

Supporting Information for Arctic sea ice loss weakens Northern Hemisphere summertime storminess but not until the late 21st century

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Introduction

In the Supporting Information, we show details of individual models which are not shown in the main manuscript.

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Table S1. Summary of coupled and uncoupled Arctic sea ice loss experiments. Arctic sea ice loss is quantified as decrease in sea ice area poleward of 60°N.

Ocean coupling	Short name	Arctic sea ice loss [10 ⁶ km ²]	Years× ensemble members	References
Coupled	WACCM4-C	4.3	200×1	(Blackport & Kushner, 2017) (England et al., 2020) (England et al., 2020) (Sun et al., 2018) (Sun et al., 2015)
	BK17	3.5	425(275)×1	
	E20-A	3.5	250×1	
	E20-A&AA	3.6	250×1	
	CM3 ΔICE (2061–90)	7.5	30×5	
Uncoupled	WACCM4-U	3.9	200×1	(Smith et al., 2019)
	AWI-CM-1-1-MR		1×100	
	CanESM5		1×200	
	CESM2		1×200	
	HadGEM3-GC31-MM	2.5	1×300	
	IPSL-CM6A-LR		1×200	
	MIROC6		1×100	
	TaiESM1		1×100	

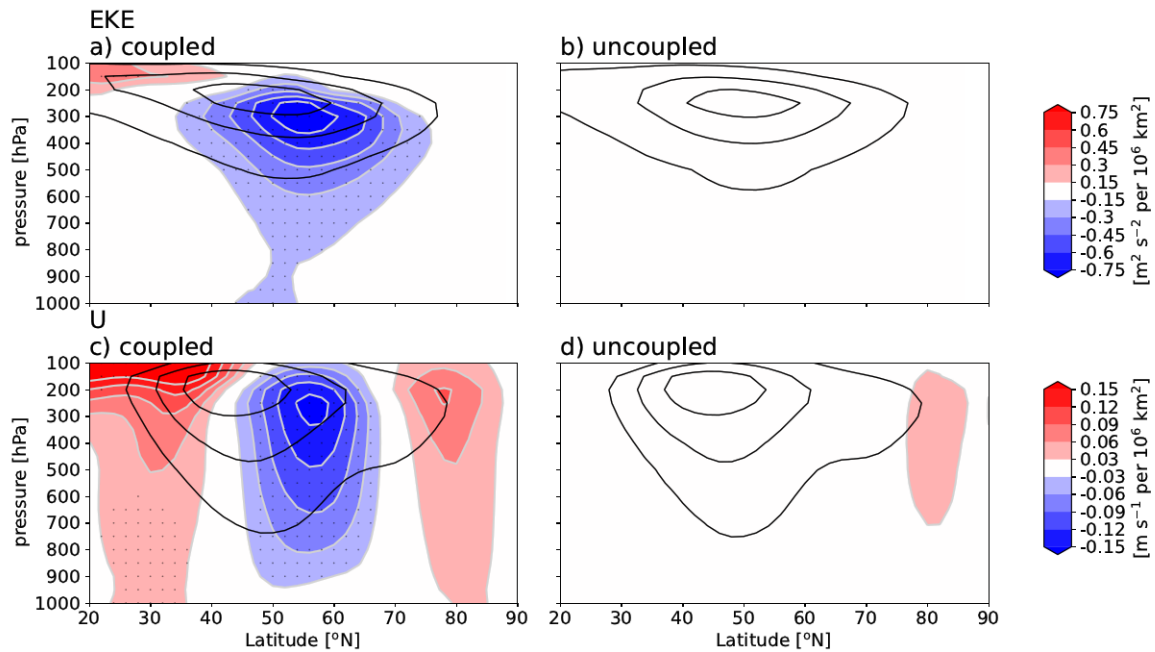


Figure S1. Response of summertime zonal-mean (a,b) EKE and (c,d) zonal wind to Arctic sea ice loss in the (a,c) coupled and (b,d) uncoupled climate model simulations. Responses are normalized by Arctic sea ice loss in each experiment before being averaged across models. The summertime climatology of zonal-mean EKE and zonal wind is shown in black contours ($25 \text{ m}^2 \text{ s}^{-2}$ starting from $25 \text{ m}^2 \text{ s}^{-2}$ for EKE and 5 m s^{-1} starting from 5 m s^{-1} for zonal wind). Stipples indicate where all models agree in the sign of the response. Near-zero responses are not stippled for conciseness.

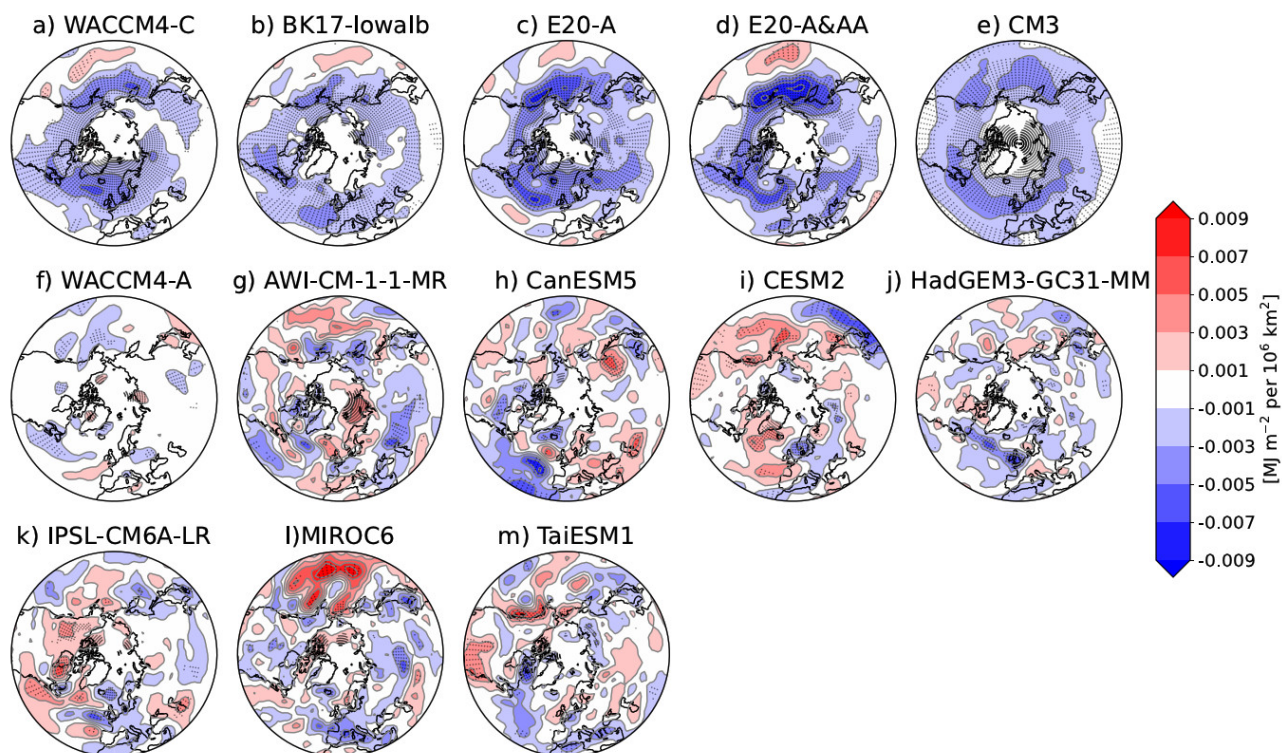


Figure S2. Response of vertically integrated EKE to Arctic sea ice loss in the (a–e) coupled and (f–m) uncoupled climate model simulations. Responses are normalized by Arctic sea ice loss in each experiment. Stipples denote statistically significant response at the 95% confidence level using a two-sided Student's t-test.

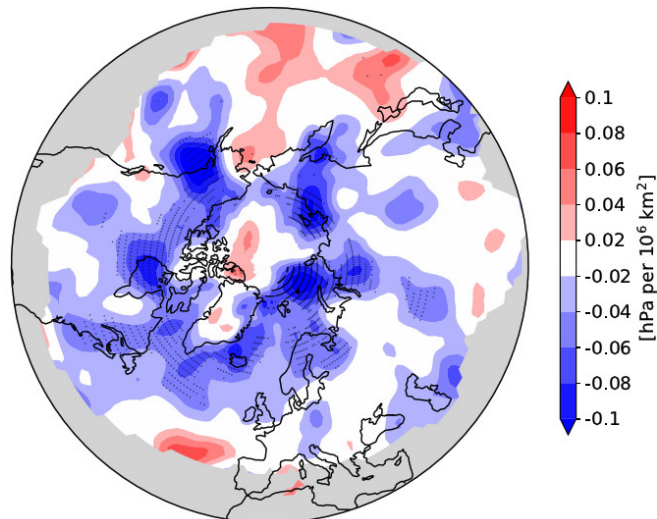


Figure S3. Response of mean intensity in the coupled simulations (CM3, 2061–90). Mean intensity is calculated as average magnitude of pressure anomalies of cyclones and anticyclones per approximately 10^6 km² area (555 km radius). Stipples denote statistically significant response at the 95% confidence level using a two-sided Student's t-test. Contours are suppressed where climatological track density is less than two.

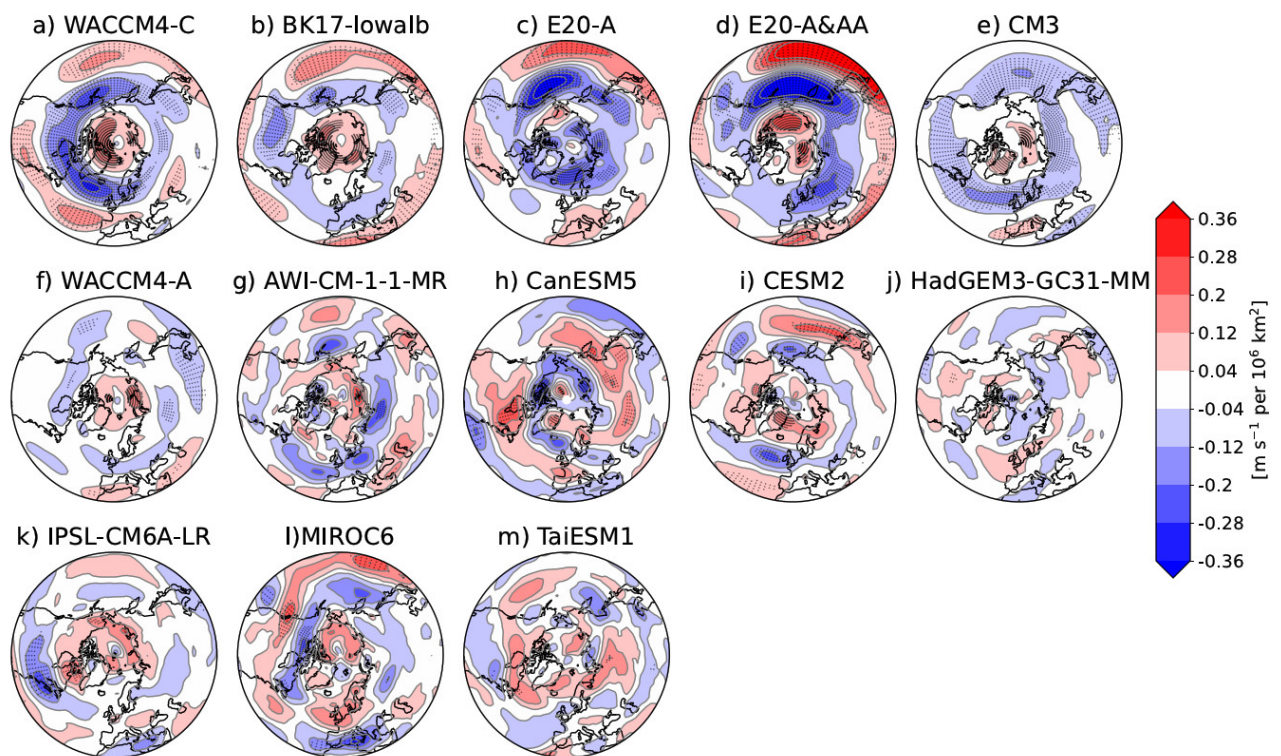


Figure S4. Same as Fig. S2, but for 500-hPa zonal wind.

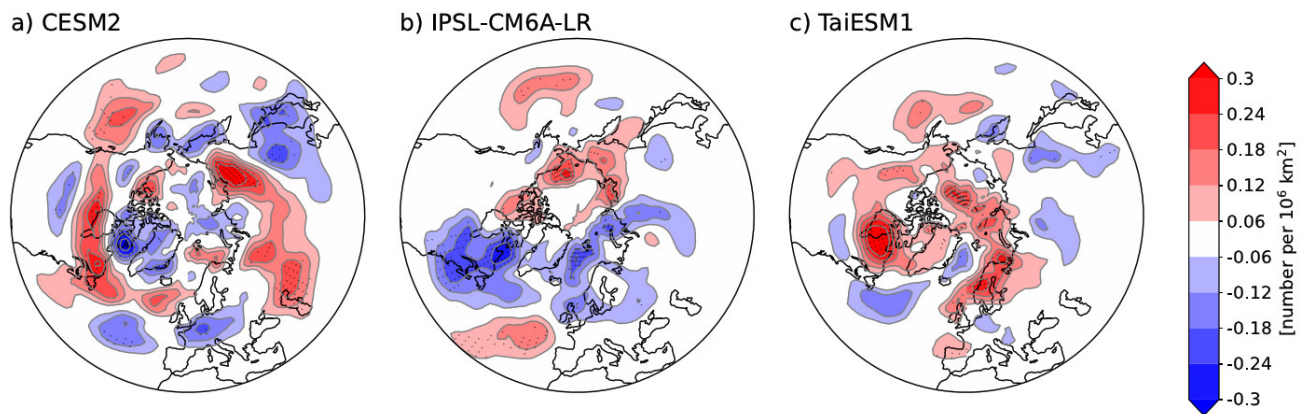


Figure S5. Same as Fig. S2, but for track density in the uncoupled simulations. Track density response in the coupled models (CM3) is shown in Figure 1b.

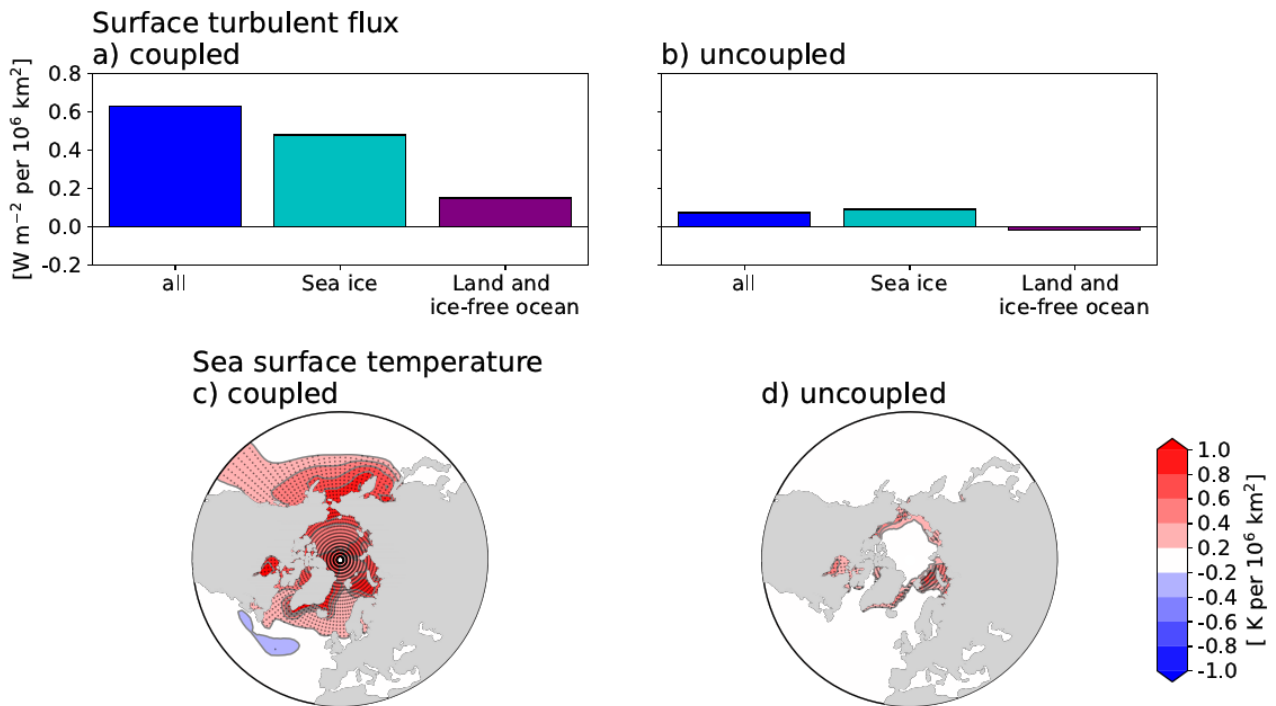


Figure S6. Response of summertime (a,b) surface turbulent flux (blue, $50\text{--}90^\circ\text{N}$) and (c,d) sea surface temperature to Arctic sea ice loss in the (a,c) coupled and (b,d) uncoupled climate model simulations. In (a,b) the contribution from surface turbulent flux changes over sea ice and other grids are shown in cyan and purple, respectively. Responses are normalized by Arctic sea ice loss in each experiment before being averaged across models. In (c,d), stipples indicate where all models agree in the sign of the response. Note that data from BK17 (Table S1) is not included in (c).

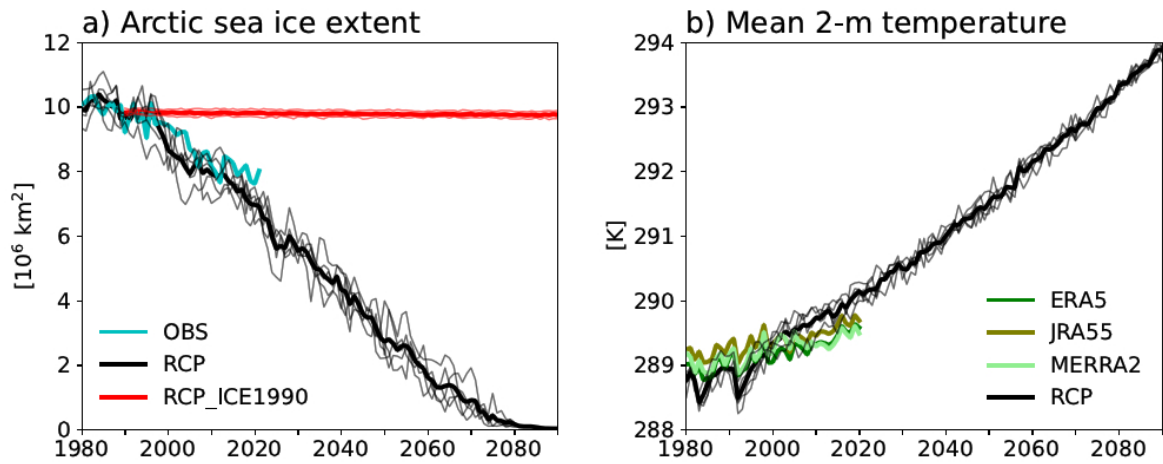


Figure S7. (a) Time series of summertime Arctic sea ice extent in RCP ensemble mean (black) and observation (cyan) from National Snow and Ice Data Center (<https://nsidc.org>). (b) Time series of summertime global-mean 2-m temperature in RCP ensemble mean (black), ERA5 (green), JRA55 (olive), and MERRA2 (light green). In both (a) and (b), individual ensembles of RCP and RCP_ICE1990 simulations are shown in black and red thin lines, respectively.

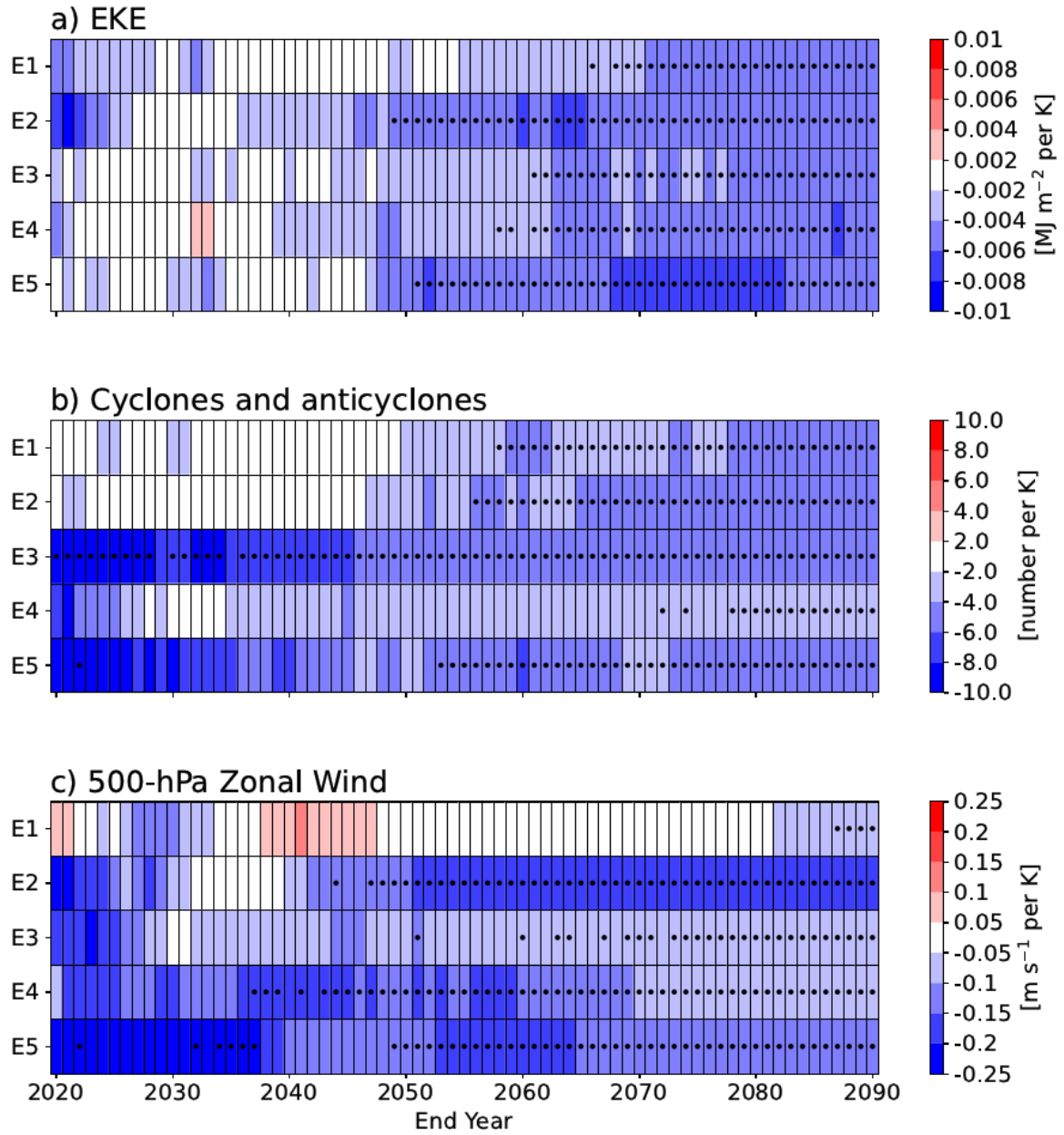


Figure S8. (a) Linear trends of EKE due to Arctic sea ice loss (Δ ICE) from 1990 to different end years (x-axis) for individual ensemble members (E1–5, y-axis). The trends are weighted by the trend in global-mean near surface temperature from RCP simulations during the same period. Significant trends at the 95% confidence level are dotted. (b, c) Same as (a), but for number of cyclones and anticyclones and 500-hPa zonal wind, respectively.

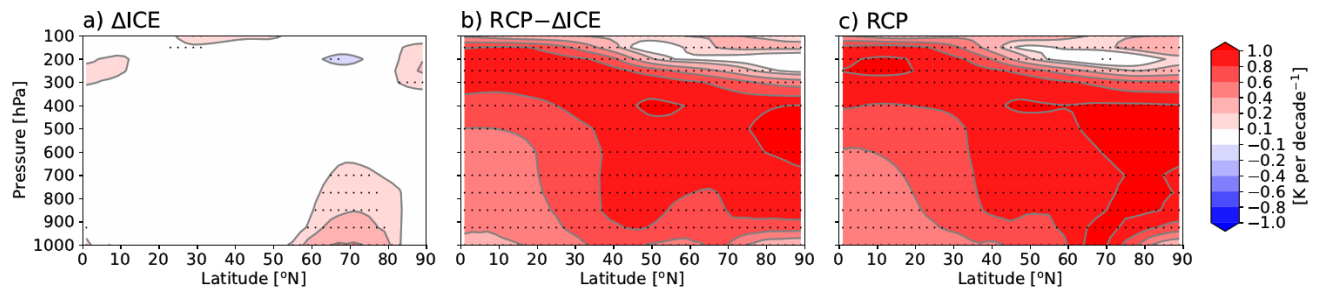


Figure S9. Linear trends of ensemble-mean zonal-mean temperature from 1990 to 2020 due to (a) Arctic sea ice loss (ΔICE), (b) anthropogenic forcing without Arctic sea ice loss ($\text{RCP}-\Delta\text{ICE}$), and (c) anthropogenic forcing (RCP). Significant trends at the 95% confidence level are stippled.

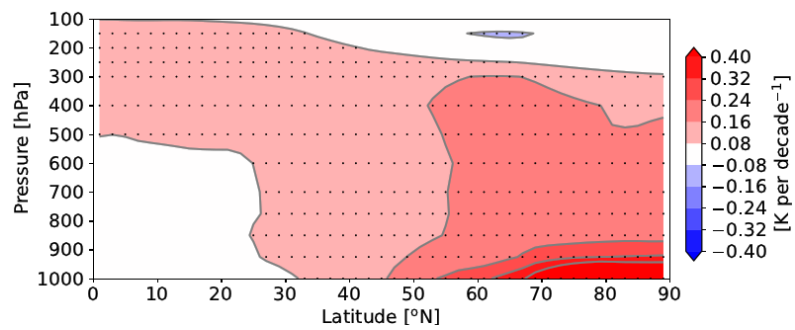


Figure S10. Linear trends of ensemble-mean zonal-mean temperature from 1990 to 2090 due to Arctic sea ice loss. Significant trends at the 95% confidence level are stippled.

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