Supporting Information for "The GFDL Global Atmosphere and Land Model AM4.0/LM4.0 – Part I: Simulation Characteristics with Prescribed SSTs"

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S1 AM4.0 vertical levels

Table S1. Coefficients p_k and b_k for computing model interface pressures using $p = p_k + b_k * p_s$, where p is pressure and p_s is surface pressure. Pressures and heights of interface levels corresponding to a scale height of 7.5 km and p_s=1013.25 hPa are also shown.

k	p_k (Pa)	b_k	$p = p_k + b_k * p_s$ (hPa)	z (km)
1	100	0	1.00	51.91
2	400	0	4.00	41.51
3	818.6021	0	8.19	36.14
4	1378.886	0	13.79	32.23
5	2091.795	0	20.92	29.10
6	2983.641	0	29.84	26.44
7	4121.79	0	41.22	24.02
8	5579.222	0	55.79	21.75
9	6907.19	0.00513	74.30	19.60
10	7735.787	0.01969	97.30	17.57
11	8197.665	0.04299	125.5	15.66
12	8377.955	0.07477	159.5	13.87
13	8331.696	0.11508	199.9	12.17
14	8094.722	0.16408	247.2	10.58
15	7690.857	0.22198	301.8	9.083
16	7139.018	0.28865	363.9	7.681
17	6464.803	0.36281	432.3	6.389
18	5712.357	0.44112	504.1	5.236
19	4940.054	0.51882	575.1	4.248
20	4198.604	0.59185	641.7	3.426
21	3516.633	0.6581	702.0	2.753
22	2905.199	0.71694	755.5	2.202
23	2366.737	0.76843	802.3	1.751
24	1899.195	0.81293	842.7	1.382
25	1497.781	0.851	877.3	1.081
26	1156.253	0.88331	906.6	0.834
27	867.792	0.91055	931.3	0.633
28	625.5933	0.93331	951.9	0.468
29	426.2132	0.95214	969.0	0.335
30	264.7661	0.9675	983.0	0.228
31	145.0665	0.97968	994.1	0.143
32	60	0.98908	1002.8	0.078
33	15	0.99575	1009.1	0.031
34	0	1	1013.2	0

S2 TOA SW radiation for individual seasons

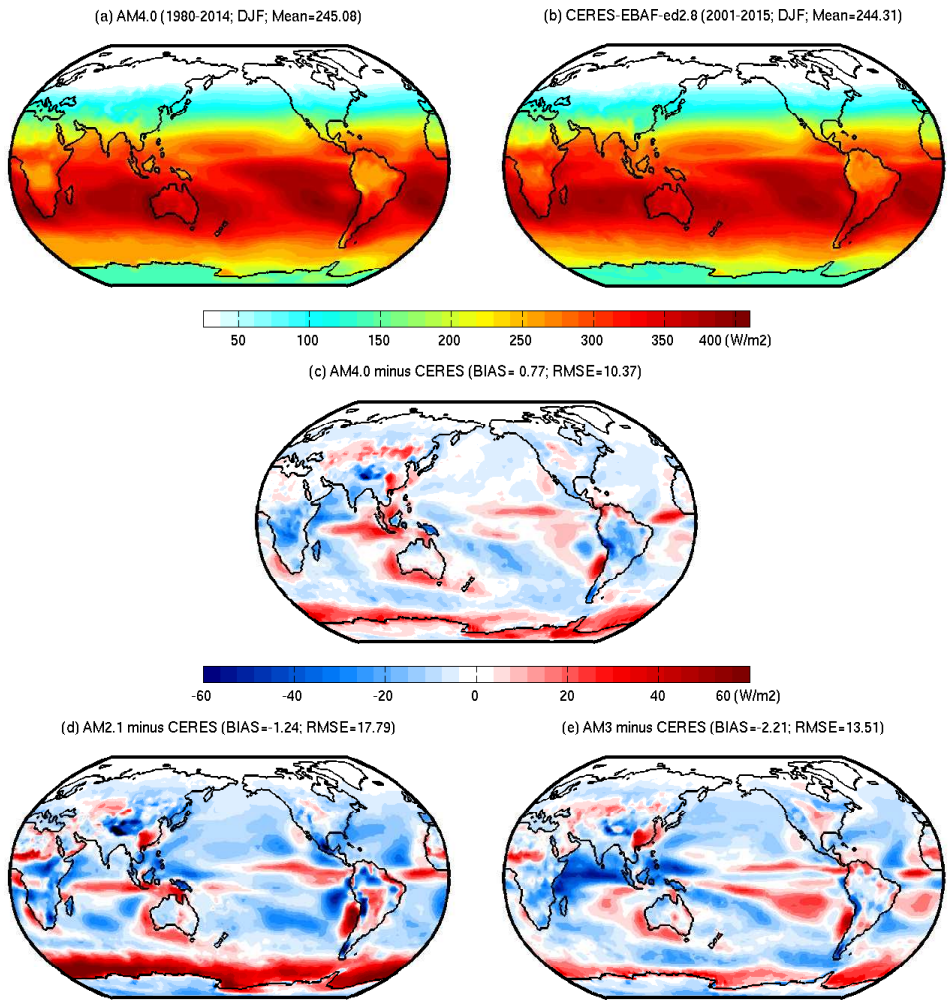


Figure S1. Long-term DJF seasonal mean TOA net SW downward (absorption) radiative flux in $\mathrm{W\,m^{-2}}$ from (a) AM4.0 AMIP simulation, (b) observational estimate based on CERES-EBAF-ed2.8, averaged for the 2001-2015 period. (c) shows model biases (AM4.0 minus CERES). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Titles of panels (a-b) show global mean values. Titles of panels (c-e) show global mean biases and RMS errors.

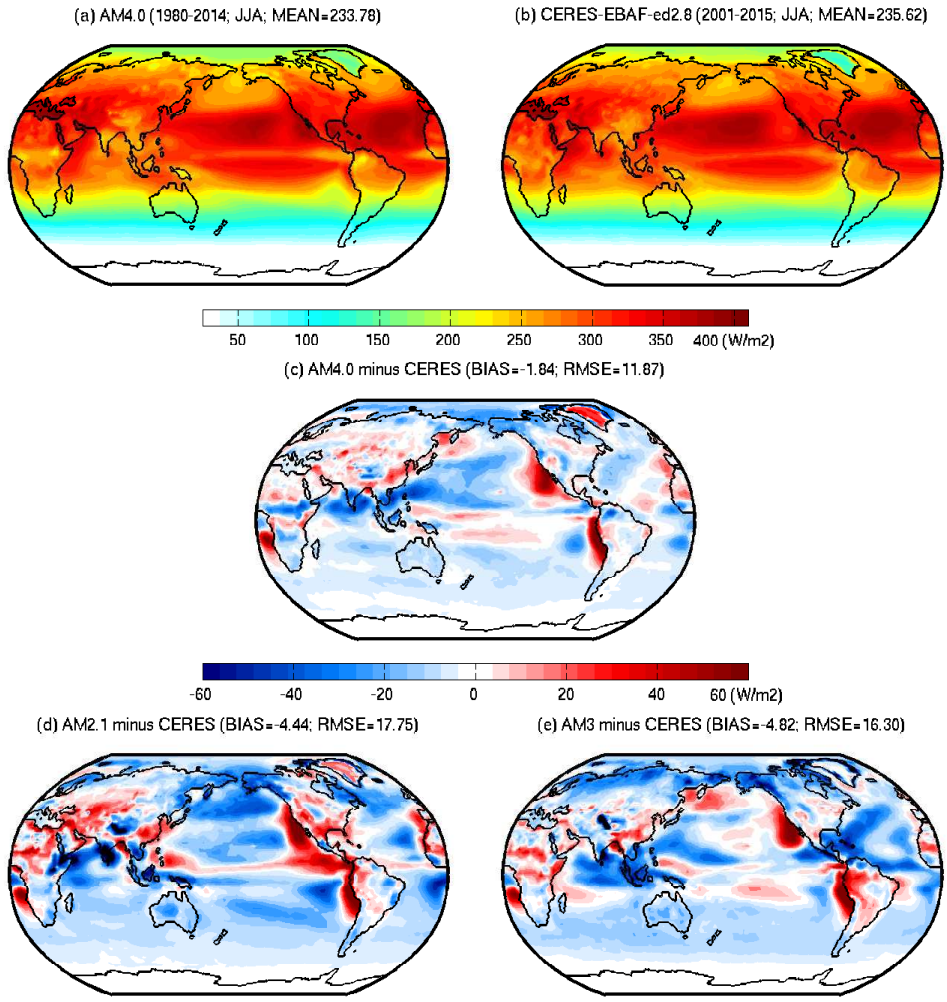
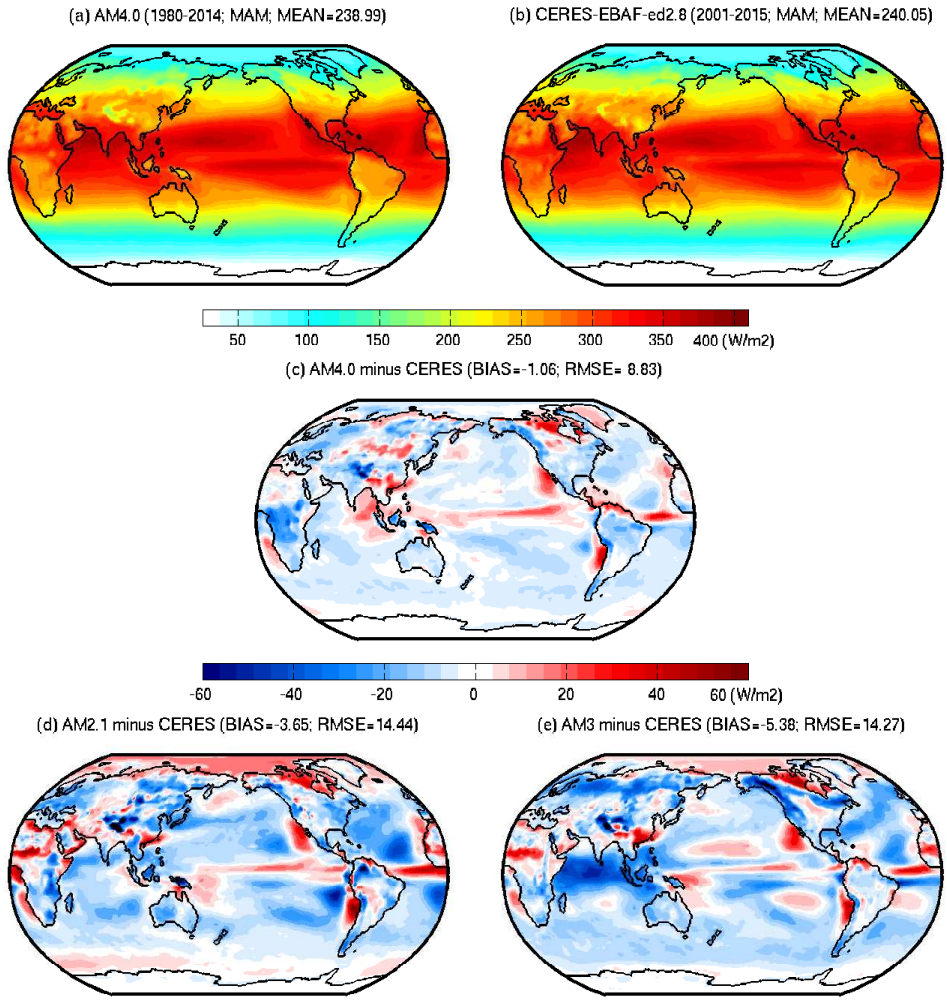


Figure S2. As in Fig. S1 except for the JJA season.



32 **Figure S3.** As in Fig. S1 except for the MAM season.

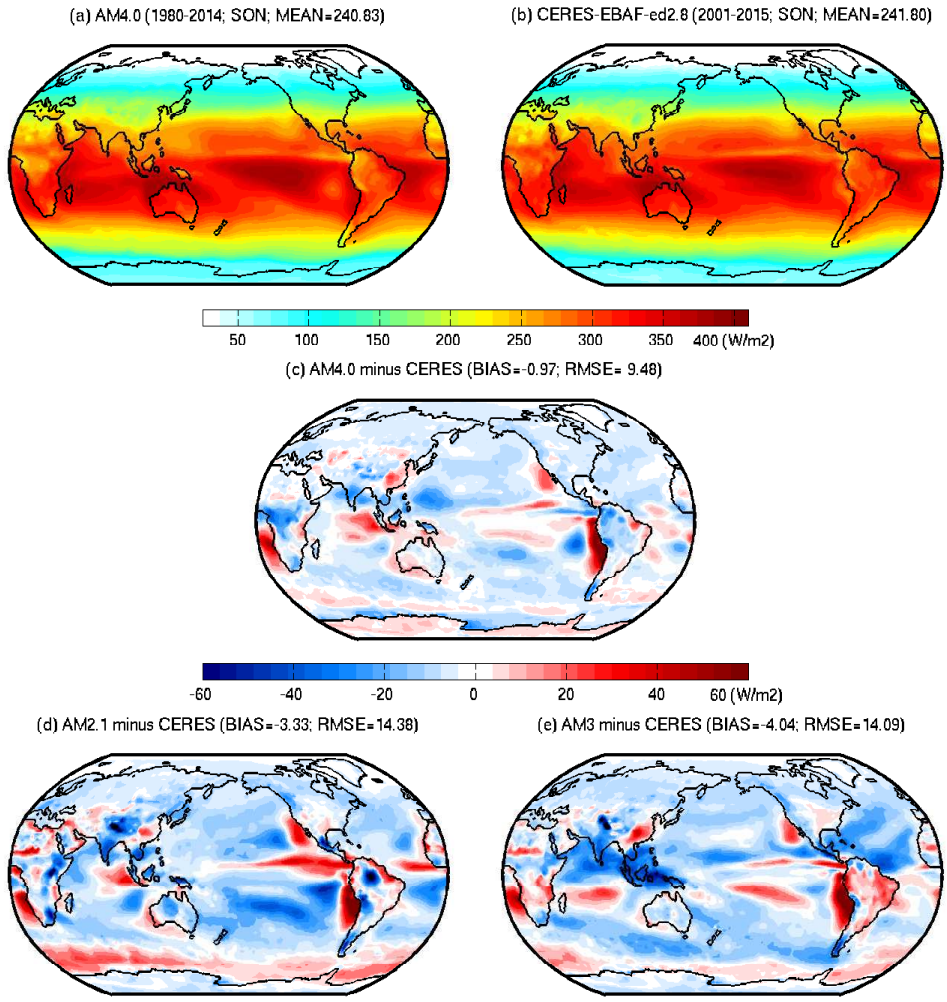


Figure S4. As in Fig. S1 except for the SON season.

S3 TOA LW radiation for individual seasons

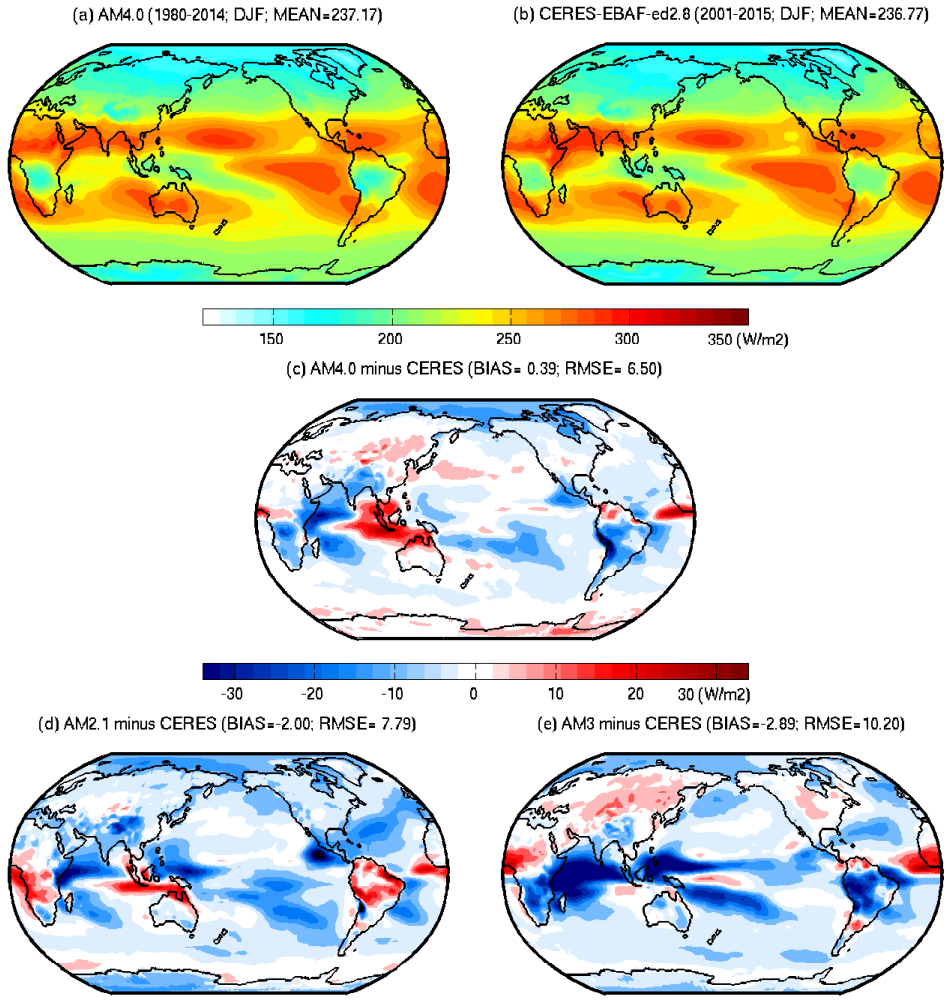
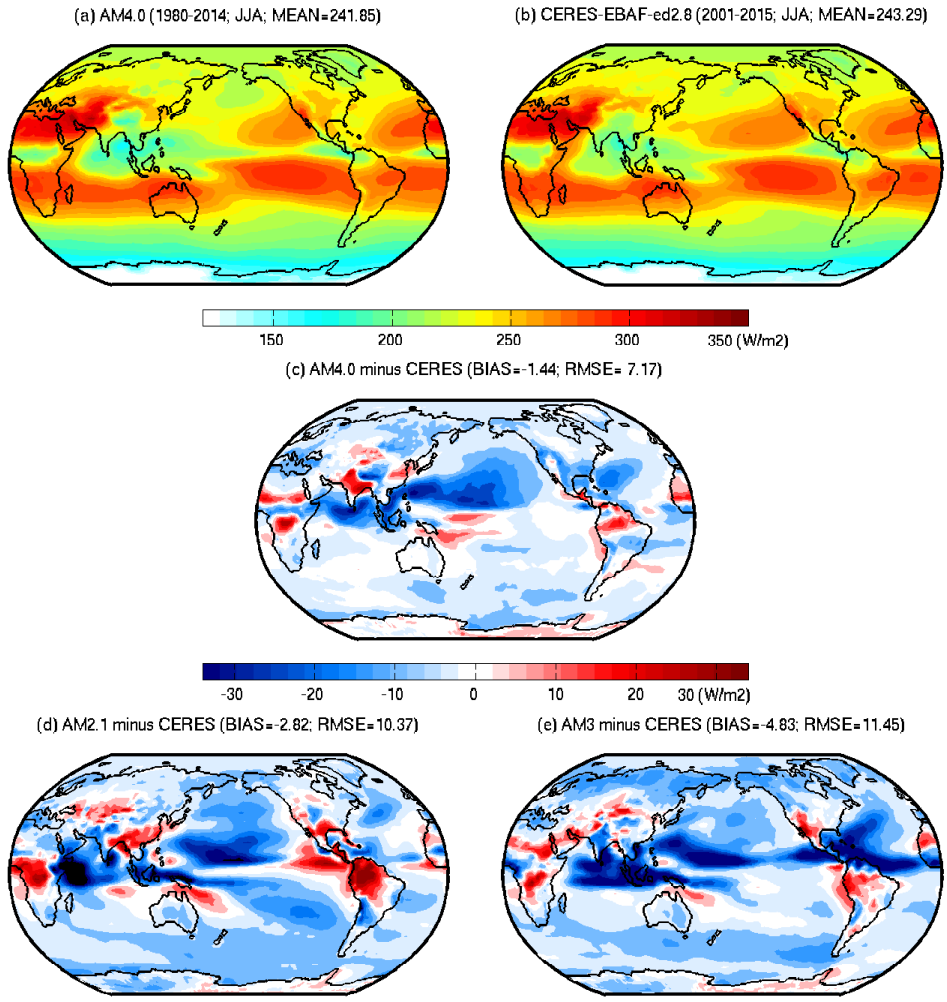
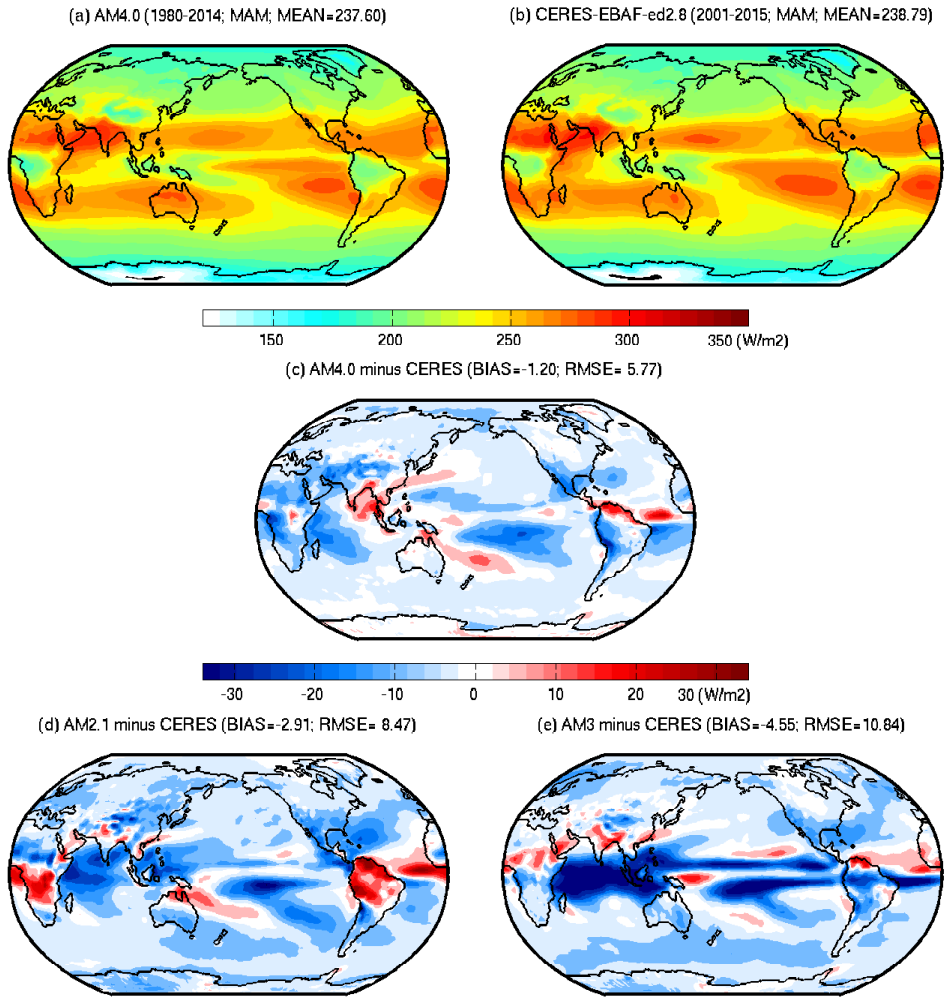


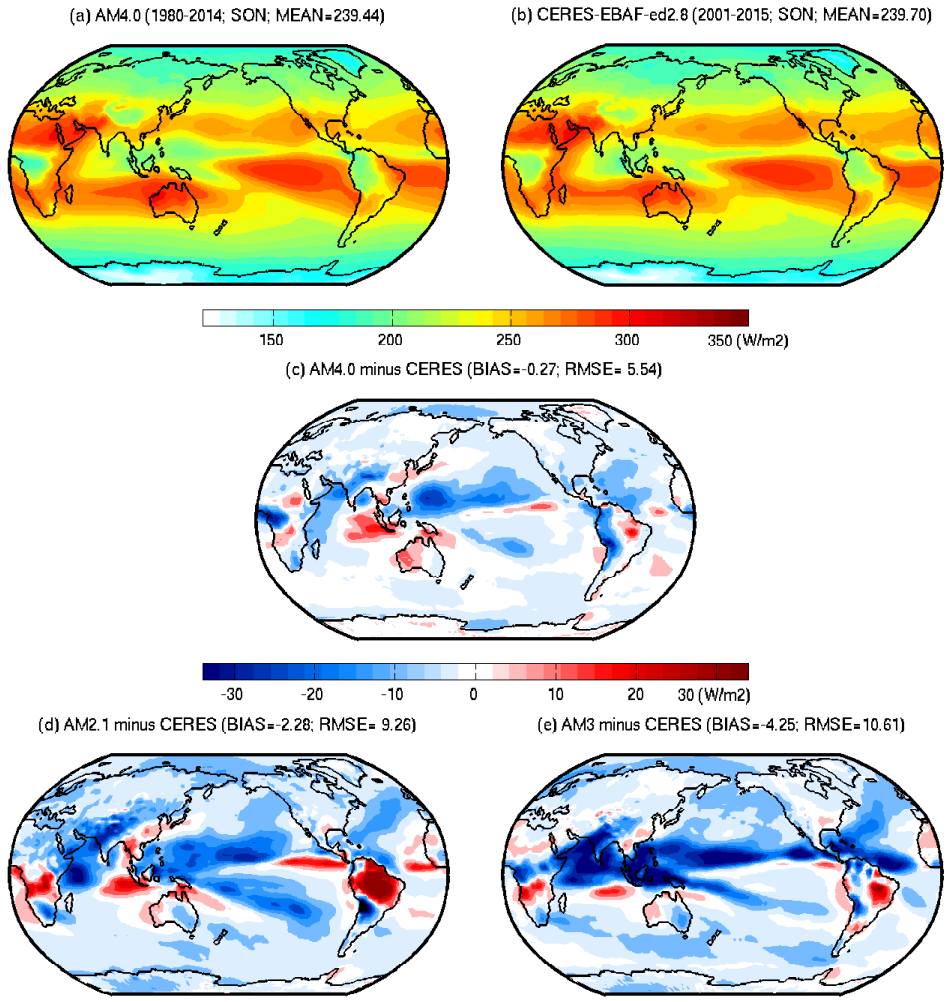
Figure S5. Long-term DJF seasonal mean OLR in $\mathrm{W\,m^{-2}}$ from (a) AM4.0/LM4.0 AMIP simulation, (b) observational estimate based on CERES-EBAF-ed2.8, averaged over the 2001-2015 period. (c) shows model biases (AM4.0/LM4.0 minus CERES). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Legends of panels (a-b) show global mean and spatial standard deviation. Legends of panels (c-e) show global mean biases, spatial correlations and RMS errors.



41 **Figure S6.** As in Fig. S5 except for the JJA season.



42 **Figure S7.** As in Fig. S5 except for the MAM season.



43 **Figure S8.** As in Fig. S5 except for the SON season.

S4 DJF and JJA seasonal mean precipitation

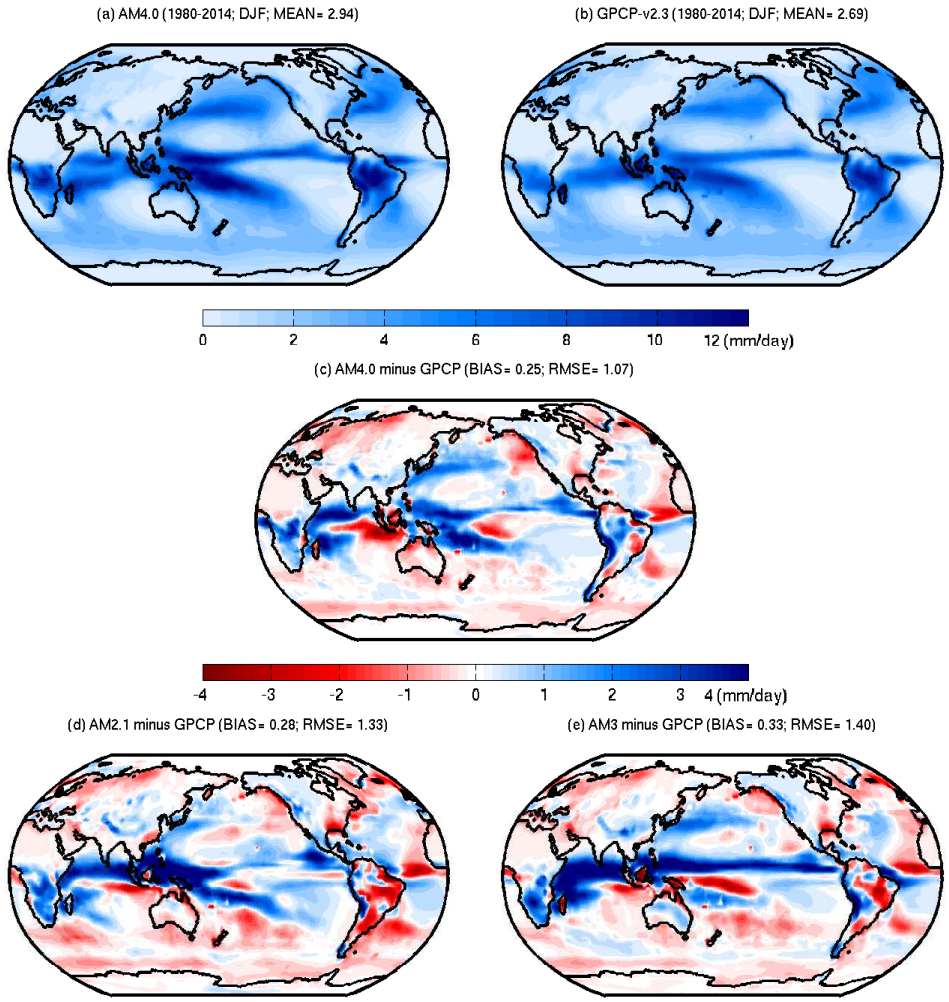


Figure S9. Long-term DJF seasonal mean precipitation in mm day^{-1} from (a) AM4.0 AMIP simulation, (b) observational estimate based on GPCPv2.3, averaged over the 1980-2014 period. (c) shows model biases (AM4.0 minus GPCPv2.3). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Titles of panels (a-b) include global mean values. Titles in panels (c-e) include global mean biases and RMS errors.

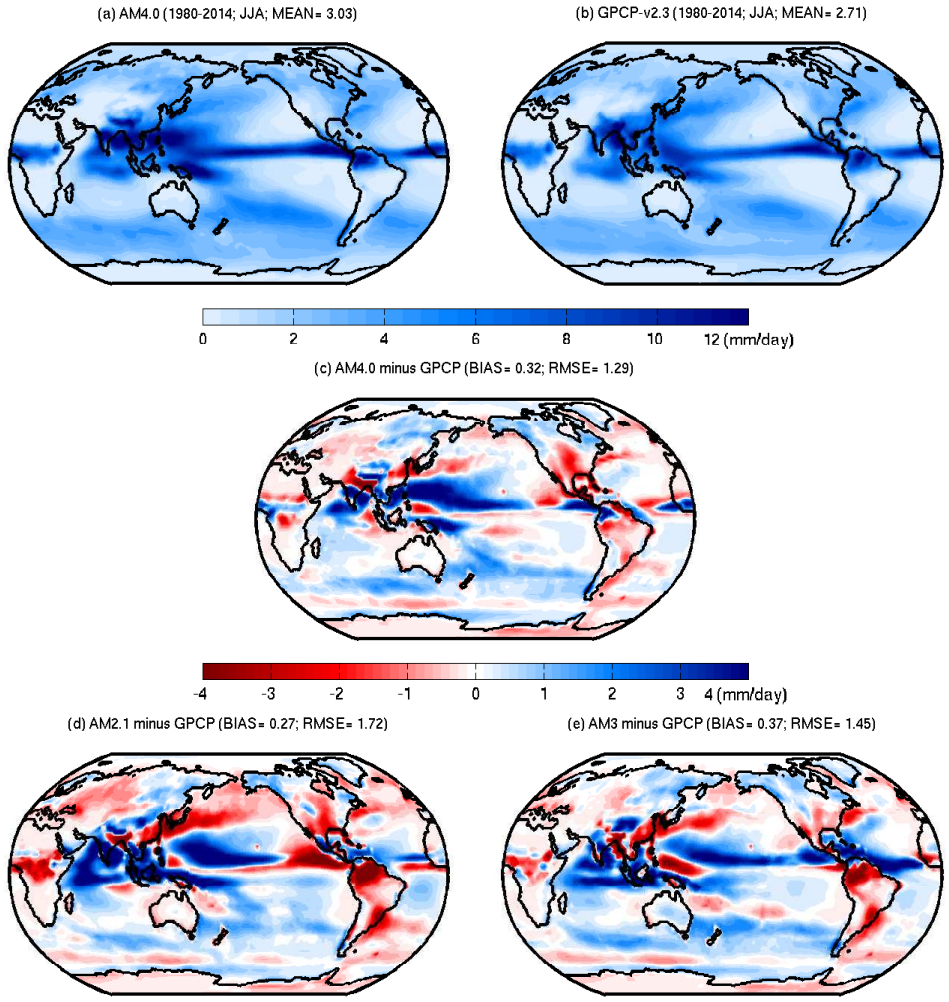


Figure S10. As in Fig. S9 except for JJA season.

S5 Annual mean surface air temperature

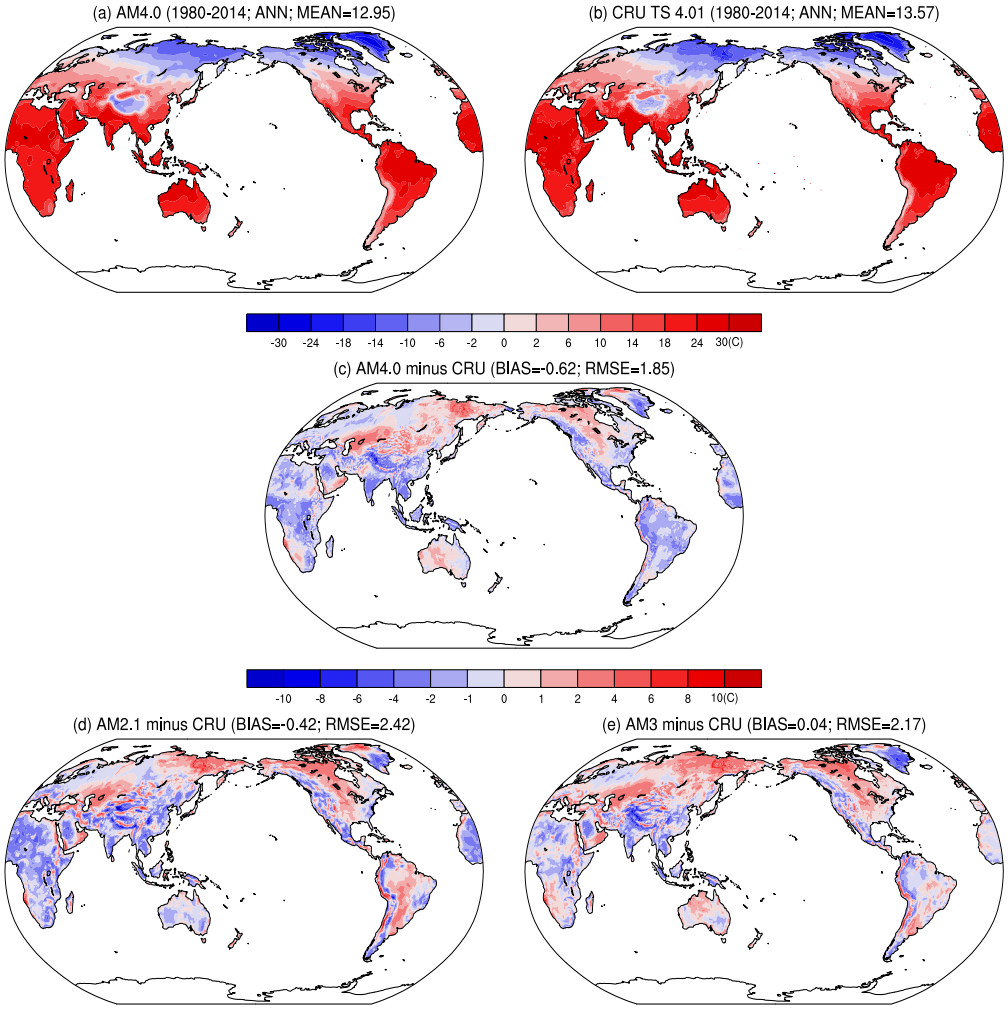


Figure S11. Long-term annual mean 2-m temperature (°C) over land from (a) AM4.0 AMIP simulation, (b) observational estimate based on CRU TS version 4.01, averaged over the 1980-2014 period. (c) shows model biases (AM4.0 minus CRU). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Titles of panels (a-b) show the global mean values over land. Titles of panels (c-e) show global mean biases and RMS errors.

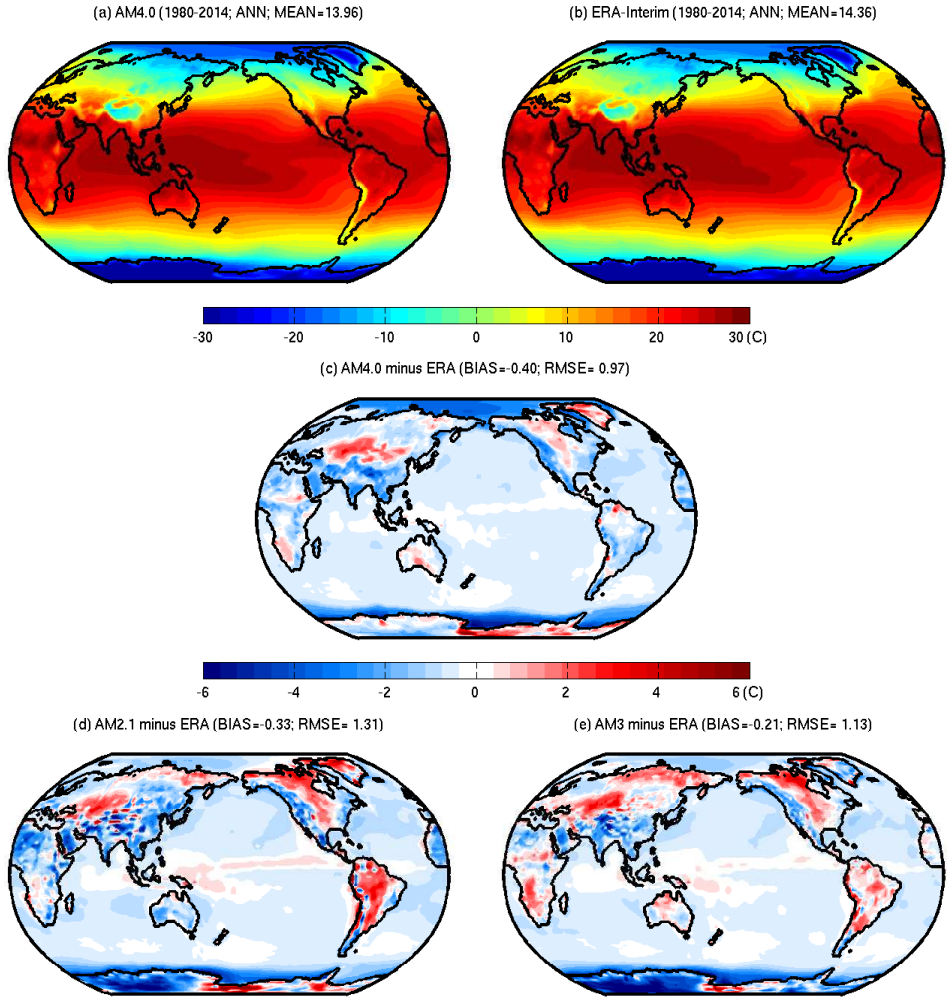


Figure S12. As in Fig. S11 except for surface air temperature compared to the ERA-interim climatology (1980-2014).

S6 Annual mean zonal mean temperature

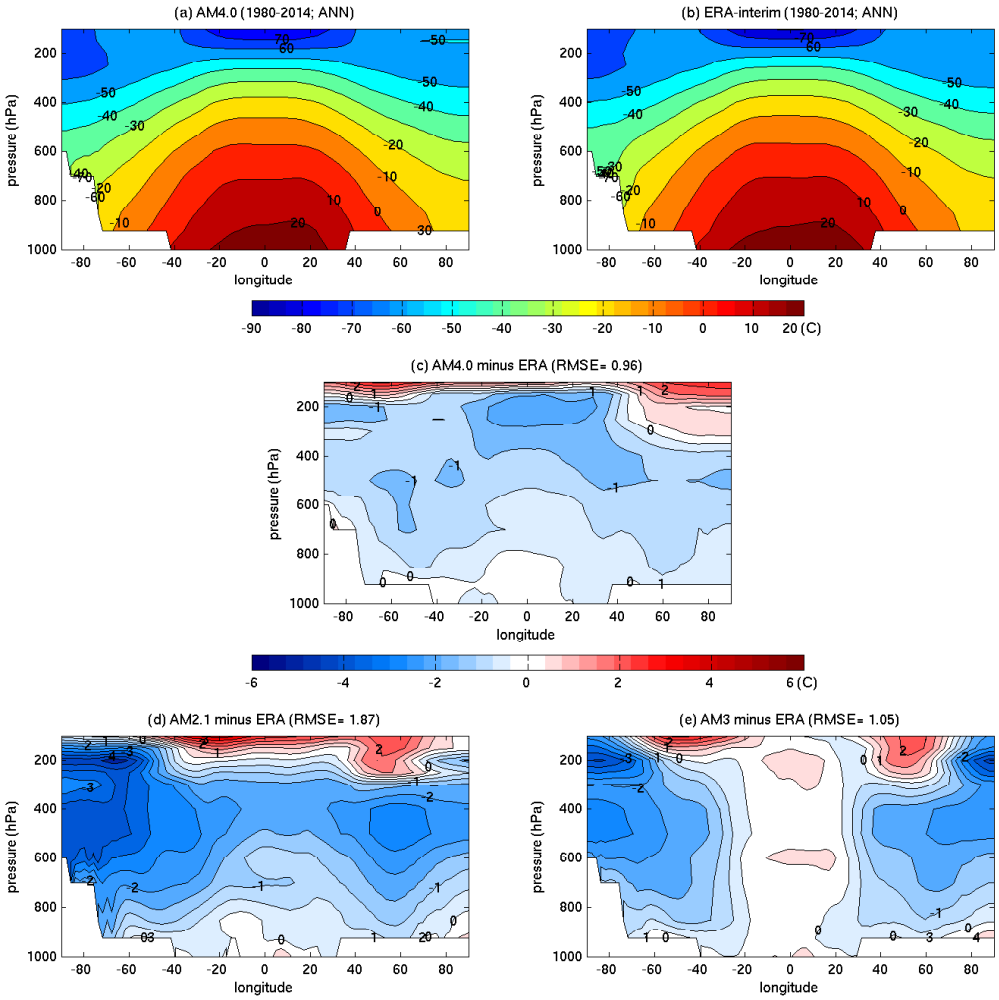


Figure S13. Long-term annual mean zonal mean troposphere temperature in Celsius from (a) AM4.0 AMIP simulation, (b) ERA-interim (1980-2014). (c) shows model biases (AM4.0 minus ERA-interim). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Titles of panels (c-e) show mass-weighted RMS errors. Model and reanalysis data are first interpolated to standard pressure levels (1000 925 850 700 600 500 300 250 200 150 100 hPa) before taking the differences.

S7 Annual mean zonal mean zonal wind

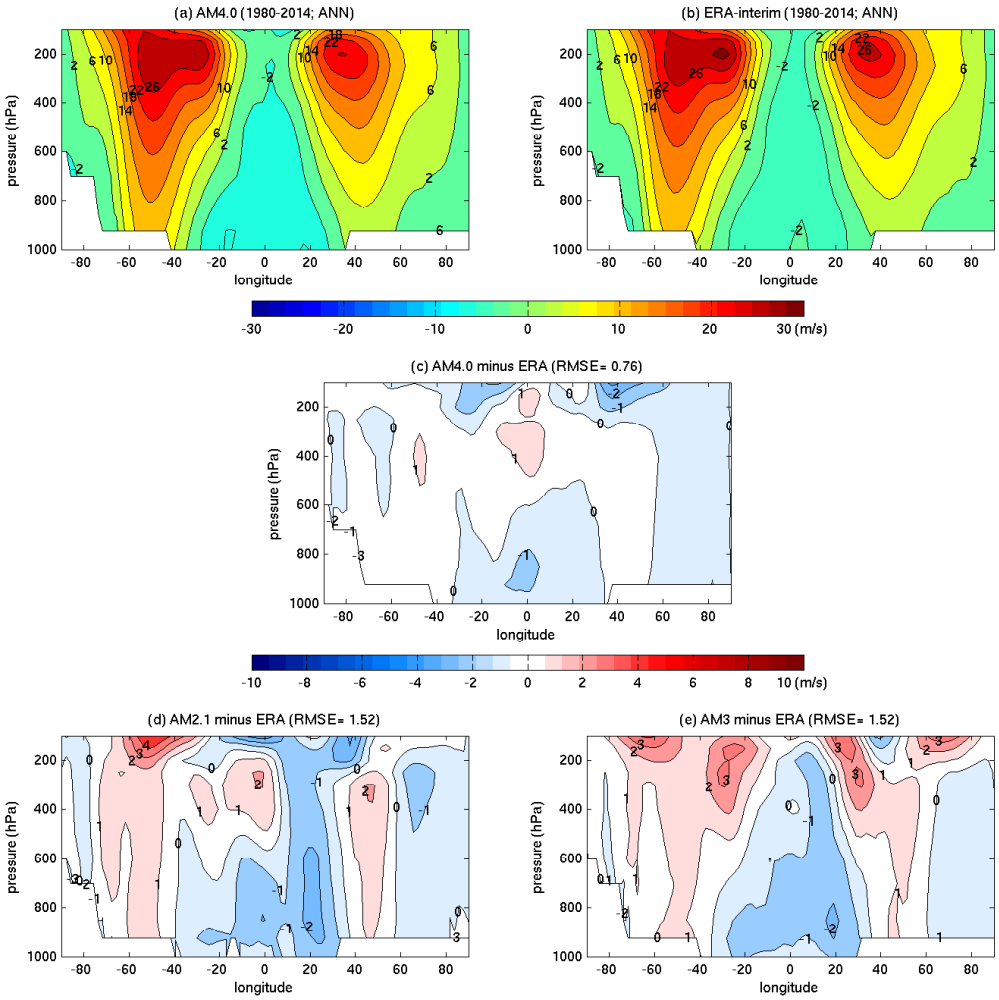


Figure S14. Long-term annual mean zonal mean zonal wind in $\mathrm{m\,s^{-1}}$ from (a) AM4.0 AMIP simulation, (b) ERA-interim (1980-2014). (c) shows model biases (AM4.0 minus ERA-interim). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. Titles of panels (c-e) show mass-weighted RMS errors. Model and reanalysis data are first interpolated to standard pressure levels (1000 925 850 700 600 500 300 250 200 150 100 hPa) before taking the differences.

S8 Stratospheric zonal mean zonal wind for individual seasons

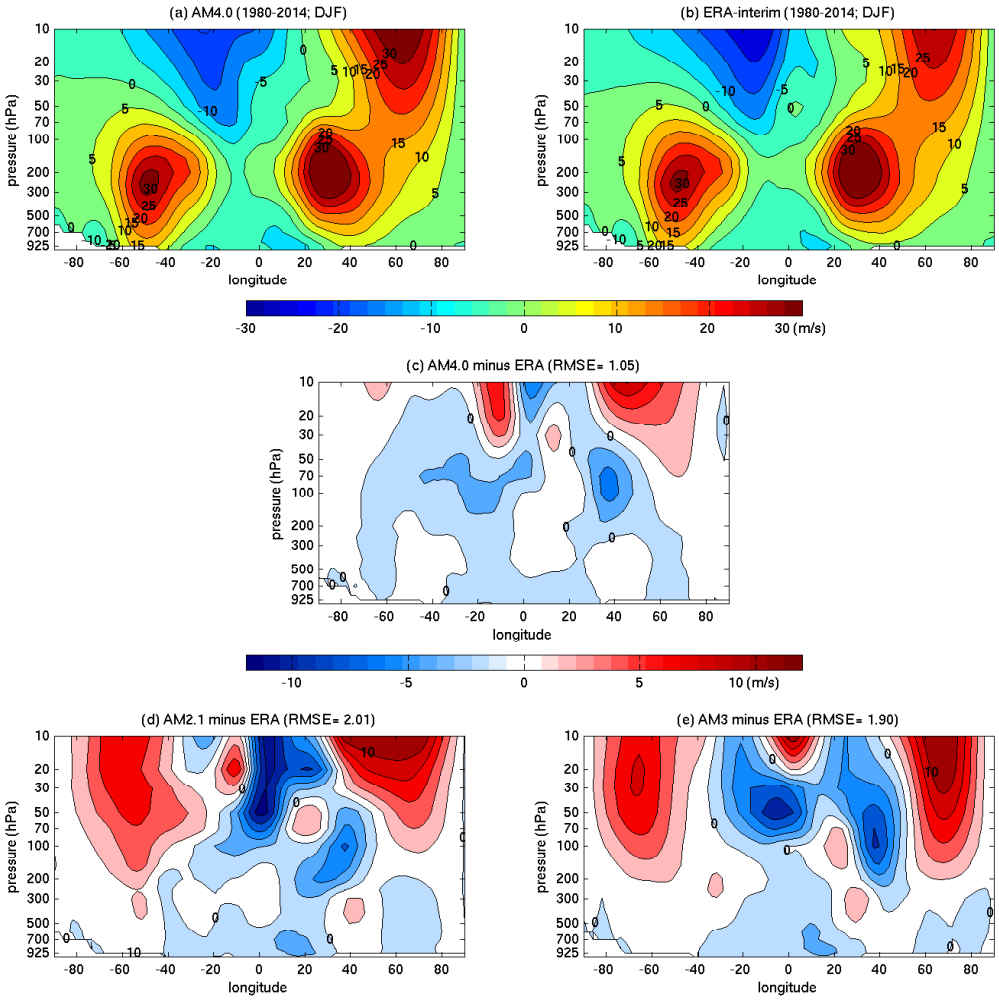


Figure S15. As in Fig. S14 except showing the DJF season stratospheric wind in log pressure coordinate.

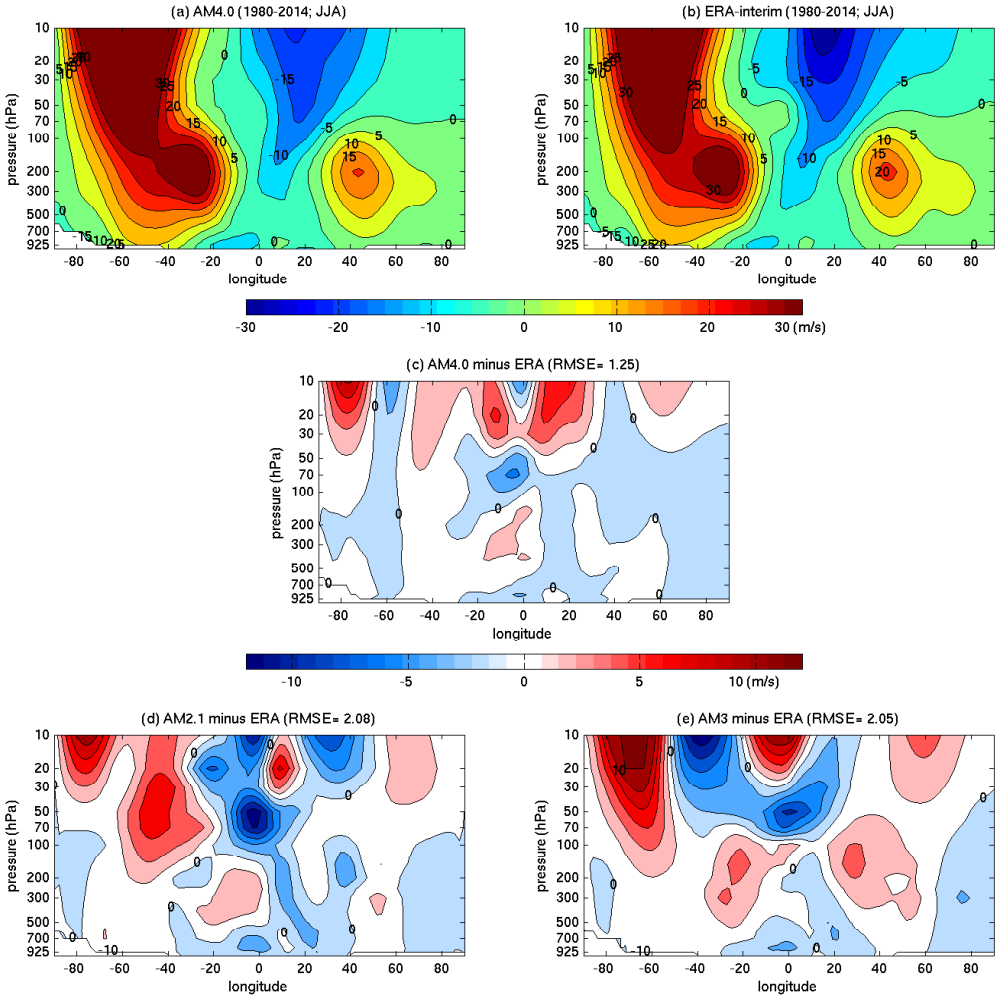


Figure S16. As in Fig. S15 except for JJA season.

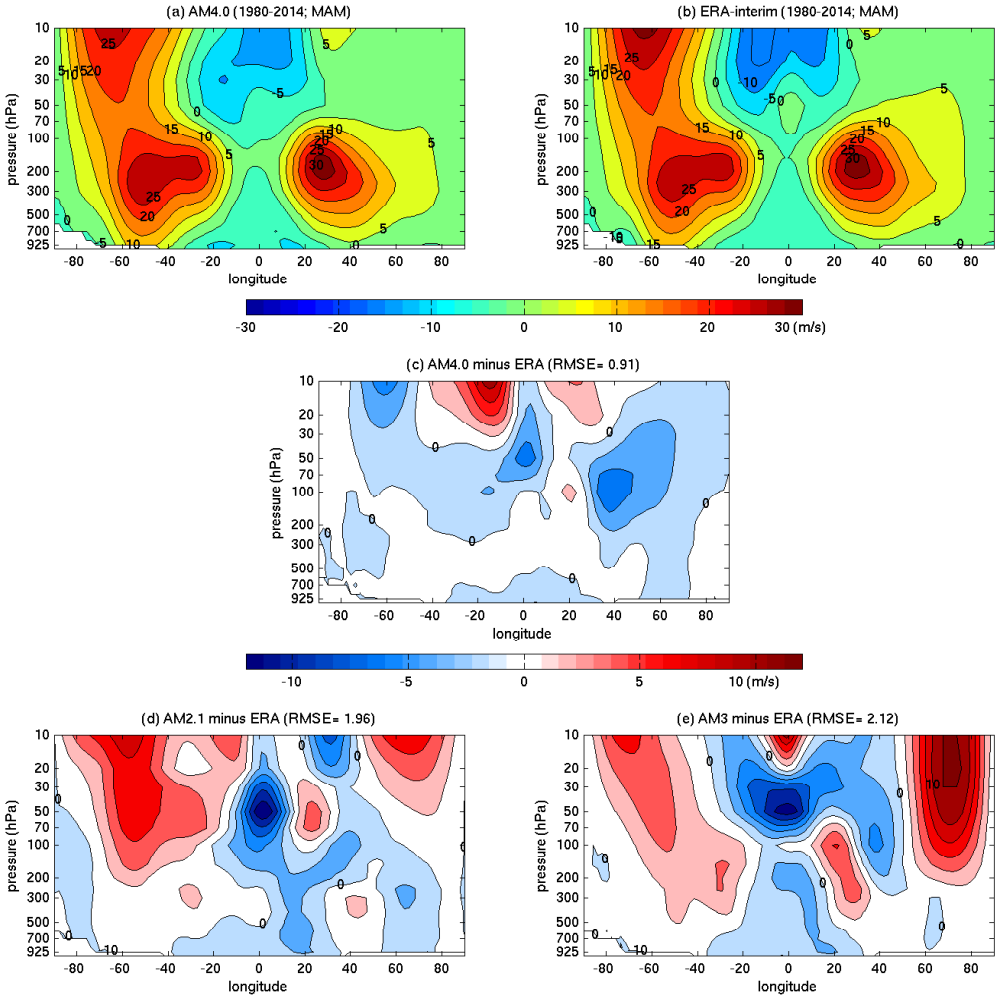


Figure S17. As in Fig. S15 except for MAM season.

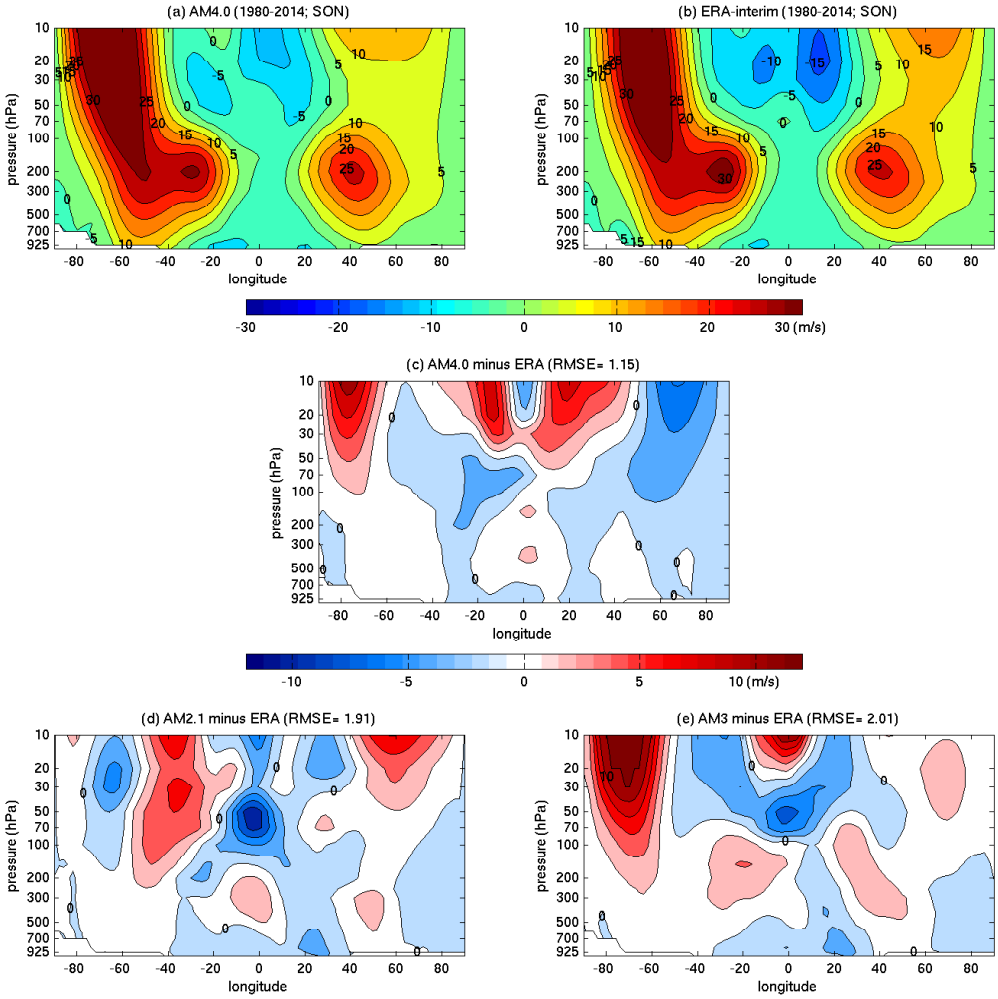


Figure S18. As in Fig. S15 except for SON season.

S9 Stratospheric zonal mean temperature for individual seasons

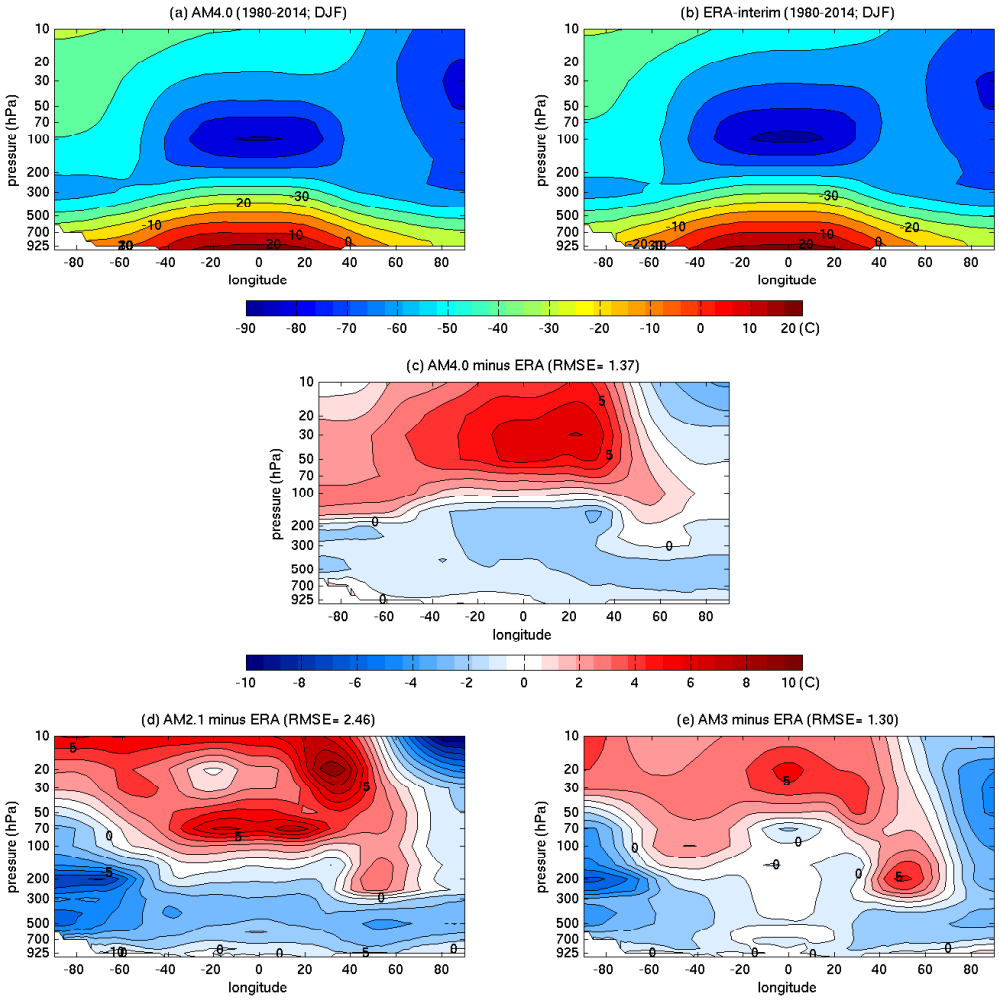


Figure S19. As in Fig. S13 except emphasizing the DJF season stratospheric temperature in log pressure coordinate.

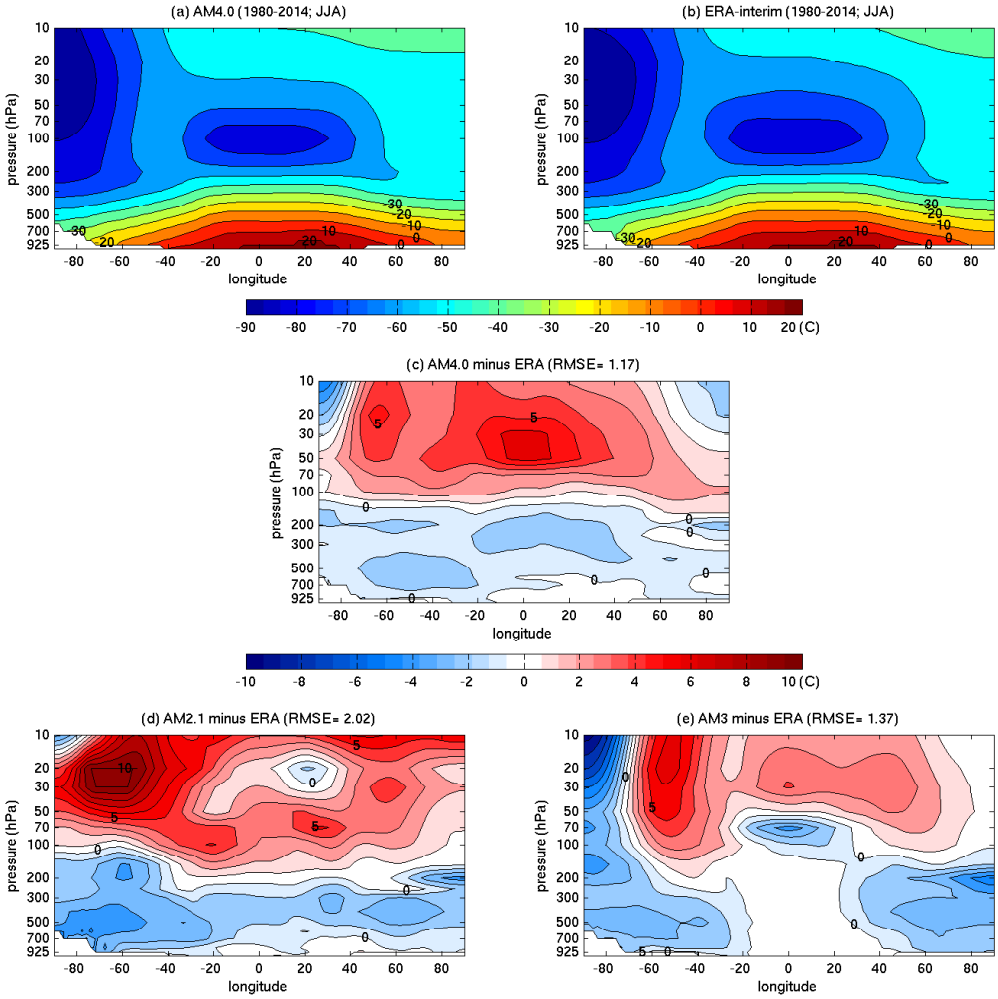


Figure S20. As in Fig. S19 except for JJA season.

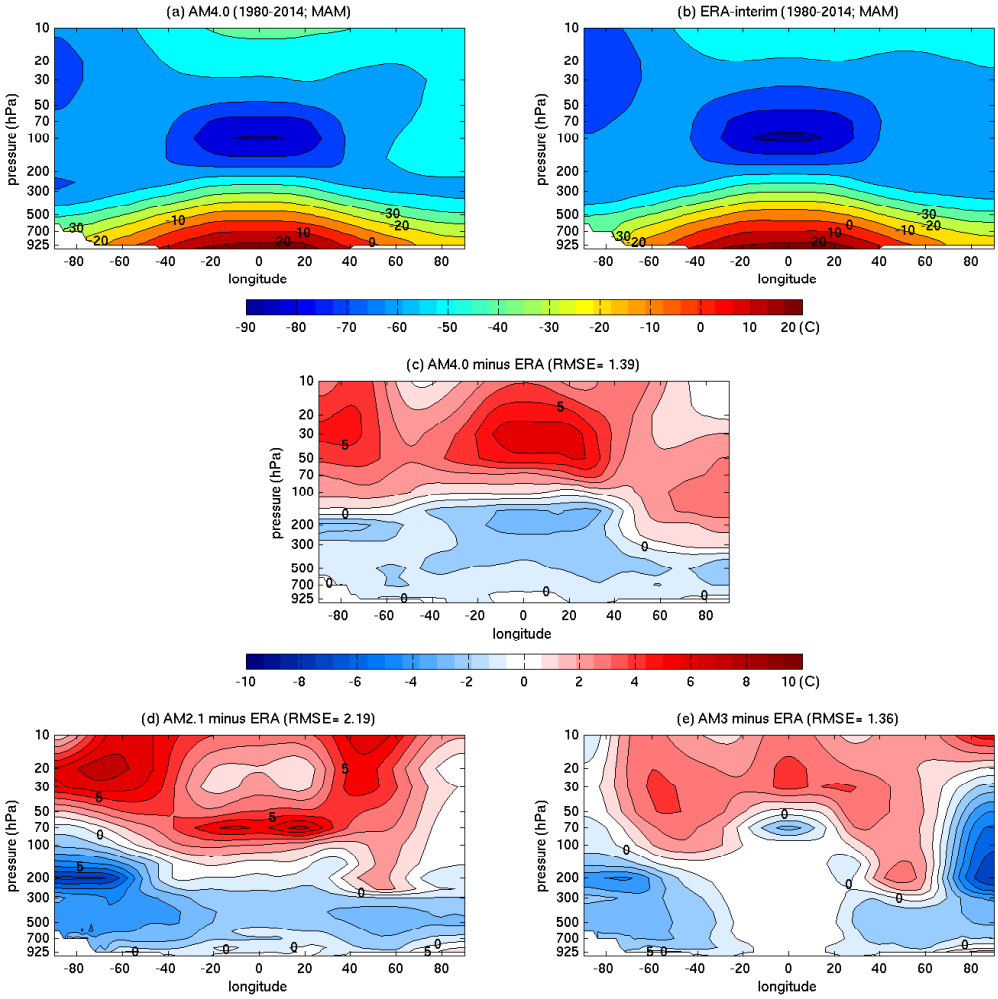


Figure S21. As in Fig. S19 except for MAM season.

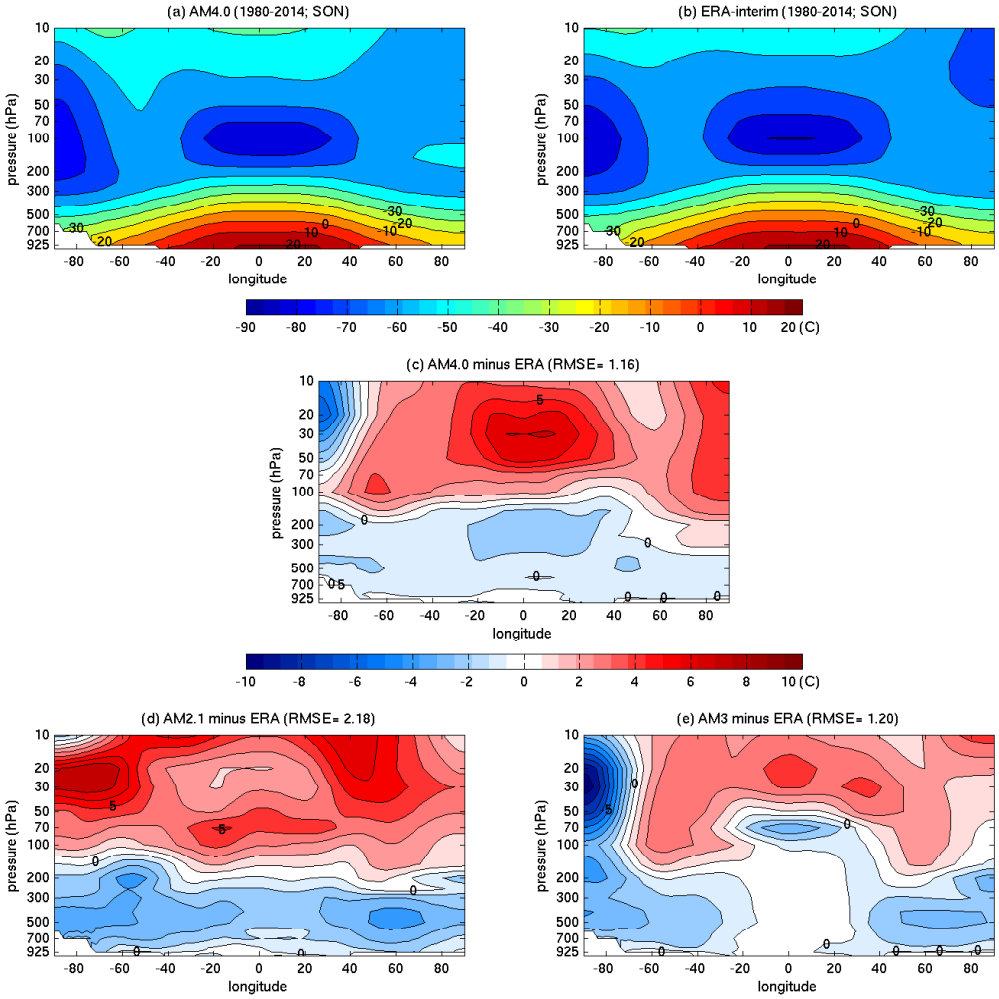


Figure S22. As in Fig. S19 except for SON season.

S10 Surface zonal mean zonal wind stress for individual seasons

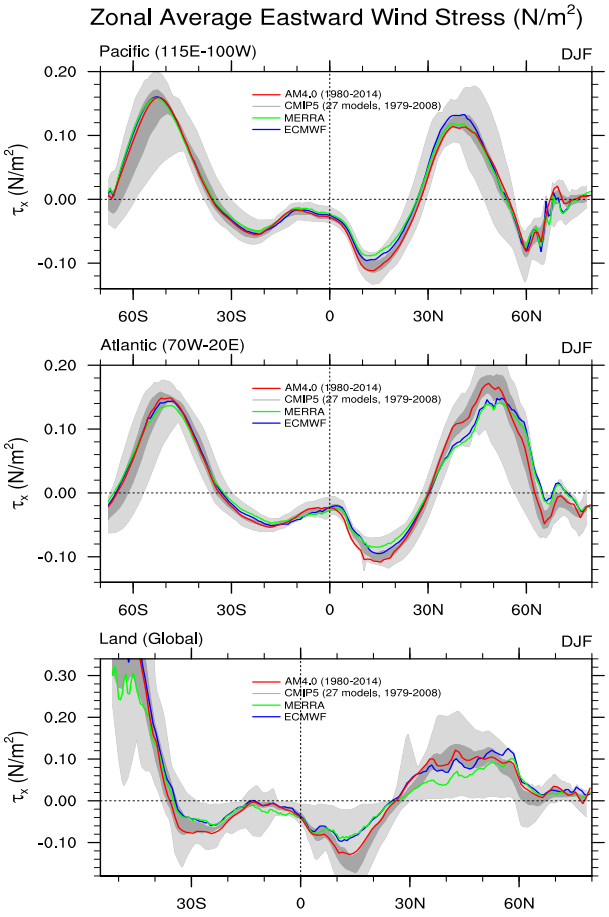


Figure S23. Comparison of DJF season zonal mean zonal wind stress over (upper) the Pacific, (middle) the Atlantic oceans, and (lower) the global land region. Colored lines show AM4.0 simulation and the observational estimates based on ERA-interim and MERRA data (see legends). The shading shows ensemble spread from 27 CMIP5 models. The full spread of the CMIP5 ensemble is in light gray and the results between the 25 and 75 percentiles are in darker gray.

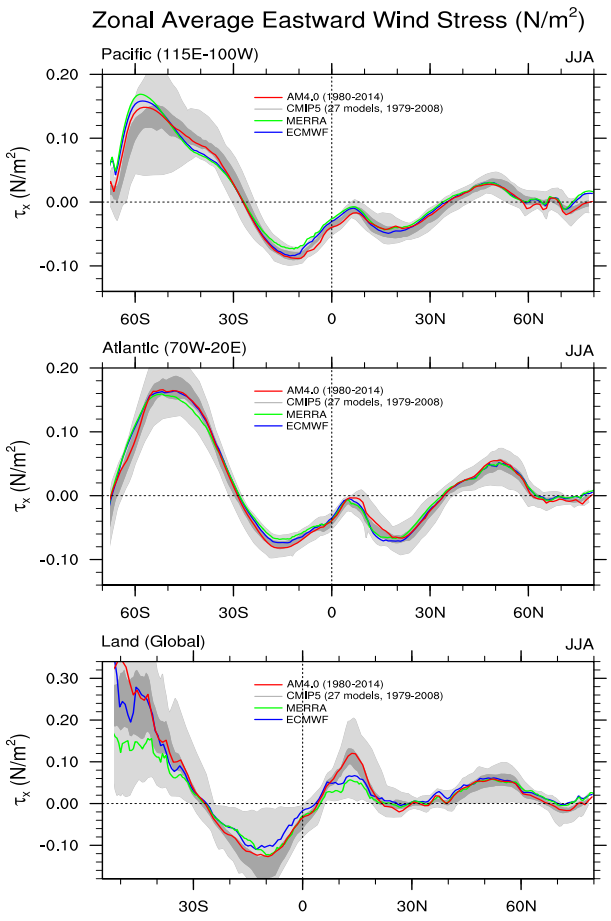


Figure S24. As in Fig. S23 except for the JJA season.

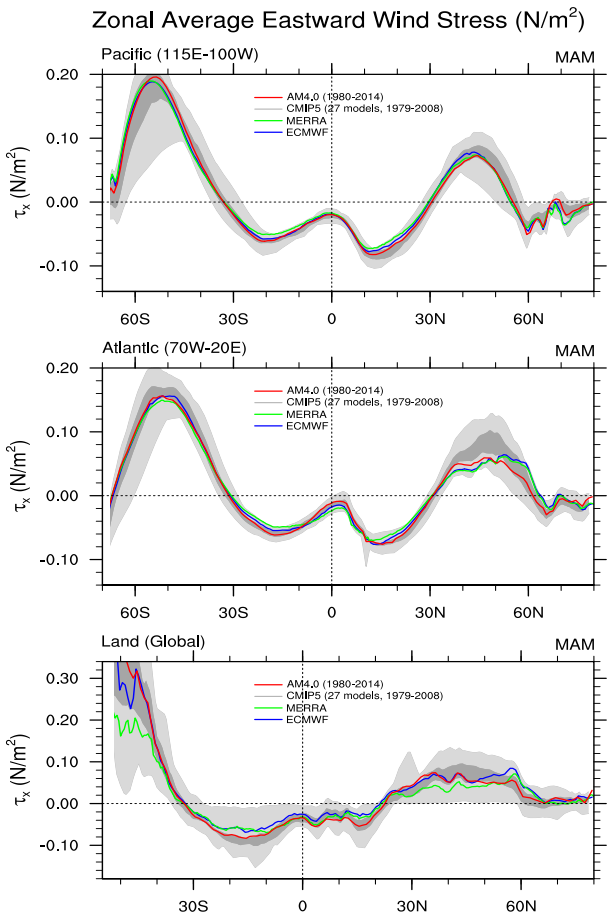
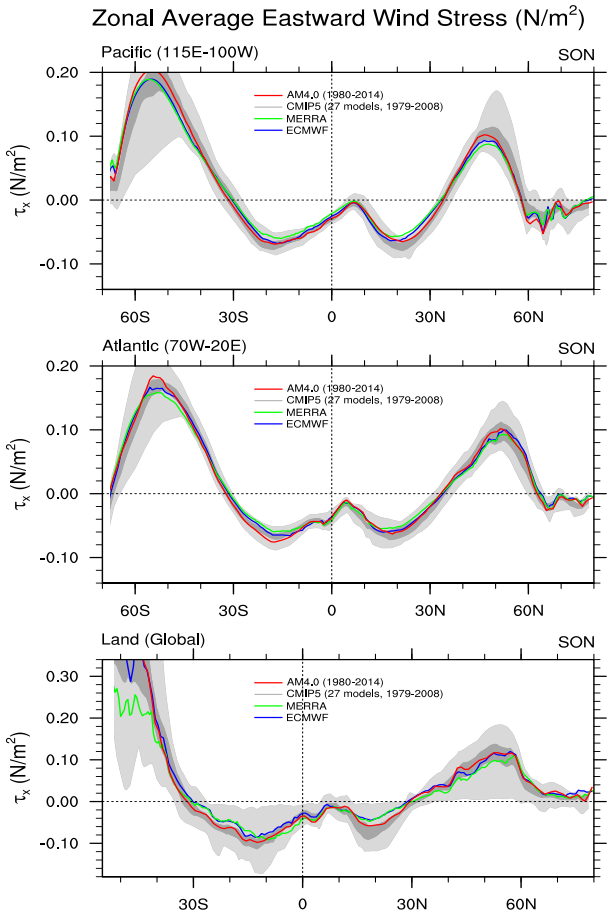


Figure S25. As in Fig. S23 except for the MAM season.



92 **Figure S26.** As in Fig. S23 except for the SON season.

S11 NH sea level pressure for individual seasons

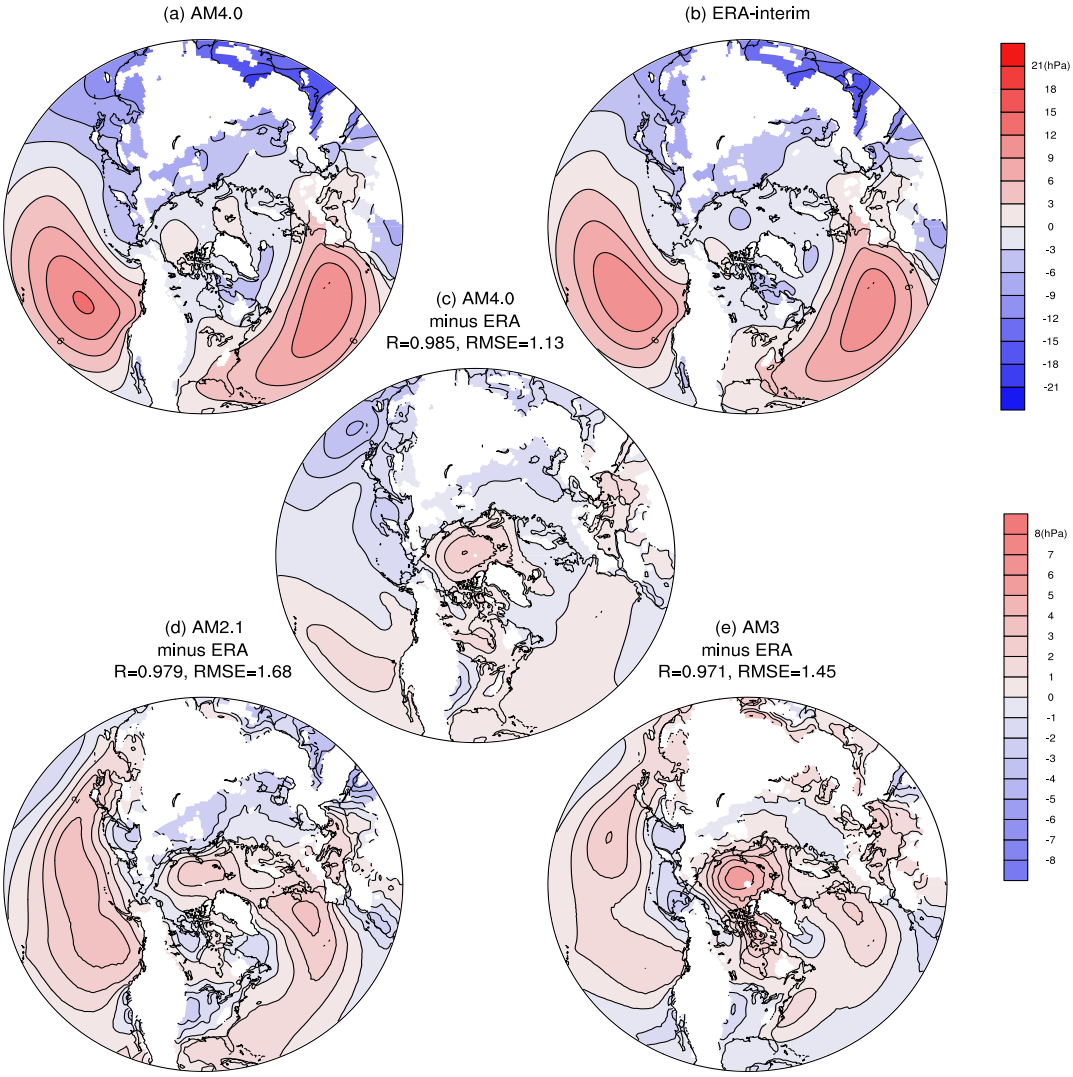
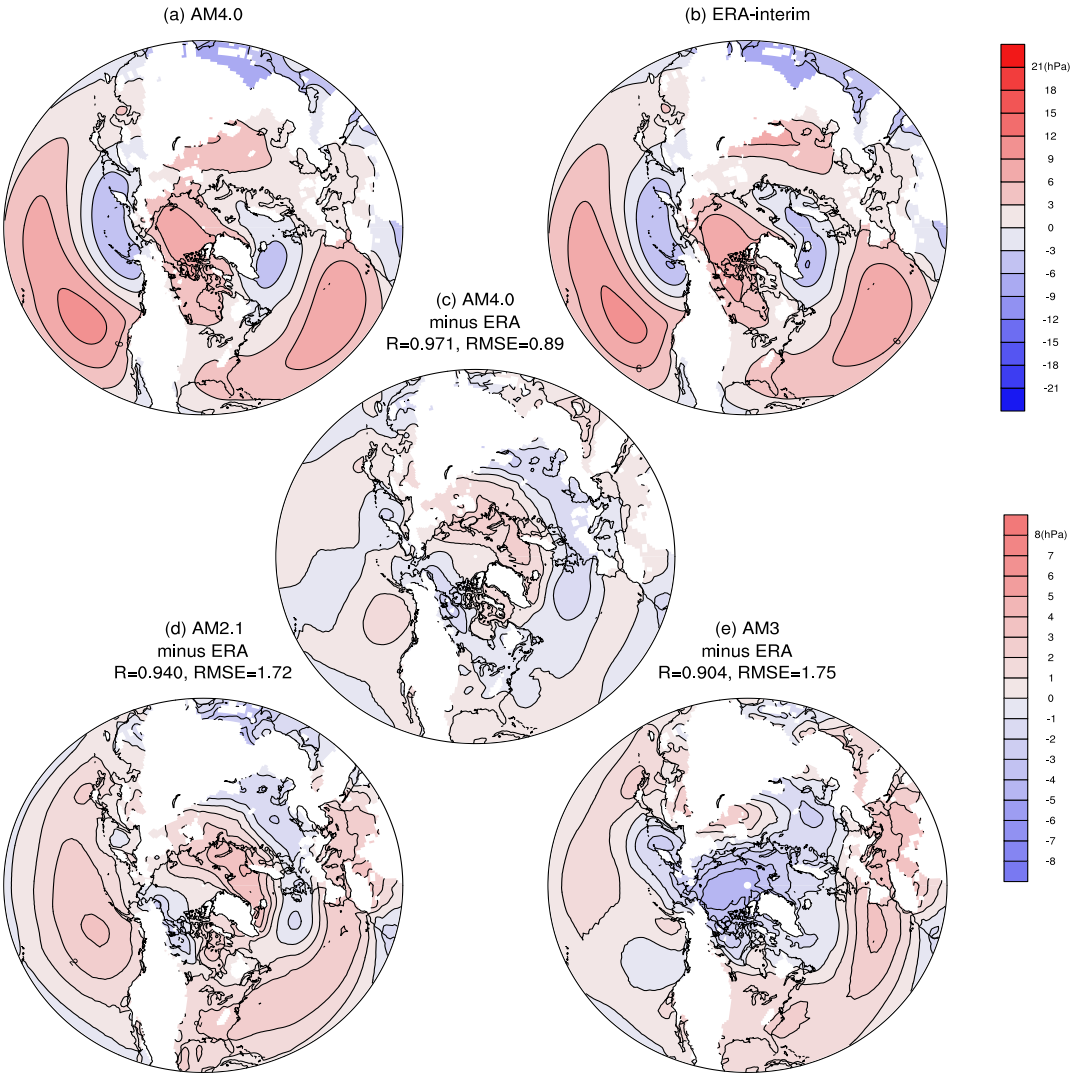
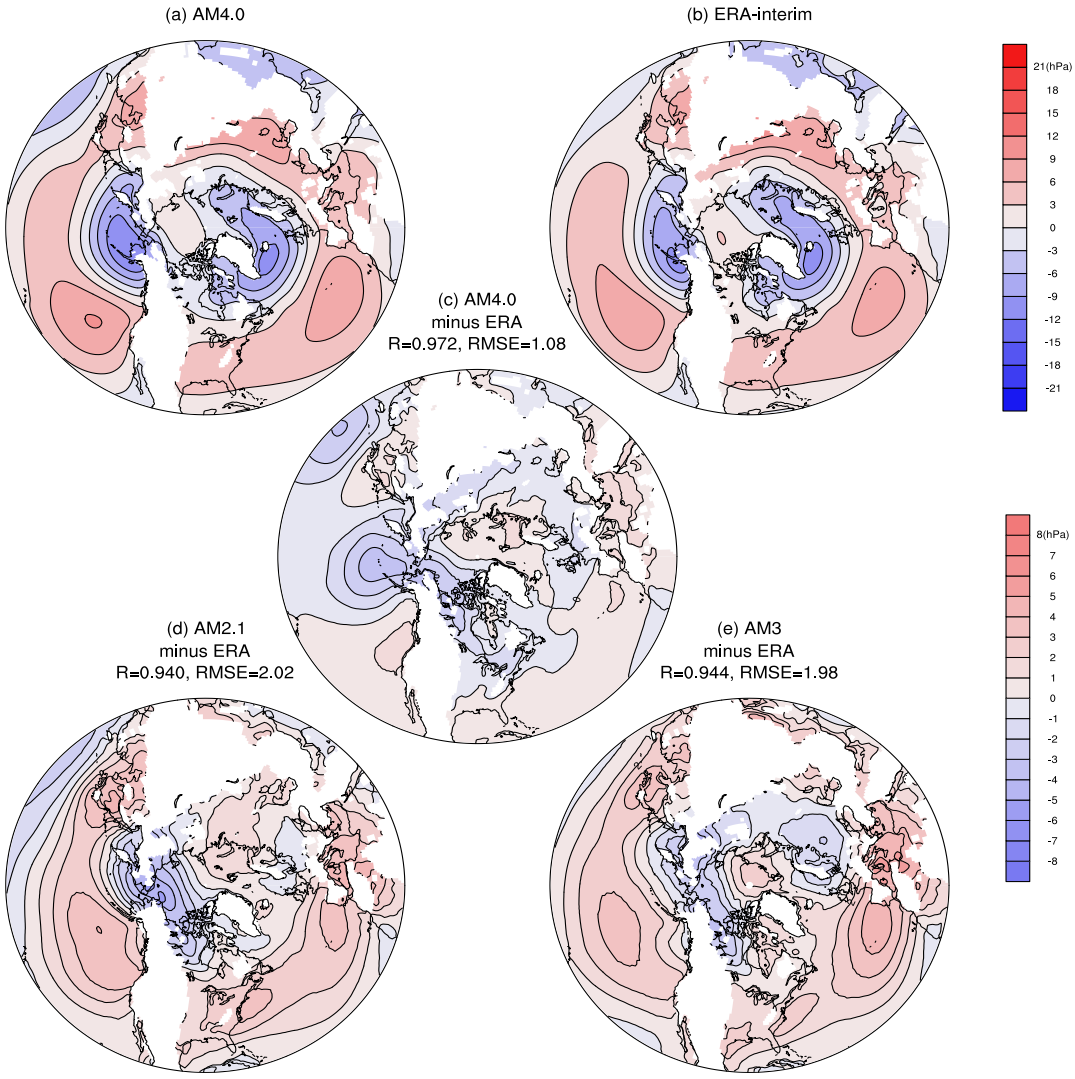


Figure S27. Long-term Northern Hemisphere JJA seasonal mean sea level pressure minus 1013.25 hPa (contour intervals: 3 hPa, thick lines: zero contour) from (a) AM4.0 AMIP simulation and (b) ERA-interim. (c) shows model bias (AM4.0 minus ERA-interim; contour intervals: 1 hPa). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. The titles of panels (c-e) show spatial correlations and RMS errors. Sea level pressure is masked out where surface pressure is less than 950 hPa.



100 **Figure S28.** As in Fig. S27 except for the MAM season.



101 **Figure S29.** As in Fig. S27 except for the SON season.

S12 NH 500hPa geopotential height stationary wave

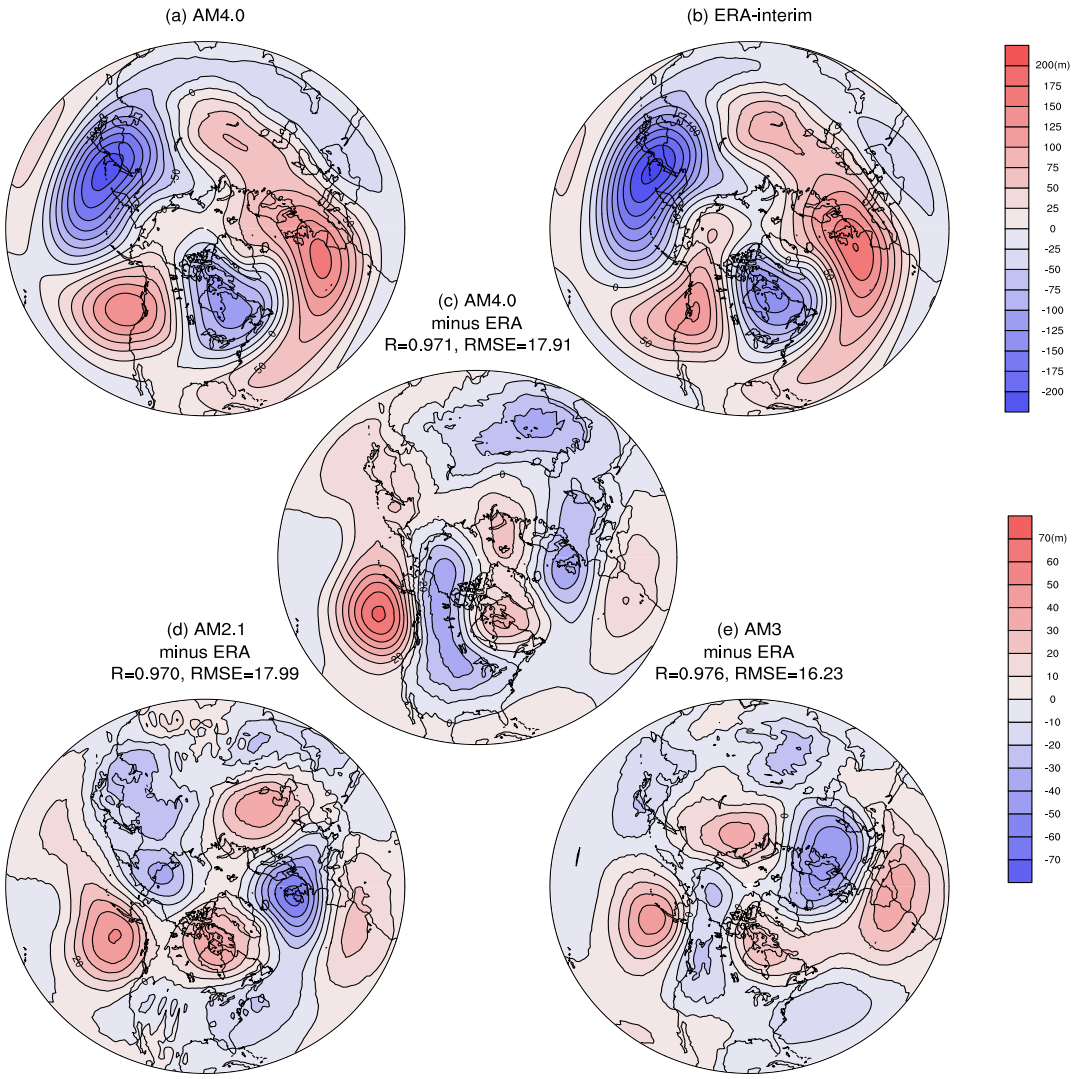


Figure S30. Long-term Northern Hemisphere DJF seasonal mean departure of 500hPa geopotential height from its zonal mean from (a) AM4.0 AMIP simulation and (b) ERA-interim. (c) shows model bias (AM4.0 minus ERA-interim). (d) As in (c) except for AM2.1. (e) As in (c) except for AM3. The titles of panels (c-e) show spatial correlations and RMS errors.

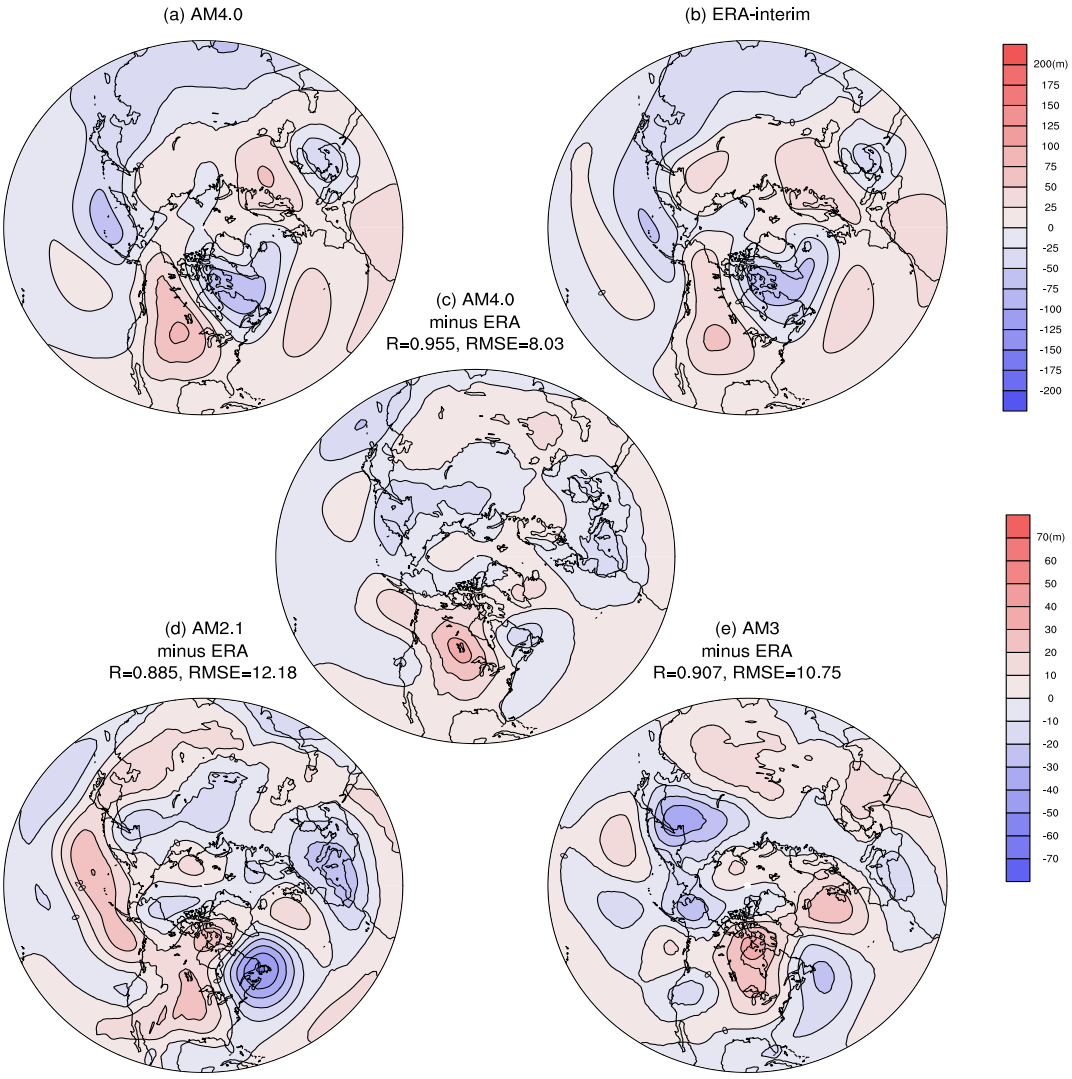


Figure S31. As in Fig. S30 except for the JJA season.

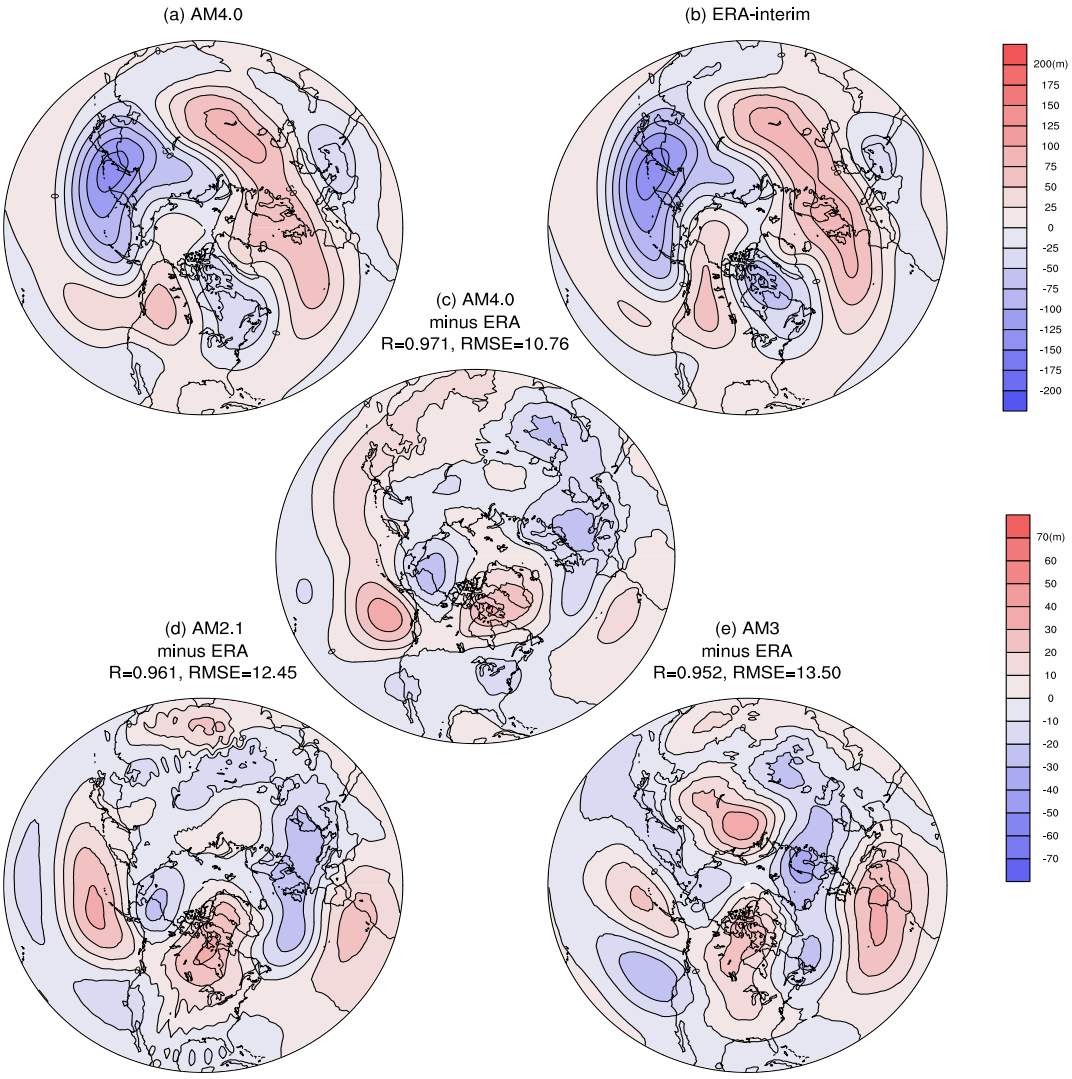


Figure S32. As in Fig. S30 except for the MAM season.

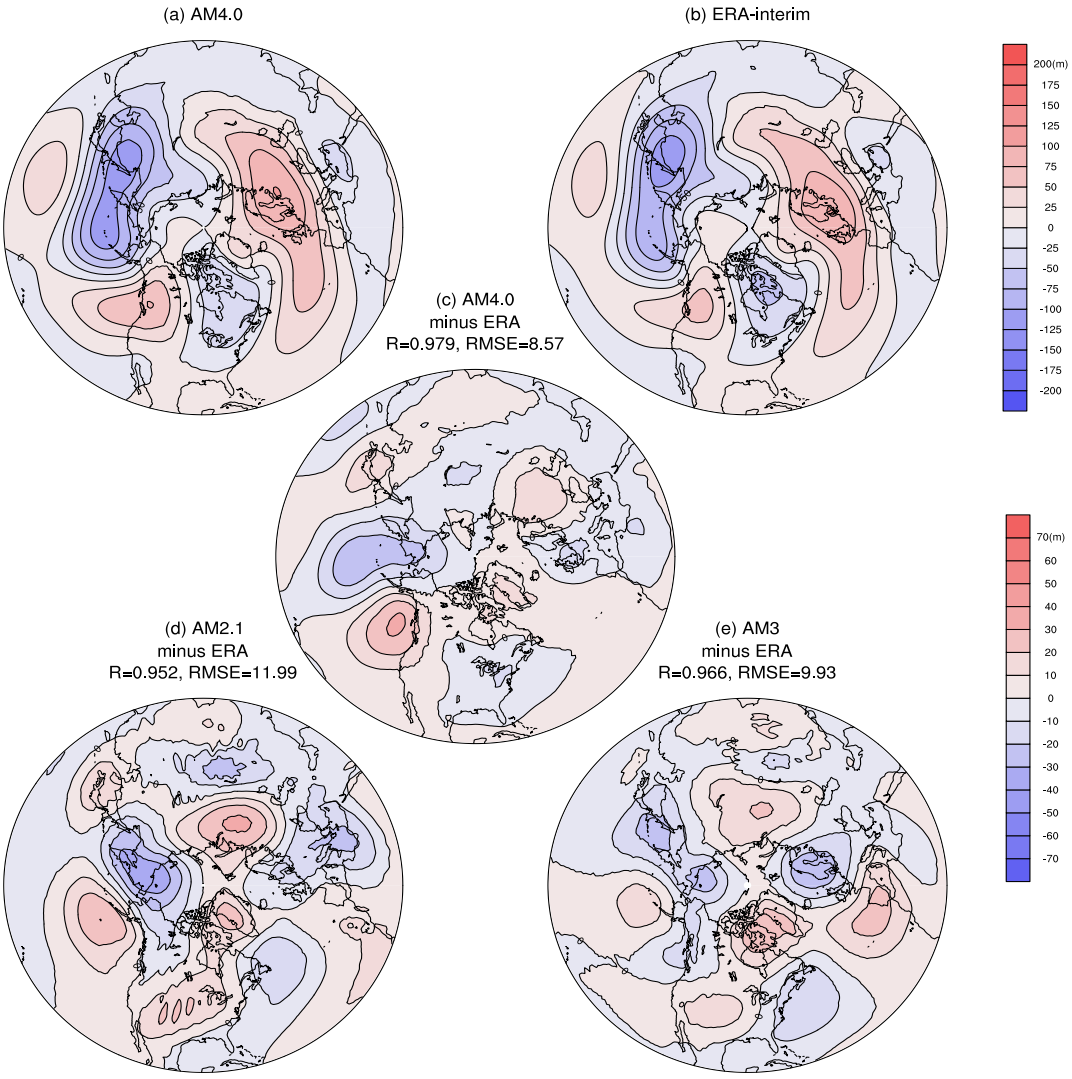


Figure S33. As in Fig. S30 except for the SON season.

S13 Mid-latitude storm track statistics without filtering

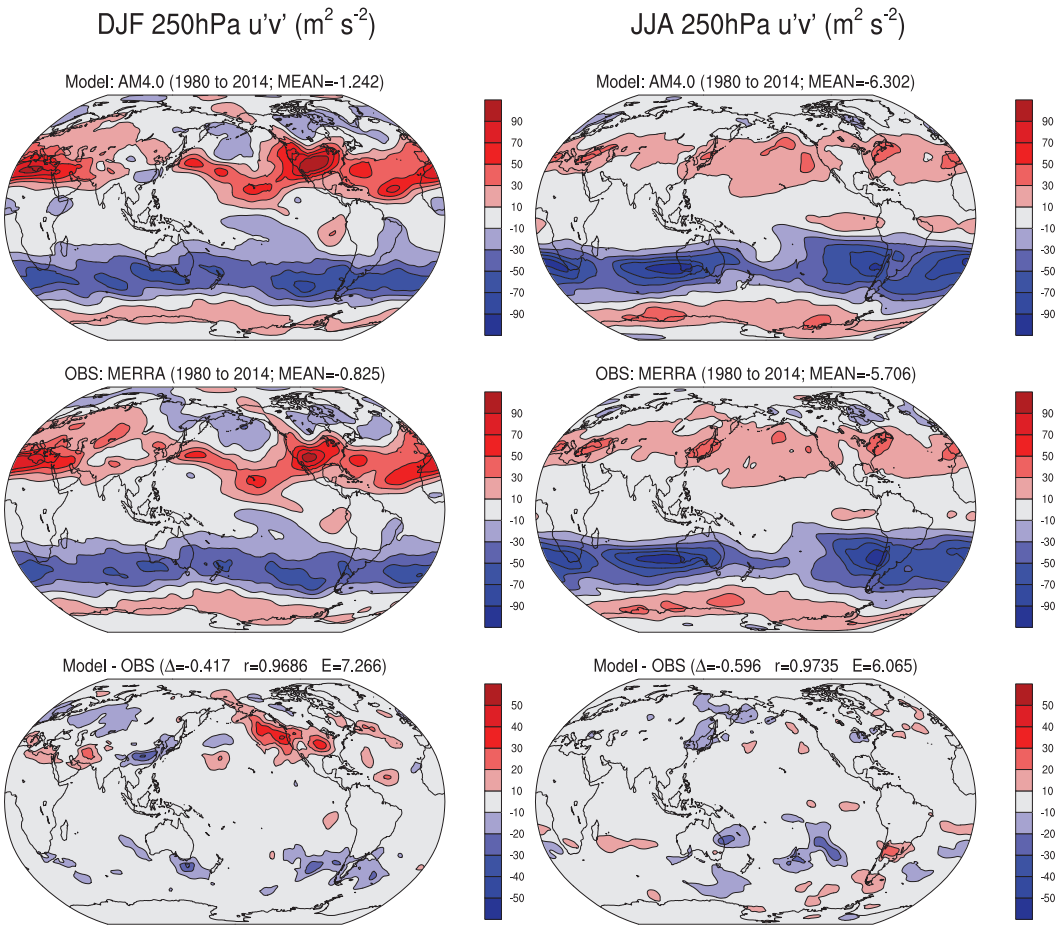


Figure S34. Comparison of 250hPa unfiltered u'v' with the MERRA reanalysis for the (left column) DJF and (right column) JJA season.

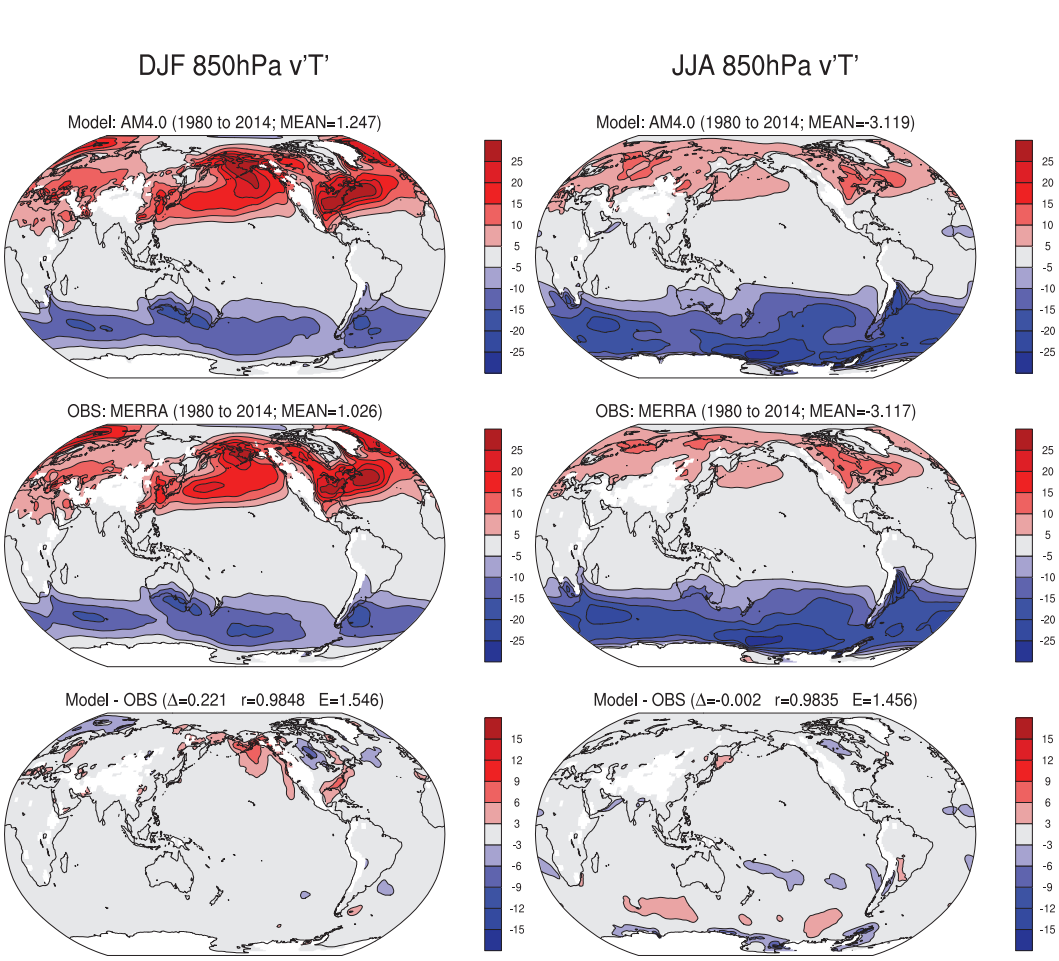


Figure S35. Comparison of 850hPa unfiltered v'T' with the MERRA reanalysis for the (left column) DJF and (right column) JJA season.