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Supplement of

Southern Hemisphere sudden stratospheric warmings continue to be relevant under global warming

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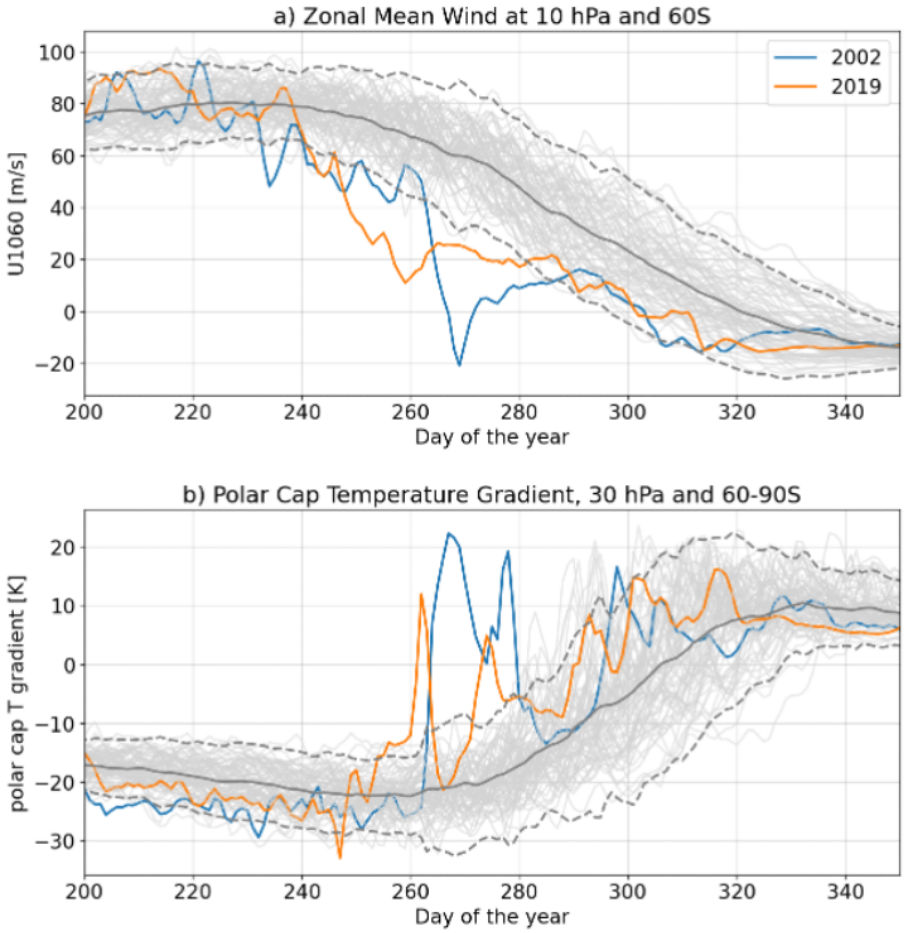

Figure S1. Days 200 to 350 of the year of the annual cycle of ERA5 data (1950 to 2025) for a) the zonal mean zonal wind (U) at 10 hPa and 60°S and for b) the temperature gradient from 60°to 90°S. Individual years are depicted as thin gray lines. The dark gray line shows the mean over all years, the dashed lines indicate +/- 2 standard deviations. Colored lines in a) indicate years for which a stratospheric warming event was defined ($U_{1060S} < 20m/s$), in b) indicate years in which the temperature gradient turns positive before October. The same years are detected in a) and b).

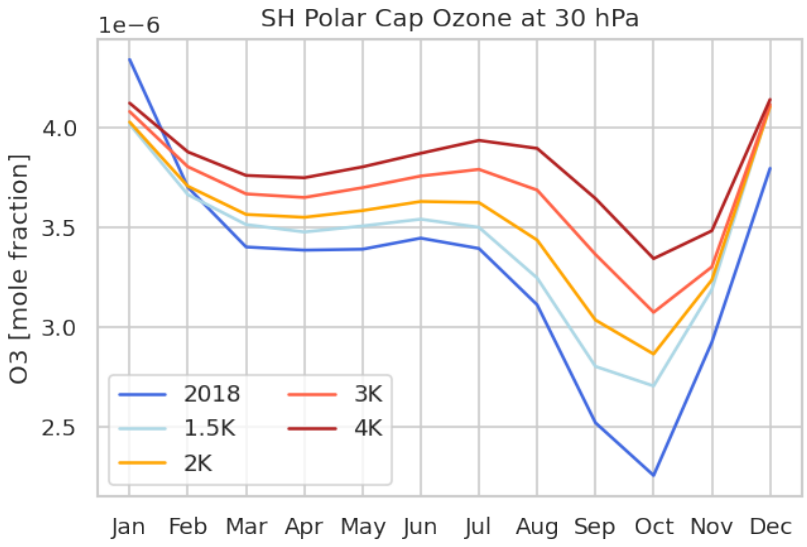

Figure S2. Seasonal cycle of polar cap ozone concentrations at 30 hPa for the different time slice experiments: 2018 (dark blue), 1.5K (light blue), 2K (yellow), 3K (orange), and 4K (red).

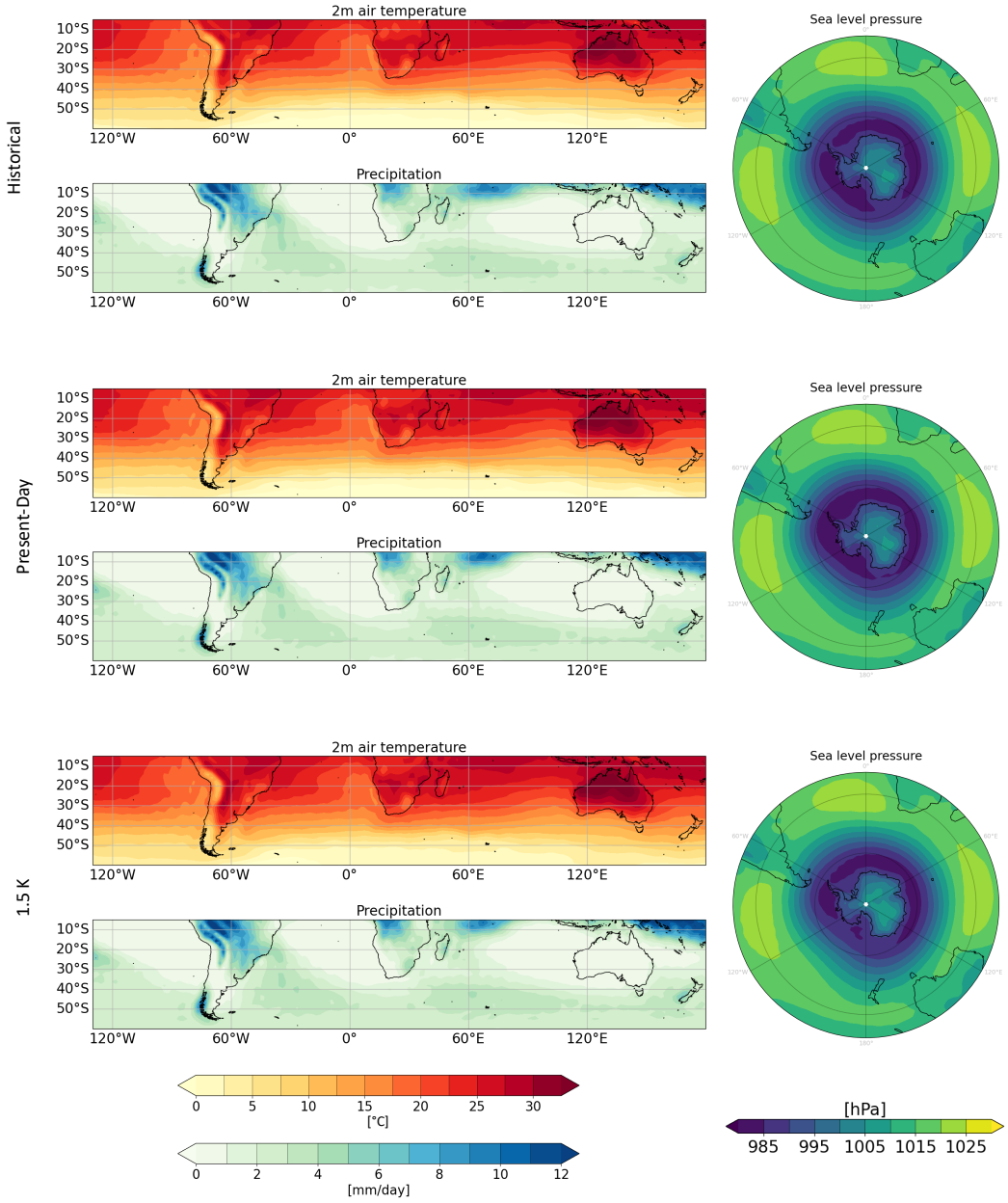

Figure S3. Part 1 of the October-November-December climatologies of 2 m air temperature [°C], precipitation [mm/day] and sea level pressure [hPa] for model experiments (top to bottom): Historical, Present-Day time slice, and 1.5K global warming time slice.

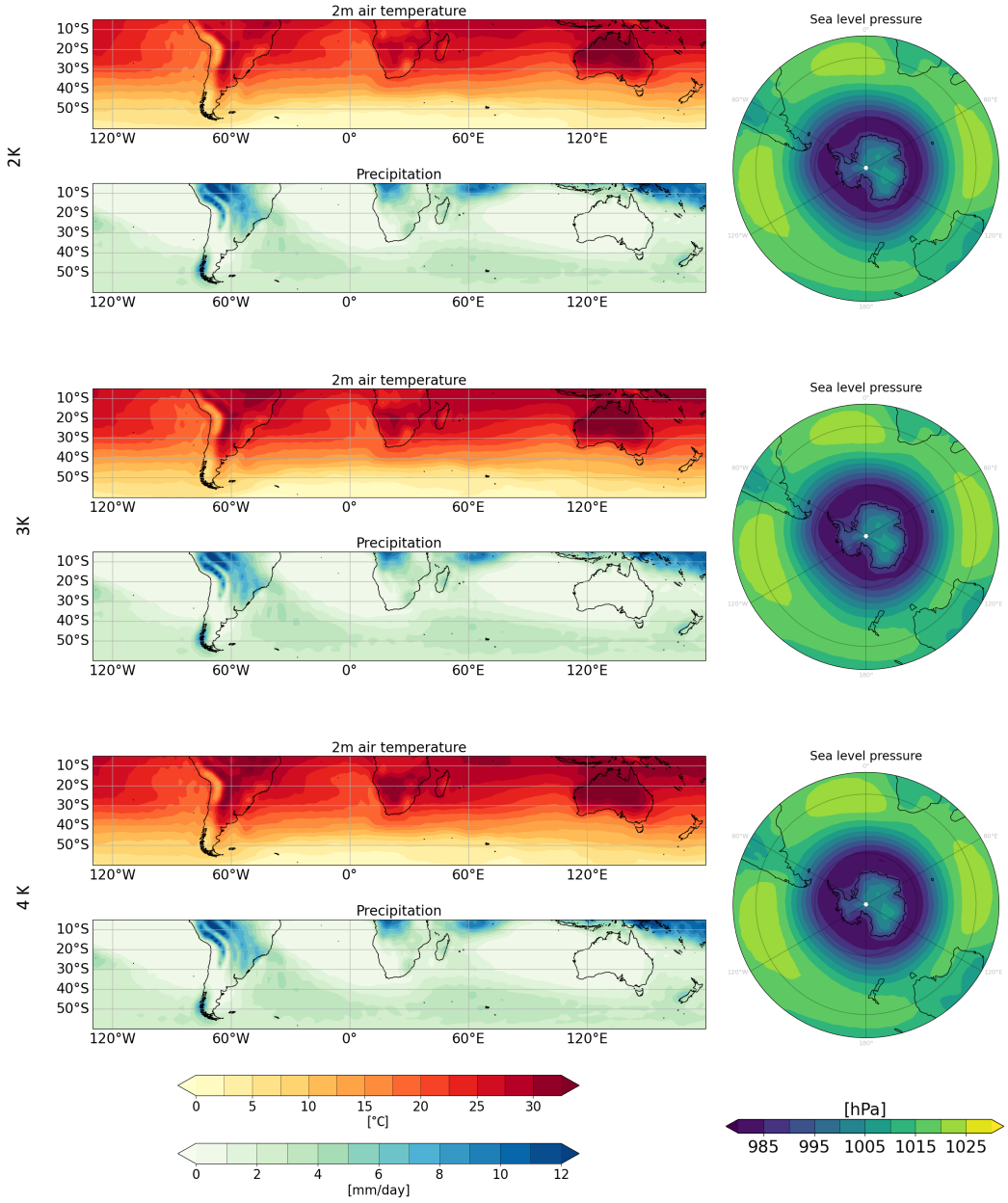

Figure S3. Part 2 of the October-November-December climatologies of 2 m air temperature [°C], precipitation [mm/day] and sea level pressure [hPa] for model experiments (top to bottom): 2K, 3K and 4K P global warming time slice.

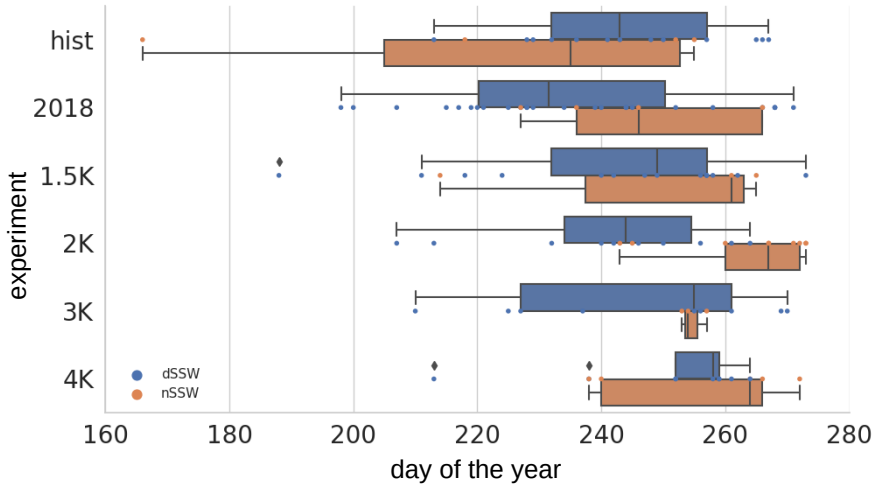

Figure S4. Boxplot of SSW onset days for the different model experiments on the y-axis. dSSWs (blue) and nSSWs (orange) are considered separately. Dots show the individual events that were considered for the statistics, while diamonds show outliers. The box represents the quartiles, the whiskers the spread of the distribution (excluding outliers). The median is indicated by a solid line.

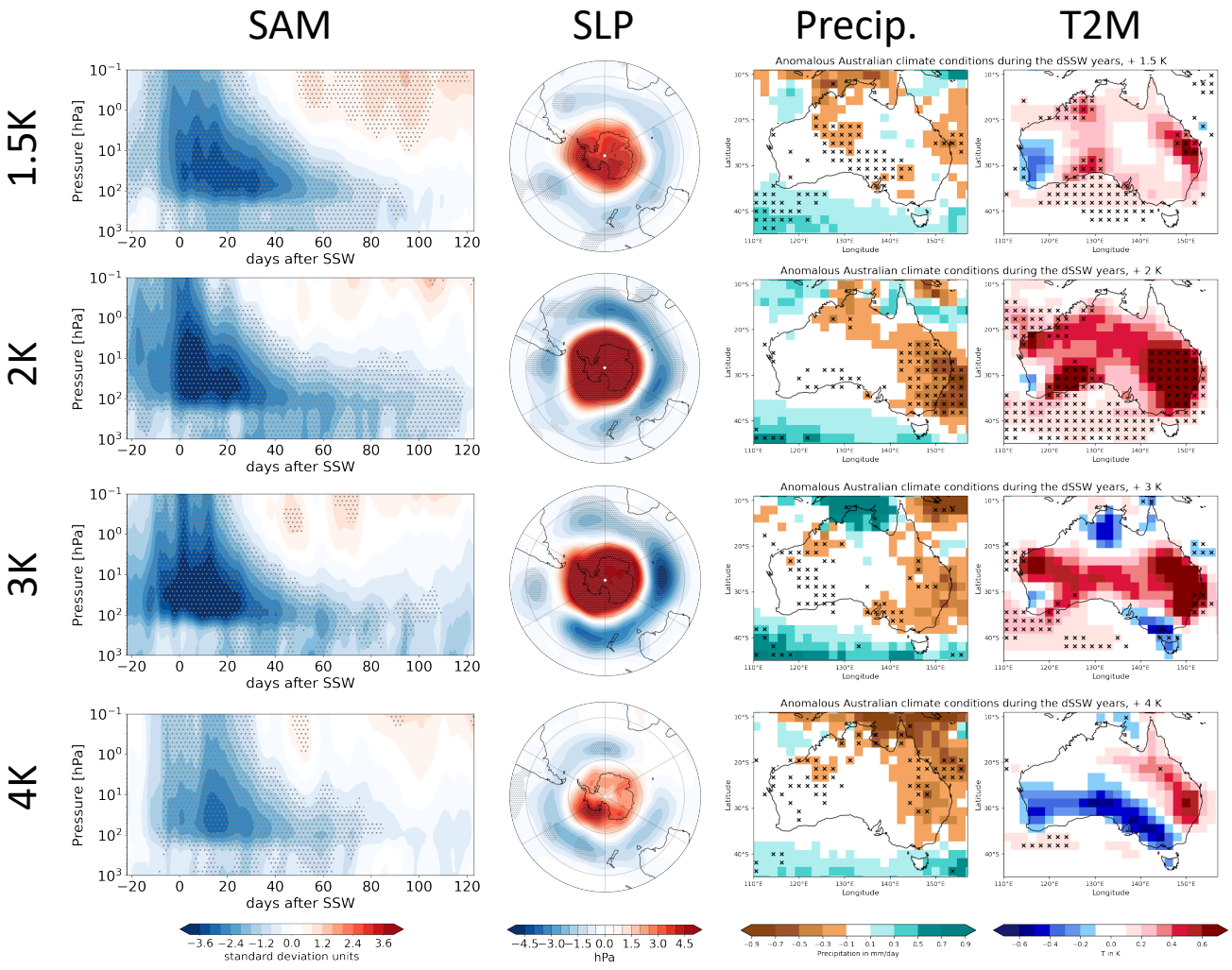

Figure S5. dSSW composites for the different global warming levels: 1.5 K, 2 K, 3 K, and 4 K (top to bottom) showing anomalies of the SAM with respect to the central day of the dSSWs, as well as of SLP, precipitation (Precip.) and 2 m air temperature (T2M) averaged over OND for years with dSSWs (left to right). Stippling indicates statistical significance ($p - value \leq 0.05$).

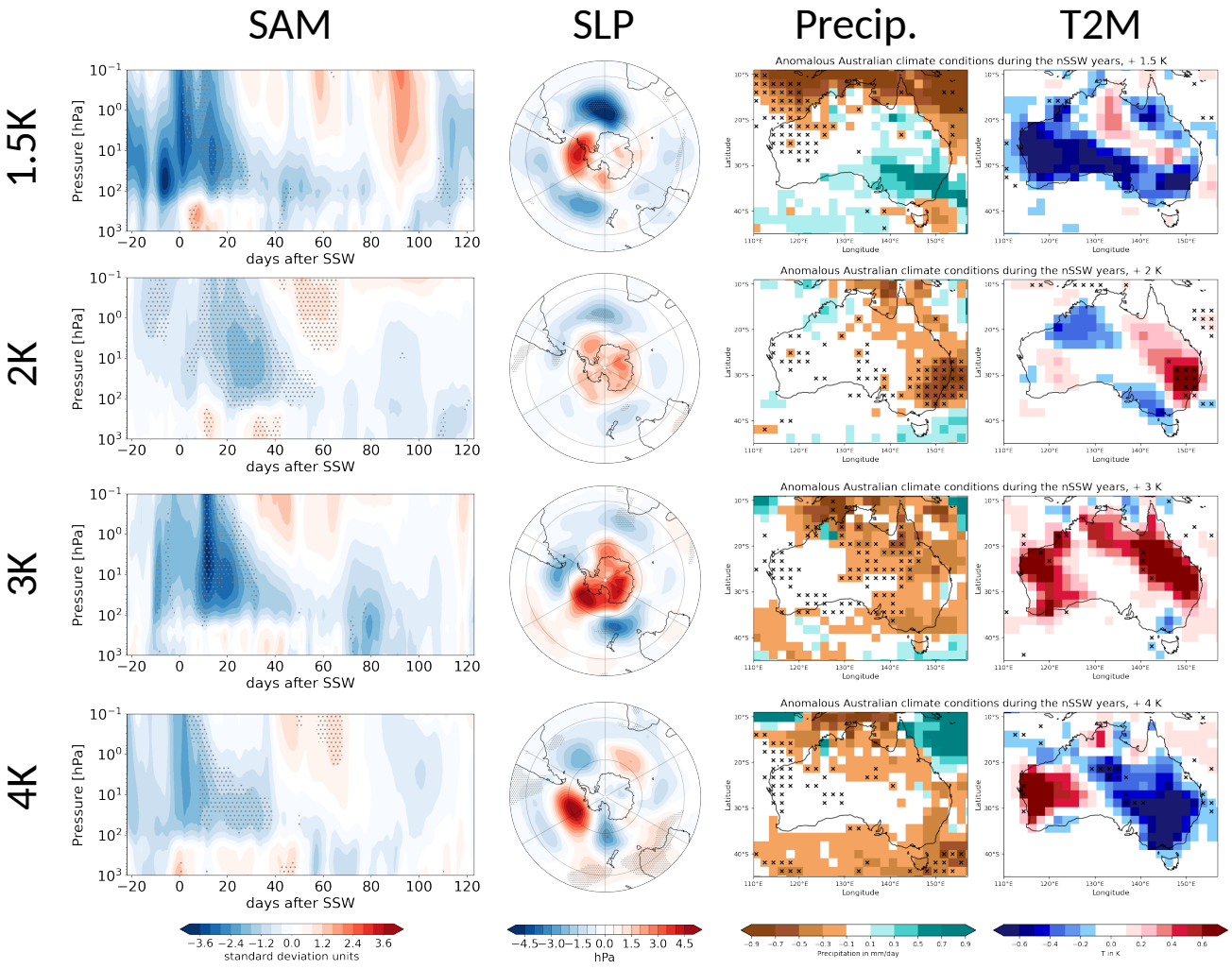

Figure S6. nSSW composites for the different global warming levels: 1.5 K, 2 K, 3 K, and 4 K (top to bottom) showing anomalies of the SAM with respect to the central day of the nSSWs, as well as of SLP, precipitation (Precip.) and 2 m air temperature (T2M) averaged over OND for years with nSSWs (left to right). Stippling indicates statistical significance ($p - value \leq 0.05$).

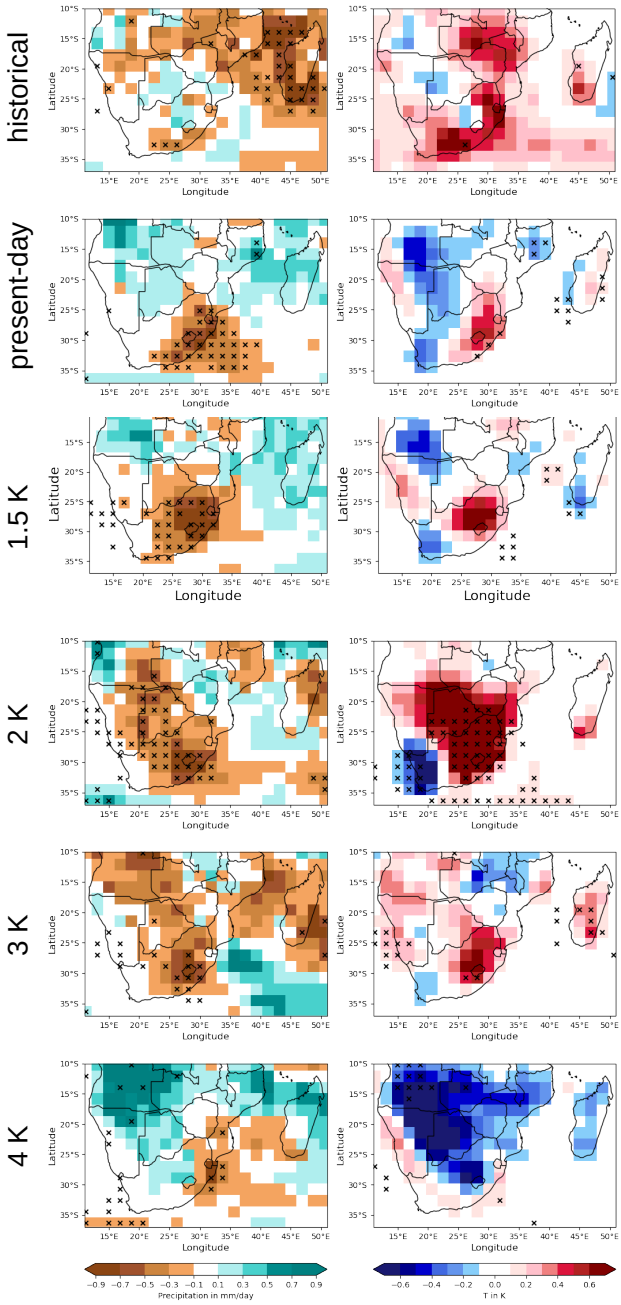

Figure S7. dSSW composites for South Africa in all model experiments: historical, present-day, 1.5K, 2K, 3K, and 4K (top to bottom) showing anomalies in precipitation (left column) and 2 m air temperature (right column) averaged over OND for years with dSSWs. Stippling indicates statistical significance ($p - value \leq 0.05$).

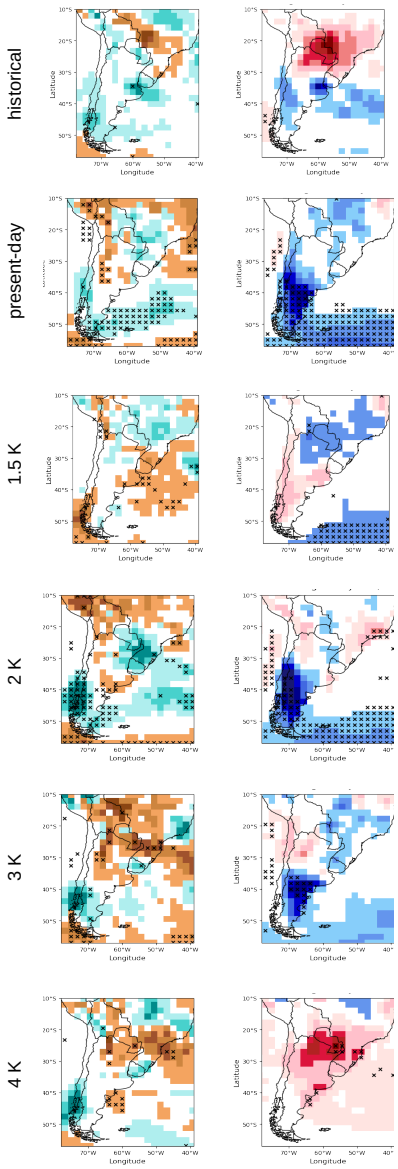

Figure S8. SSW composites for South America in all model experiments: historical, present-day, 1.5K, 2K, 3K, and 4K (top to bottom) showing anomalies in precipitation (left column) and 2 m air temperature (right column) averaged over OND for years with SSWs. Stippling indicates statistical significance ($p - value \leq 0.05$).

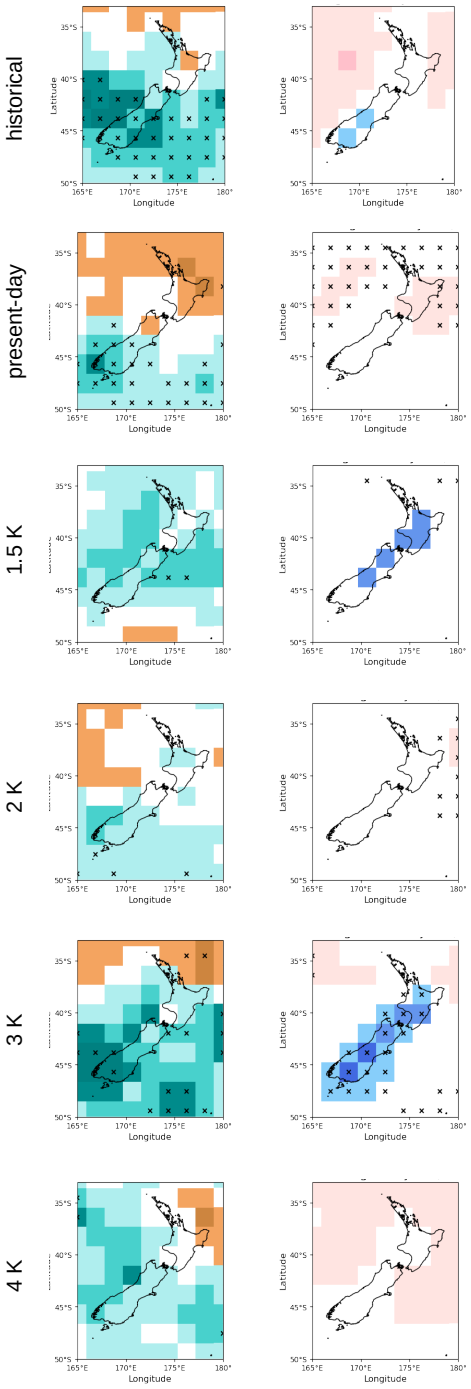

Figure S9. SSW composites for New Zealand in all model experiments: historical, present-day, 1.5K, 2K, 3K, and 4K (top to bottom) showing anomalies in precipitation (left column) and 2 m air temperature (right column) averaged over OND for years with SSWs. Stippling indicates statistical significance ($p - value \leq 0.05$).