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On the drivers of regime shifts in the Antarctic marginal seas, exemplified by the Weddell Sea

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Table S1: A list of performed experiments, giving runtime and an abbreviated description of the applied forcing or alterations. Experiments where a regime shift was observed within the runtime are printed in bold, blue font. Experiments featured in the article are marked with their name.

#	# years	featured	short descripition of forcing (alterations)
1	39+156	REF	ERA Interim
2	78		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Amundsen (Am), Bellingshausen (Be), Weddell (Wed) Seas)
3	78		increase Tair (+4) south of 70° S from 140-360° (Ross, Am, Be, Wed)
4	78		repeat the 10 years with Amundsen Sea Low (ASL) central pressure lowest
5	78		repeat the 10 years with ASL position furthest east
6	78		repeat the 10 years with ASL position furthest east during Sep-Feb
7	39		increase precip (x1.2) south of 70° S from 140-360° (Ross, Am, Be, Wed)
8	39		increase lwrd (x1.2) south of 70° S from 140-360° (Ross, Am, Be, Wed)
9	78		reduce Vwind (x0.5) and increase Tair (+4) south of 70° S from 140-360° (Ross, Am, Be, Wed)
10	39		reduce Vwind (x0.3) south of 70° S from 140-360° (Ross, Am, Be, Wed)
11	39		increase Tair (+8) south of 70° S from 140-360° (Ross, Am, Be, Wed)
12	39		increase Vwind (x1.5) south of 70° S from 140-360° (Ross, Am, Be, Wed)
13	39		increase Uwind (x1.5) south of 70° S from 140-360° (Ross, Am, Be, Wed)
14	39		reduce Uwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed)
15	39		reduce Vwind (x0.4) south of 60° S circumpolar
16	78		repeat the 10 years with ASL position furthest west during Sep-Feb
17	39		reduce Vwind (x0.5) and increase Tair (+4) south of 70° S from 140-360° (Ross, Am, Be, Wed), also h0=0.25
18	39		increase Uwind (x1.5) south of 60° S circumpolar
19	39		southward shift of wind at 37° S by 1.5°
20	78		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and uwind-5, vwind+3 along east Wed coast
21	39		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and uwind+5, vwind-3 along east Wed coast
22	39		reduce Vwind (x0.5) south of 70° S from 140-294° (Ross, Am, Be) and 60° from 294-360° (Wed)
23	39		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and uwind+7 along east Wed coast
24	39		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and vwind-6 along east Wed coast
25	39		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and uwind+5, vwind-3 along east Wed and Ross coast
26	39		reduce Vwind (x0.5) south of 70° S from 140-360° (Ross, Am, Be, Wed) and uwind+10, vwind-6 along east Wed and Ross coast
27	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed and uwind-5, vwind+3 along east Wed and Ross coast

28	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed
29	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed from day 91-270
30	39		repeat 2017
31	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind-3, vwind-5 along east Wed (-5,+3 Ross) coast
32	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind-5, vwind-3 along east Wed (-5,+3 Ross) coast
33	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind-5.8 along east Wed (-5,+3 Ross) coast
34	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind-5, vwind+3 along east Wed (-5,+3 Ross) coast
35	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind-3, vwind+5 along east Wed (-5,+3 Ross) coast
36	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and vwind+5.8 along east Wed (-5,+3 Ross) coast
37	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind+3, vwind+5 along east Wed (-5,+3 Ross) coast
38	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed (day 91-270) and uwind+5, vwind+3 along east Wed (-5,+3 Ross) coast
39	39		reduce Vwind (x0.5) and increase Tair (+4) south of 76.3° S in Ross, 74° S in Wed from day 91-270
40	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and increase Tair (+4) along east Wed coast (day 271-90)
41	39		reduce Vwind (x0.5) and increase Tair (+4) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and increase Tair (+4) along east Wed coast (day 271-90)
42	39		reduce Vwind (x0.5) and increase Tair (+4) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and uwind-5, vwind+3 along east Wed coast
43	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and uwind-5, vwind+3, Tair+4 along east Wed coast
44	39		reduce Vwind (x0.5) and increase Tair(+4) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and uwind-5, vwind+3, Tair+4 along east Wed coast
45	39		reduce Vwind (x0.5) south of 76.3° S in Ross, 74° S in Wed from day 91-270 and increase Tair (+4) along east Wed coast
46	**39**		**HadCM3 A1B 2050-2099**
47	57		add diff in seas. cycle HadCM3 A1B 2070-2089 - 20C 1980-1999 for T, wind and radiative fluxes
48	20		add diff in seas. cycle HadCM3 A1B 2070-2089 - 20C 1980-1999 for T, wind, dew point and radiative fluxes
49	24		add diff in seas. cycle HadCM3 A1B 2070-2089 - 20C 1980-1999
50	**78**		**S -50° HadCM3 A1B 2050-2099**
51	**195**	**SA_G**	**seasonal cycle HadCM3 A1B 2070-2089**
52	**78**	**R_ERA**	**unaltered ERA Interim after SA_G cycle 2 REVERSE**
53	**159**	**R_H20C**	**unaltered HadCM3 20C after SA_G cycle 2 REVERSE**
54	**117**	**SA_S**	**S -50° seasonal cycle HadCM3 A1B 2070-2089**
55	78		seasonal cycle HadCM3 A1B 2070-2089 except wind
56	**39**		**seasonal cycle HadCM3 A1B 2070-2089 except precipitation and shortwave**
57	78		day 60-243 seasonal cycle HadCM3 A1B 2070-2089
58	**78**		**seasonal cycle HadCM3 A1B 2070-2089 except precipitation**

59	**78**		**seasonal cycle HadCM3 A1B 2070-2089 except temperature**
60	**78**		**seasonal cycle HadCM3 A1B 2070-2089 except dew point**
61	78		seasonal cycle HadCM3 A1B 2070-2089 except evaporation
62	**78**		**seasonal cycle HadCM3 A1B 2070-2089 except longwave**
63	78		prolongued summer, shortened winter
64	**117**	**SA_W**	**Wed seasonal cycle HadCM3 A1B 2070-2089**
65	117	SUMMER_S	south of 50°S prolongued summer, shortened winter
66	**117**	**SUMMER_S+SAw_W**	**south of 50°S prolongued summer, shortened winter, Wed Wind + fitted variable sinus**
67	78		south of 50°S prolongued summer, shortened winter, Wed Wind + fitted sinus
68	**117**		**south of 50°S prolongued summer, shortened winter, Wed Wind + fitted variable sinus, evap reduced in Wed in winter *0.01**
69	78		south of 50°S prolongued summer, shortened winter, Wed Wind + fitted sinus, evap reduced in Wed in winter *0.01
70	**117**		**south of 50°S prolongued summer, shortened winter, Wed Wind + fitted variable sinus, & copy wind to RS**
71	159	H20C	HadCM3 20C
72	39		southward shift of wind at 37° S by 3.75°
73	39		Wed seasonal cycle HadCM3 A1B 2070-2089 only wind
74	39		seasonal cycle HadCM3 A1B 2070-2089 only wind
75	78		seasonal cycle HadCM3 A1B 2070-2089 only wind & Tair

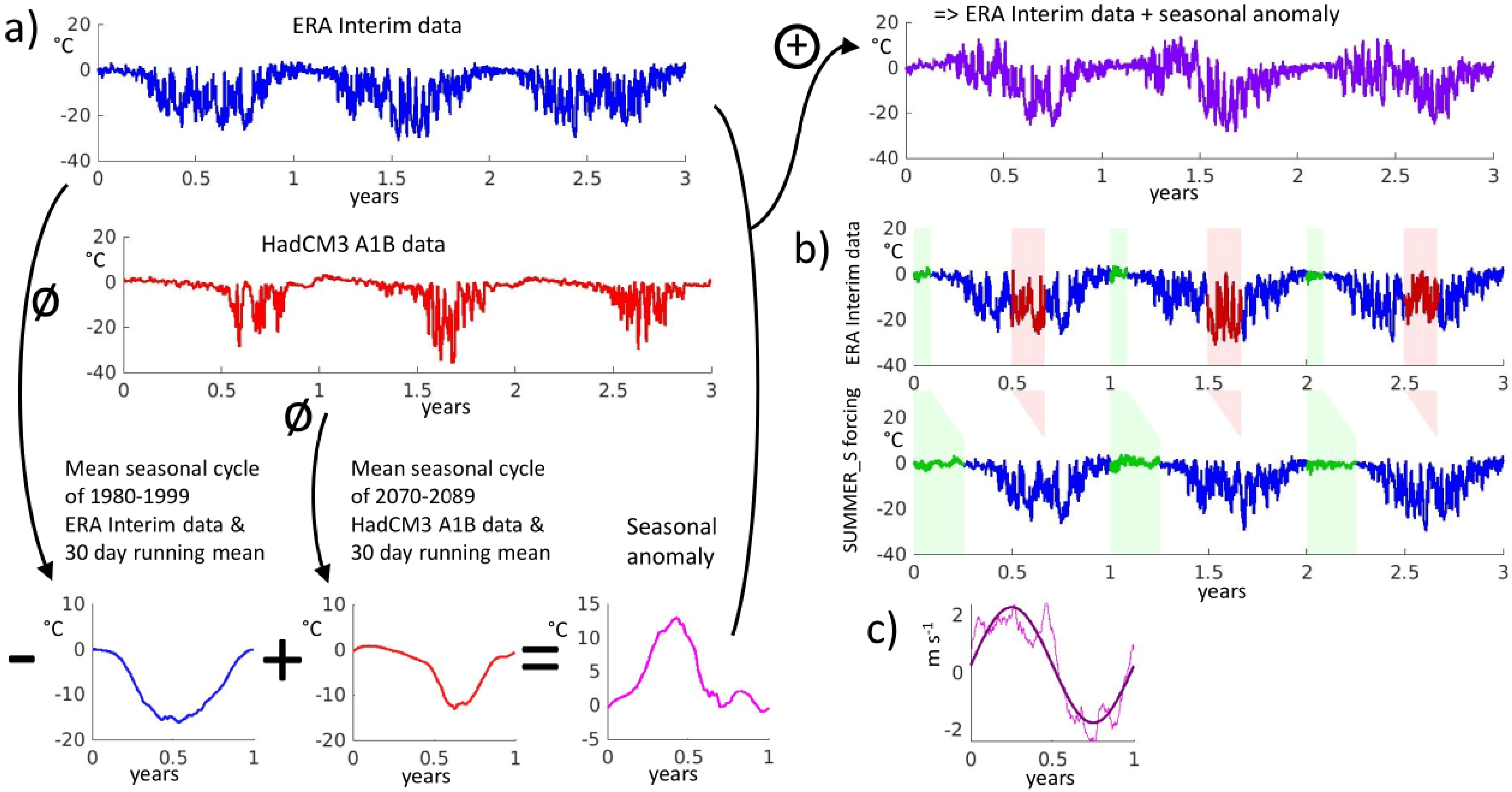

Figure S1: Schematic depiction of the construction of a) the seasonal anomaly used in the atmospheric forcing in SA_G, SA_S and SA_W (see Sections 2.3 and 2.4), b) the change applied to atmospheric variables in SUMMER_S (see Section 2.3), c) the fitting of a sine function with the periodicity of one year as used for the Weddell region wind field in SUMMER_S+SAw_W (see Section 2.3).

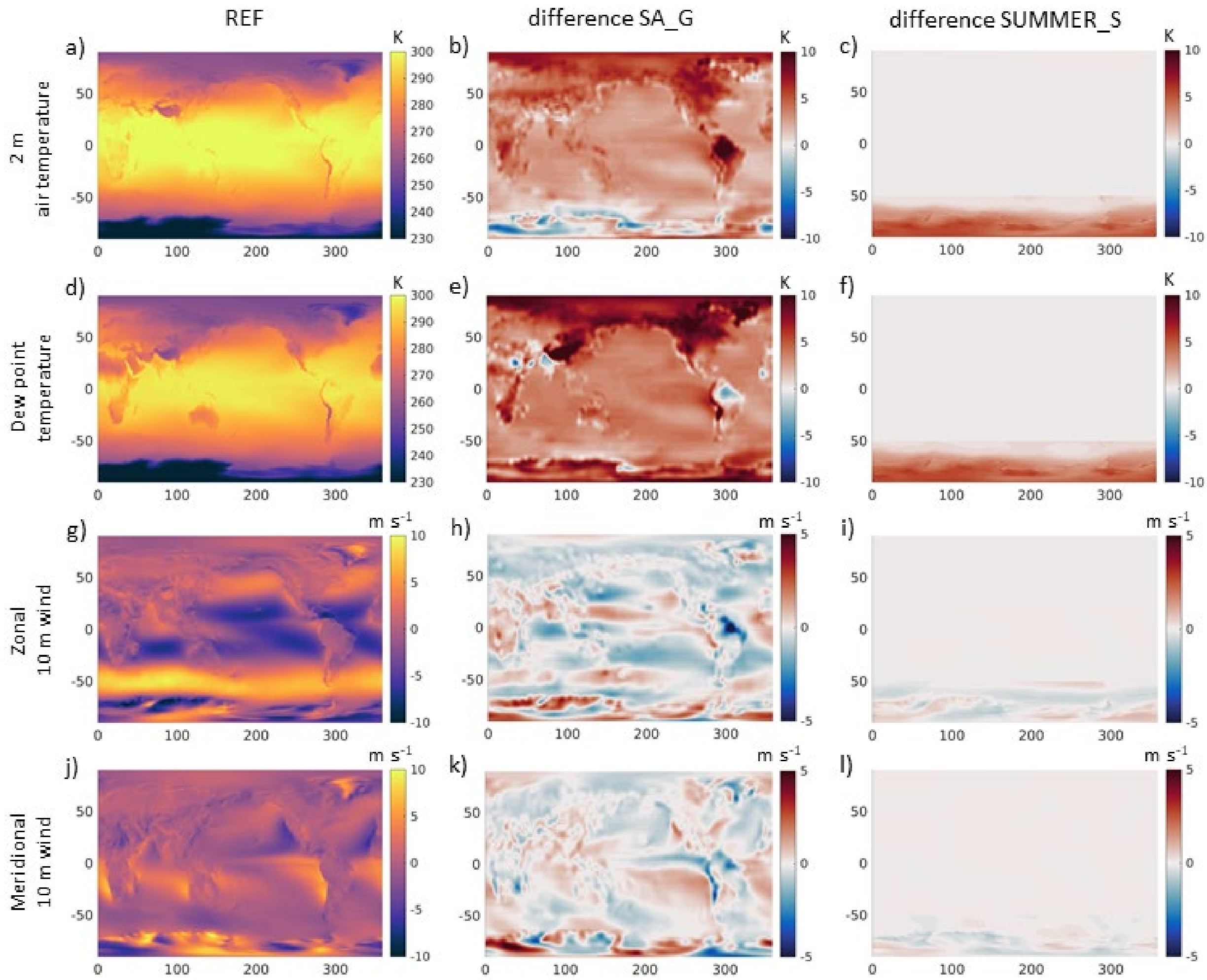

Figure S2: 39-year mean of atmospheric forcing variables in ERA Interim (left-hand column), and differences in forcing fields SA_G - REF (middle column) and SUMMER_S - REF (right-hand column). Continued on next page.

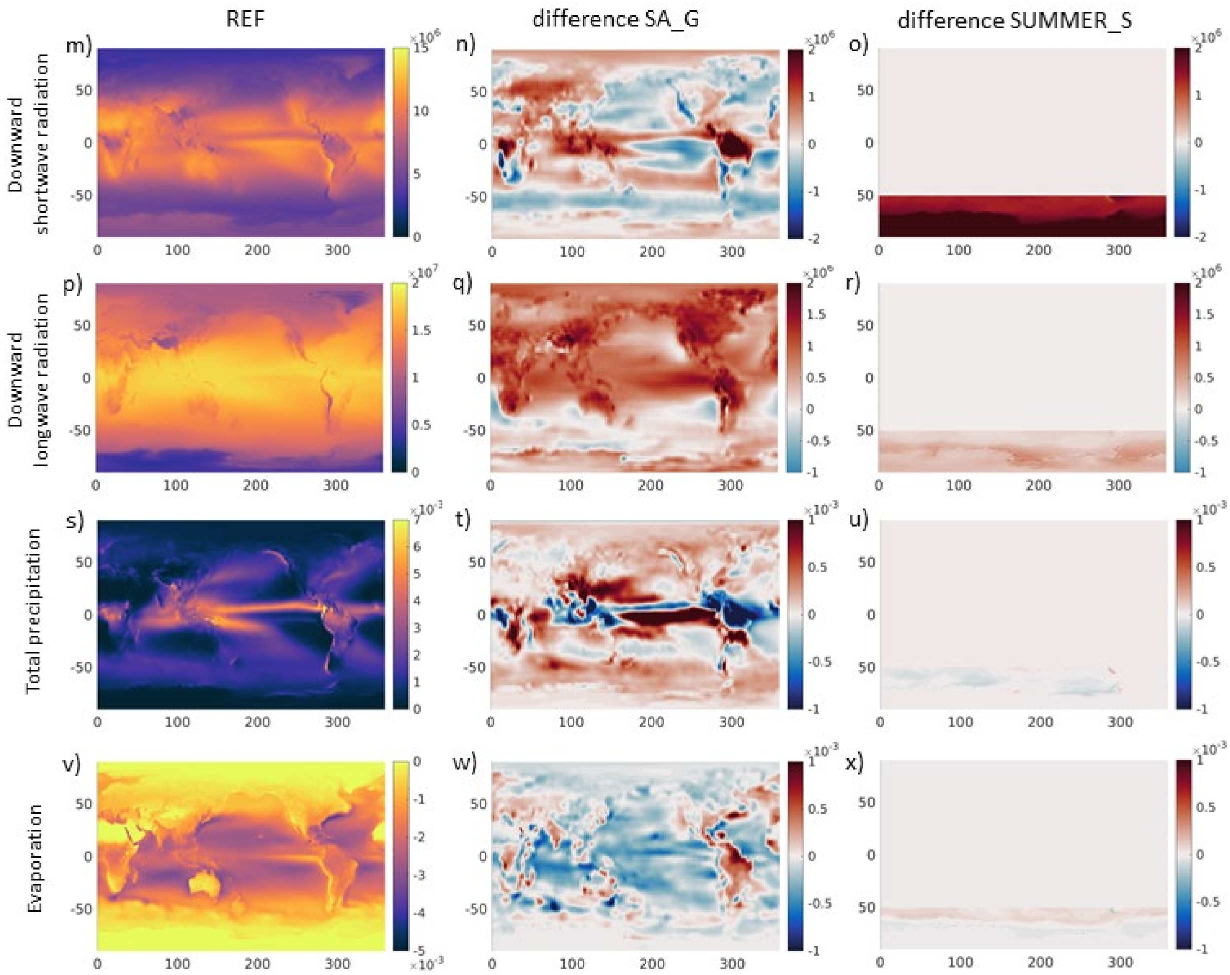

Figure S2: continued.

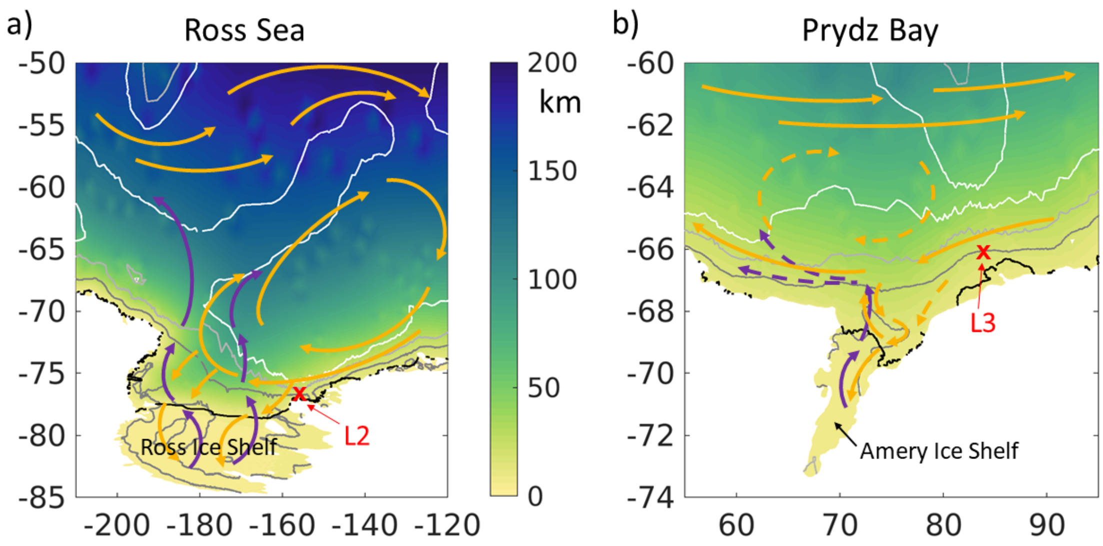

Figure S3: Detail view of the a) Ross Sea and b) Prydz Bay regions, parts of the global model domain. The grid resolution is shown in color, with ice shelf fronts (black line), 650-m isobath (dark grey), 2000-m isobath (light grey) and 3500-m isobath (white) added. Locations L2 and L3 are marked with red crosses. A simplified sketch of the circulation is overlaid with orange (warm) and purple (cold) water pathways.

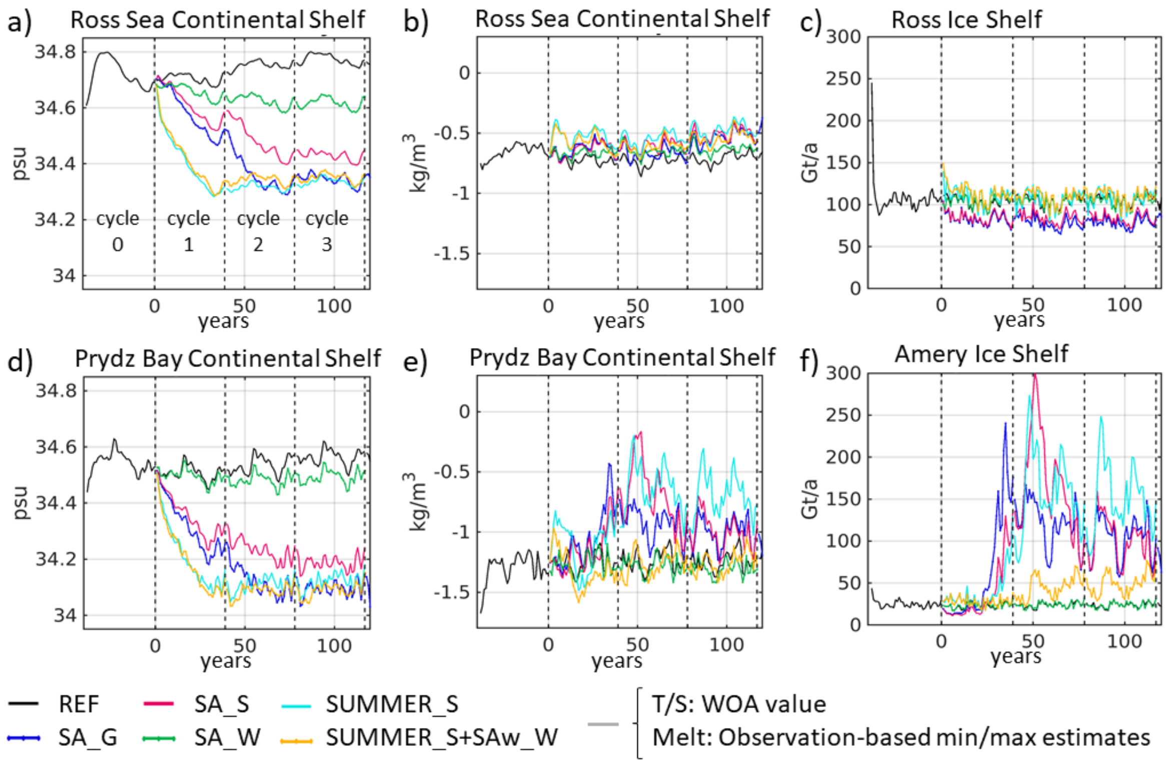

Figure S4: Annual mean a) salinity and b) temperature on the Ross Sea continental shelf (averaged over volume 200-700 m depth, south of 75°S east of 180°E and -71°S in the western part, excluding the ice shelf cavity), and c) area-averaged annual mean Ross Ice Shelf melt rates. Annual mean d) salinity and e) temperature on the Prydz Bay continental shelf (averaged over volume 200-1000 m depth, south of 67°S between 64°S and 82°S, excluding the ice shelf cavity), and f) area-averaged annual mean Amery Ice Shelf melt rates.

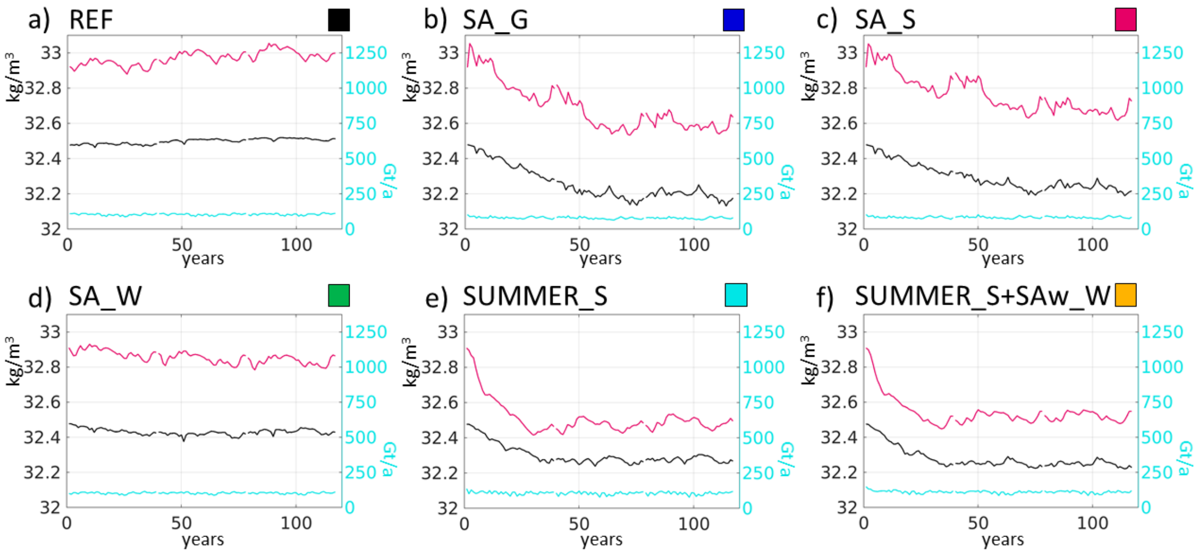

Figure S5: Annual mean values of maximum density σ1 along the Ross Ice Shelf front (red), bottom density at 550 m depth at the continental shelf break at location L2 marked in Fig. S2a) (black; left-hand y-axis for both) and basal melt of Ross Ice Shelf (light blue, right-hand y-axis) for experiments (a) REF, (b) SA_G, (c) SA_S, (d) SA_W, (e) SUMMER_S, and (f) SUMMER_S_SAw_W.

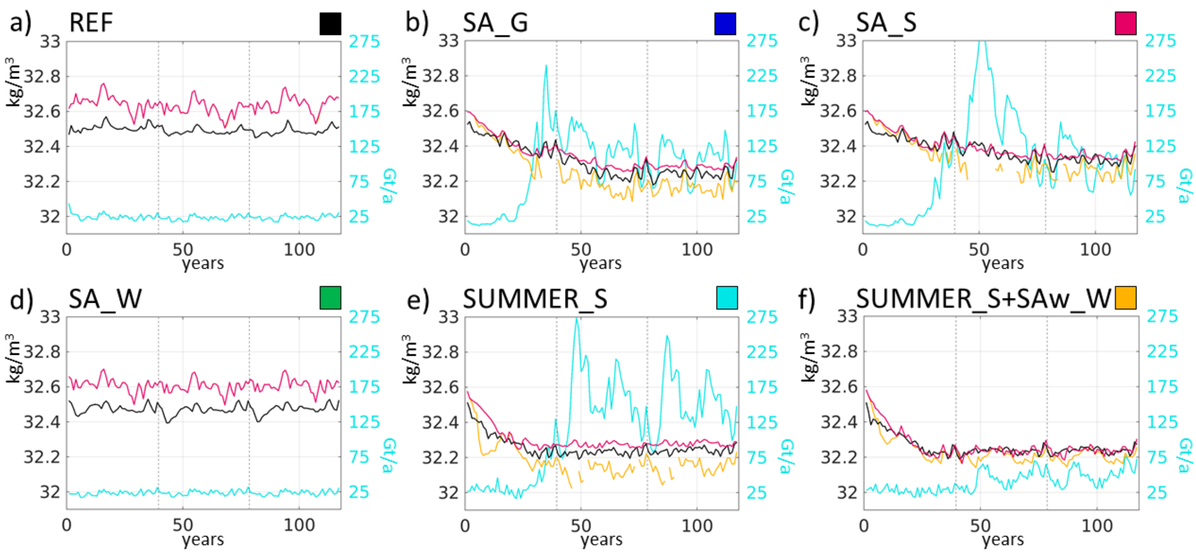

Figure S6: Annual mean values of maximum density σ1 along the Amery Ice Shelf front (red), bottom density at 490 m depth at the continental shelf break at location L3 marked in Fig. S2b) (black; left-hand y-axis for both) and basal melt of Amery Ice Shelf (light blue, right-hand y-axis) for experiments (a) REF, (b) SA_G, (c) SA_S, (d) SA_W, (e) SUMMER_S, and (f) SUMMER_S_SAw_W. Since there is no easy local separation of the warm water inflow from the dense shelf water inflow as in the FRIS case, the warm water is picked up as the densest water at the ice shelf front once it enters the cavity. In an attempt to overcome this, the yellow line shows the densest water with temperatures below -1.5 °C at the ice shelf front, the density of which – if present – seems to have a strong influence on the variability of the meltrates. In REF and SA_W, the densest water at the ice shelf front is always cold, so that the yellow curve coincides exactly with the red curve and is hidden beneath it.

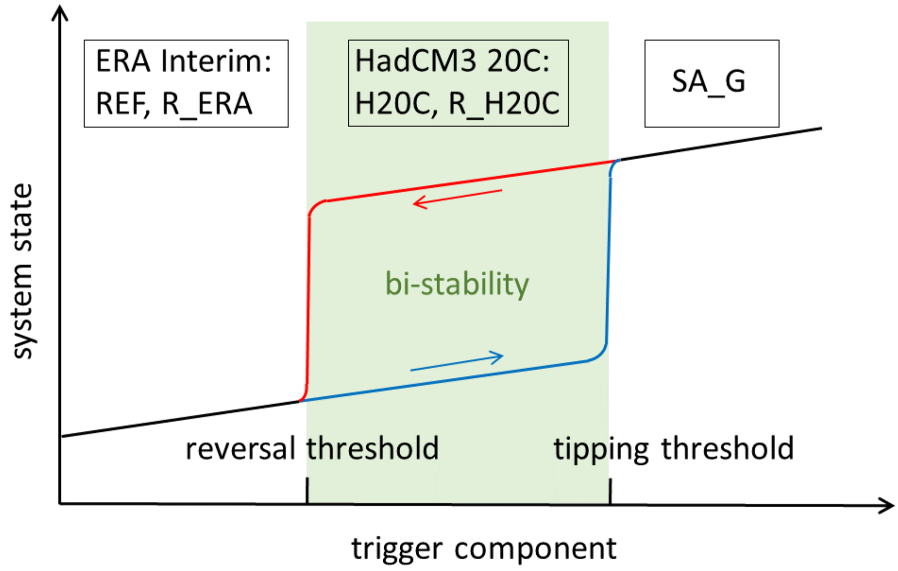

Figure S7: Schematic depiction of tipping hysteresis behaviour with experiments presented in Section 2.3 and their atmospheric forcing placed in the according zones.