

1 **Supplementary Information for Arctic Amplification, and its Seasonal Mi-**  
2 **gration, Over a Wide Range of Abrupt CO<sub>2</sub> Forcing**

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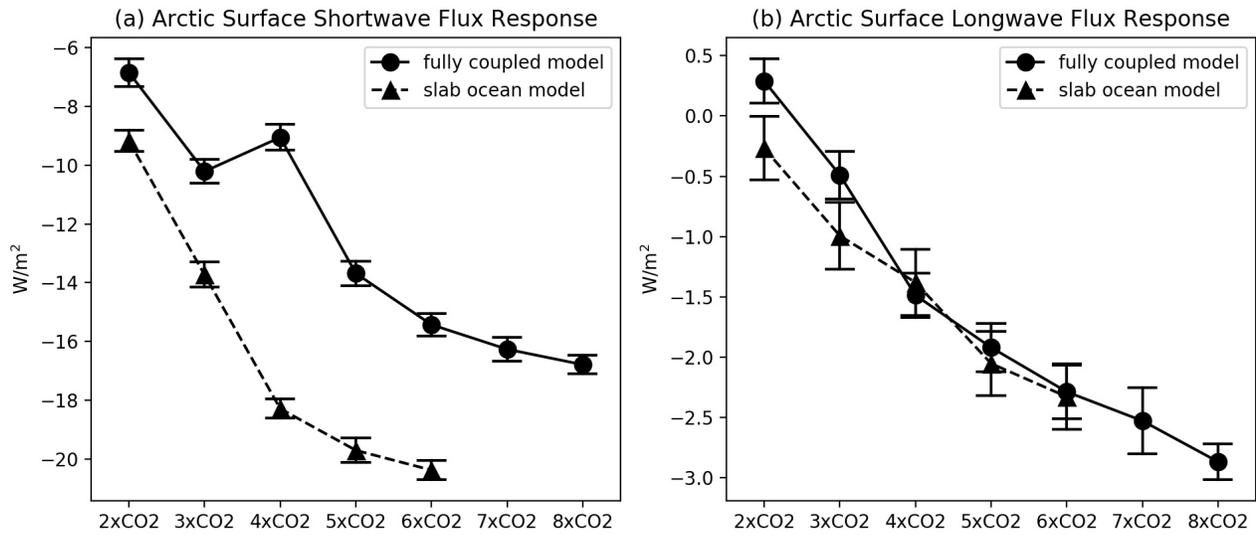
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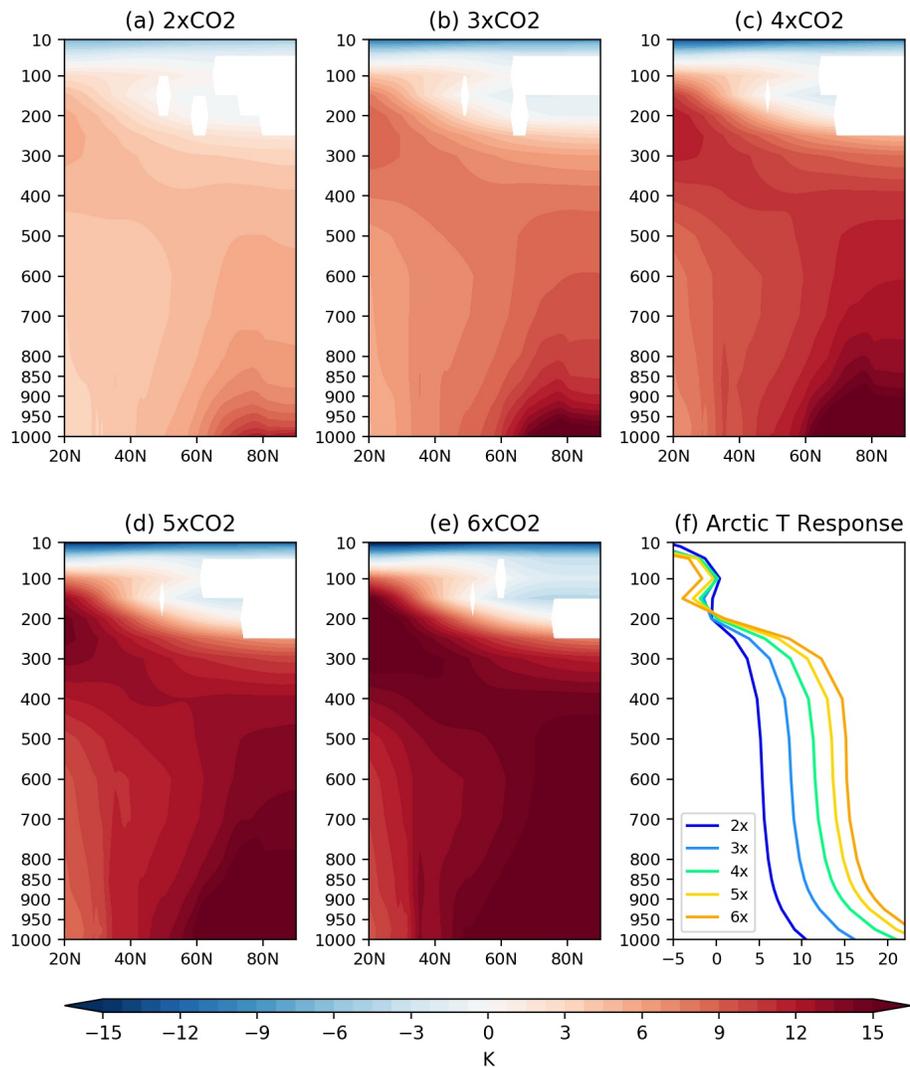
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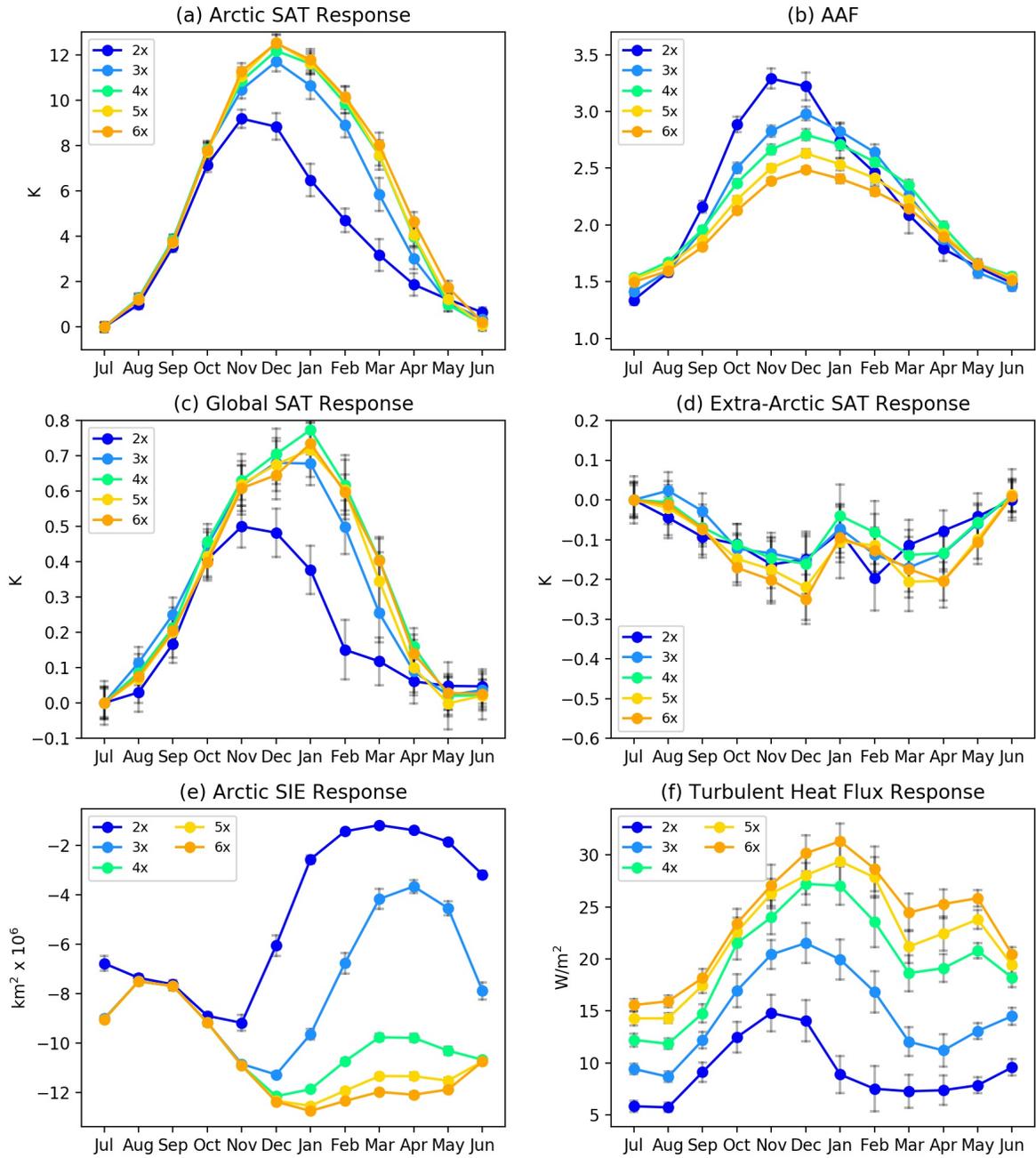
15  
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17 **Supplementary Figures**



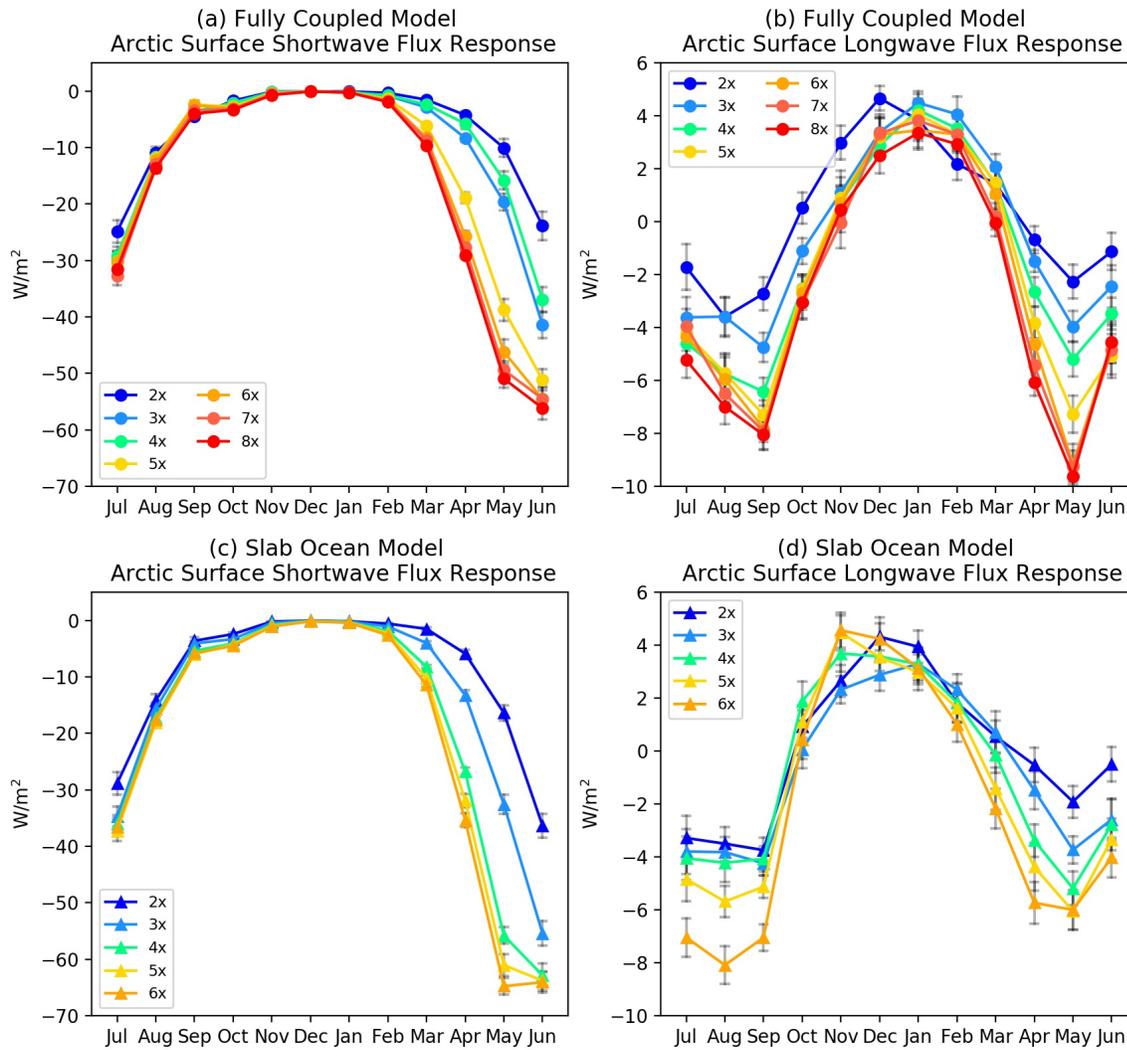
**Supplementary Figure 1: Annual-mean Arctic surface net shortwave and longwave flux responses as functions of increasing CO<sub>2</sub> forcing in fully coupled and slab ocean model experiments. **a** Surface net shortwave flux response. **b** Surface net longwave flux response. Positive values mean fluxes from the ocean into the atmosphere. The solid line with circle symbols represent responses for the fully coupled model experiments, whereas the dashed line with triangle symbols for the slab ocean model experiments. Error bars denote 95% confidence intervals calculated using Student's *t*-distribution.**



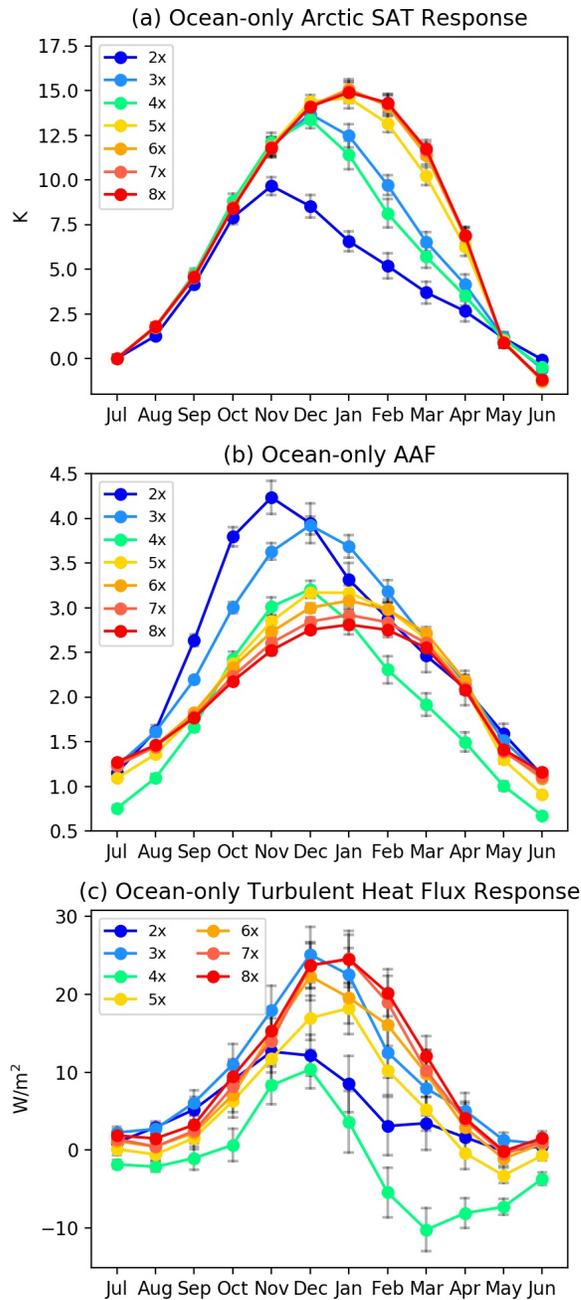
**Supplementary Figure 2: Zonal-mean air temperature responses to varying CO<sub>2</sub> forcing in in vertical-latitude coordinate for slab ocean model experiments. a-e** The zonal-mean air temperature responses for 2x to 6xCO<sub>2</sub> respectively in slab ocean model experiments. Only the responses passing Student's *f* test with 95% confidence interval are shown. **h** Polar cap-averaged (60°N-90°N) air temperature responses.



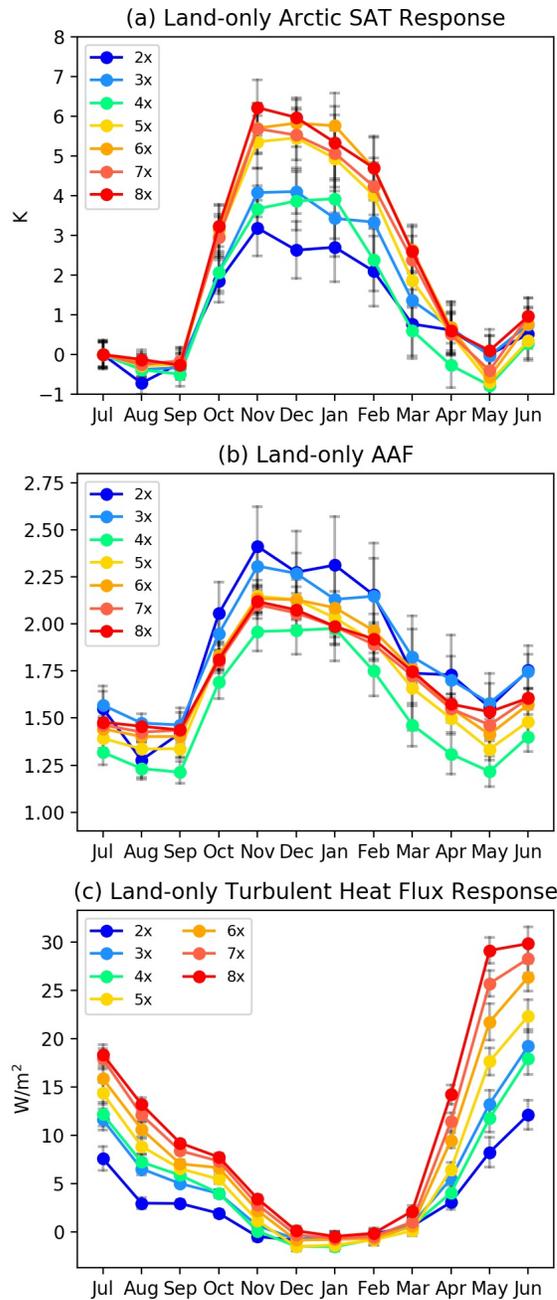
**Supplementary Figure 3: Seasonal evolutions of Arctic SAT, SIE, turbulent heat flux responses and AAFs in abrupt CO<sub>2</sub> slab ocean model experiments.** **a** The evolution of Arctic SAT responses for 2x to 8xCO<sub>2</sub>. **b** Similar as **a** but for AAF. **c-d** Same as **a** but for global and extra-Arctic (90°S-59°N) SAT responses. **e-f** Same as **a** but for SIE and turbulent heat flux responses. Error bars denote 95% confidence intervals calculated using Student's *t*-distribution. Values in **a**, **c** and **d** are referenced to July values.



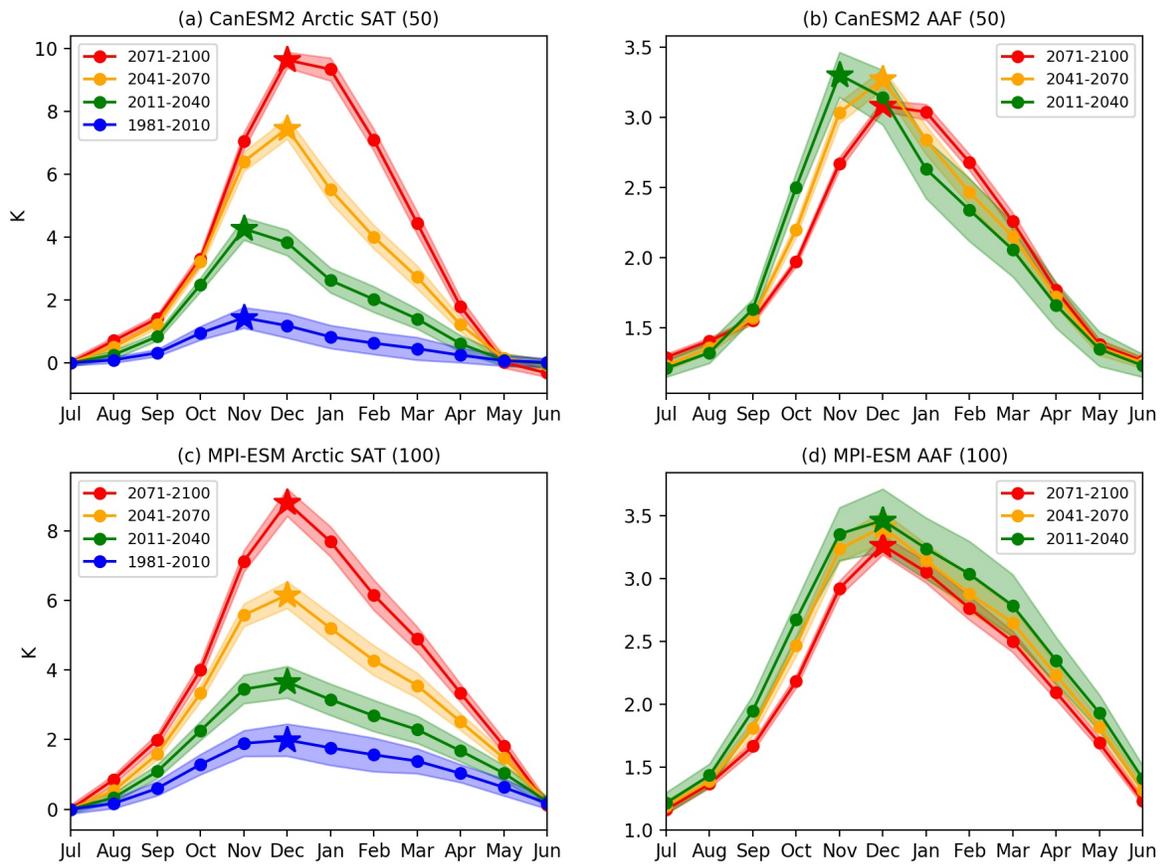
**Supplementary Figure 4: Seasonal evolutions of Arctic surface net shortwave and longwave responses in abrupt CO<sub>2</sub> experiments.** **a** The evolution of Arctic surface net shortwave responses for 2x to 8xCO<sub>2</sub> in fully coupled model experiments. **b** Similar as **a** but for longwave responses. **c-d** Similar as **a-b** but for slab ocean model experiments. Positive values mean fluxes from the ocean into the atmosphere. Error bars denote 95% confidence intervals calculated using Student's *t*-distribution.



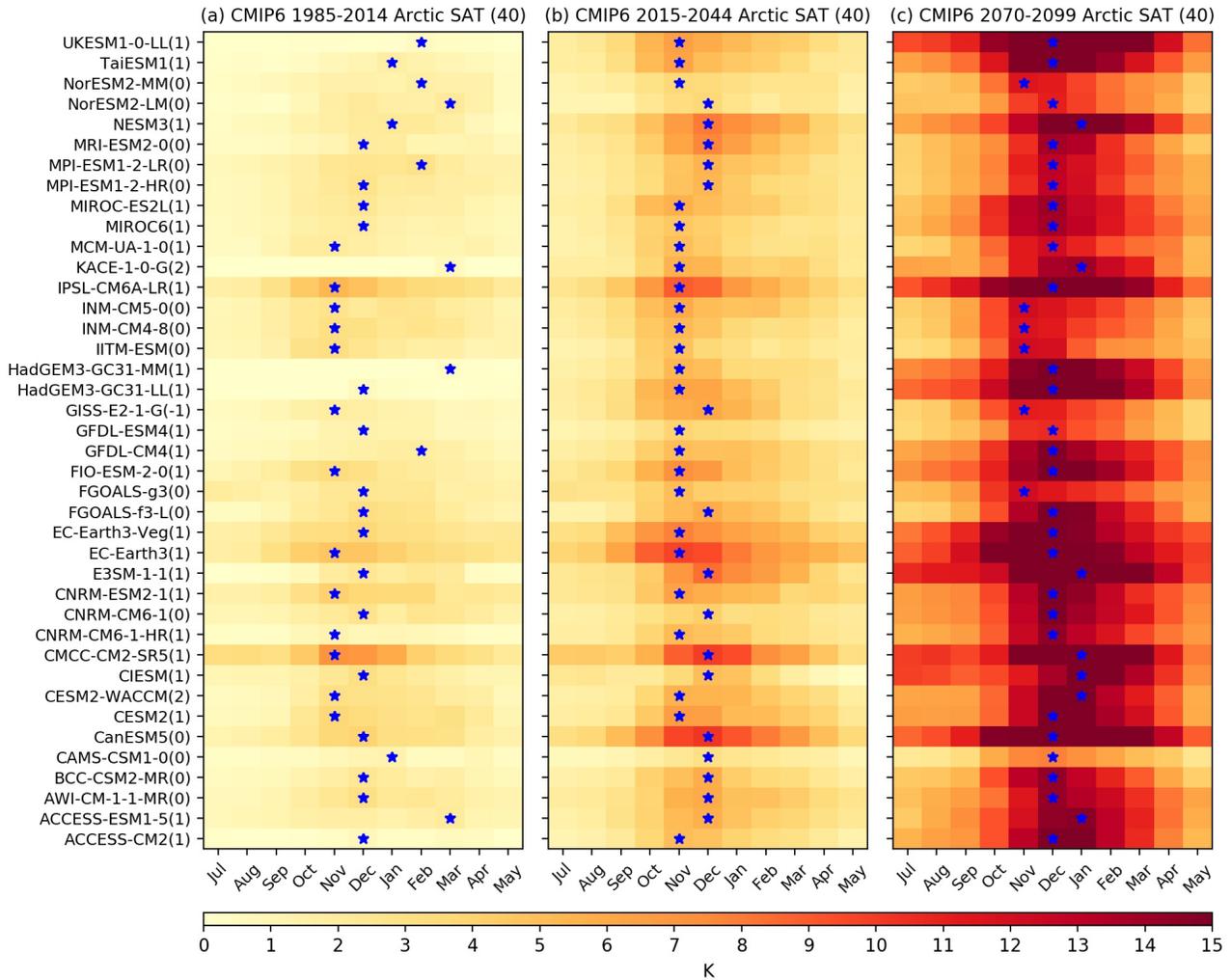
**Supplementary Figure 5: Seasonal evolutions of Arctic SAT responses, AAF, and turbulent heat flux responses in abrupt CO<sub>2</sub> experiments for ocean-only grids. a** The evolution of Arctic SAT responses for 2x to 8xCO<sub>2</sub> in fully coupled model experiments. **b** Similar as **a** but for AAF. **c** Similar as **a** but for turbulent heat flux responses. Positive values mean fluxes from the ocean into the atmosphere. Error bars denote 95% confidence intervals calculated using Student's *t*-distribution.



**Supplementary Figure 6: Seasonal evolutions of Arctic SAT responses, AAF, and turbulent heat flux responses in abrupt CO<sub>2</sub> experiments for land-only grids. a** The evolution of Arctic SAT responses for 2x to 8xCO<sub>2</sub> in fully coupled model experiments. **b** Similar as **a** but for AAF. **c** Similar as **a** but for turbulent heat flux responses. Positive values mean fluxes from the ocean into the atmosphere. Error bars denote 95% confidence intervals calculated using Student's *t*-distribution.



**Supplementary Figure 7: Seasonal evolutions of Arctic SAT responses and AAFs in CanESM2 and MPI-ESM SMILES.** **a** The evolution of Arctic SAT responses (reference to 1951-1980 averages) in CanESM2 SMILE. **b** Similar as **a** but for AAFs. **c-d** Similar as **a-b** but for MPI-ESM SMILE (reference to 1921-1950 averages). The solid line represents ensemble means and the color shading indicates one standard deviation across ensemble members. In **a,c**, all values are referenced to July values. The ensemble size is labeled in the parenthesis of each title.



**Supplementary Figure 8: Seasonal evolutions of Arctic SAT responses for each CMIP6 model used in this study.** **a** The evolution of Arctic SAT responses (reference to 1951-1980 averages) for each CMIP6 model during 1985-2014 period. **b** Similar as **a** but during 2015-2044 period. **c** Similar as **a** but during 2070-2099 period. All values are referenced to July values. The number of lagged month (2070-2099 against 2015-2044) for each model is labeled in the the parenthesis next to the model name, and the total number of models is labeled in the parenthesis of each title.