Supporting Information for “Arctic Sea Ice in CMIP6”

SIMIP Community[1]

[1]Dirk Notz, Jakob Dörr, David A Bailey, Ed Blockley, Mitchell Bushuk, Jens Boldingh Debernard, Evelien Dekker, Patricia DeRepentigny, David Docquier, Neven S. Fučkar, John C. Fyfe, Alexandra Jahn, Marika Holland, Elizabeth Hunke, Doroteaciro Iovino, Narges Khosravi, François Massonnet, Gurvan Madec, Siobhan O’Farrell, Alek Petty, Arun Rana, Lettie Roach, Erica Rosenblum, Clement Rousset, Tido Semmler, Julienne Stroeve, Bruno Tremblay, Takahiro Toyoda, Hiroyuki Tsujino, Martin Vancoppenolle

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Introduction This supporting information contains additional data tables and two additional figures. Tables S1 to S3 contain all model-specific values used in this paper for CMIP3, CMIP5 and CMIP6. Table S4 lists for each CMIP6 model the range of the first practically ice-free year. Tables S5 to S9 provide detailed information on all CMIP6 data

Corresponding author: Dirk Notz, dirk.notz@uni-hamburg.de

sets used in this study. Figure S1 shows the sea-ice loss in individual CMIP models as a function of their initial sea-ice area. Figure S2 shows the 20-year running mean of GMST.

Table S1. Key metrics of CMIP3 models as obtained from all simulations of all available models. The number after the model name is the number of available simulations. The numbers after the ± denote one standard deviation of the ensemble spread of a given model, calculated by correcting for small sample size n by using Bessel's correction and then dividing the resulting standard deviation by the scale mean of the chi distribution with $n-1$ degrees of freedom. dSIA/dGMST is the September sea-ice loss per global warming [million km^2/°C], dSIA/dCO2 is the September sea-ice loss per anthropogenic CO_2 emission [m^2/ton], dGMST/dCO2 is the change in global mean surface temperature per anthropogenic CO_2 emission [°C/1000 Gt], all evaluated over the period 1979–2014. SIA Mar. and SIA Sept. are the mean sea-ice area in March and September [million km^2], all evaluated over the period 1979–1998.

	dSIA/dGMST	dSIA/dCO2	dGMST/dCO2	SIA Mar.	SIA Sept.
	[million km^2/°C]	[m^2/t]	[°C/1000Gt]	[million km^2]	[million km^2]
BCCR-BCM2-0 (1)	-2.31	-1.12	0.47	15.58	8.06
CCCMA-CGCM3-1 (5)	-0.86±0.29	-0.68±0.34	0.79±0.07	13.86±0.11	6.23±0.14
CCCMA-CGCM3-1-T63 (1)	-0.98	-0.9	0.93	15.62	7.22
CNRM-CM3 (1)	-1.14	-0.75	0.55	14.82	5.87
CSIRO-MK3-5 (1)	-1.17	-0.85	0.71	14.14	7.05
GFDL-CM2-0 (1)	-1.73	-1.67	0.9	21.89	7.09
GFDL-CM2-1 (1)	-2.03	-2.08	0.89	18.46	4.49
GISS-AOM (2)	-1.74±0.91	-0.79±0.71	0.48±0.13	12.83±0.11	6.24±0.16
GISS-MODEL-E-R (1)	-1.24	-0.87	0.67	15.52	11.61
INMCM3-0 (1)	-1.69	-1.75	0.89	11.88	4.11
IPSL-CM4 (1)	-1.93	-2.02	0.93	13.58	5.4
MIROC3-2-HIRES (1)	-1.77	-2.22	1.17	13.96	2.42
MIROC3-2-MEDRES (3)	-1.39±0.89	-1.04±0.54	0.7±0.09	14.66±0.06	6.87±0.36
MIUB-ECHO-G (3)	-1.4±0.45	-0.93±0.49	0.69±0.19	15.73±0.44	5.07±0.37
MPI-ECHAM5 (3)	-1.05±0.08	-0.71±0.43	0.51±0.04	13.14±0.54	6.78±0.22
MRI-CGCM2-3-2A (5)	-0.89±0.27	-0.4±0.1	0.44±0.11	16.88±0.11	8.94±0.19
NCAR-CCSM3-0 (5)	-1.83±0.5	-1.91±0.82	0.97±0.16	15.53±0.4	5.91±0.23
UKMO-HADCM3 (1)	-1.29	-0.91	0.56	15.15	4.0
UKMO-HADGEM1 (1)	-2.5	-2.05	0.83	16.0	6.06
Multi-model mean	-1.52±0.48	-1.24±0.6	0.74±0.21	15.22±2.24	6.28±2.03
Observations	-4.01±0.32	-2.73±0.2	0.54±0.04	14.35±0.54	5.97±0.66

Table S2. Key metrics of CMIP5 models as obtained from all simulations of all available models. The number after the model name is the number of available simulations. The numbers after the ± denote one standard deviation of the ensemble spread of a given model, calculated by correcting for small sample size n by using Bessel's correction and then dividing the resulting standard deviation by the scale mean of the chi distribution with $n-1$ degrees of freedom. dSIA/dGMST is the September sea-ice loss per global warming [million km^2/°C], dSIA/dCO2 is the September sea-ice loss per anthropogenic CO_2 emission [m^2/ton], dGMST/dCO2 is the change in global mean surface temperature per anthropogenic CO_2 emission [°C/1000 Gt], all evaluated over the period 1979–2014. SIA Mar. and SIA Sept. are the mean sea-ice area in March and September [million km^2], SIV Mar. and SIV Sept. are the mean sea-ice volume in March and September [1000 km^3], all evaluated over the period 1979–1998. Sept. SIA variability is the standard deviation of September Arctic sea-ice area from the pre-industrial control run [million km^2].

	dSIA/dGMST	dSIA/dCO2	dGMST/dCO2	SIA Mar.	SIA Sept.	SIV Mar.	SIV Sept.	Sept. SIA variability
	[million km^2/°C]	[m^2/t]	[°C/1000Gt]	[million km^2]	[million km^2]	[thousand km^3]	[thousand km^3]	[million km^2]
ACCESS1-0 (1)	-2.38	-1.79	0.78	14.67	5.47	26.19	8.73	0.62
ACCESS1-3 (1)	-3.3	-2.58	0.78	13.97	5.62	28.42	13.06	0.53
BCC-CSM1-1 (1)	-4.52	-4.35	0.89	19.68	5.04	26.85	4.47	0.92
BCC-CSM1-1-M (1)	-1.74	-1.94	1.07	18.17	2.82	21.84	1.52	0.9
BNU-ESM (1)	-1.96	-2.13	1.02	14.92	3.0	23.64	7.91	0.27
CANESM2 (5)	-1.76±0.23	-2.18±0.24	1.21±0.04	14.25±0.1	3.18±0.06	18.32±0.16	3.74±0.12	0.57
CCSM4 (6)	-1.74±0.18	-1.57±0.24	0.89±0.09	14.48±0.24	5.98±0.22	33.75±1.4	19.43±1.46	0.45
CESM1-BGC (1)	-2.45	-2.44	0.88	14.19	6.19	34.67	20.86	0.46
CESM1-CAM5 (3)	-2.89±0.24	-2.39±0.32	0.8±0.04	14.65±0.11	6.24±0.12	38.09±0.76	23.48±0.73	0.46
CESM1-WACCM (3)	-1.32±0.39	-1.02±0.29	0.79±0.12	15.89±0.11	7.95±0.19	50.51±1.97	37.88±2.05	0.31
CMCC-CM (1)	-3.36	-2.57	0.72	16.47	9.65	45.5	35.54	0.52
CMCC-CMS (1)	-0.86	-0.86	0.84	15.32	7.67	37.58	28.8	0.29
CNRM-CM5 (5)	-3.17±1.06	-2.63±1.34	0.78±0.17	16.35±0.51	5.2±0.41	24.5±1.15	5.16±0.85	0.56
CSIRO-MK3-6-0 (10)	-1.03±0.31	-0.9±0.32	0.71±0.08	15.84±0.28	9.79±0.22	36.6±1.3	24.67±1.11	0.23
EC-EARTH (11)	-1.62±0.34	-1.47±0.5	0.72±0.08	14.94±0.27	7.23±0.49	39.46±4.7	28.93±4.85	0.5
FGOALS-G2 (1)	-2.56	-1.68	0.58	12.1	8.02	42.91	34.4	0.21
FIO-ESM (1)	-	-1.47	0.61±0.04	15.08	5.46	30.54	14.16	-
FIO-ESM (3)	-1.74±0.48	-1.08±0.52	0.63±0.06	15.27±0.24	5.42±0.3	31.0±1.31	14.39±1.72	0.41
GFDL-CM3 (1)	-2.25	-2.68	1.11	14.67	6.28	30.86	16.73	0.6
GFDL-ESM2G (1)	-1.58	-1.5	0.8	20.74	7.34	27.93	9.06	0.53
GFDL-ESM2M (1)	-0.93	-0.37	0.62	15.86	5.42	20.45	5.16	0.53
GISS-E2-H (2)	-2.16±0.43	-1.58±0.38	0.75±0.05	13.32±0.08	2.15±0.39	-	-	0.78
GISS-E2-H-CC (1)	-3.55	-3.05	0.85	13.92	3.26	-	-	0.68
GISS-E2-R (2)	-2.7	-2.27±0.5	0.68	15.48±0.12	3.18±0.13	-	-	0.51
GISS-E2-R-CC (1)	-3.38	-2.58	0.74	15.65	3.38	-	-	0.54
HADGEM2-AO (1)	-2.07	-2.41	0.86	14.76	3.64	27.4	9.73	-
HADGEM2-CC (3)	-2.43±0.52	-1.96±0.55	0.75±0.09	16.17±0.13	5.41±0.21	34.29±1.13	14.83±1.1	0.61
HADGEM2-ES (4)	-2.31±0.61	-2.25±0.68	0.97±0.23	15.57±0.35	4.42±0.22	30.59±1.01	11.94±0.61	0.63
INMCM4 (1)	-2.45	-1.09	0.4	14.08	4.17	28.82	5.98	0.47
IPSL-CM5A-LR (4)	-1.48±0.43	-1.54±0.25	1.0±0.1	15.83±0.48	6.3±0.5	36.09±3.13	18.61±3.18	0.51
IPSL-CM5A-MR (1)	-1.67	-1.68	0.91	14.2	4.83	26.69	10.38	0.43
IPSL-CM5B-LR (1)	-1.49	-1.19	0.56	17.16	8.38	49.33	30.4	0.52
MIROC-ESM (1)	-2.08	-1.76	0.64	12.74	5.27	32.84	19.79	0.57
MIROC-ESM-CHEM (1)	-2.69	-2.49	0.79	13.14	5.99	34.88	21.42	0.53
MIROC5 (5)	-2.02±0.4	-1.94±0.66	0.82±0.15	12.83±0.11	6.51±0.07	36.85±0.89	23.7±0.73	0.47
MPI-ESM-LR (3)	-1.53±0.27	-1.35±0.43	0.78±0.03	13.66±0.09	5.3±0.12	24.69±0.51	8.41±0.56	0.43
MPI-ESM-MR (1)	-1.59	-1.42	0.82	13.84	5.39	25.93	8.92	0.39
MRI-CGCM3 (1)	-4.66	-1.81	0.32	20.64	5.7	27.18	8.67	0.7
NORESM1-M (1)	-1.62	-1.17	0.62	13.33	7.03	41.89	30.37	0.41
NORESM1-ME (1)	-1.13	-0.61	0.66	13.87	7.61	46.29	35.56	0.38
Multi-model mean	-2.21±0.9	-1.84±0.76	0.78±0.18	15.19±1.95	5.67±1.83	32.59±8.1	17.13±10.52	0.51
Observations	-4.01±0.32	-2.73±0.2	0.54±0.04	14.35±0.54	5.97±0.66	-	-	-

Table S3. Key metrics of CMIP6 models as obtained from all simulations of all available models. The number after the model name is the number of available simulations. The numbers after the ± denote one standard deviation of the ensemble spread of a given model, calculated by correcting for small sample size n by using Bessel's correction and then dividing the resulting standard deviation by the scale mean of the chi distribution with $n-1$ degrees of freedom. dSIA/dGMST is the September sea-ice loss per global warming [million km^2/°C], dSIA/dCO2 is the September sea-ice loss per anthropogenic CO_2 emission [m^2/ton], dGMST/dCO2 is the change in global mean surface temperature per anthropogenic CO_2 emission [°C/1000 Gt], all evaluated over the period 1979–2014. SIA Mar. and SIA Sept. are the mean sea-ice area in March and September [million km^2], SIV Mar. and SIV Sept. are the mean sea-ice volume in March and September [1000 km^3], all evaluated over the period 1979–1998. Sept. SIA variability is the standard deviation of September Arctic sea-ice area from the pre-industrial control run [million km^2].

	dSIA/dGMST	dSIA/dCO2	dGMST/dCO2	SIA Mar.	SIA Sept.	SIV Mar.	SIV Sept.	Sept. SIA variability
	[million km^2/°C]	[m^2/t]	[°C/1000Gt]	[million km^2]	[million km^2]	[thousand km^3]	[thousand km^3]	[million km^2]
ACCESS-CM2 (2)	-2.72±0.42	-2.31±0.77	0.79±0.12	16.09±0.04	6.02±0.09	35.14±0.02	16.65±0.02	0.52
ACCESS-ESM1-5 (3)	-1.87±0.27	-1.76±0.57	0.88±0.21	14.5±0.08	5.19±0.25	26.36±0.86	10.7±0.71	0.45
AWI-CM-1-1-MR (5)	-1.61±0.47	-1.32±0.42	0.79±0.1	15.0±0.19	3.88±0.22	24.52±0.96	6.84±0.83	0.4
BCC-CSM2-MR (3)	-2.6±1.02	-2.18±0.75	0.82±0.17	16.73±0.11	6.65±0.41	21.45±0.51	5.98±0.52	-
BCC-ESM1 (3)	-3.02±0.31	-3.0±0.12	0.92±0.1	17.83±0.13	7.95±0.34	24.07±0.76	7.54±0.92	-
CAMS-CSM1-0 (3)	-1.06±0.38	-0.82±0.59	0.53±0.15	19.33±0.12	7.26±0.1	28.91±0.53	9.99±0.37	0.41
CANESM5 (25)	-2.32±0.28	-3.12±0.58	1.28±0.13	15.94±0.39	6.78±0.26	-	-	0.49
CESM2 (11)	-3.72±0.44	-3.64±0.7	0.9±0.11	13.95±0.14	4.25±0.42	24.9±1.31	9.69±1.56	0.58
CESM2-WACCM (3)	-3.54±0.15	-3.88±0.63	1.03±0.1	14.29±0.14	5.75±0.16	31.56±0.93	17.34±1.04	0.44
CESM2-WACCM-FV2 (1)	-3.55	-3.33	0.88	14.88	5.53	29.57	15.26	0.45
CNRM-CM6-1 (10)	-1.64±0.6	-1.13±0.59	0.68±0.13	15.75±0.59	5.72±0.41	20.02±1.21	4.56±0.65	-
CNRM-CM6-1-HR (1)	-2.04	-1.51	0.71	14.72	5.83	19.89	5.18	0.48
CNRM-ESM2-1 (5)	-2.33±1.02	-1.48±0.94	0.62±0.14	15.75±0.97	5.02±0.47	19.16±1.62	3.4±0.66	0.79
E3SM-1-0 (5)	-3.86±0.57	-4.31±0.67	1.07±0.09	20.66±0.38	5.33±0.3	38.15±2.25	16.53±2.25	0.7
EC-EARTH3 (5)	-2.65±0.64	-2.57±1.43	0.82±0.26	15.22±1.13	6.56±1.06	38.7±6.76	23.89±6.13	1.06
EC-EARTH3-VEG (7)	-2.67±0.52	-2.48±1.07	0.89±0.22	15.76±1.58	6.99±1.09	43.16±7.68	28.46±6.81	0.84
FGOALS-F3-L (1)	-1.68	-1.5	0.78±0.15	11.32	3.69	-	-	-
FIO-ESM-2-0 (3)	-2.58±0.82	-2.39±0.68	0.77	14.07±0.12	3.08±0.47	27.85±2.95	11.09±3.09	0.5
GFDL-CM4 (1)	-2.34	-2.29	0.93	15.41	6.4	24.33	9.86	0.47
GFDL-ESM4 (1)	-2.33	-1.9	0.79±0.14	14.09	5.84	21.9	8.34	0.49
GISS-E2-1-G (10)	-2.12±0.37	-1.91±0.41	0.74±0.1	17.26±0.22	8.23±0.24	29.34±0.7	9.88±0.7	0.5
GISS-E2-1-G-CC (1)	-2.74	-2.52	0.8	17.16	8.32	29.6	10.22	0.6
GISS-E2-1-H (10)	-4.6±0.95	-4.12±0.92	0.8±0.11	21.01±0.36	10.52±0.48	31.45±1.1	10.24±0.84	0.74
HADGEM3-GC31-LL (4)	-2.74±0.24	-3.04±0.4	1.08±0.24	15.84±0.33	6.76±0.31	38.68±1.87	21.45±1.8	0.5
HADGEM3-GC31-MM (4)	-2.99±0.51	-2.97±0.69	0.93±0.07	14.8±0.1	6.43±0.12	36.06±1.03	19.8±1.06	0.51
INM-CM4-8 (1)	-0.56	-0.16	0.69	15.81	6.99	-	-	0.45
INM-CM5-0 (10)	-1.49±0.8	-1.0±0.8	0.67±0.1	15.9±0.27	6.62±0.3	-	-	0.53
IPSL-CM6A-LR (32)	-3.39±0.87	-3.33±1.23	0.83±0.15	15.12±0.53	4.9±0.49	28.08±1.71	9.85±1.46	0.69
MIROC-ES2L (3)	-1.39±0.47	-1.15±0.5	0.63±0.11	12.8±0.08	4.37±0.03	32.67±0.24	16.23±0.07	0.38
MIROC6 (10)	-2.24±0.42	-1.93±0.47	0.6±0.09	12.07±0.16	5.35±0.21	-	-	0.4
MPI-ESM-1-2-HAM (2)	-2.42±0.39	-1.72±0.18	0.68±0.01	13.95±0.19	5.27±0.22	29.59±0.45	10.35±0.96	0.47
MPI-ESM1-2-HR (10)	-2.61±0.57	-2.03±0.59	0.7±0.12	13.93±0.45	4.21±0.25	25.26±1.48	5.39±0.78	0.5
MPI-ESM1-2-LR (10)	-1.95±0.42	-1.58±0.5	0.69±0.07	13.6±0.22	4.44±0.2	24.38±0.84	6.33±0.72	0.4
MRI-ESM2-0 (5)	-3.08±0.72	-2.49±0.63	0.7±0.07	14.24±0.25	4.61±0.43	22.53±1.18	8.14±1.14	0.59
NESM3 (5)	-3.95±0.67	-4.31±1.0	0.98±0.17	18.25±0.74	5.13±0.51	26.65±1.65	6.08±1.17	0.66
NORCPM1 (30)	-1.45±0.37	-0.93±0.37	0.64±0.09	14.96±0.14	9.12±0.13	64.71±1.64	54.07±2.21	0.38
NORESM2-LM (3)	-2.45±0.76	-1.97±0.4	0.62±0.21	14.04±0.07	6.01±0.16	33.18±0.96	20.44±1.35	0.53
NORESM2-MM (1)	-1.09	-1.43	0.64	14.19	7.24	39.82	27.4	-
SAM0-UNICON (1)	-2.14	-1.96	0.91	15.85	7.0	45.07	30.28	0.39
UKESM1-0-LL (12)	-2.05±0.44	-2.45±0.29	1.15±0.15	16.34±0.24	7.55±0.21	48.11±1.97	31.75±1.94	0.51
Multi-model mean	-2.44±0.86	-2.25±1.0	0.81±0.16	15.46±2.01	6.07±1.55	30.99±9.5	14.55±10.47	0.54
Observations	-4.01±0.32	-2.73±0.2	0.54±0.04	14.35±0.54	5.97±0.66	-	-	-

Table S4. Year in which September mean sea-ice area drops below 1 million km^2 for the first time, based on all available simulations. The number in brackets indicates the number of available simulations. Models in bold are among the group of selected models defined in section 2 and shown in Figure 3.

	SSP119	SSP126	SSP245	SSP585
ACCESS-CM2	–	**2029 (1)**	**2037 (1)**	**2034 (1)**
ACCESS-ESM1-5	–	**2038 (1)**	**2042 - 2051 (3)**	**2037 - 2044 (3)**
AWI-CM-1-1-MR	–	2026 (1)	2027 (1)	2028 (1)
BCC-CSM2-MR	–	2079 (1)	2074 (1)	2046 (1)
CAMS-CSM1-0	>2100 (2)	>2100 (2)	>2100 (2)	2079 - 2089 (2)
CESM2	–	<2014 (2)	<2014 - 2024 (3)	<2014 (2)
CESM2-WACCM	–	**2036 (1)**	**2035 (1)**	**2037 (1)**
CNRM-CM6-1	–	>2100 (1)	2078 (1)	2060 (1)
CNRM-CM6-1-HR	–	–	2062 (1)	2053 (1)
CNRM-ESM2-1	–	–	**2029 (1)**	–
CanESM5	**2034 - 2049 (5)**	**2028 - 2046 (10)**	**2029 - 2038 (10)**	**2027 - 2037 (10)**
EC-Earth3	–	**2058 (1)**	**2046 - 2055 (4)**	**2029 (1)**
EC-Earth3-Veg	**2024 - 2056 (6)**	**2031 - 2068 (7)**	**2028 - 2046 (7)**	**2028 - 2044 (7)**
FGOALS-f3-L	–	–	2039 (1)	–
FIO-ESM-2-0	–	<2014 - 2019 (3)	<2014 - 2021 (3)	<2014 - 2017 (3)
GFDL-CM4	–	–	2051 (1)	2052 (1)
GFDL-ESM4	>2100 (1)	>2100 (1)	2078 (1)	2062 (1)
HadGEM3-GC31-LL	–	**2030 (1)**	**2026 (1)**	**2017 - 2028 (4)**
HadGEM3-GC31-MM	–	**2031 (1)**	–	**2026 - 2031 (4)**
INM-CM4-8	–	>2100 (1)	>2100 (1)	>2100 (1)
INM-CM5-0	–	>2100 (1)	>2100 (1)	2093 (1)
IPSL-CM6A-LR	**2017 (1)**	**2021 - 2033 (6)**	**2019 - 2026 (5)**	**2015 - 2029 (6)**
MIROC-ES2L	2035 (1)	2054 (1)	2043 (1)	2035 (1)
MIROC6	**>2100 (1)**	**2056 - 2071 (3)**	**2049 - 2066 (3)**	**2046 - 2052 (3)**
MPI-ESM1-2-HR	–	2035 - 2057 (2)	2036 - 2050 (2)	2026 - 2039 (2)
MPI-ESM1-2-LR	–	2030 - >2100 (10)	2041 - 2057 (10)	2037 - 2050 (10)
MRI-ESM2-0	**2026 (1)**	**2024 (1)**	**2034 (1)**	**2019 (1)**
NESM3	–	2017 - 2024 (2)	2017 - 2026 (2)	2016 - 2018 (2)
NorESM2-LM	–	–	**2065 - 2072 (2)**	**2053 (1)**
NorESM2-MM	–	>2100 (1)	–	–
UKESM1-0-LL	2030 - 2037 (5)	2030 - 2036 (5)	2030 - 2036 (5)	2031 - 2034 (5)

Table S5. Version number and doi for historical CMIP6 simulations used in this study

	version	DOI
ACCESS-CM2	v20190815	10.22033/ESGF/CMIP6.4271
ACCESS-ESM1-5	v20190922	10.22033/ESGF/CMIP6.4272
AWI-CM-1-1-MR	v20181218	10.22033/ESGF/CMIP6.359
BCC-CSM2-MR	v20181127	10.22033/ESGF/CMIP6.2948
BCC-ESM1	v20181202	10.22033/ESGF/CMIP6.2949
CAMS-CSM1-0	v20190708	10.22033/ESGF/CMIP6.9754
CANESM5	v20190429	10.22033/ESGF/CMIP6.3610
CESM2	v20190308	10.22033/ESGF/CMIP6.7627
CESM2-WACCM	v20190227	10.22033/ESGF/CMIP6.10071
CESM2-WACCM-FV2	v20191120	10.22033/ESGF/CMIP6.11298
CNRM-CM6-1	v20180917	10.22033/ESGF/CMIP6.4066
CNRM-CM6-1-HR	v20191021	10.22033/ESGF/CMIP6.4067
CNRM-ESM2-1	v20181206	10.22033/ESGF/CMIP6.4068
E3SM-1-0	v20190926	10.22033/ESGF/CMIP6.4497
EC-EARTH3	v20190711	10.22033/ESGF/CMIP6.4700
EC-EARTH3-VEG	n/a	10.22033/ESGF/CMIP6.4706
FGOALS-F3-L	v20191031n/a	10.22033/ESGF/CMIP6.3355
FIO-ESM-2-0	v20191127	10.22033/ESGF/CMIP6.9199
GFDL-CM4	v20180701	10.22033/ESGF/CMIP6.8594
GFDL-ESM4	v20190726	10.22033/ESGF/CMIP6.8597
GISS-E2-1-G	v20180827	10.22033/ESGF/CMIP6.7127
GISS-E2-1-G-CC	v20190815	10.22033/ESGF/CMIP6.11762
GISS-E2-1-H	v20190403	10.22033/ESGF/CMIP6.7128
HADGEM3-GC31-LL	n/a	n/a
HADGEM3-GC31-MM	n/a	n/a
INM-CM4-8	v20190530	10.22033/ESGF/CMIP6.5069
INM-CM5-0	v20190610	10.22033/ESGF/CMIP6.5070
IPSL-CM6A-LR	v20180803	10.22033/ESGF/CMIP6.5195
MIROC-ES2L	v20190823	10.22033/ESGF/CMIP6.5602
MIROC6	v20181212	10.22033/ESGF/CMIP6.5603
MPI-ESM-1-2-HAM	v20190627	n/a
MPI-ESM1-2-HR	v20190710	10.22033/ESGF/CMIP6.6594
MPI-ESM1-2-LR	v20190710	10.22033/ESGF/CMIP6.6595
MRI-ESM2-0	n/a	n/a
NESM3	v20190704	10.22033/ESGF/CMIP6.8769
NORCPM1	v20190914	http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.CMIP.NCC.NorCPM1.historical
NORESM2-LM	v20191108	http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.CMIP.NCC.NorESM2-LM.historical
NORESM2-MM	v20191108	http://cera-www.dkrz.de/WDCC/meta/CMIP6/CMIP6.CMIP.NCC.NorESM2-MM.historical
SAM0-UNICON	v20190323	10.22033/ESGF/CMIP6.7789
UKESM1-0-LL	n/a	10.22033/ESGF/CMIP6.6113

Table S6. Version number and doi for SSP1-1.9 CMIP6 simulations used in this study

	version	DOI
CAMS-CSM1-0	v20190708	10.22033/ESGF/CMIP6.11045
CanESM5	v20190429	10.22033/ESGF/CMIP6.3682
EC-Earth3-Veg	n/a	n/a
GFDL-ESM4	v20180701	10.22033/ESGF/CMIP6.8683
IPSL-CM6A-LR	v20190410	10.22033/ESGF/CMIP6.5261
MIROC-ES2L	v20190823	10.22033/ESGF/CMIP6.5740
MIROC6	v20190807	10.22033/ESGF/CMIP6.5741
MRI-ESM2-0	v20190904	10.22033/ESGF/CMIP6.6908
UKESM1-0-LL	n/a	n/a

Table S7. Version number and doi for SSP1-2.6 CMIP6 simulations used in this study

	version	DOI
ACCESS-CM2	v20190909	10.22033/ESGF/CMIP6.4319
ACCESS-ESM1-5	v20190919	10.22033/ESGF/CMIP6.4320
AWI-CM-1-1-MR	v20181218	10.22033/ESGF/CMIP6.2796
BCC-CSM2-MR	v20190319	10.22033/ESGF/CMIP6.3028
CAMS-CSM1-0	v20190708	10.22033/ESGF/CMIP6.11046
CESM2	dates	10.22033/ESGF/CMIP6.7746
CESM2-WACCM	n/a	n/a
CNRM-CM6-1	v20190219	10.22033/ESGF/CMIP6.4184
CanESM5	v20190429	10.22033/ESGF/CMIP6.3683
EC-EARTH3	v20190701	10.22033/ESGF/CMIP6.4874
EC-EARTH3-VEG	n/a	n/a
FIO-ESM-2-0	v20191228	n/a
GFDL-ESM4	v20180701	10.22033/ESGF/CMIP6.8684
HADGEM3-GC31-LL	n/a	n/a
HADGEM3-GC31-MM	n/a	n/a
INM-CM4-8	v20190603	10.22033/ESGF/CMIP6.12325
INM-CM5-0	v20190619	10.22033/ESGF/CMIP6.12326
IPSL-CM6A-LR	v20190903	10.22033/ESGF/CMIP6.5262
MIROC-ES2L	v20190823	10.22033/ESGF/CMIP6.5742
MIROC6	v20190627	10.22033/ESGF/CMIP6.5743
MPI-ESM1-2-HR	v20190815	10.22033/ESGF/CMIP6.4397
MPI-ESM1-2-LR	v20190710	10.22033/ESGF/CMIP6.6690
MRI-ESM2-0	n/a	n/a
NESM3	v20190730	10.22033/ESGF/CMIP6.8780
NORESM2-MM	v20191108	n/a
UKESM1-0-LL	n/a	n/a

Table S8. Version number and doi for SSP2-4.5 CMIP6 simulations used in this study

	version	DOI
ACCESS-CM2	v20190909	10.22033/ESGF/CMIP6.4321
ACCESS-ESM1-5	v20190919	10.22033/ESGF/CMIP6.4322
AWI-CM-1-1-MR	v20181218	10.22033/ESGF/CMIP6.2800
BCC-CSM2-MR	v20190318	10.22033/ESGF/CMIP6.3030
CAMS-CSM1-0	v20190708	10.22033/ESGF/CMIP6.11047
CESM2	n/a	10.22033/ESGF/CMIP6.7748
CESM2-WACCM	n/a	10.22033/ESGF/CMIP6.10101
CNRM-CM6-1	v20190219	10.22033/ESGF/CMIP6.4189
CNRM-CM6-1-HR	v20191202	10.22033/ESGF/CMIP6.4190
CNRM-ESM2-1	v20190328	10.22033/ESGF/CMIP6.4191
CanESM5	v20190429	10.22033/ESGF/CMIP6.3685
EC-Earth3	v20190927	10.22033/ESGF/CMIP6.4880
EC-Earth3-Veg	n/a	n/a
FGOALS-F3-L	n/a	n/a
FIO-ESM-2-0	v20191228	n/a
GFDL-CM4	v20180701	10.22033/ESGF/CMIP6.9263
GFDL-ESM4	v20180701	10.22033/ESGF/CMIP6.8686
HADGEM3-GC31-LL	n/a	n/a
INM-CM4-8	v20190603	10.22033/ESGF/CMIP6.12327
INM-CM5-0	v20190619	10.22033/ESGF/CMIP6.12328
IPSL-CM6A-LR	v20190119	10.22033/ESGF/CMIP6.5264
MIROC-ES2L	v20190823	10.22033/ESGF/CMIP6.5745
MIROC6	v20190627	10.22033/ESGF/CMIP6.5746
MPI-ESM1-2-HR	v20190815	10.22033/ESGF/CMIP6.4398
MPI-ESM1-2-LR	v20190710	10.22033/ESGF/CMIP6.6693
MRI-ESM2-0	n/a	n/a
NESM3	v20190804	10.22033/ESGF/CMIP6.8781
NORESM2-LM	v20191108	n/a
UKESM1-0-LL	n/a	n/a

Table S9. Version number and doi for SSP5-8.5 CMIP6 simulations used in this study

	version	DOI
ACCESS-CM2	v20190909	10.22033/ESGF/CMIP6.4332
ACCESS-ESM1-5	v20190919	10.22033/ESGF/CMIP6.4333
AWI-CM-1-1-MR	n/a	10.22033/ESGF/CMIP6.2817
BCC-CSM2-MR	v20190315	10.22033/ESGF/CMIP6.3050
CAMS-CSM1-0	v20190708	10.22033/ESGF/CMIP6.11052
CESM2	n/a	10.22033/ESGF/CMIP6.7768
CESM2-WACCM	n/a	10.22033/ESGF/CMIP6.10115
CNRM-CM6-1	v20190219	10.22033/ESGF/CMIP6.4224
CNRM-CM6-1-HR	v20191202	10.22033/ESGF/CMIP6.4225
CanESM5	v20190429	10.22033/ESGF/CMIP6.3696
EC-Earth3	v20190928	10.22033/ESGF/CMIP6.4912
EC-Earth3-Veg	n/a	n/a
FIO-ESM-2-0	v20191228	n/a
GFDL-CM4	v20180701	10.22033/ESGF/CMIP6.9268
GFDL-ESM4	v20180701	10.22033/ESGF/CMIP6.8706
HADGEM3-GC31-LL	n/a	n/a
HADGEM3-GC31-MM	n/a	n/a
INM-CM4-8	v20190603	10.22033/ESGF/CMIP6.12337
INM-CM5-0	v20190724	10.22033/ESGF/CMIP6.12338
IPSL-CM6A-LR	v20190903	10.22033/ESGF/CMIP6.5271
MIROC-ES2L	v20190823	10.22033/ESGF/CMIP6.5770
MIROC6	v20190627	10.22033/ESGF/CMIP6.5771
MPI-ESM1-2-HR	v20190815	10.22033/ESGF/CMIP6.4403
MPI-ESM1-2-LR	v20190710	10.22033/ESGF/CMIP6.6705
MRI-ESM2-0	n/a	n/a
NESM3	v20190803	10.22033/ESGF/CMIP6.8790
NORESM2-LM	v20191108	n/a
UKESM1-0-LL	n/a	n/a

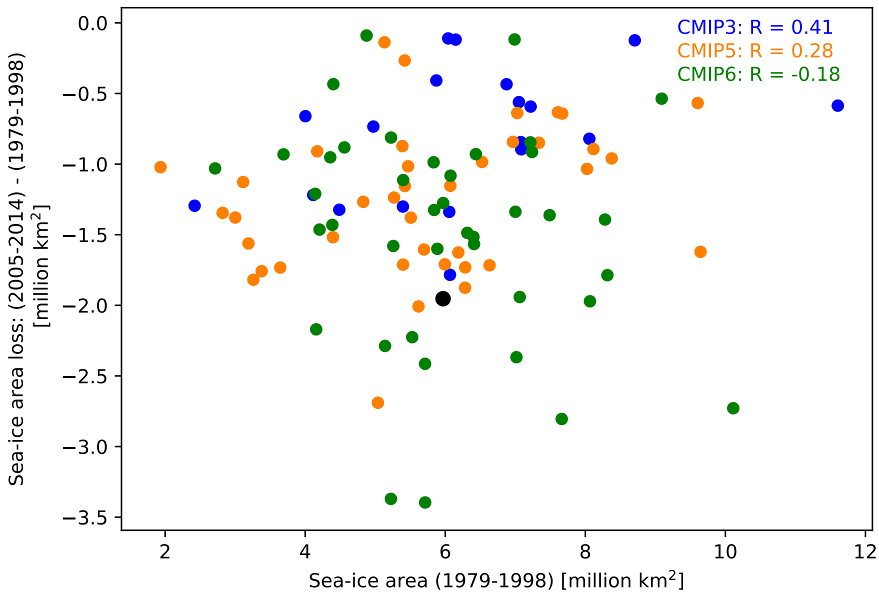

Figure S1. Sea-ice loss as a function of mean sea-ice area. The black dot indicates the observational estimate.

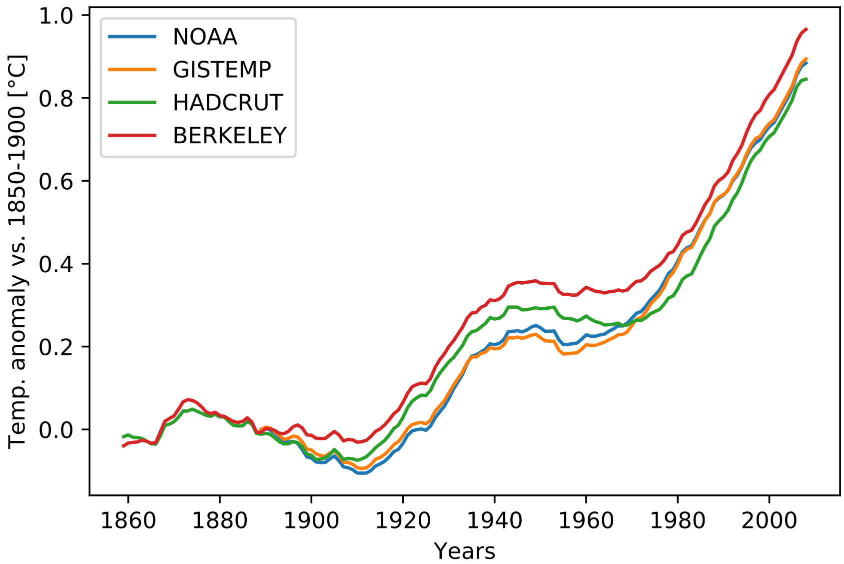

Figure S2. 20-year running mean of annual-mean global mean surface temperature anomaly for the different products used here.