Supplement

S1 Model biases

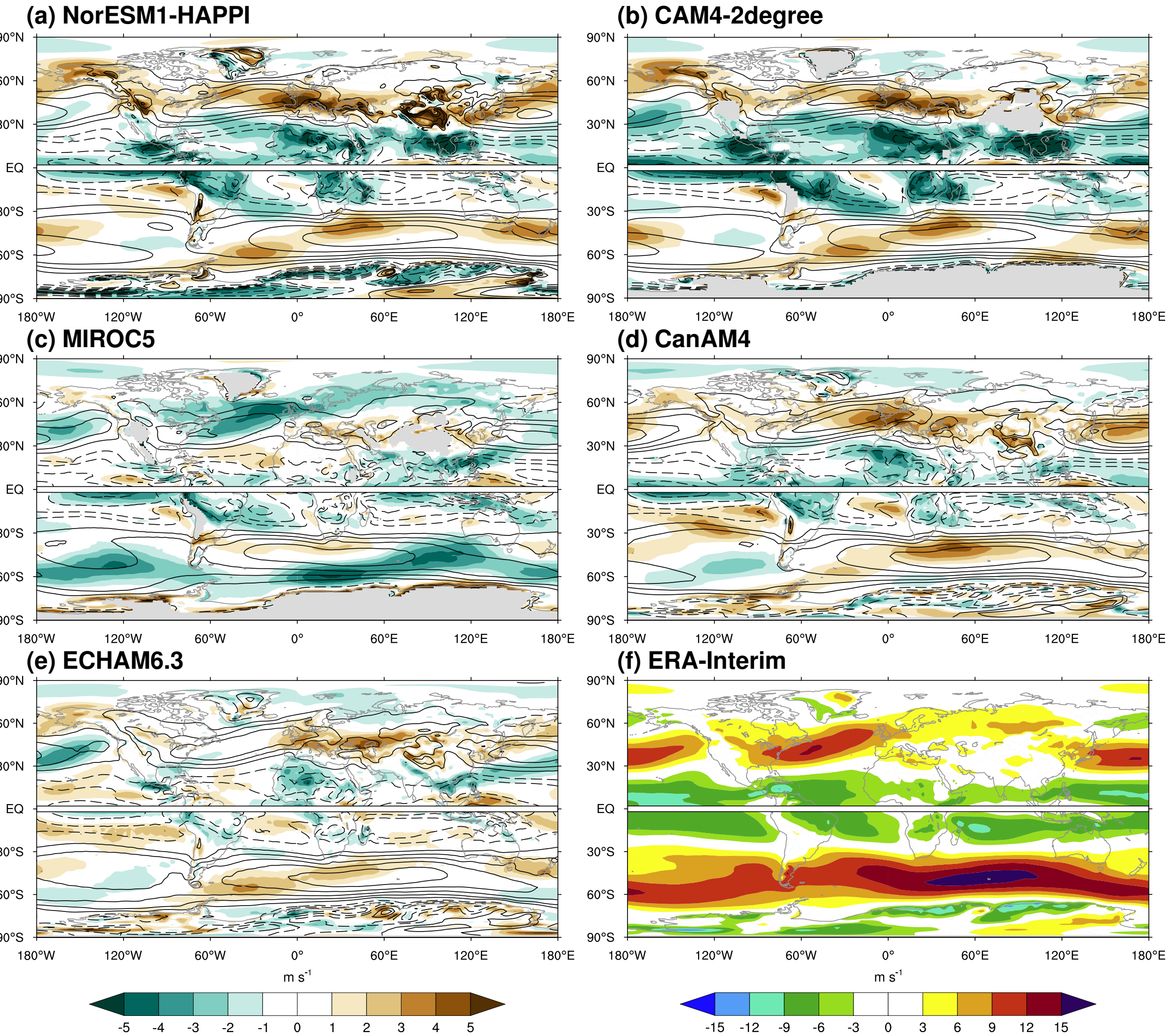

Figure S1.1. Model bias in winter (Northern Hemisphere DJF, Southern Hemisphere JJA) zonal wind at 850 hPa ($u850$) compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units m s^{-1}) along with the ERA-Interim climatology (contour interval 3 m s^{-1}). (f) shows the ERA-Interim climatology.

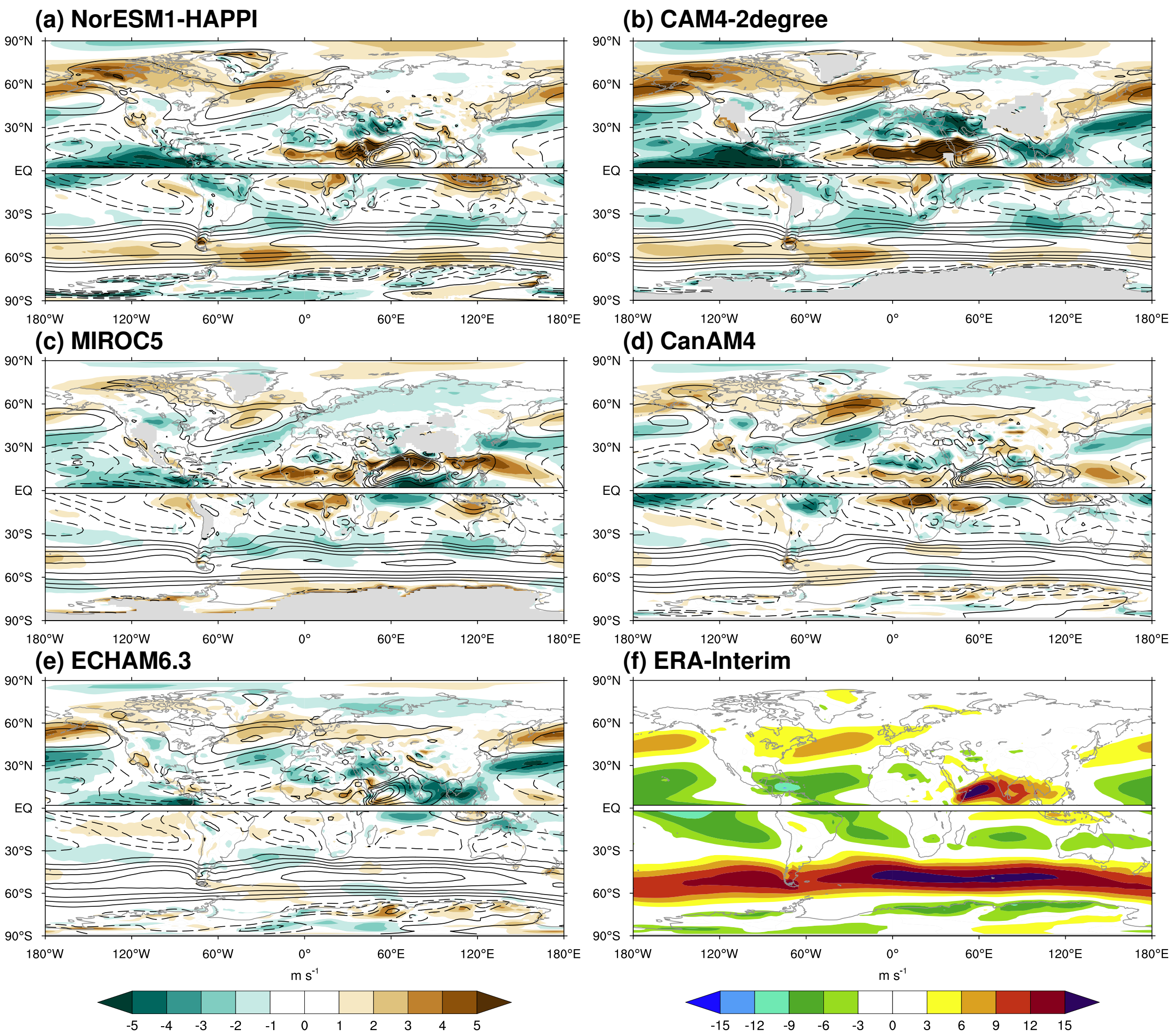

Figure S1.2. Model bias in summer (Northern Hemisphere JJA, Southern Hemisphere DJF) zonal wind at 850 hPa ($u850$) compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units m s^{-1}) along with the ERA-Interim climatology (contour interval 3 m s^{-1}). (f) shows the ERA-Interim climatology.

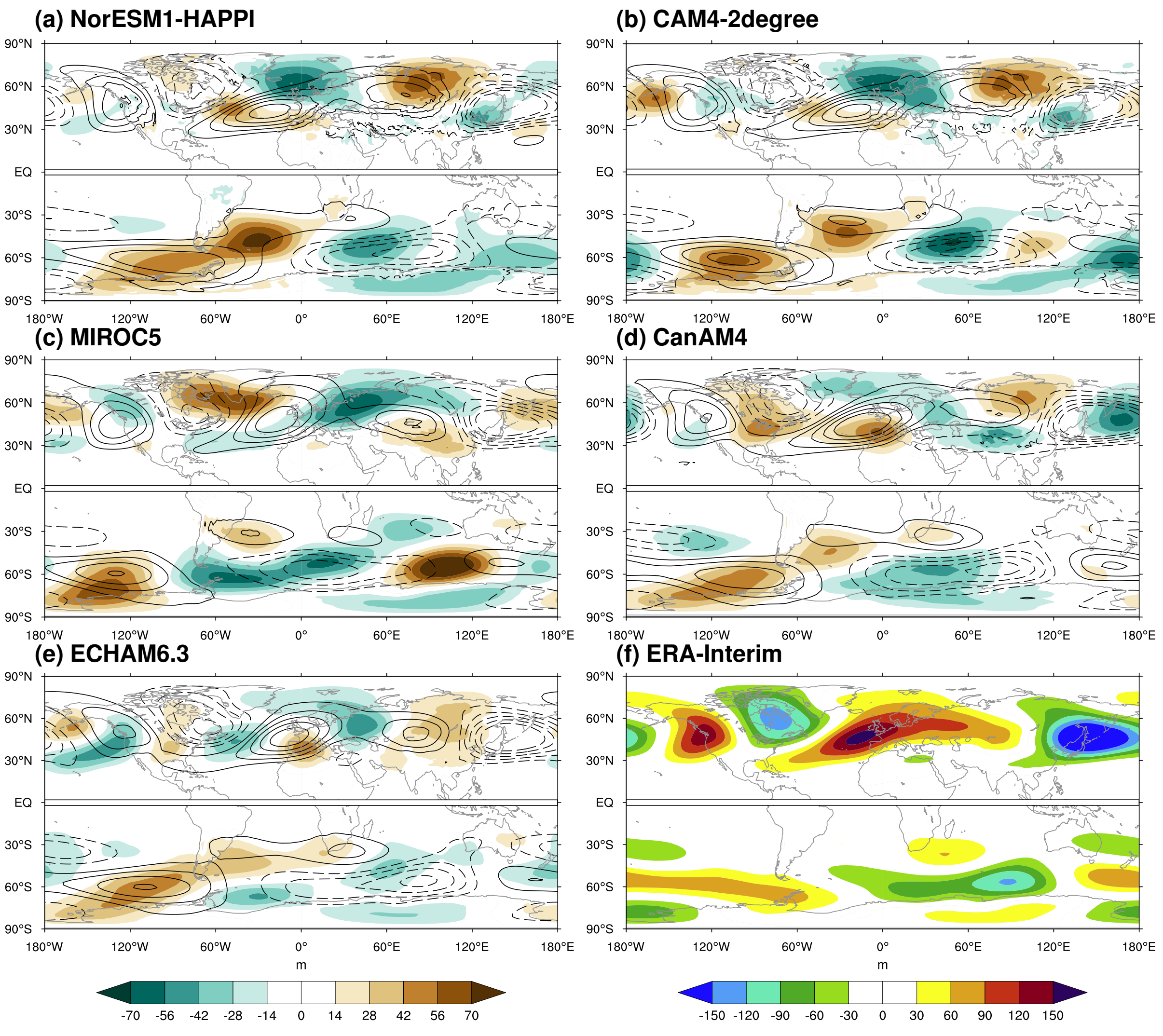

Figure S1.3. Model bias in winter (Northern Hemisphere DJF, Southern Hemisphere JJA) stationary waves at 500 hPa compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units m) along with the ERA-Interim climatology (contour interval 30 m). (f) shows the ERA-Interim climatology. Stationary waves are defined as departures from the zonal mean of geopotential height (Z^*) at 500 hPa.

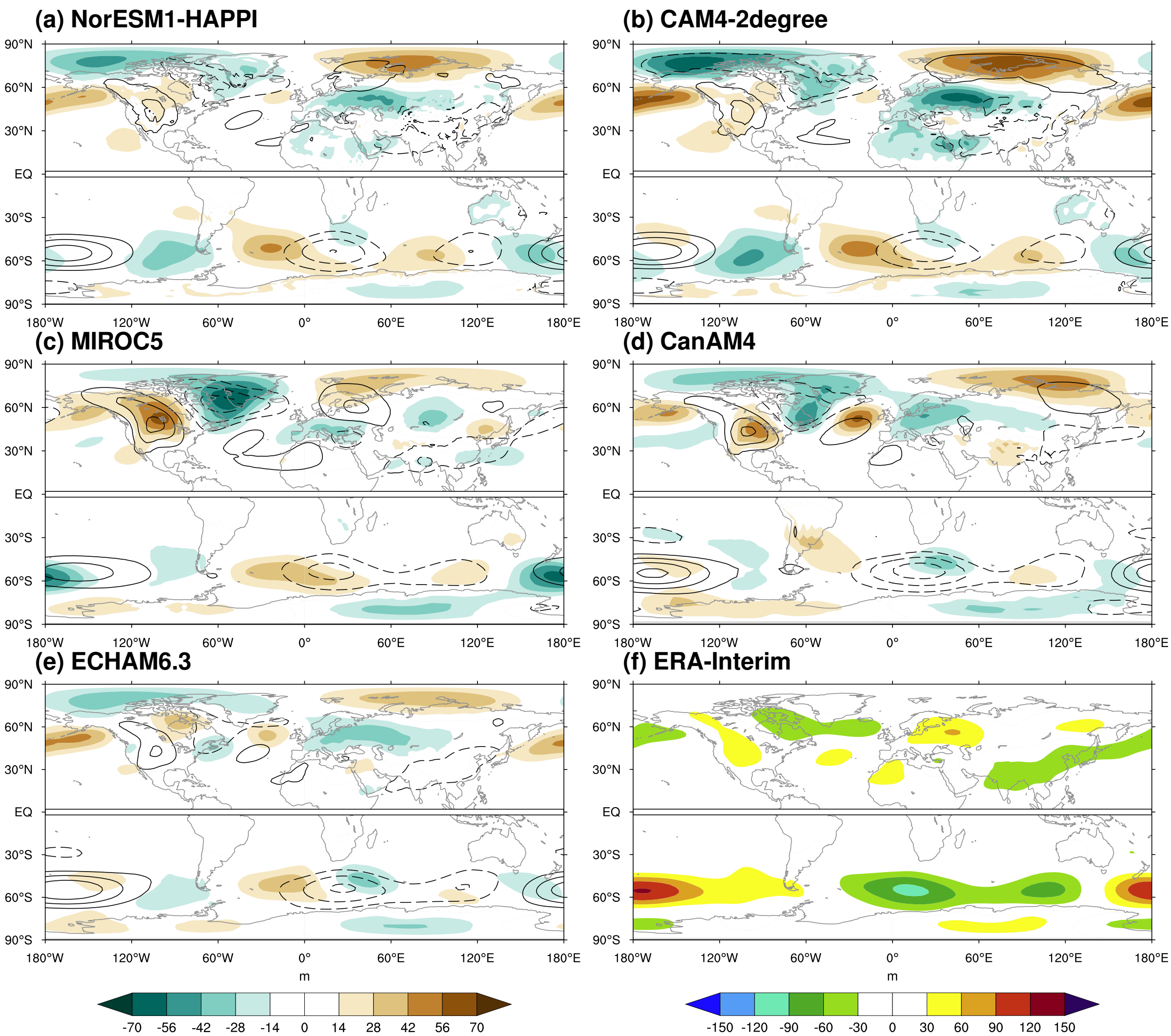

Figure S1.4. Model bias in summer (Northern Hemisphere JJA, Southern Hemisphere DJF) stationary waves at 500 hPa compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units m) along with the ERA-Interim climatology (contour interval 30 m). (f) shows the ERA-Interim climatology. Stationary waves are defined as departures from the zonal mean of geopotential height (Z^*) at 500 hPa.

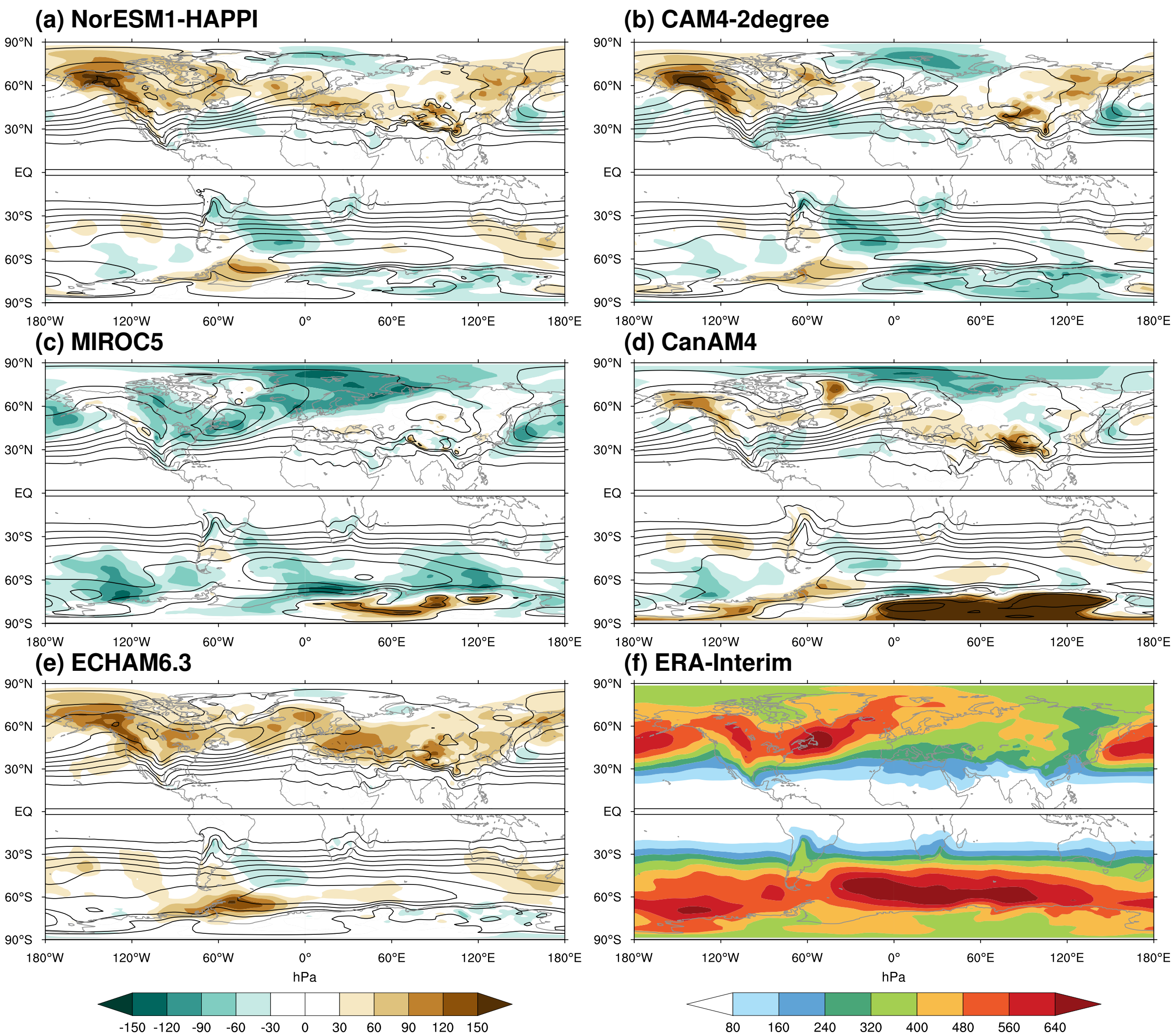

Figure S1.5. Model bias in winter (Northern Hemisphere DJF, Southern Hemisphere JJA) MSLP storm tracks compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units hPa) along with the ERA-Interim climatology (contour interval 80 hPa). (f) shows the ERA-Interim climatology. The storm tracks are defined as the standard deviation of bandpass filtered daily MSLP.

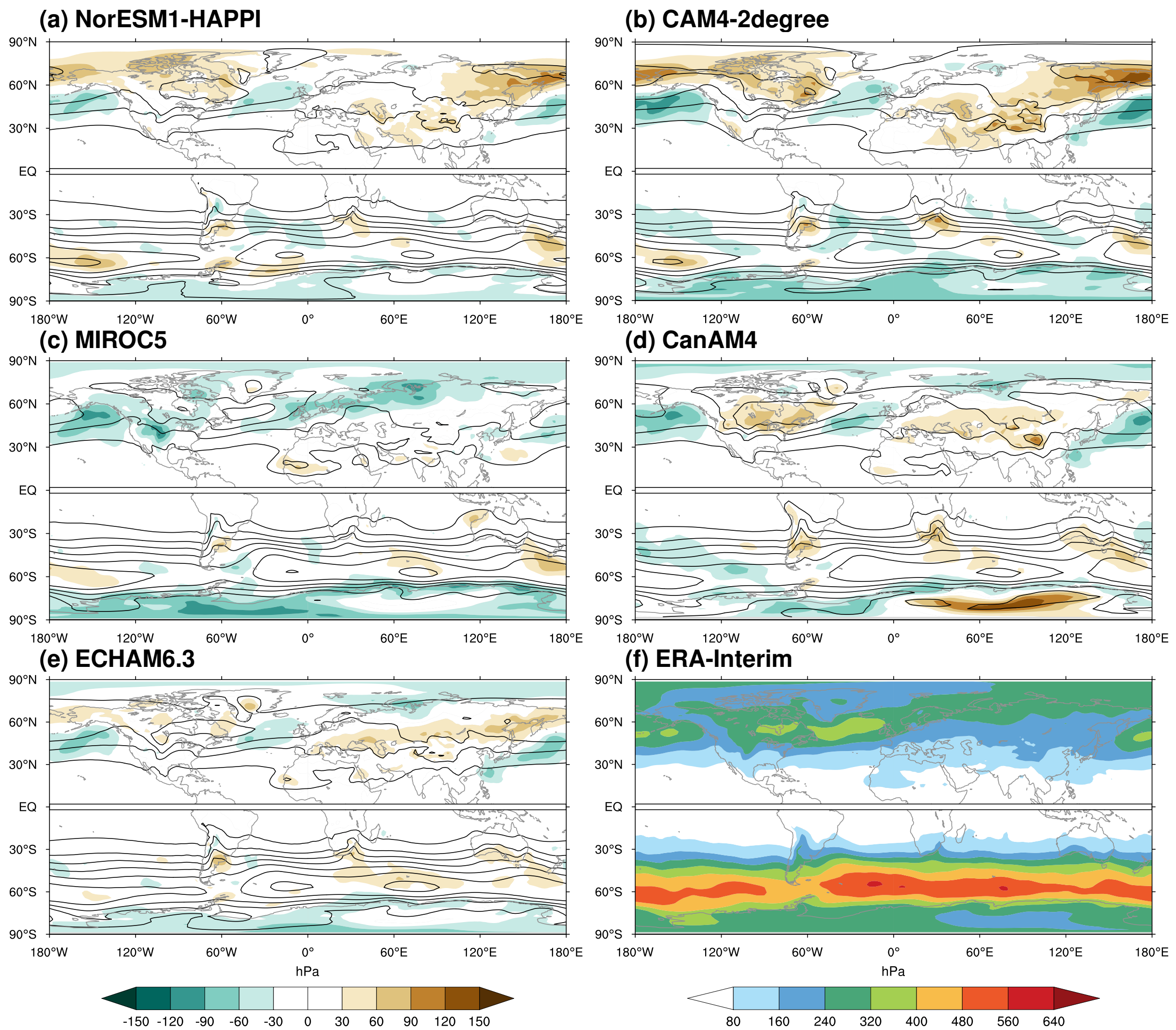

Figure S1.6. Model bias in summer (Northern Hemisphere JJA, Southern Hemisphere DJF) MSLP storm tracks compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units hPa) along with the ERA-Interim climatology (contour interval 80 hPa). (f) shows the ERA-Interim climatology. The storm tracks are defined as the standard deviation of bandpass filtered daily MSLP.

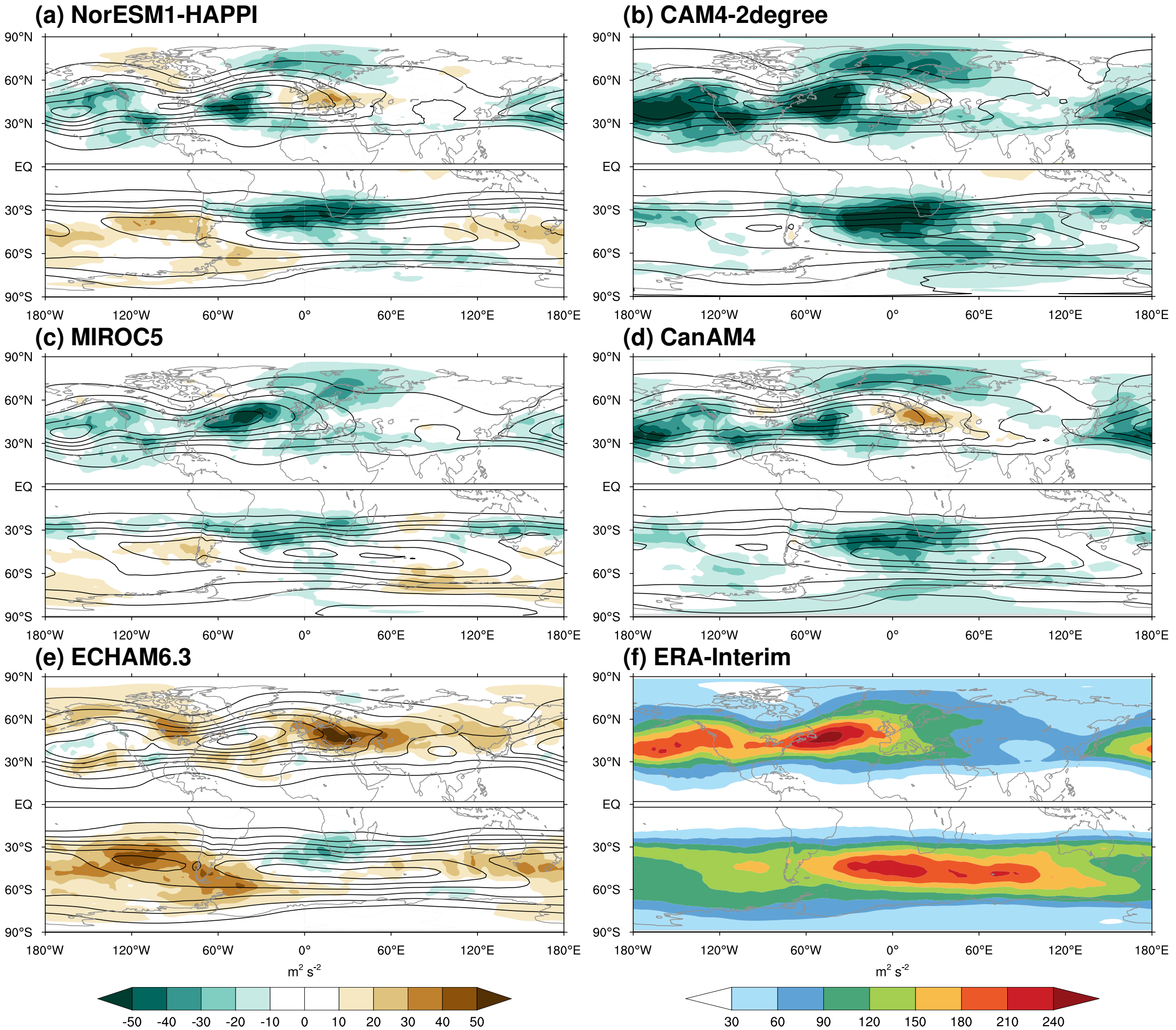

Figure S1.7. Model bias in winter (Northern Hemisphere DJF, Southern Hemisphere JJA) EKE storm tracks at 250 hPa ($EKE250$) compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units m^2 s^{-2}) along with the ERA-Interim climatology (contour interval 30 m^2 s^{-2}). (f) shows the ERA-Interim climatology (contour interval 30 m^2 s^{-1}). The storm tracks are defined as the variance of bandpass filtered daily EKE.

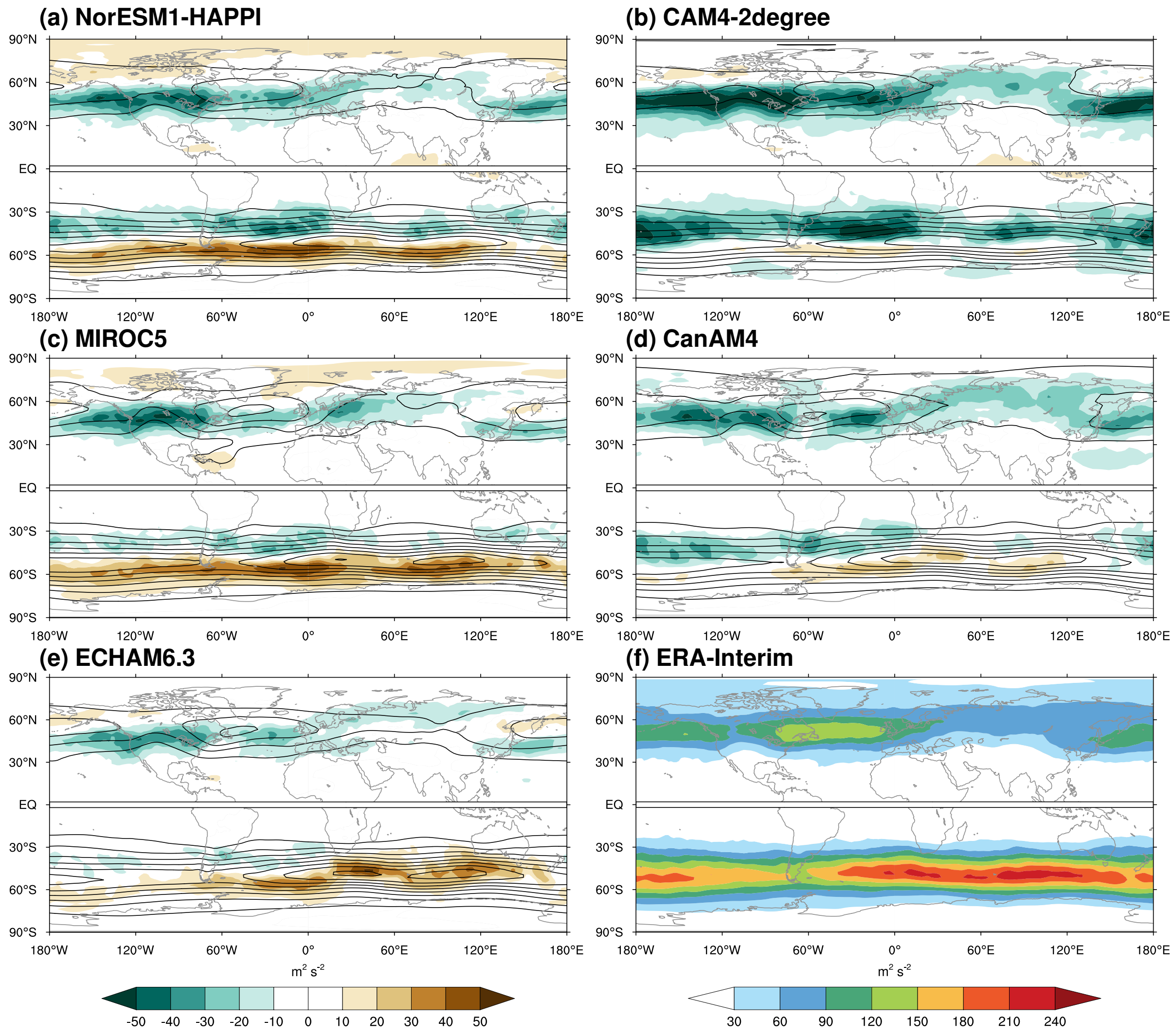

Figure S1.8. Model bias in summer (Northern Hemisphere DJF, Southern Hemisphere JJA) EKE storm tracks at 250 hPa ($EKE250$) compared to ERA-Interim. (a)-(e) show the bias in individual models (shading; units $m^2\ s^{-2}$) along with the ERA-Interim climatology (contour interval 30 $m^2\ s^{-2}$). (f) shows the ERA-Interim climatology (contour interval 30 $m^2\ s^{-1}$). The storm tracks are defined as the variance of bandpass filtered daily EKE.

S2 Summer responses in circulation fields

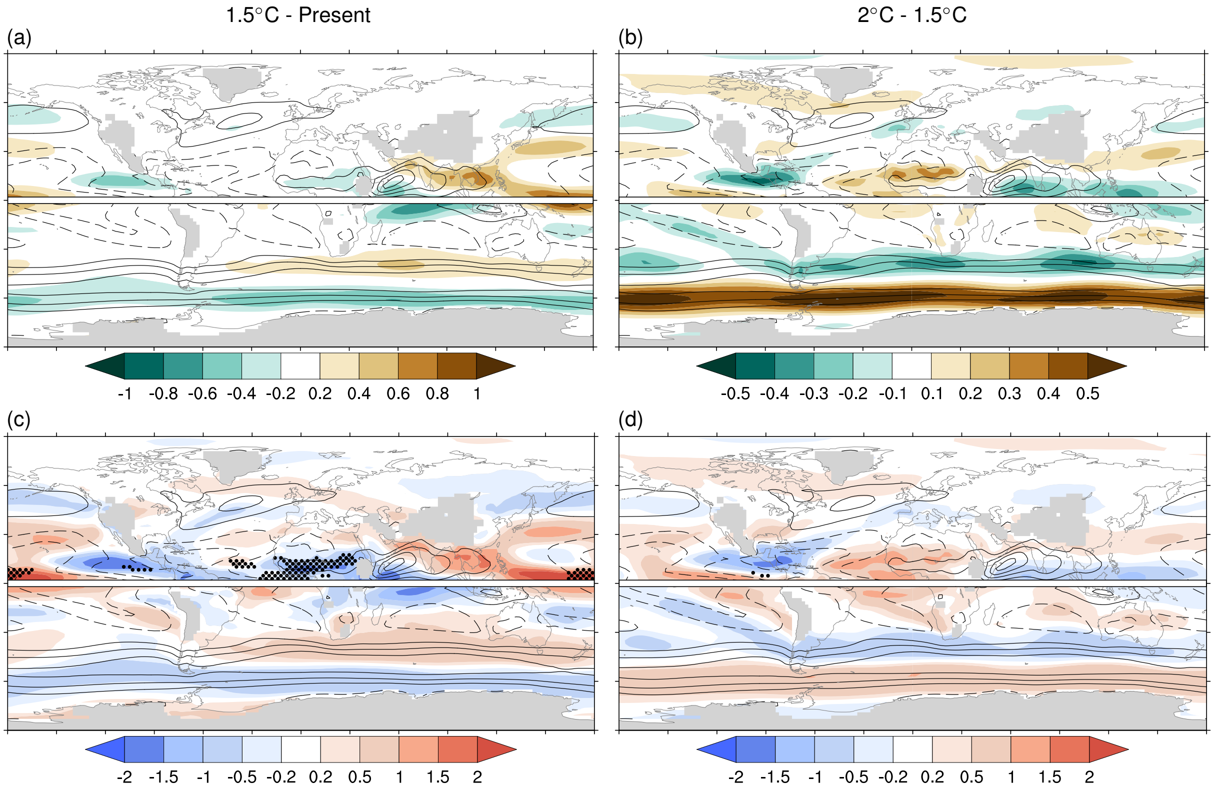

Figure S2.1. Response of summer (Northern Hemisphere JJA, Southern Hemisphere DJF) zonal wind at 850 hPa ($u850$) for 1.5°C−PD (left) and 2.0°C−1.5°C (right). Top panels show responses (shading; units m s^{-1}) along with the climatology (contour interval 4 m s^{-1}) for the (a) PD and (b) 1.5°C experiments. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response; grey shading indicates regions of high topography intersecting the plotted variable.

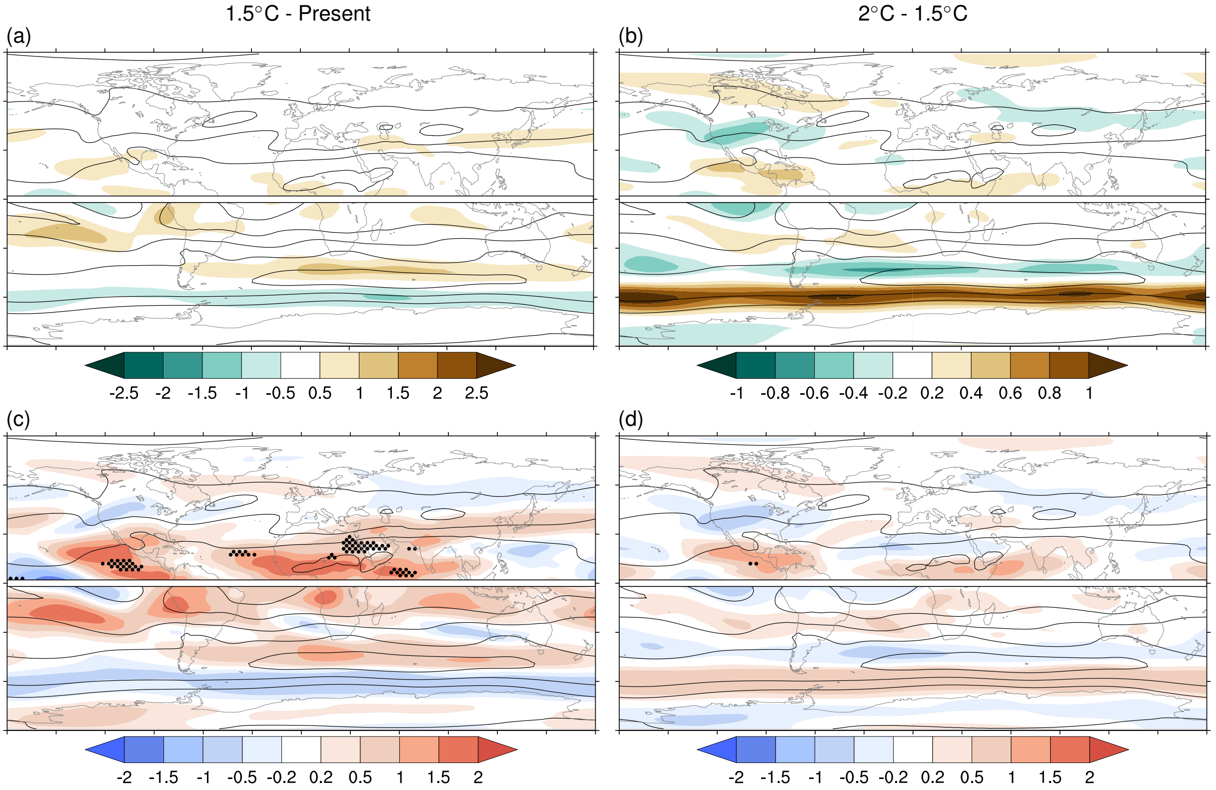

Figure S2.2. Response of summer (Northern Hemisphere JJA, Southern Hemisphere DJF) zonal wind at 250 hPa ($u250$) for 1.5°C−PD (left) and 2.0°C−1.5°C (right). Top panels show responses (shading; units m s^{-1}) along with the climatology (contour interval 10 m s^{-1}) for the (a) PD and (b) 1.5°C experiments. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response.

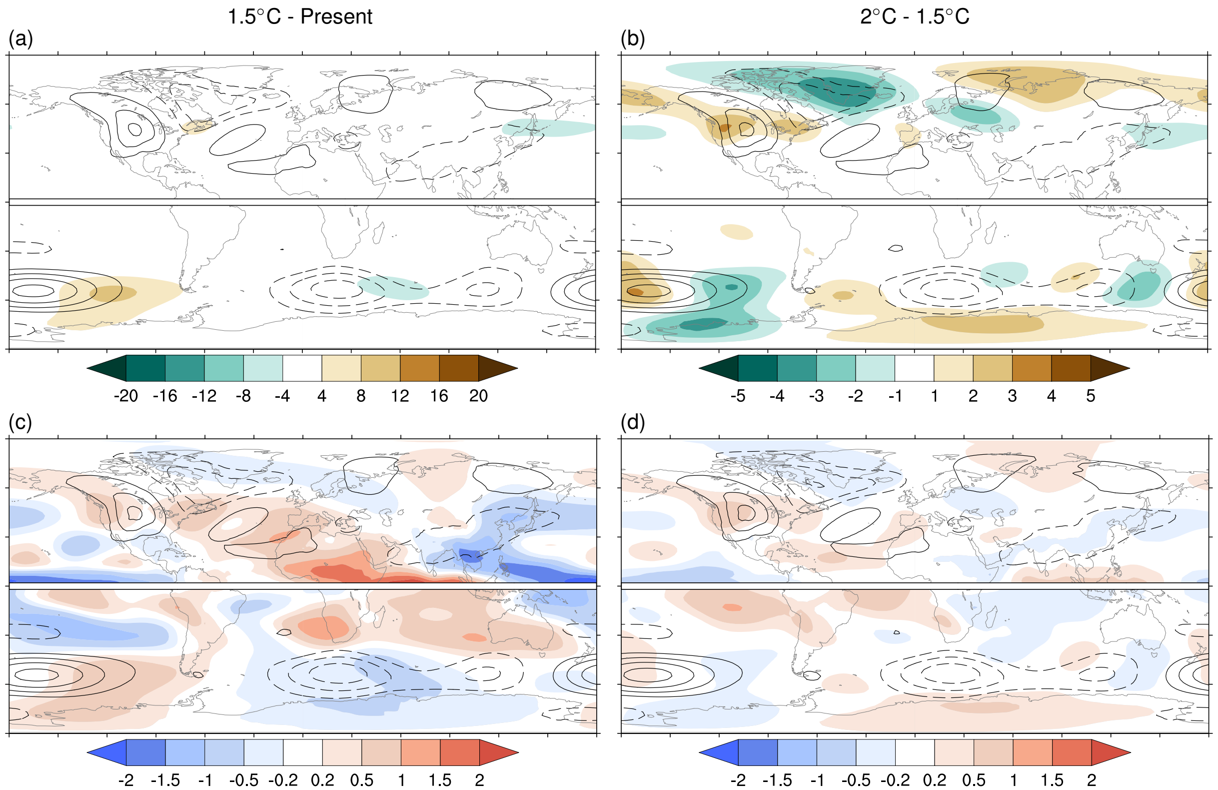

Figure S2.3. Response of summer (Northern Hemisphere JJA, Southern Hemisphere DJF) stationary waves at 500 hPa for 1.5°C−PD (left) and 2.0°C−1.5°C (right). Top panels show responses (shading; units m) along with the climatology (contour interval 25 m) for the (a) PD and (b) 1.5°C experiments. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response. Stationary waves are defined as the departures from the zonal mean of geopotential height (Z^*) at 500 hPa.

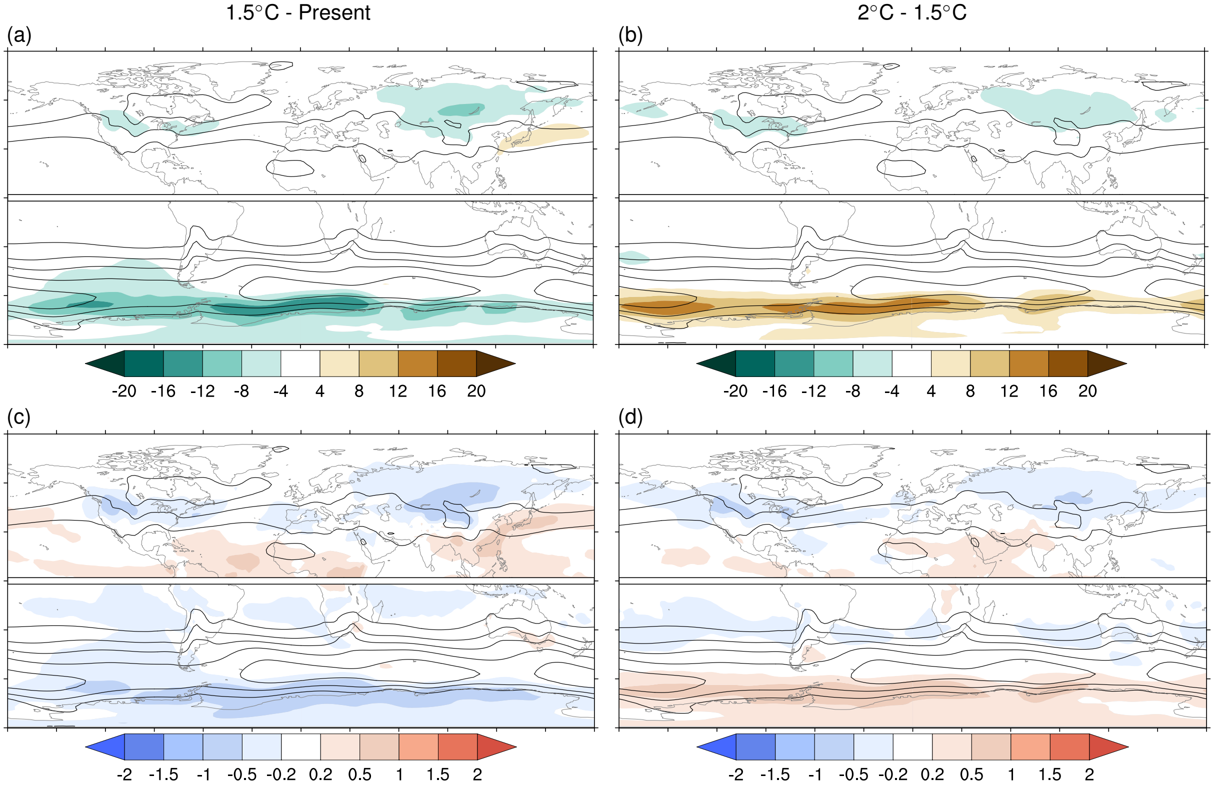

Figure S2.4. Response of summer (Northern Hemisphere JJA, Southern Hemisphere DJF) MSLP storm tracks for 1.5°C−PD (left) and 2.0°C−1.5°C (right). Top panels show responses (shading; units hPa) along with the climatology (contour interval 100 hPa) for the (a) PD and (b) 1.5°C experiments. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response. The storm tracks are defined as the standard deviation of bandpass filtered daily MSLP.

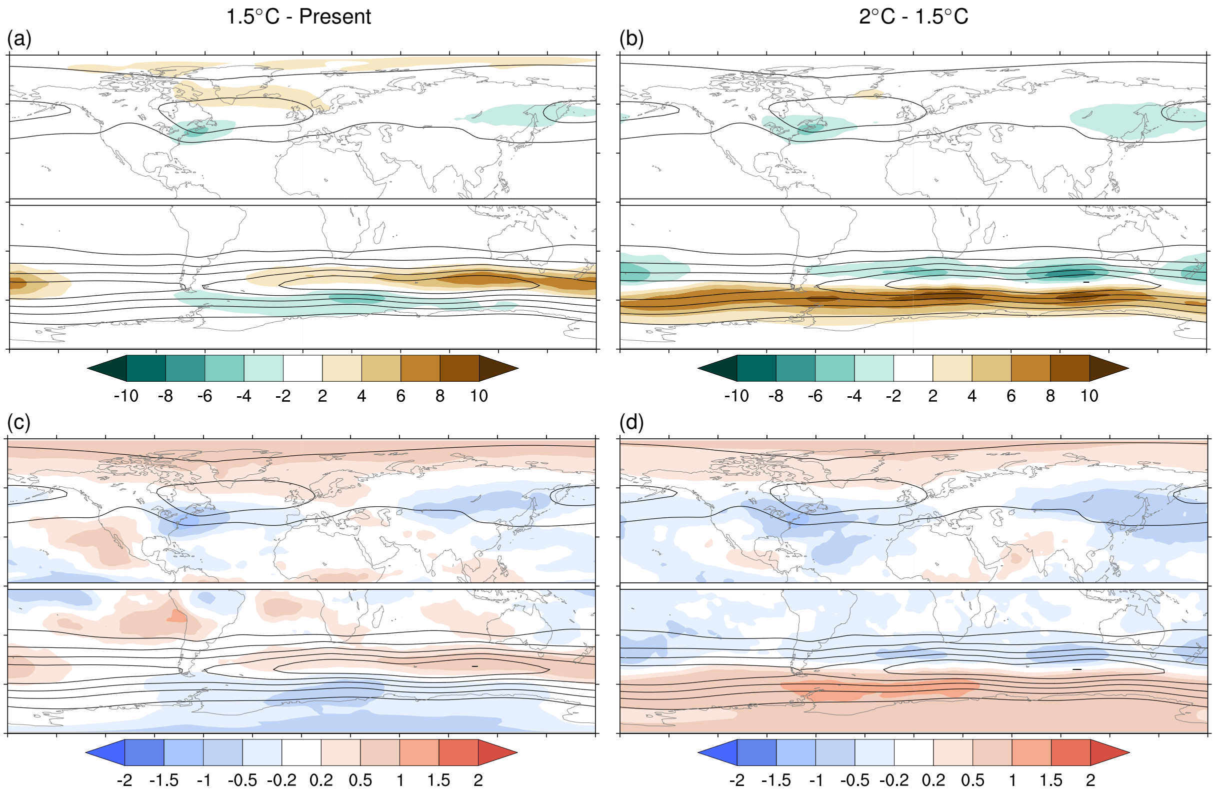

Figure S2.5. Response of summer (Northern Hemisphere JJA, Southern Hemisphere DJF) EKE storm tracks for 1.5°C−PD (left) and 2.0°C−1.5°C (right). Top panels show responses (shading; units hPa) along with the climatology (contour interval 100 hPa) for the (a) PD and (b) 1.5°C experiments. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response. The storm tracks are defined as bandpass filtered daily EKE at 250 hPa.

S3 2.0°C minus PD responses

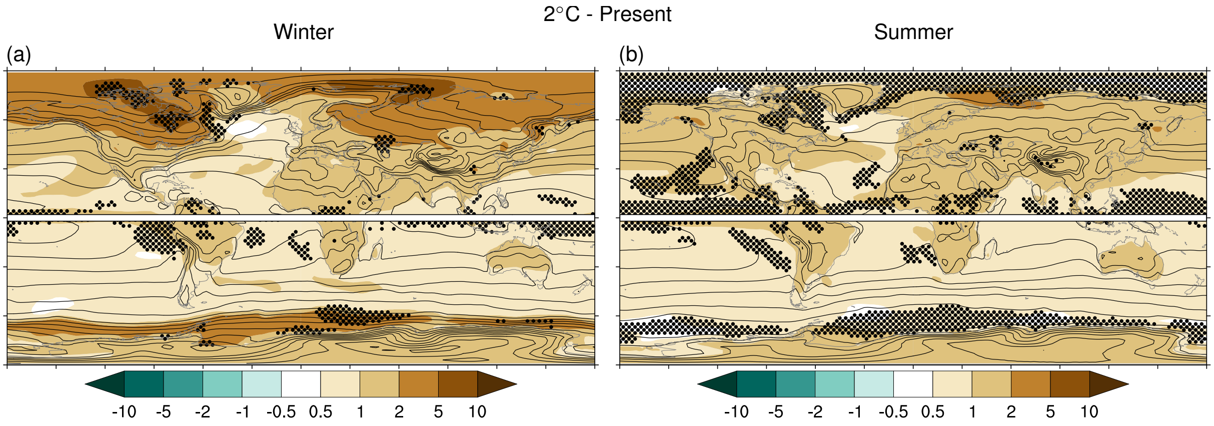

Figure S3.1. Response of winter (left) and summer (right) surface air temperature for 2.0°C−PD (shading; units K) along with the climatology (contour interval 5 K) for the PD experiment. Black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response.

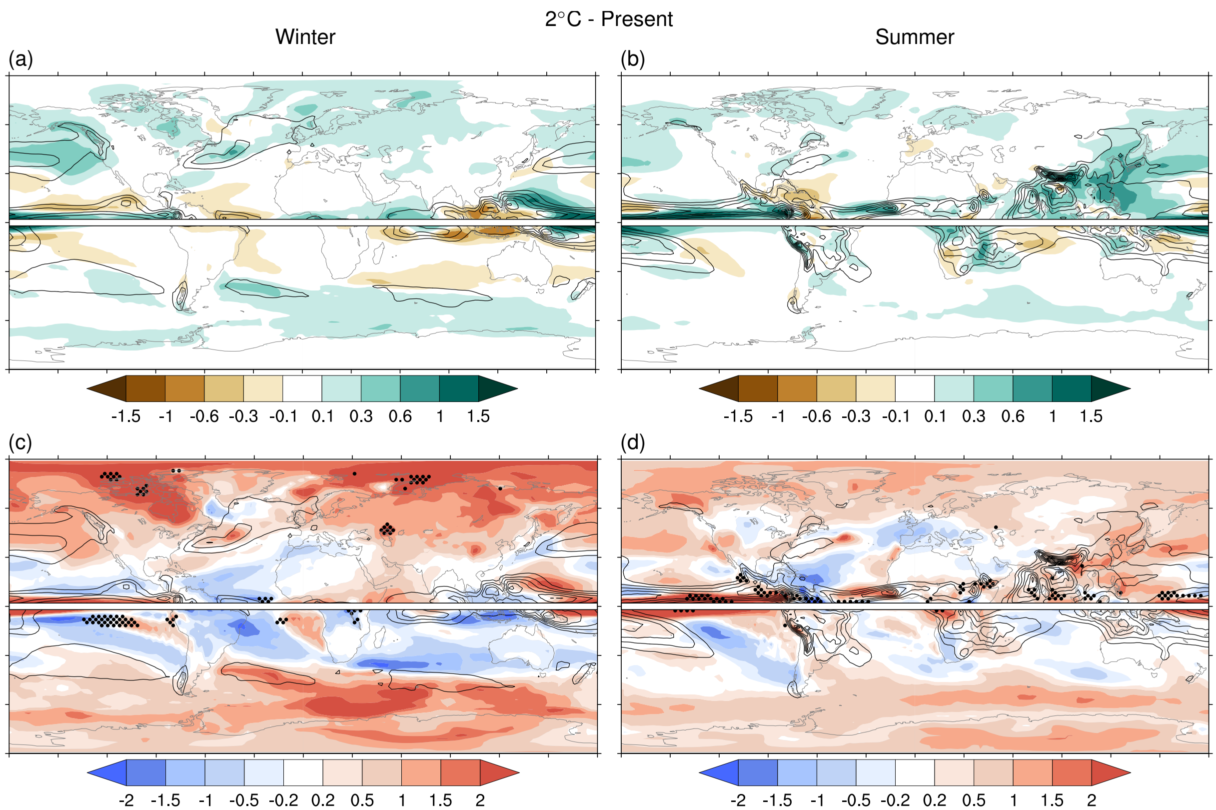

Figure S3.2. Response of winter (left) and summer (right) precipitation for 2.0°C$-$PD. Top panels show responses (shading; units mm d^{-1}) along with the climatology (contour interval 2 mm d^{-1} starting from 4 mm d^{-1}) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response. In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response.

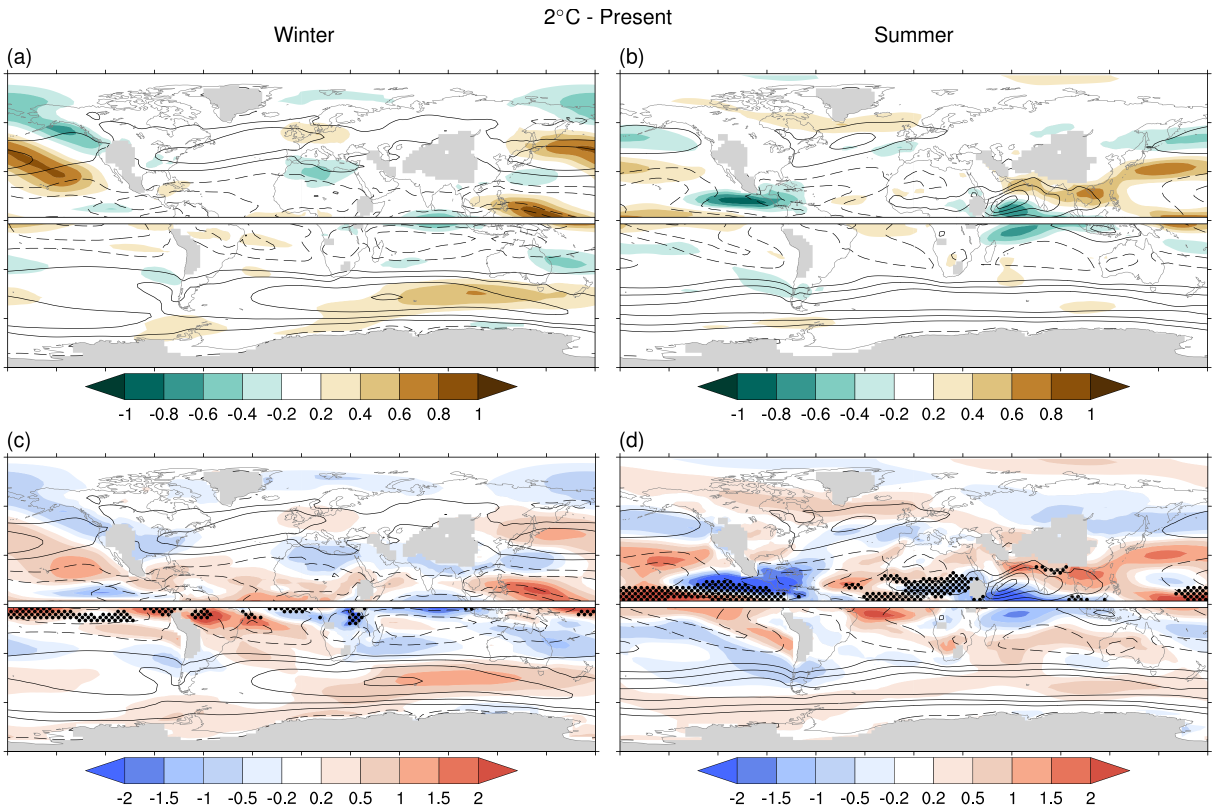

Figure S3.3. Response of winter (left) and summer (right) zonal wind at 850 hPa for 2.0°C−PD. Top panels show responses (shading; units m s^{-1}) along with the climatology (contour interval 4 m s^{-1}) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response (shading; units m s^{-1}). In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response; grey shading indicates regions of high topography intersecting the plotted variable.

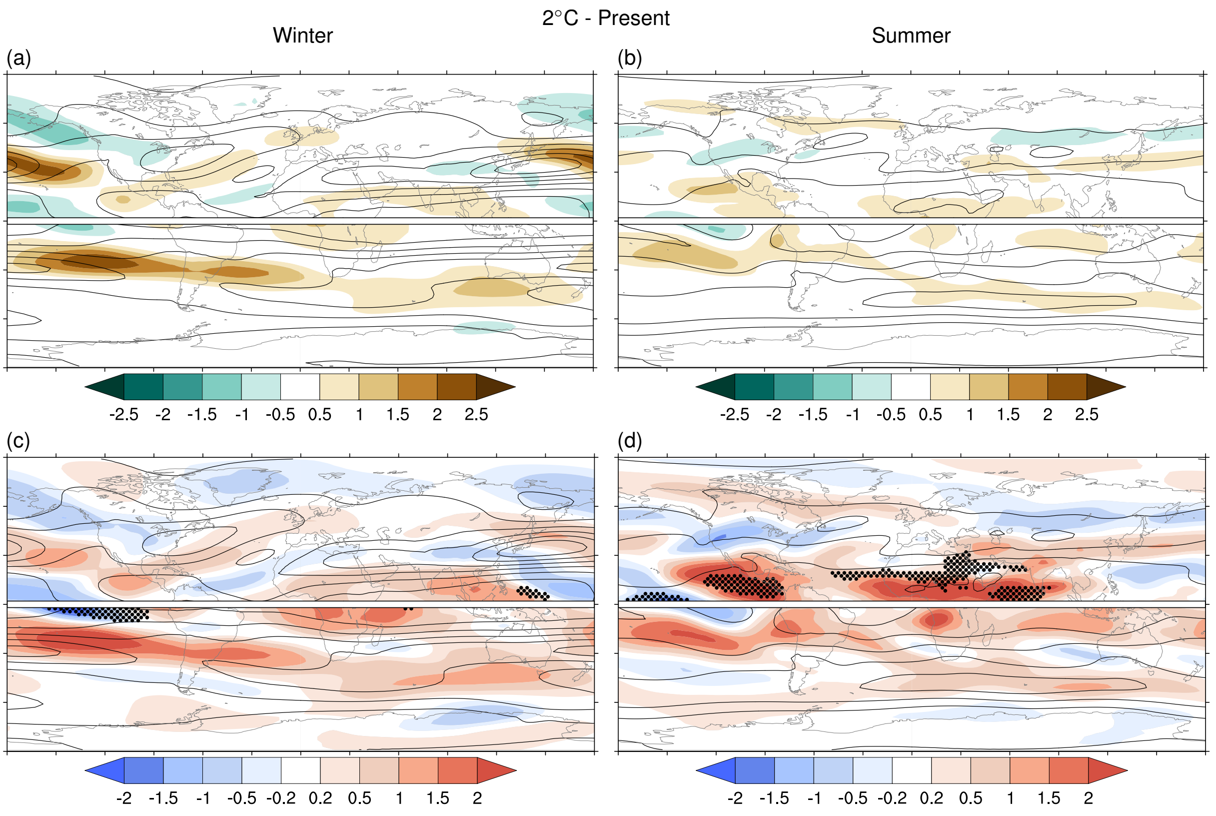

Figure S3.4. Response of winter (left) and summer (right) zonal wind at 250 hPa for 2.0°C−PD. Top panels show responses (shading; units m s^{-1}) along with the climatology (contour interval 10 m s^{-1}) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response (shading; units m s^{-1}). In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response.

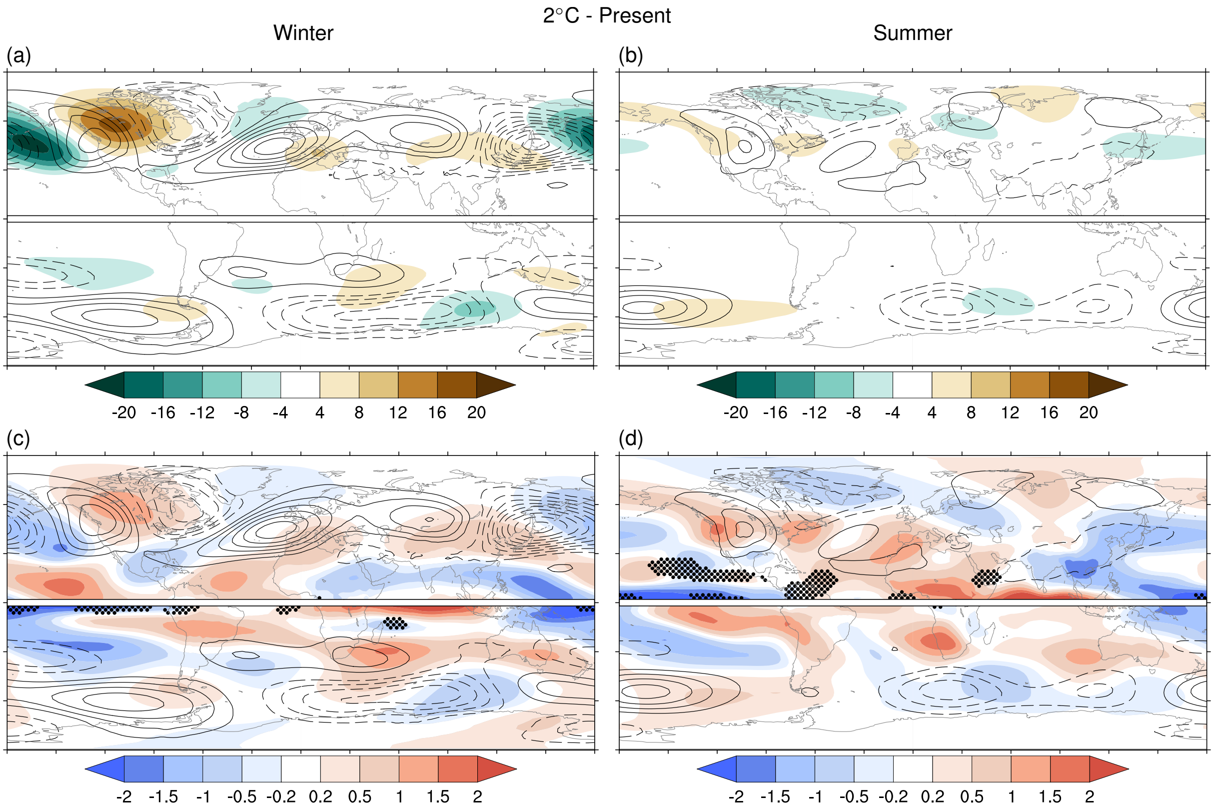

Figure S3.5. Response of winter (left) and summer (right) stationary waves at 500 hPa for 2.0°C−PD. Top panels show responses (shading; units m) along with the climatology (contour interval 25 m) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response (shading; units m). In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response. Stationary waves are defined as departures from the zonal mean of geopotential height (Z^*) at 500 hPa.

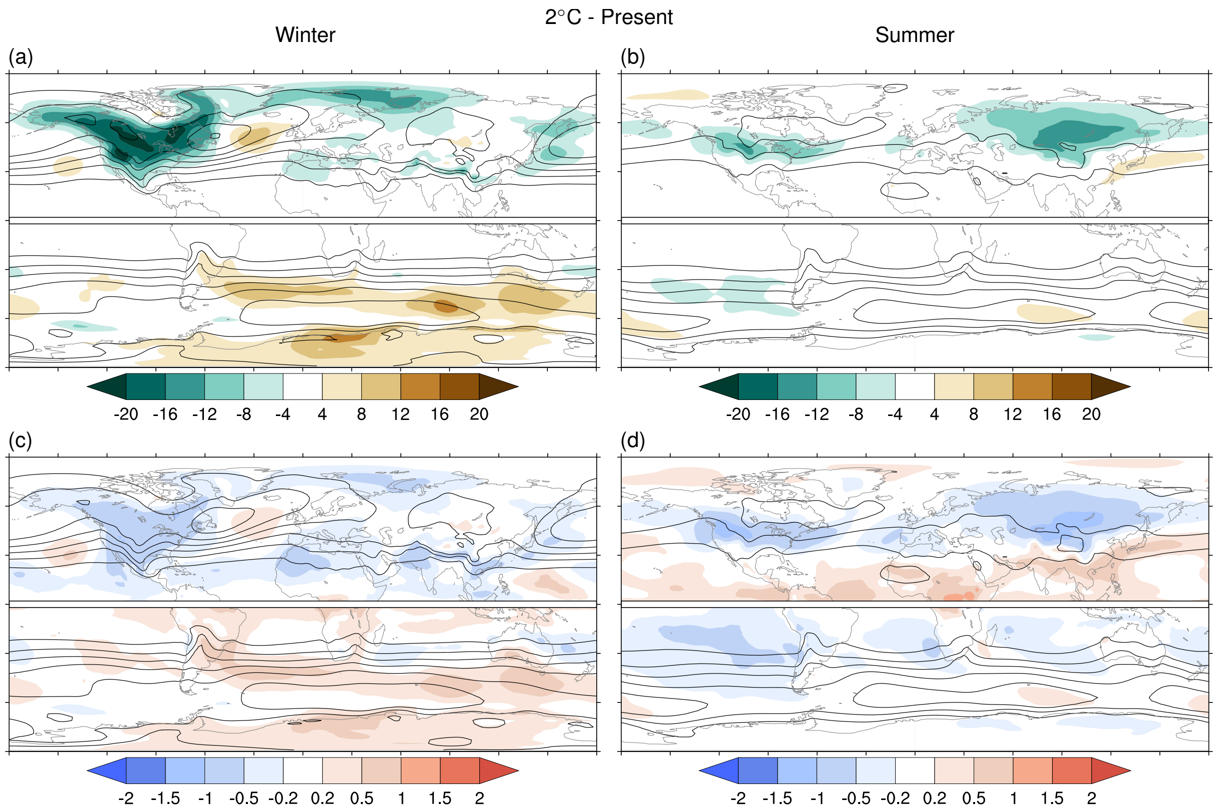

Figure S3.6. Response of winter (left) and summer (right) MSLP storm tracks for 2.0°C−PD. Top panels show responses (shading; units hPa) along with the climatology (contour interval 100 hPa) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response (shading; units hPa). In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response.

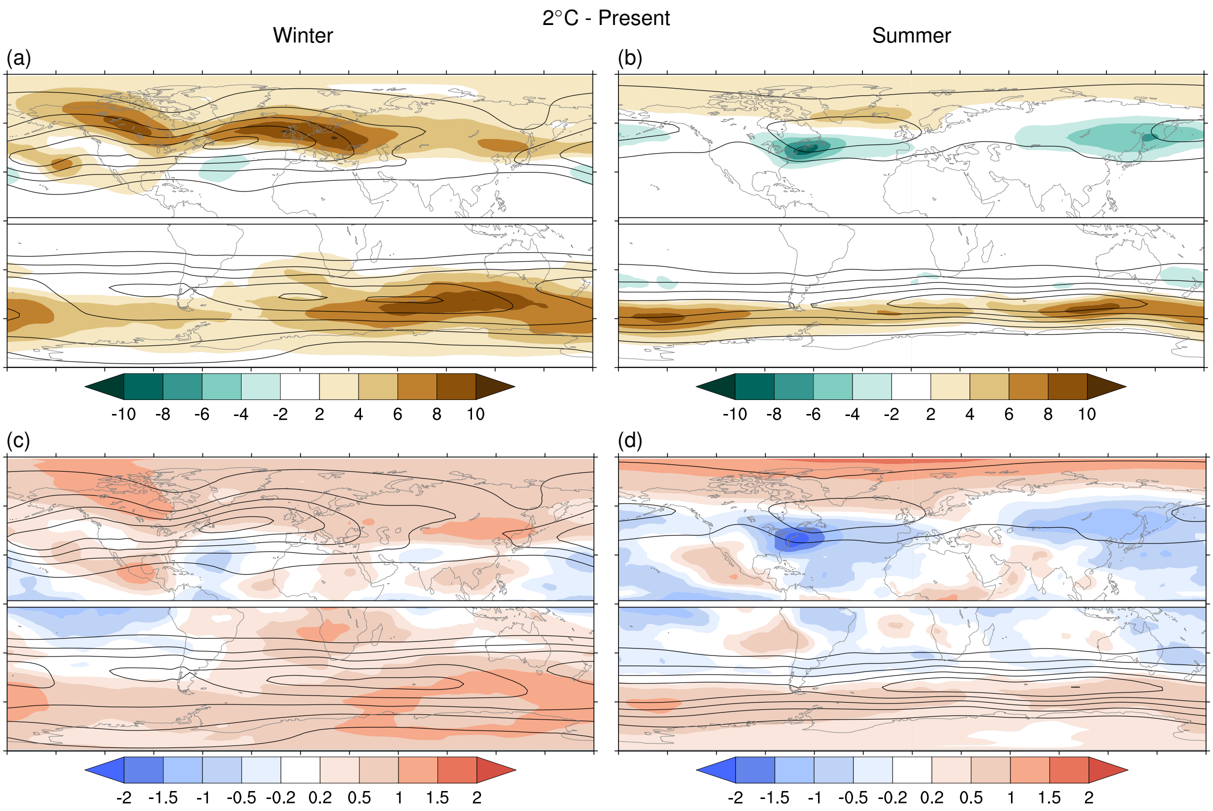

Figure S3.7. Response of winter (left) and summer (right) EKE storm tracks for 2.0°C−PD. Top panels show responses (shading; units m^2 s^{-2}) along with the climatology (contour interval 40 m^2 s^{-2}) for the PD experiment. Bottom panels show signal-to-noise ratio β/σ, where the sign corresponds to the sign of the response (shading; units m^2 s^{-2}). In (c) and (d), black dots (if present) mask out regions where consensus is low ($f^2 > 1$) on the magnitude of the response. The storm tracks are defined as bandpass filtered daily eddy kinetic energy at 200 hPa.