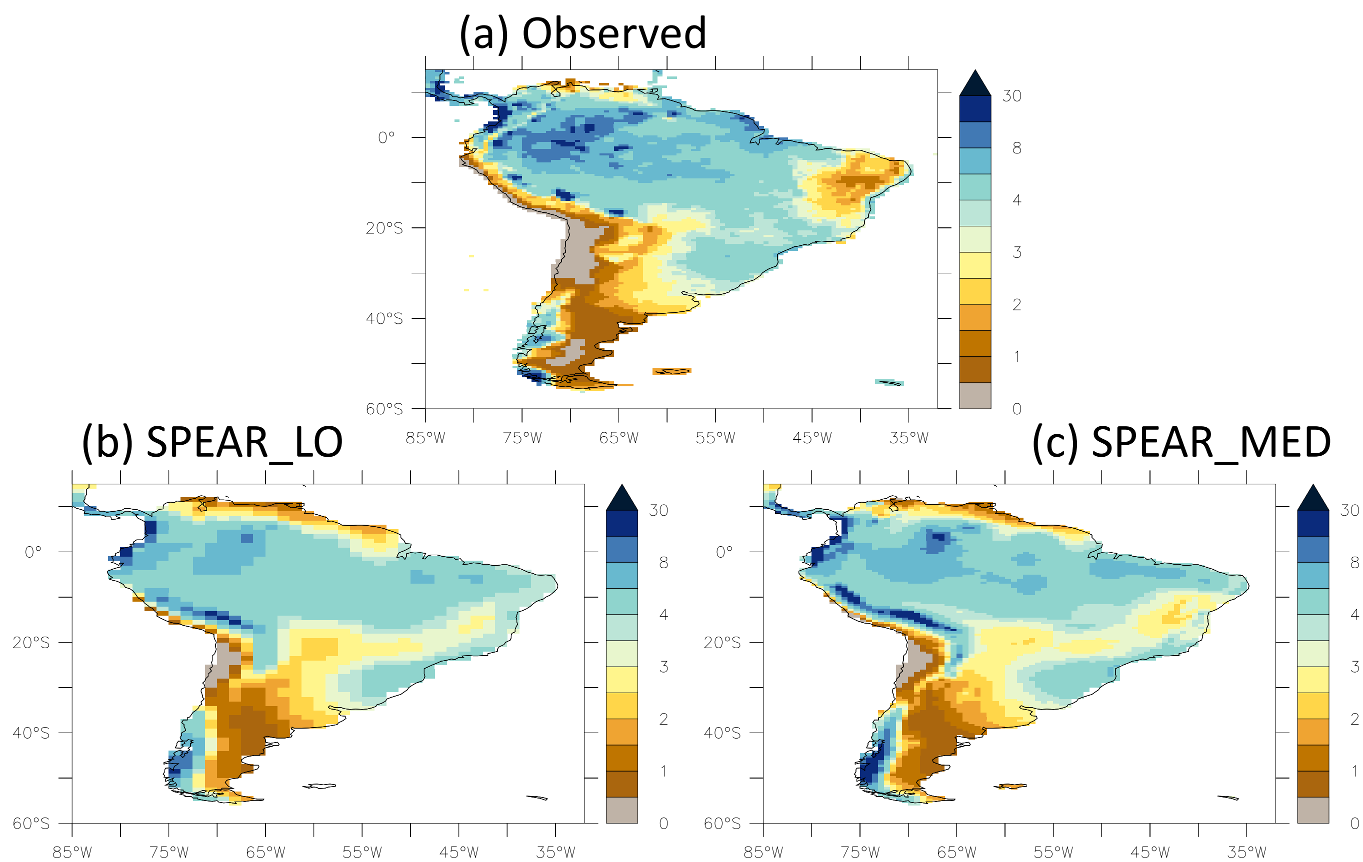

Figure S4: Time mean, annual mean precipitation (units are mm day^{-1}). (a) Observations from the Global Precipitation Climatology Centre (GPCC, Schneider et al., 2017), calculated as the mean from 1981-2010. (b) Results from SPEAR_LO (c) Results from SPEAR_MED.

Annual mean precipitation (mm day^{-1})

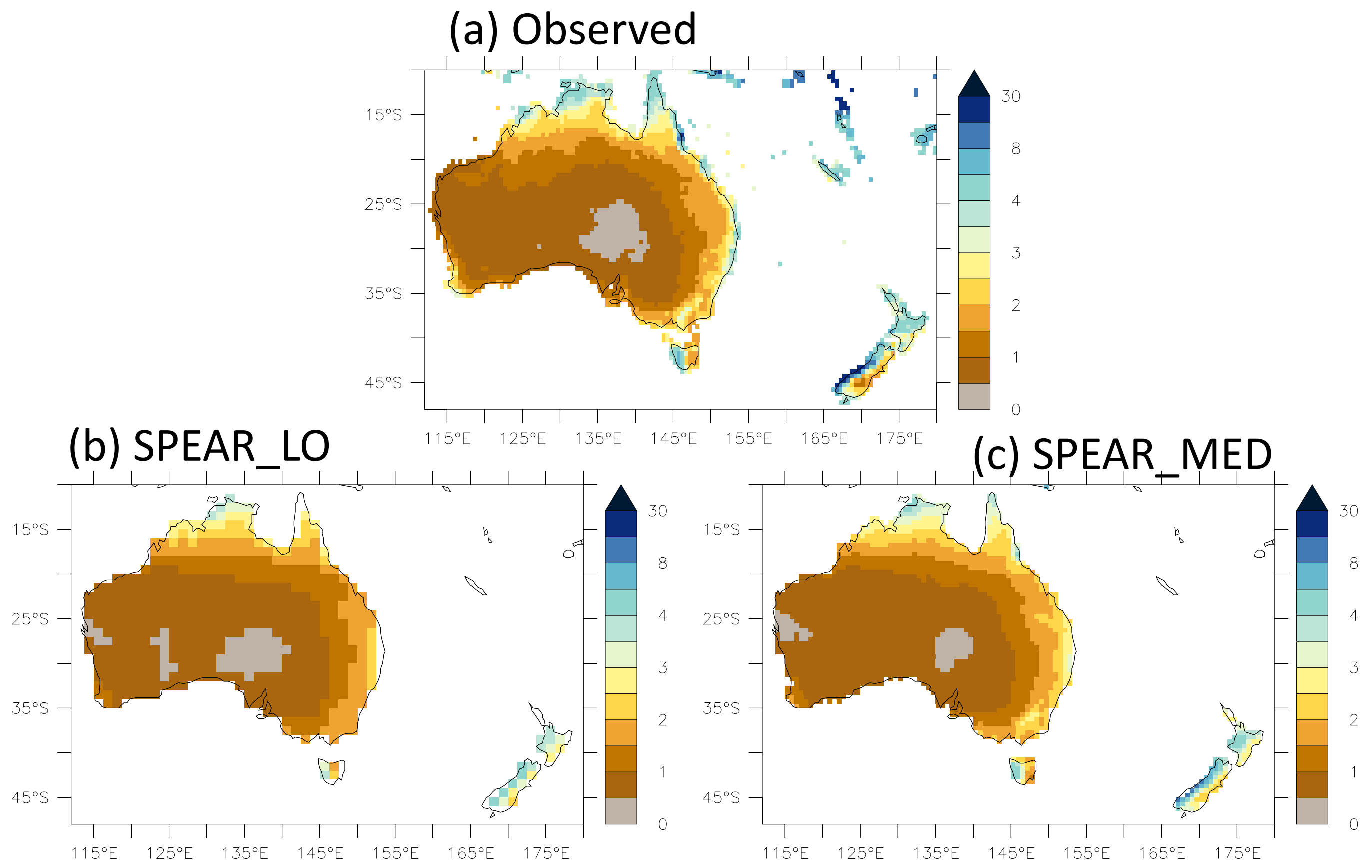

Figure S5: Time mean, annual mean precipitation (units are mm day^{-1}). (a) Observations from the Global Precipitation Climatology Centre (GPCC, Schneider et al., 2017), calculated as the mean from 1981-2010. (b) Results from SPEAR_LO (c) Results from SPEAR_MED.

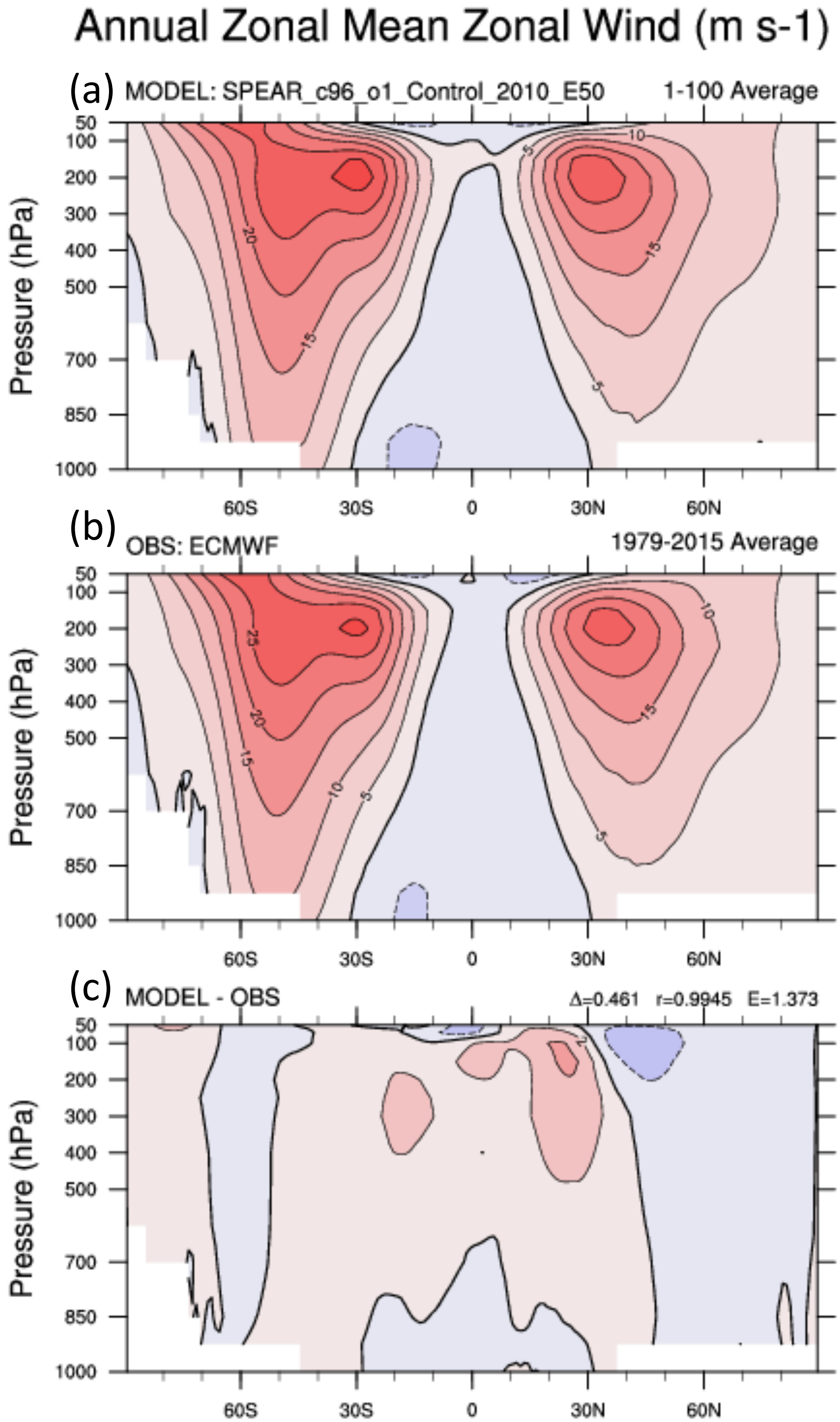

Figure S6 (a) Zonal mean zonal wind from years 1-100 of the SPEAR_LO 2010 Control simulation. Units are m s^{-1}. (b) Zonal mean zonal wind from ECMWF-Interim reanalysis (Dee et al, 2011), averaged over 1979-2015. (c) Zonal mean wind bias, calculated as zonal mean wind in SPEAR_LO minus zonal mean wind in reanalysis.

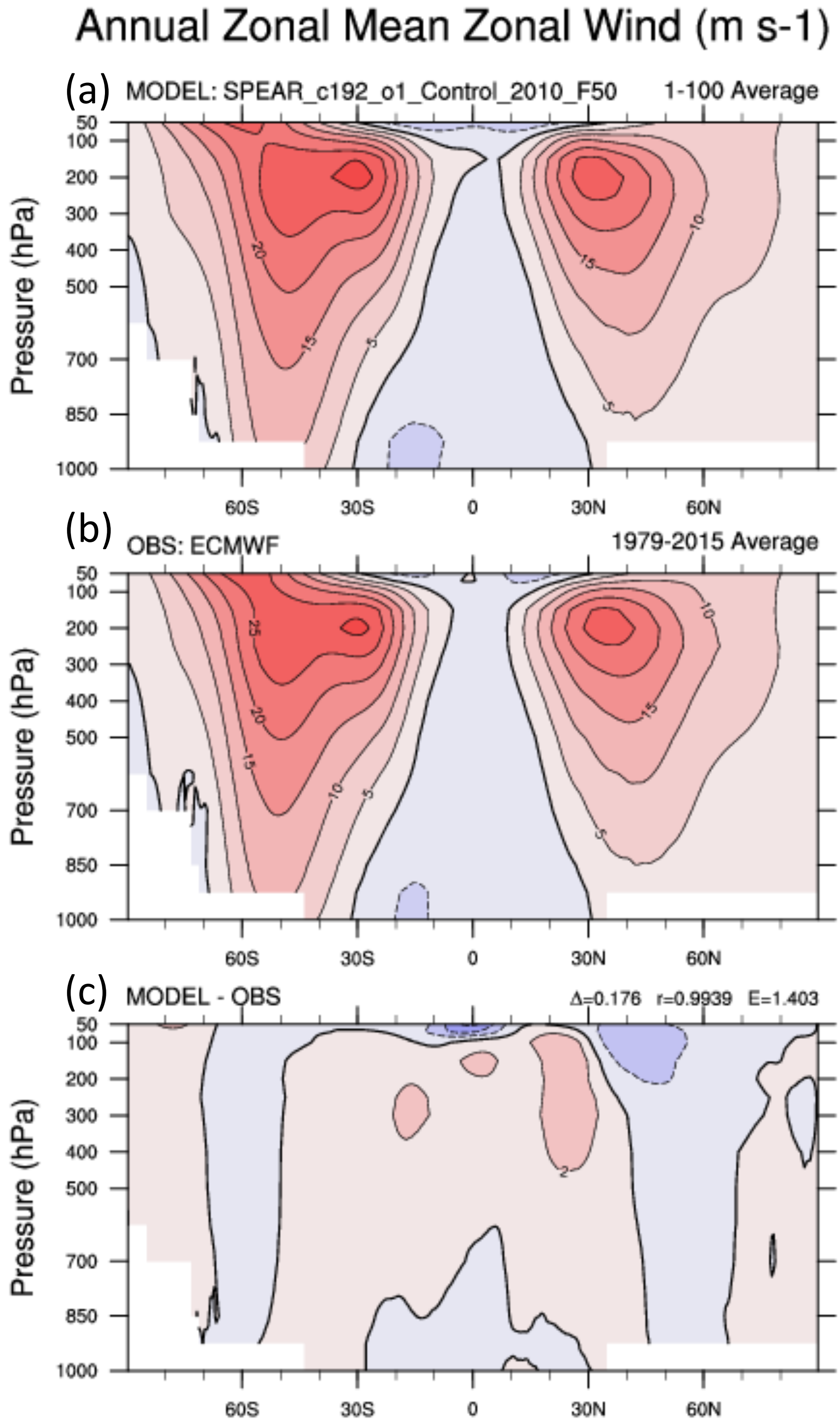

Figure S7 (a) Zonal mean zonal wind from years 1-100 of the SPEAR_MED 2010 Control simulation. Units are m s^{-1}. (b) Zonal mean zonal wind from ECMWF-Interim reanalysis (Dee et al, 2011), averaged over 1979-2015. (c) Zonal mean wind bias, calculated as zonal mean wind in SPEAR_MED minus zonal mean wind in reanalysis.

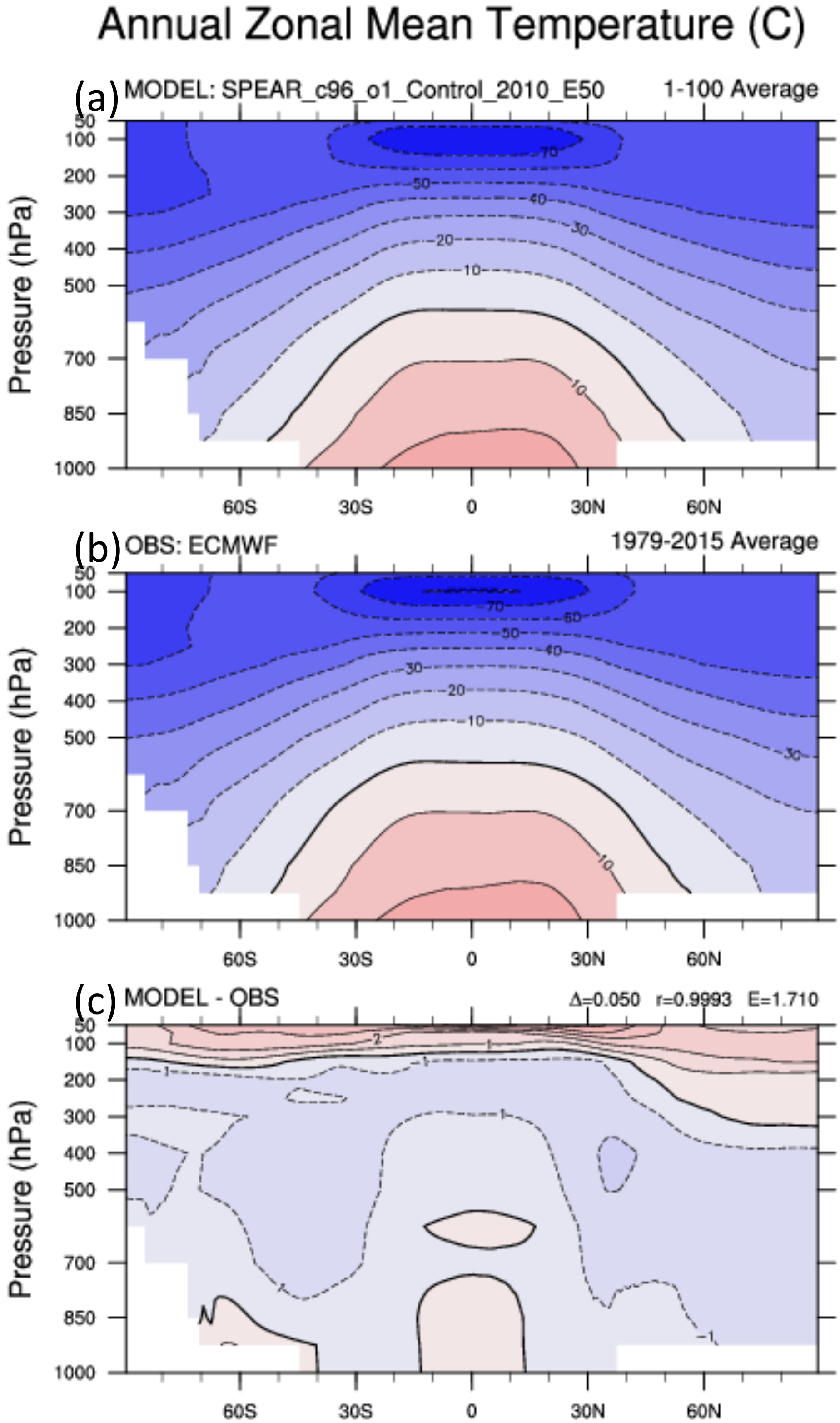

Figure S8 (a) Zonal mean temperature from years 1-100 of the SPEAR_LO 2010 Control simulation. Units are ^{o}C. (b) Zonal mean temperature from ECMWF-Interim reanalysis (Dee et al, 2011), averaged over 1979-2015. (c) Zonal mean temperature bias, calculated as zonal mean temperature in SPEAR_LO minus zonal mean temperature in reanalysis.

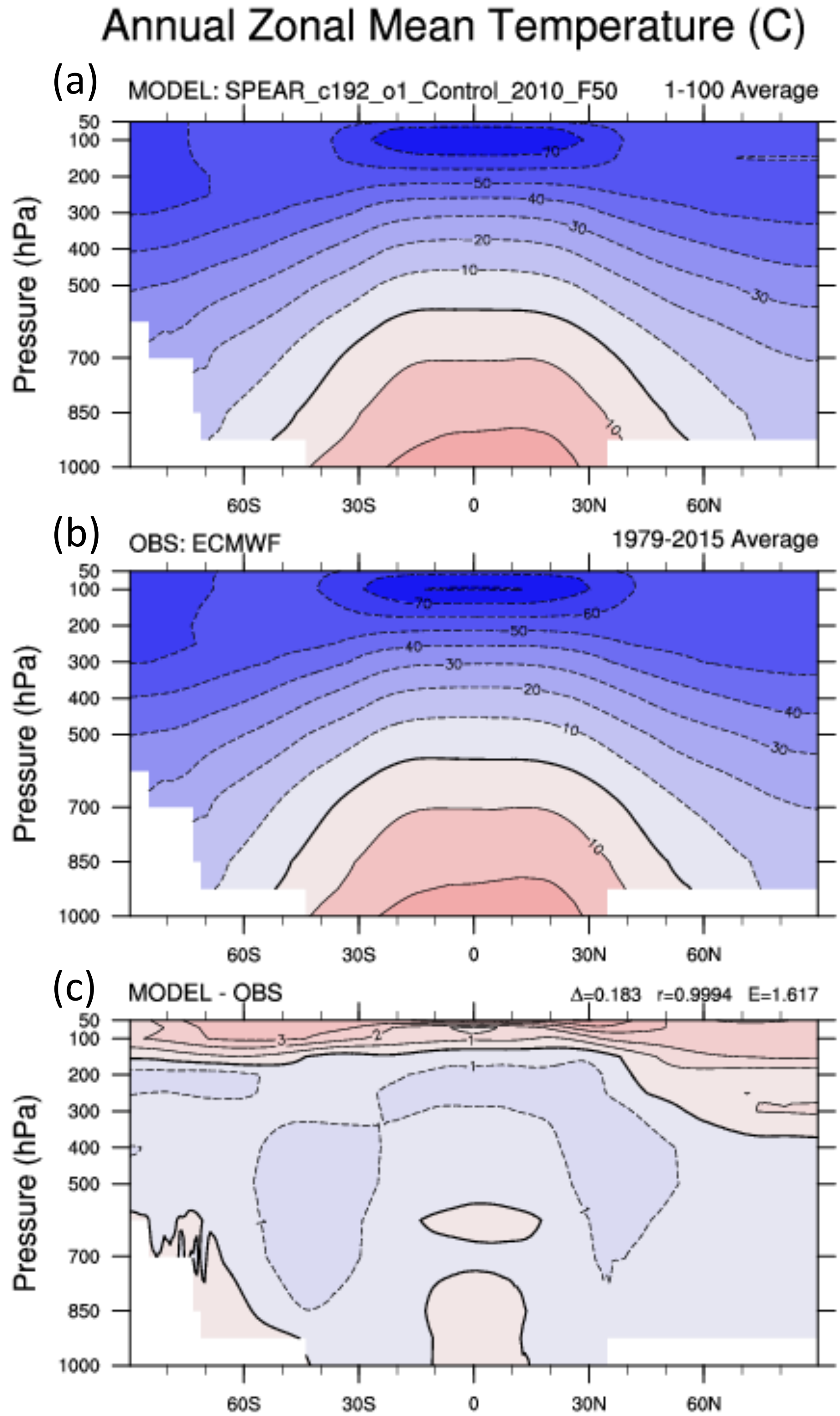

Figure S9 (a) Zonal mean temperature from years 1-100 of the SPEAR_MED 2010 Control simulation. Units are °C. (b) Zonal mean temperature from ECMWF-Interim reanalysis (Dee et al, 2011), averaged over 1979-2015. (c) Zonal mean temperature bias, calculated as zonal mean temperature in SPEAR_MED minus zonal mean temperature in reanalysis.

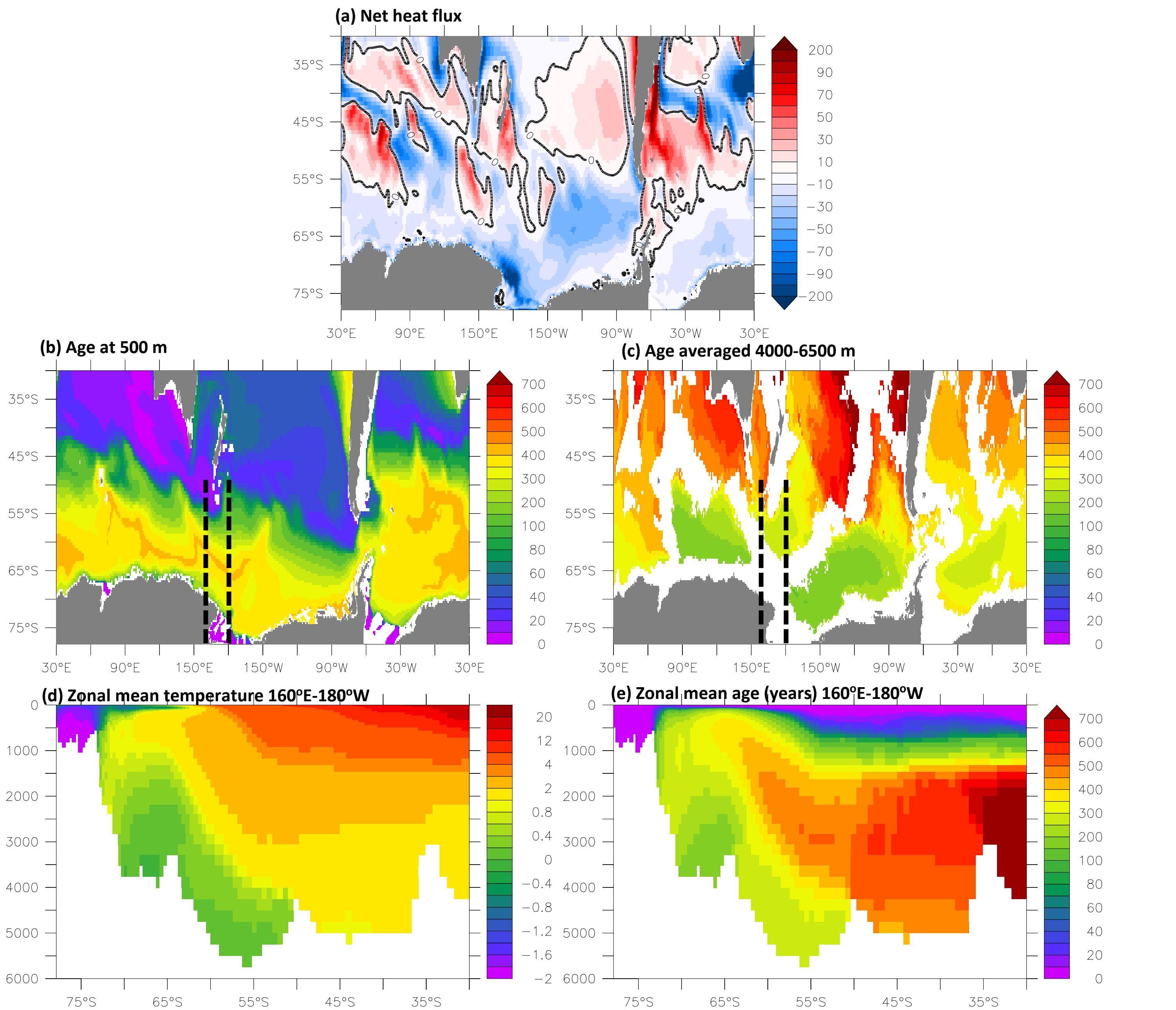

Figure S10 Illustration of dense water formation down the Antarctic continental slope. All fields plotted from time-mean over years 901-100 of the 1850 control simulation for SPEAR_LO. (a) Time mean ocean-atmosphere heat flux; negative values mean flux from ocean to atmosphere. Note the large ocean to atmosphere heat flux around 160°E off the Antarctic cost. Units are W m^{-2}. (b) Age at 500 m, units are years, and (c) age averaged over 4000-6500m. At 500 m, note the young water on the continental shelf , especially around 160°E, and the much older water offshore. (d) Zonal mean (160°E-180°W) for temperature. Note the cold (dense) plume descending from the shelf waters down the slope into the deep ocean. (e) Zonal mean age, indicating that the cold water descending the slope has relatively young age values, demonstrating the penetration of younger waters into the deep Southern Ocean via descent along the continental slope.

REFERENCES

Dee, D.P., Uppala, D. P. Dee, S. M. Uppala, A. J. Simmons, P. Berrisford, P. Poli, S. Kobayashi, et al., 2011: The ERA-Interim reanalysis: configuration and performance of the data assimilation system. Quarterly Journal of the Royal Meteorological Society, 37, 553-597. https://doi.org/10.1002/qj.828

Schneider et al (2017): Evaluating the Hydrological Cycle over Land Using the Newly-Corrected Precipitation Climatology from the Global Precipitation Climatology Centre (GPCC). Atmosphere 8(3), 52; doi:10.3390/atmos8030052

Acknowledgements

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