

Supporting Information:

Constraining the date of a seasonally ice-free Arctic using a simple model

David B. Bonan¹, Tapio Schneider¹, Ian Eisenman², Robert C.J. Wills³

¹Environmental Science and Engineering, California Institute of Technology

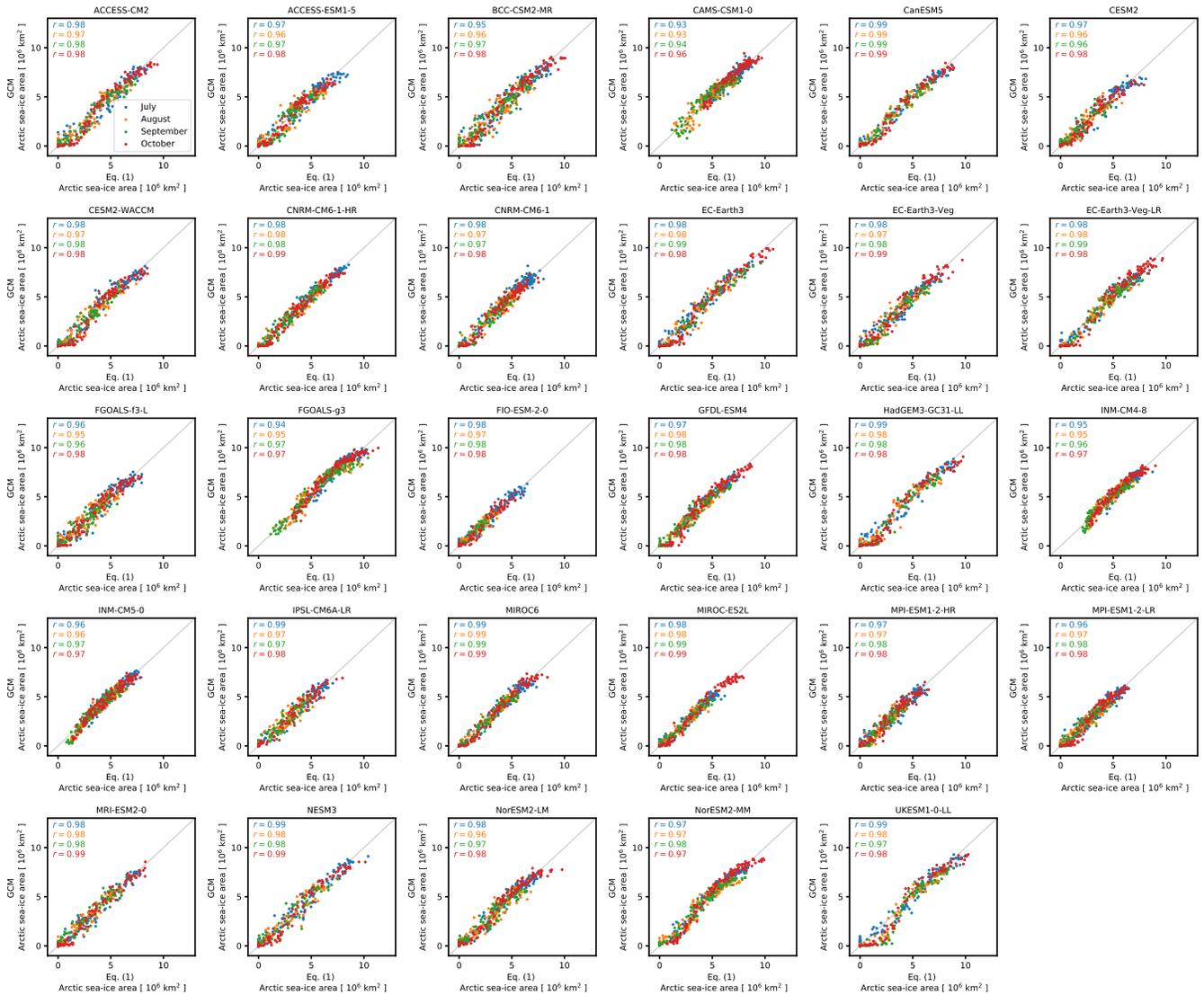
²Scripps Institute of Oceanography, University of California, San Diego

³Department of Atmospheric Sciences, University of Washington

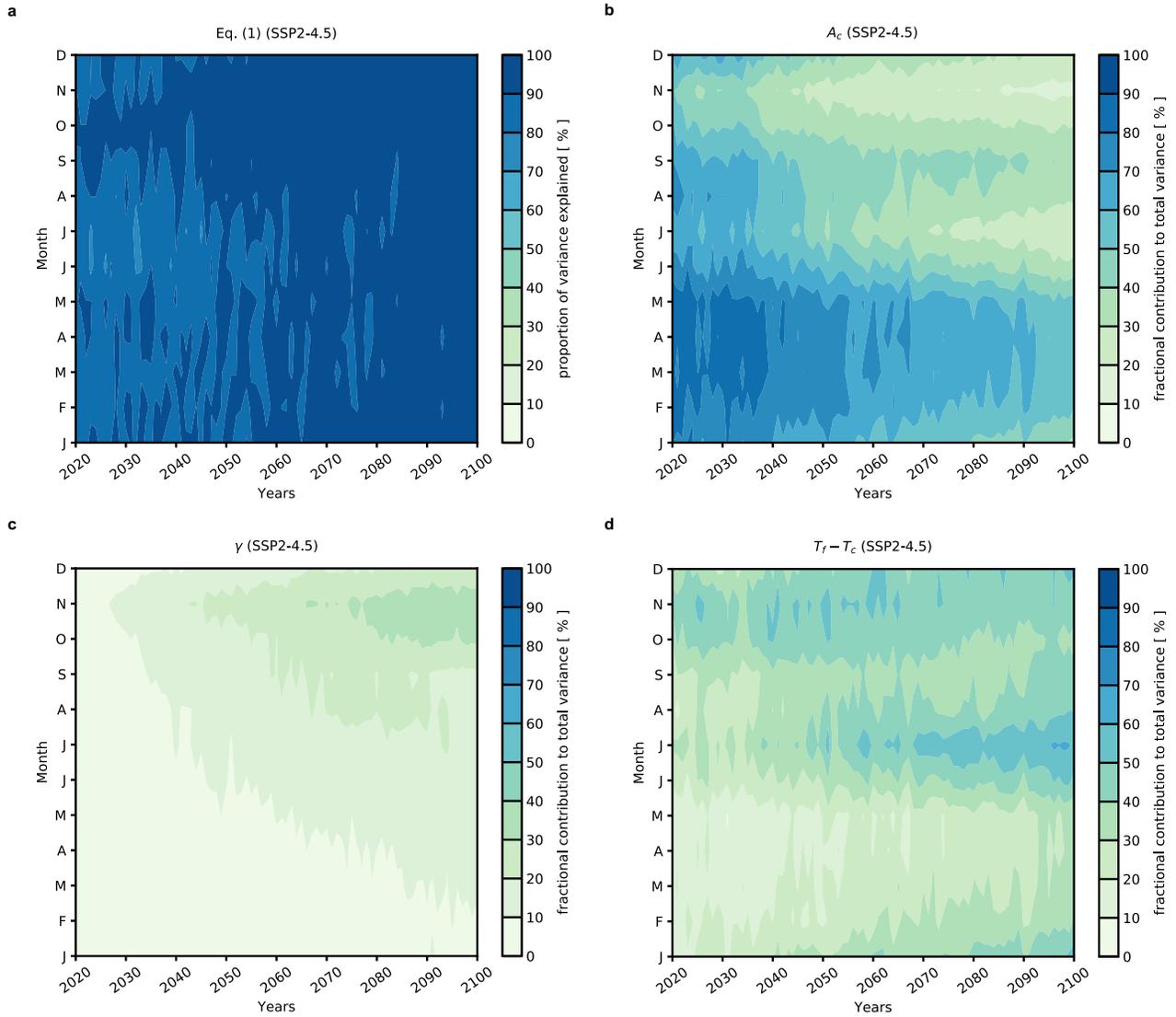
May 11, 2021

	model name	ensemble member
1.	ACCESS-CM2	rlilpf1
2.	ACCESS-ESM1-5	rlilpf1
3.	BCC-CSM2-MR	rlilpf1
4.	CAMS-CSM1-0	rlilpf1
5.	CanESM5	rlilpf1
6.	CESM2	r4ilpf1
7.	CESM2-WACCM	rlilpf1
8.	CNRM-CM6-1-HR	rlilpf2
9.	CNRM-CM6-1	rlilpf2
10.	EC-Earth3	rlilpf1
11.	EC-Earth3-Veg	rlilpf1
12.	EC-Earth3-Veg-LR	rlilpf1
13.	FGOALS-f3-L	rlilpf1
14.	FGOALS-g3	rlilpf1
15.	FIO-ESM-2-0	rlilpf1
16.	GFDL-ESM4	rlilpf1
17.	HadGEM3-GC31-LL	rlilpf3
18.	INM-CM4-8	rlilpf1
19.	INM-CM5-0	rlilpf1
20.	IPSL-CM6A-LR	rlilpf1
21.	MIROC6	rlilpf1
22.	MIROC-ES2L	rlilpf2
23.	MPI-ESM1-2-HR	rlilpf1
24.	MPI-ESM1-2-LR	rlilpf1
25.	MRI-ESM2-0	rlilpf1
26.	NESM3	rlilpf1
27.	NorESM2-LM	rlilpf1
28.	NorESM2-MM	rlilpf1
29.	UKESM1-0-LL	rlilpf2

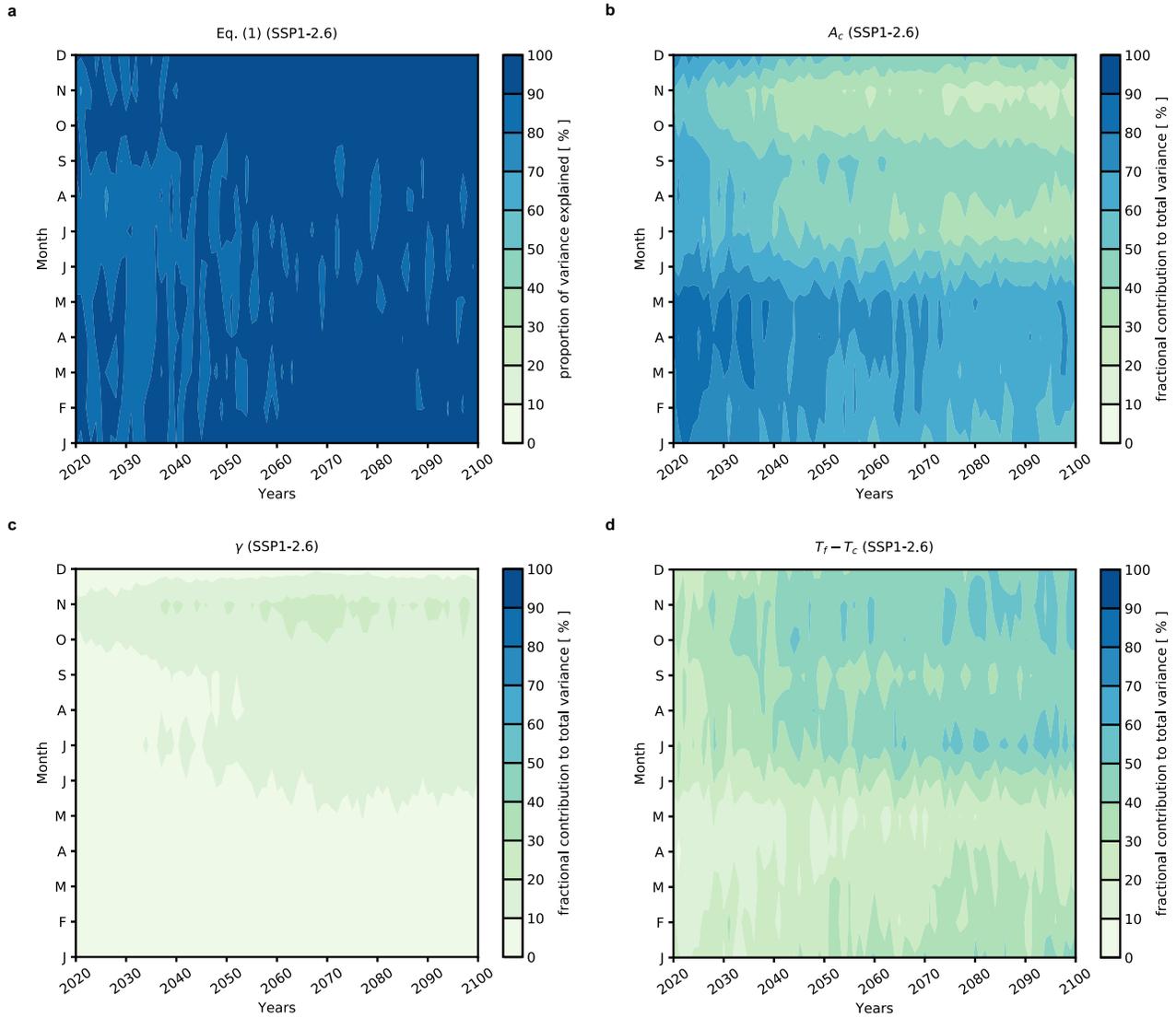
Supplemental Table 1: List of the coupled GCMs and ensemble member used for each Historical, SSP1-2.6, SSP2-4.5, and SSP5-8.5 simulation.



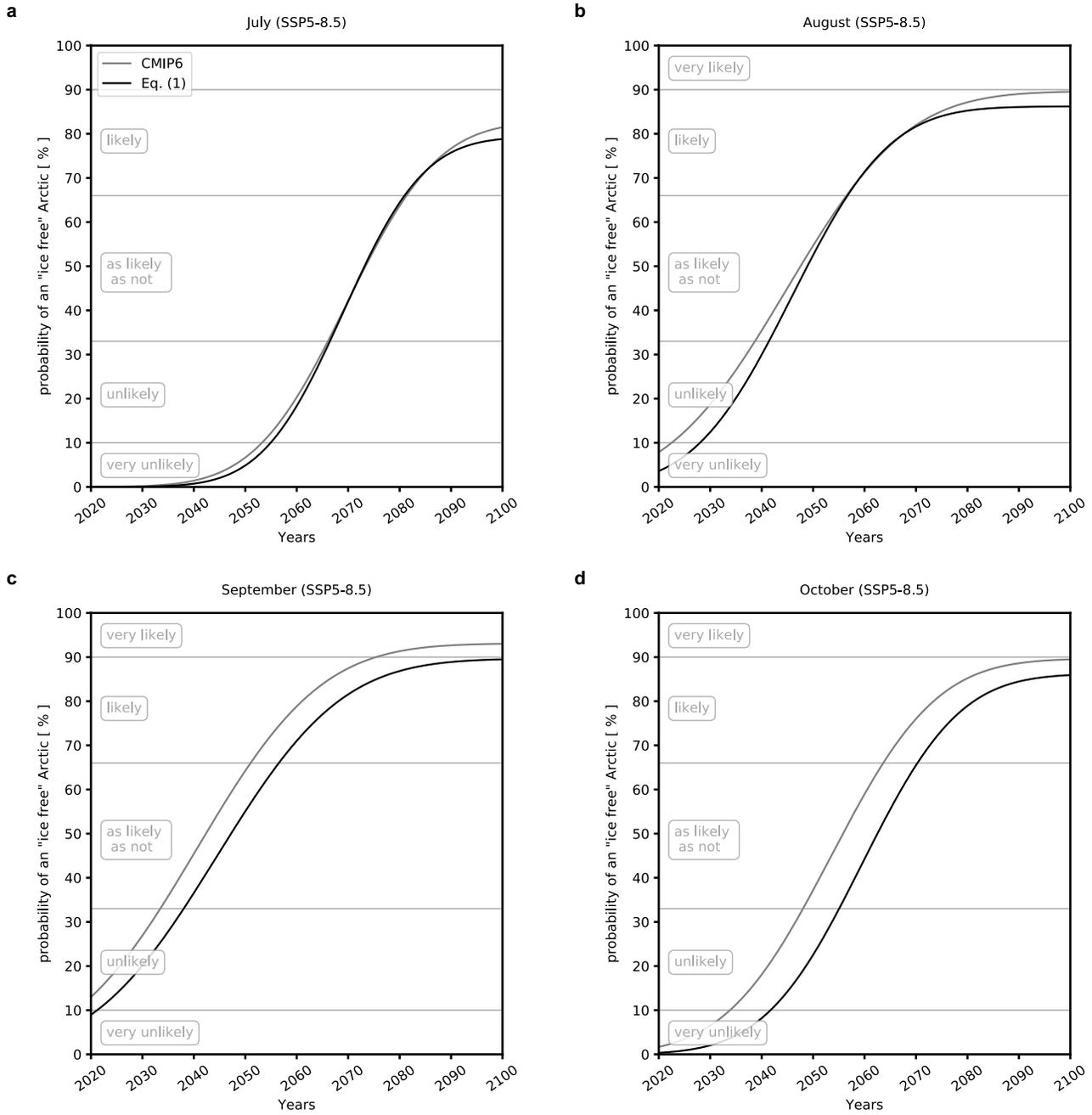
Supplemental Figure 1: **Comparison of Arctic sea-ice area from each GCM and Eq. (1).** Arctic sea-ice area from 29 different coupled GCMs (y-axis) and calculated using Eq. (1) (x-axis) in July (blue), August (orange), September (green), and October (red). All plots use Historical and SSP5-8.5 simulations from 1979–2100.



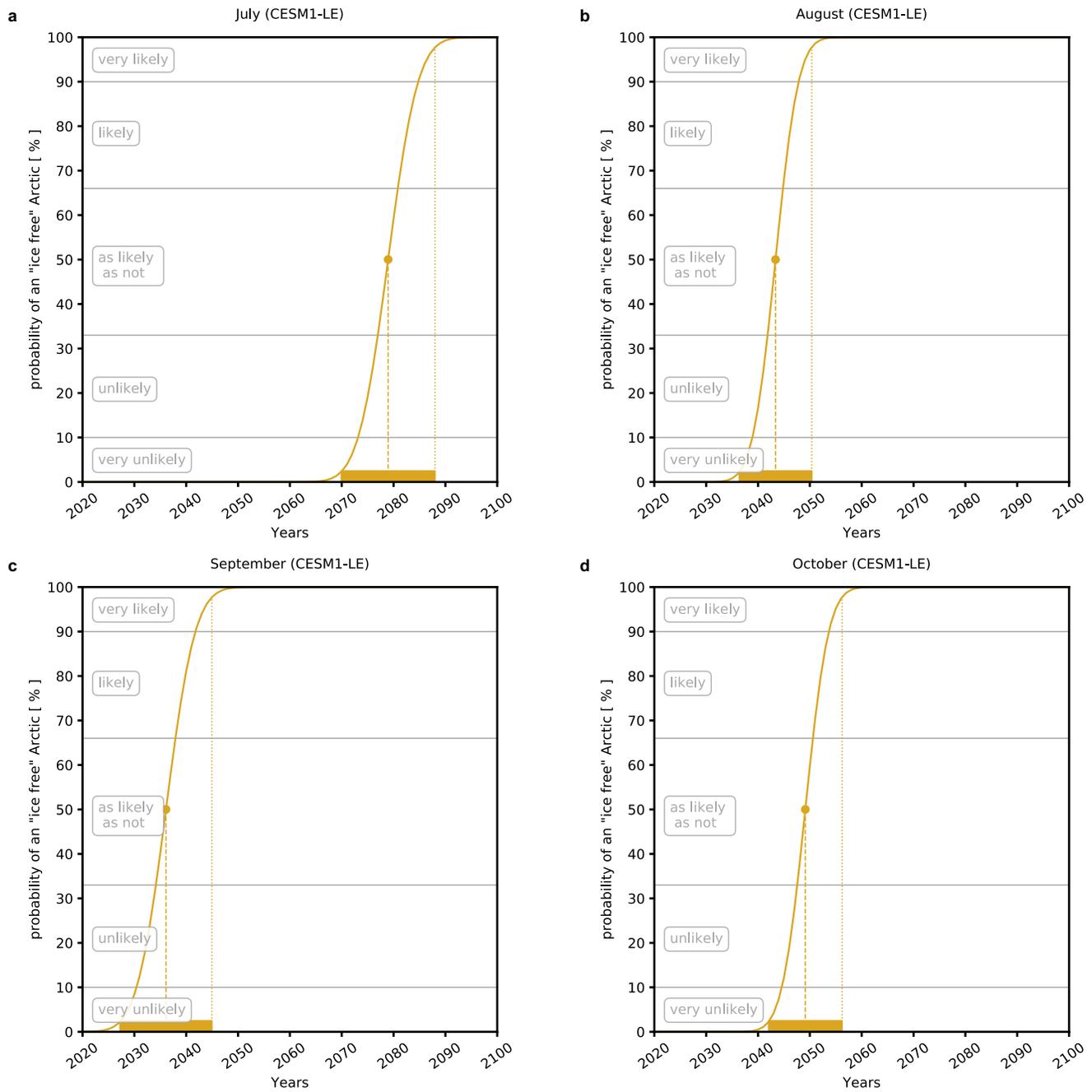
Supplemental Figure 2: **Partitioning intermodel variance in projections of Arctic sea-ice area in SSP2-4.5.** (a) The proportion of the inter-model variance (r^2 , where r is the Pearson correlation coefficient) in monthly Arctic sea-ice area from CMIP6 models that is accounted for by Eq. (1) as a function of month and year. Fractional contribution of (b) A_c , (c) γ , and (d) $T_f - T_c$ to total variance as a function of month and year.



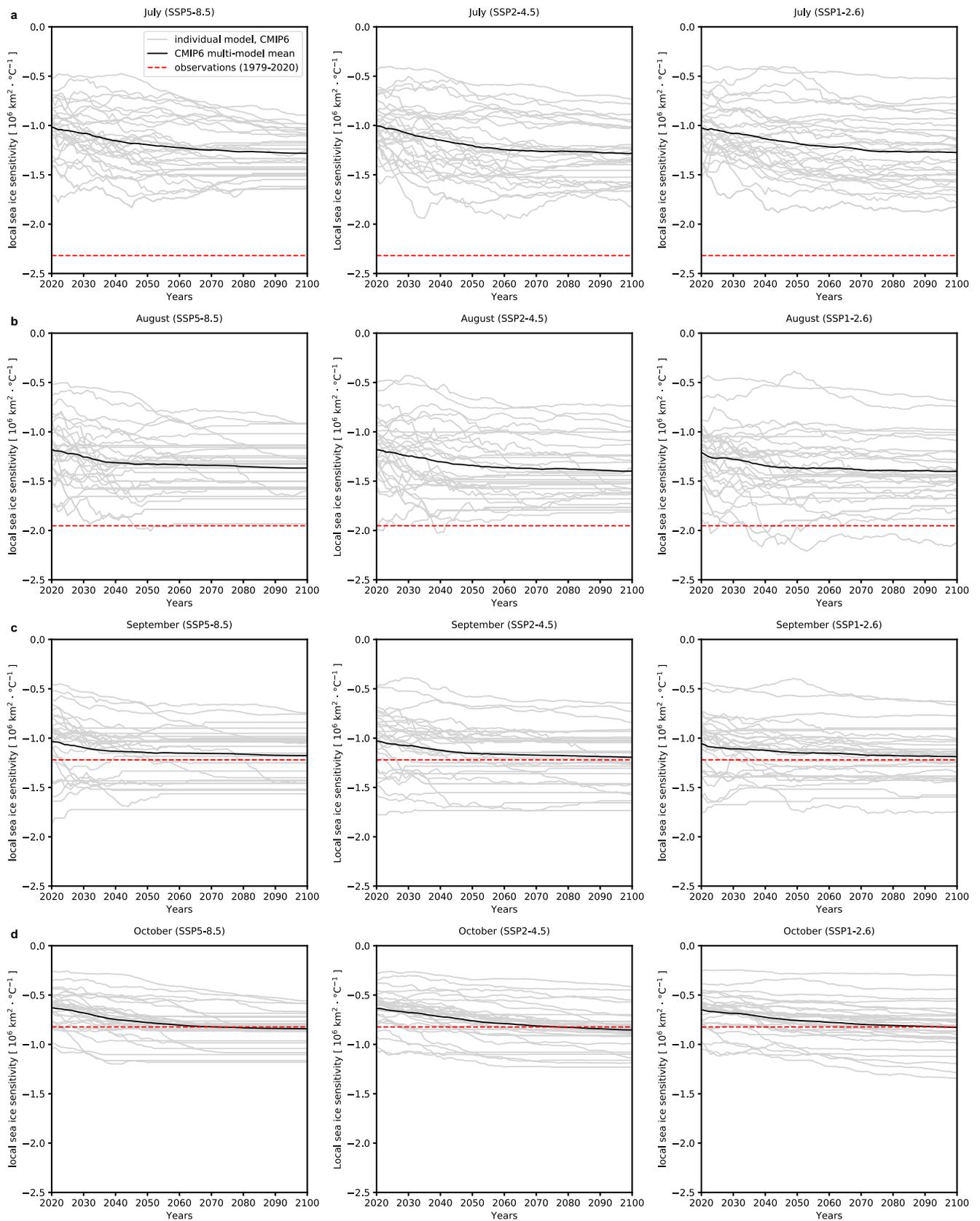
Supplemental Figure 3: **Partitioning intermodel variance in projections of Arctic sea-ice area in SSP1-2.6.** (a) The proportion of the inter-model variance (r^2 , where r is the Pearson correlation coefficient) in monthly Arctic sea-ice area from CMIP6 models that is accounted for by Eq. (1) as a function of month and year. Fractional contribution of (b) A_c , (c) γ , and (d) $T_f - T_c$ to total variance as a function of month and year.



Supplemental Figure 4: **Comparison of GCM and Eq. (1) probabilities.** Cumulative probability density function showing the year when the Arctic will experience ice free conditions in (a) July, (b) August, (c) September, and (d) October. The black line represents Eq. (1), which is identical to Fig. 4, and the grey line is the unconstrained CMIP6 output.



Supplemental Figure 5: **Influence of internal variability on the date of an ice-free Arctic.** Cumulative probability density function showing the year when the Arctic will experience ice free conditions in the CESM1-LE for (a) July, (b) August, (c) September, and (d) October. The shading denotes the 2- σ boundaries.



Supplemental Figure 6: Evolution of the local sea ice sensitivity. The local sea ice sensitivity for 29 different coupled GCMs computed using total least squares from 1979 up to each year using the month of (a) July, (b) August, (c) September, and (d) October. The bold line in each panel denotes the multi-model mean. All panels use the SSP5-8.5 simulations.