

*Geophysical Research Letters*

Supporting Information for

**Factors Driving Past Trends in Arctic Precipitation and Their Future Changes**

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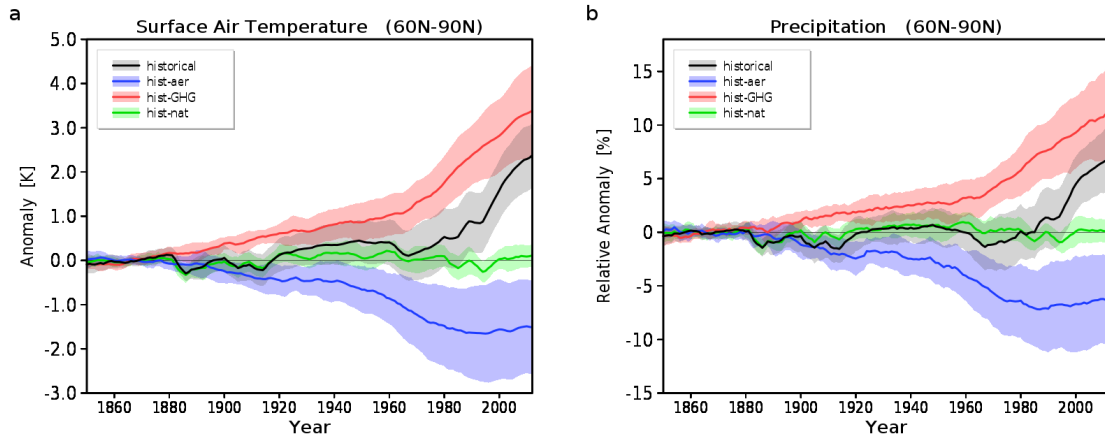
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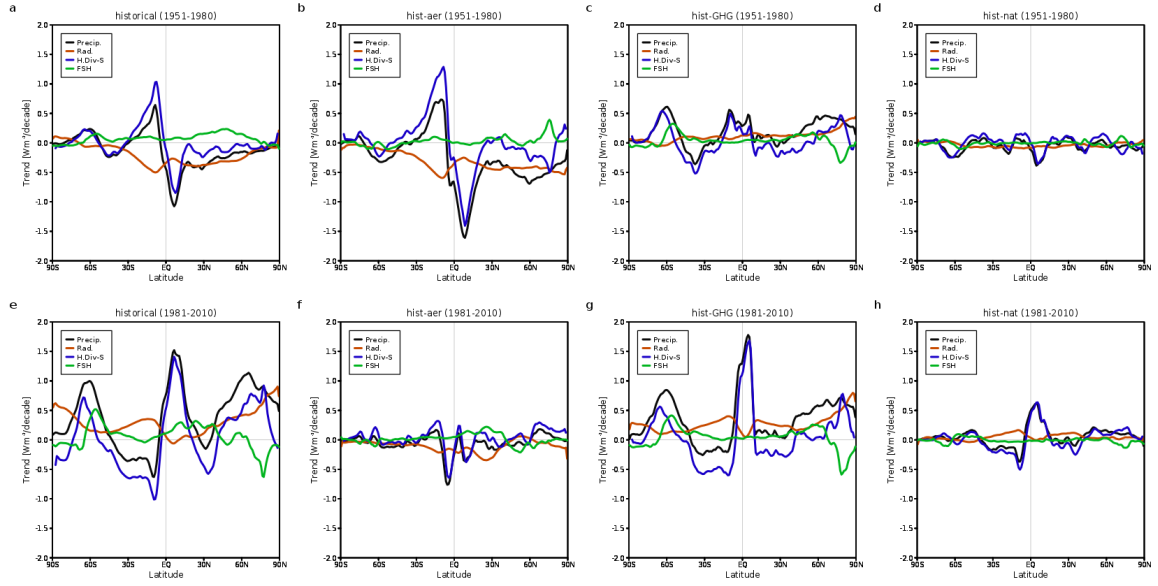
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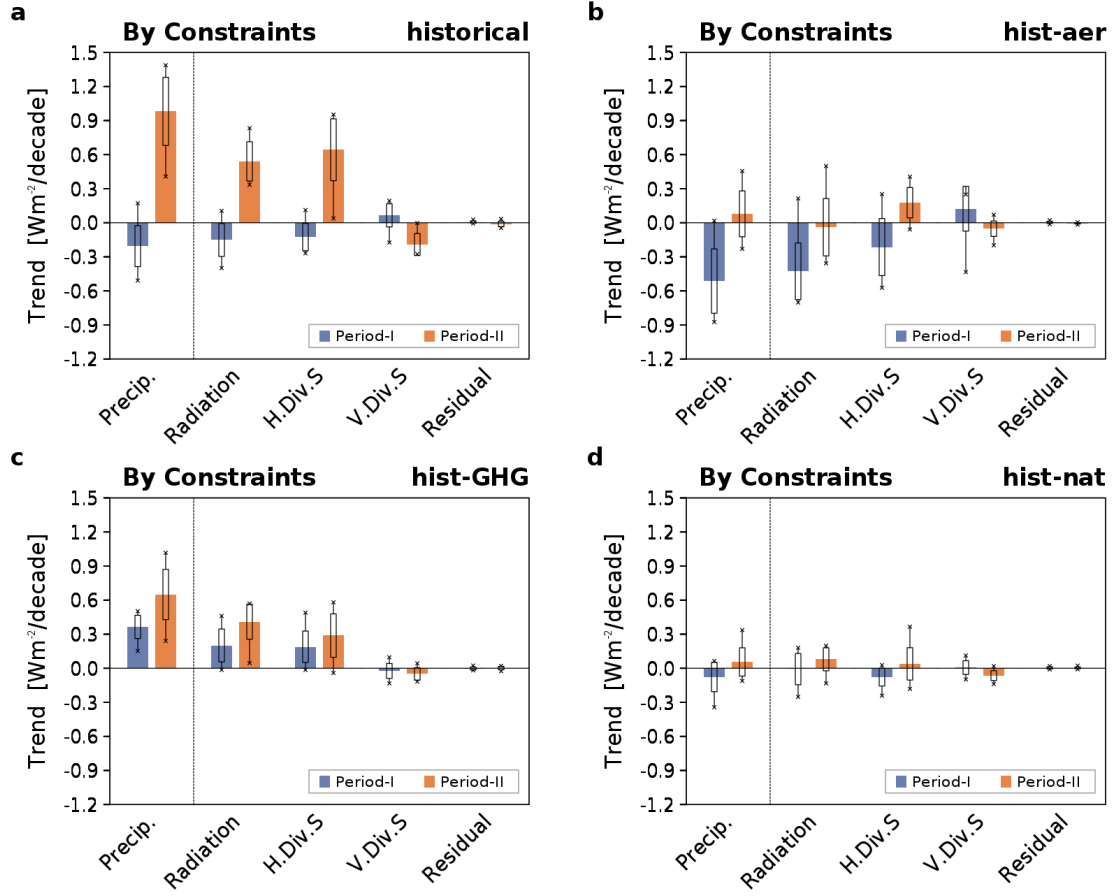
Table S1



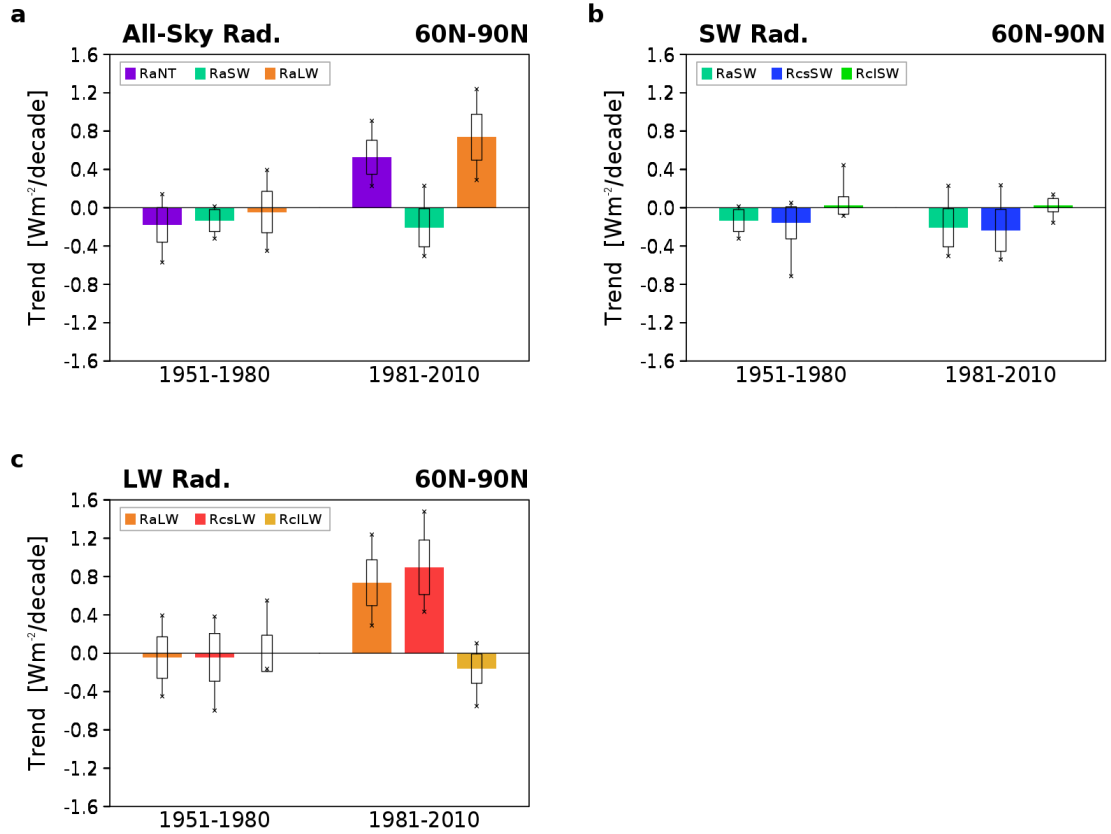
**Figure S1.** Time series of annual mean Arctic (60°N-90°N) (a) surface air temperature (K) and (b) relative precipitation (%) anomalies for the DAMIP experiments. Anomalies are relative to the 1851-1880 mean of the historical experiment. Colors indicate experiments by forcing; total forcing (historical, black), aerosol forcing (hist-aer, blue), GHG forcing (hist-GHG, red), and natural forcing (hist-nat, green). Solid lines indicate multi-model mean; shading indicates inter-model spread (30-70 %tile).



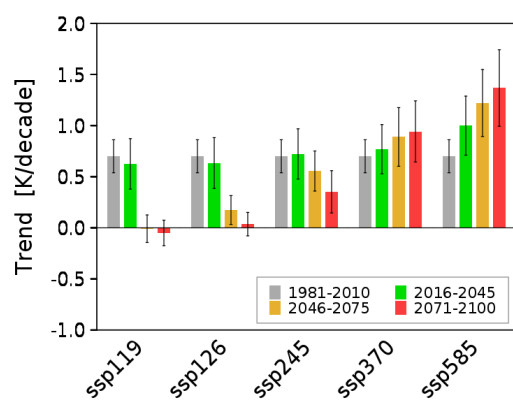
**Figure S2.** Meridional distributions of trends in zonal mean precipitation and their breakdown by constraining factors based on the (a, e) historical, (b, f) hist-aer, (c, g) hist-GHG, and (d, h) hist-nat experiments for (a-d) Period-I (1951-1980) and (e-h) Period-II (1981-2010). Colors indicate trend components of precipitation (black), radiative cooling (red), horizontal divergence of DSE (blue) and surface sensible flux (green).



**Figure S3.** Arctic mean precipitation trend and its decomposition by constraining factors for the (a) historical, (b) hist-aer, (c) hist-GHG, and (d) hist-nat experiments. The precipitation trends (the leftmost of each panel) are decomposed into radiative cooling (Radiation), horizontal (H.Div.S) and vertical (V.Div.S) divergence of the DSE, and residual (Residual) components, for Period-I (blue) and Period-II (orange), respectively.



**Figure S4.** Radiative cooling components of the Arctic precipitation trends for (a) all-sky radiation, (b) shortwave radiation, and (c) longwave radiation. (a) Net (RaNT) and its breakdown into shortwave (RaSW) and longwave (RaLW) components, (b) all-sky shortwave (RaSW) and its breakdown into clear-sky (RcsSW) and cloud (RclSW) components, and (c) all-sky longwave (RaLW) and its breakdown by clear-sky (RcsLW) and cloud (RclLW) components. Each for Period I (1951-1980) and Period II (1981-2010) in the historical experiment.



**Figure S5.** Present and future trends in Arctic mean surface air temperature, based on historical for Period II (1981-2010, gray), and each scenario experiment in ScenarioMIP (ssp119, ssp126, ssp245, ssp370, and ssp585) for Periods III (2016-2045, green), IV (2046-2075, yellow), and V (2071-2100, red).

Model	historical	hist-aer	hist-GHG	hist-nat	ssp119	ssp126	ssp245	ssp370	ssp585
ACCESS-CM2		3	3	3		5	5	5	5
ACCESS-ESM1-5	3	3	3	3		40	40	40	10
AWI-CM-1-1-MR								5	
BCC-CSM2-MR	3	3	3	3					
BCC-ESM1	3								
CAMS-CSM1-0	3								
CanESM5	50	30	50	50	50	50	50	50	50
CanESM5-CanOE						3	3	3	3
CESM2	11		3	3		3	3	3	3
CESM2-FV2	3								
CESM2-WACCM	3						5	3	5
CESM2-WACCM-FV2	3								
CNRM-CM6-1	30	10	10	10		6		6	6
CNRM-ESM2-1	9				5	5	10	5	5
E3SM-1-0	5								5
E3SM-1-1									
EC-Earth3	21				18	11	29	19	8
EC-Earth3-CC							9		
EC-Earth3-Veg	4				3	7	8	6	8
EC-Earth3-Veg-LR					3	3		3	3
FGOALS-f3-L	3								
FGOALS-g3	3	3	3	3		4	4	5	4
FIO-ESM-2-0						3	3		3
GFDL-CM4				3					
GFDL-ESM4				3					
GISS-E2-1-G	22	15	10	20	7	16	36	27	10
GISS-E2-1-H	12					10	10	6	10
GISS-E2-2-G						5	5	5	5
HadGEM3-GC31-LL	4	5	5	10			5		4
HadGEM3-GC31-MM									4
INM-CM5-0	10							5	
IPSL-CM6A-LR	32	10	10	10	6	6	11	11	7
KACE-1-0-G	3					3	3	3	3
MIROC6	10	10	50	50	50	50	50	50	50
MIROC-ES2L	3				10	10	30	10	10
MPI-ESM-1-2-HAM								3	
MPI-ESM1-2-HR	10							10	
MPI-ESM1-2-LR	10				30	30	30	30	10
MRI-ESM2-0	12	5	5	5	5	5	10	5	6
NESM3	5								
NorCPM1	30								
NorESM2-LM		3	3	3			13	3	
UKESM1-0-LL	17				5	16	17	16	5
Number of Models	30	12	13	15	12	22	24	27	26

**Table S1.** List of CMIP6 models used in the analysis for each experiment. Models in yellow cells are used for the analysis for the historical periods.