Supplement of Earth Syst. Dynam., 11, 953–976, 2020
https://doi.org/10.5194/esd-11-953-2020-supplement

Earth System Dynamics
Open Access

Supplement of

Semi-equilibrated global sea-level change projections for the next 10 000 years

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In this supplementary material, we put the sea-level contribution using different climatic model parameter sets into perspective to recent estimates of sea-level rise at the end of 2100 AD and 2300 AD. The sea-level contribution at 2300 AD for RCP8.5 is shown in Fig. S1 and reaches 2.92 m, 2.66 m, 2.57 m and 1.74 m using respectively parameter set P32b, P22, P32a and P11. For scenario RCP2.6, these numbers go down to 0.61 m (P32b), 0.62 m (P22), 0.57 m (P32a) and 0.44 m (P11). We chose parameter set P22 as the most reliable parameter set for future climate and sea-level change projections. With a contribution to sea-level of 2.7 m for RCP8.5 and 0.6 m for RCP2.6 by the year 2300, it is a mid-estimate of the considered parameter sets and in the uncertainty range of the recent SROCC estimates of 2.3-5.4 m sea-level rise for RCP8.5 and 0.6-1.1 m sea-level rise for RCP2.6 (Pörtner et al., 2019). Our fully coupled contribution from the GrIS to sea-level by 2300 AD ranges between 12.7 cm (MMCP2.6) and 78.5 cm (MMCP8.5), comparable to the results from Calov et al. (2018) who found a contribution of 5.2 cm (RCP2.6) and 88.2 cm (RCP8.5) with the inclusion of a SMB-elevation feedback (Table S2). For the AIS contribution to sea-level, there is a very large uncertainty on the short-term because of the possibility of a strong grounding line retreat due to basal melting and an increase in snowfall in East-Antarctica for a warming atmosphere (Seroussi et al., 2020; Table S1). The Antarctic sea-level contribution by 2300 AD using our preferred parameter set P22 shows a mid-range contirbution in comparison with the study of Bulthuis et al. (2019), but is below the estimates from Golledge et al. (2015) (Table S2).

Table S1: Sea level contribution from the land ice components at 2100 AD for our simulations using all parameter sets and for our preferred parameter set P22 in comparison with other studies. Comma-delimited numbers denote ranges.

2100 AD	GrIS contribution (mm s.l.e)		AIS contribution (mm s.l.e.)		Glaciers and ice caps mass loss (%)	
	MMCP2.6	**MMCP8.5**	**MMCP2.6**	**MMCP8.5**	**MMCP2.6**	**MMCP8.5**
Our study – all parameter sets	25, 64	56, 120	-17, 13	-22, 43	15, 27	20, 30
Our study – preferred parameter set P22	34	73	13	43	21	24
Goelzer et al. (2020b)	15, 47	38, 140				
Seroussi et al. (2020)			-14, 177	-78, 300		
Levermann et al. (2020)			70, 270	90, 380		
Hock et al. (2019)					11, 25	25, 47
Huss and Hock (2015)					19, 31	39, 57
Golledge et al. (2015)			10, 100	100, 390		
Calov et al. (2018)		46, 130				
Aschwanden et al. (2019)	50, 190	140, 330				
Winkelmann et al. (2015)			-40, 5	70, 80		
Bulthuis et al. (2019)			-60, 100	-30, 200		

Table S2: Sea level contribution from the land ice components at 2300 AD for our simulations using all parameter sets and for our preferred parameter set P22 in comparison with other studies. Comma-delimited numbers denote ranges. All data are given relative to the year 2000 AD.

2300 AD	GrIS contribution (m s.l.e)		AIS contribution (m s.l.e.)		Glaciers and ice caps mass loss (%)	
	MMCP2.6	**MMCP8.5**	**MMCP2.6**	**MMCP8.5**	**MMCP2.6**	**MMCP8.5**
Our study – all parameter sets	0.11, 0.20	0.61, 1.29	-0.03, 0.08	0.30, 0.79	38, 56	58, 71
Our study – preferred parameter set P22	0.13	0.79	0.08	0.79	38	58
Aschwanden et al. (2019)	0.17, 0.55	0.94, 3.74				
Calov et al. (2018)		0.26, 0.76				
Golledge et al. (2015)			0.14, 0.38	1.60, 2.96		
Bulthuis et al. (2019)			-0.14, 0.31	0.17, 1.35		

Table S3: Parameter values for four different parameter sets for the atmospheric component EC-Bilt.

	Term	P11	**P22**	P32a	P32b
Scaling coefficient in the longwave radiative scheme	amplw	1	**1**	1.05	1.05
Exponent in the longwave radiative scheme	explw	0.33	**0.4**	0.5	0.5
Relative Rossby radii of deformation, applied in the Rayleigh damping term of the equation of the quasi-geostrophic potential vorticity in the 300–500 hPa layer	λ2	0.125	**0.125**	0.131	0.131
Relative Rossby radii of deformation, applied in the Rayleigh damping term of the equation of the quasi-geostrophic potential vorticity in the 500–800 hPa layer	λ4	0.070	**0.070**	0.071	0.071
Scaling factor multiplying the vertical diffusion	avkb	1	**1.5**	2.5	2.5
Multiplication factor for the albedo	albocef	1	**0.90**	0.95	0.95
Albedo of snow	alphd	0.70	**0.70**	0.70	0.70
Albedo of bare ice	alphdi	0.60	**0.60**	0.60	0.60
Albedo of melting snow	alphs	0.51	**0.51**	0.51	0.51
Albedo of melting ice	albice	0.42	**0.42**	0.42	0.42
Reduction of precipitation in the Atlantic	corA	0.085	**0.0425**	0.085	0.085
Amplification factor in the long wave radiative scheme at the equator	ampanir	0.5	**0.9**	0.4	0.5
Amplification factor in the long wave radiative scheme between 60-90˚S	ampanir2	0.5	**0.9**	0.4	0.5

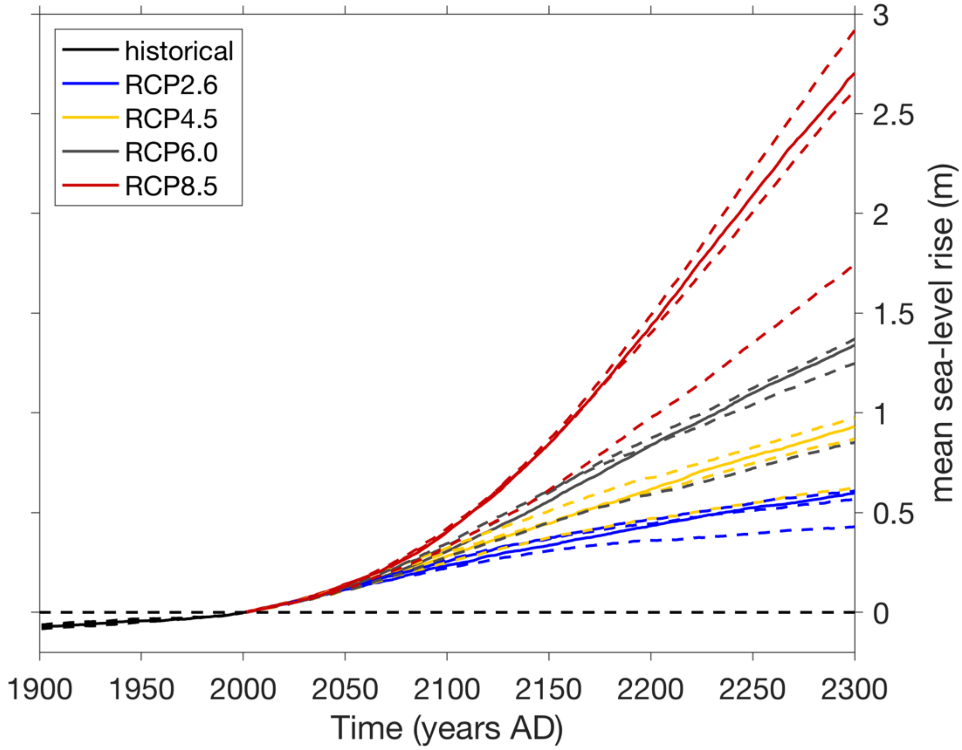

Figure S1: Global mean sea level change for the period 1900-2300 AD using 4 different parameter sets of LOVECLIM. The solid lines show the sea level change projections for parameter set P22.

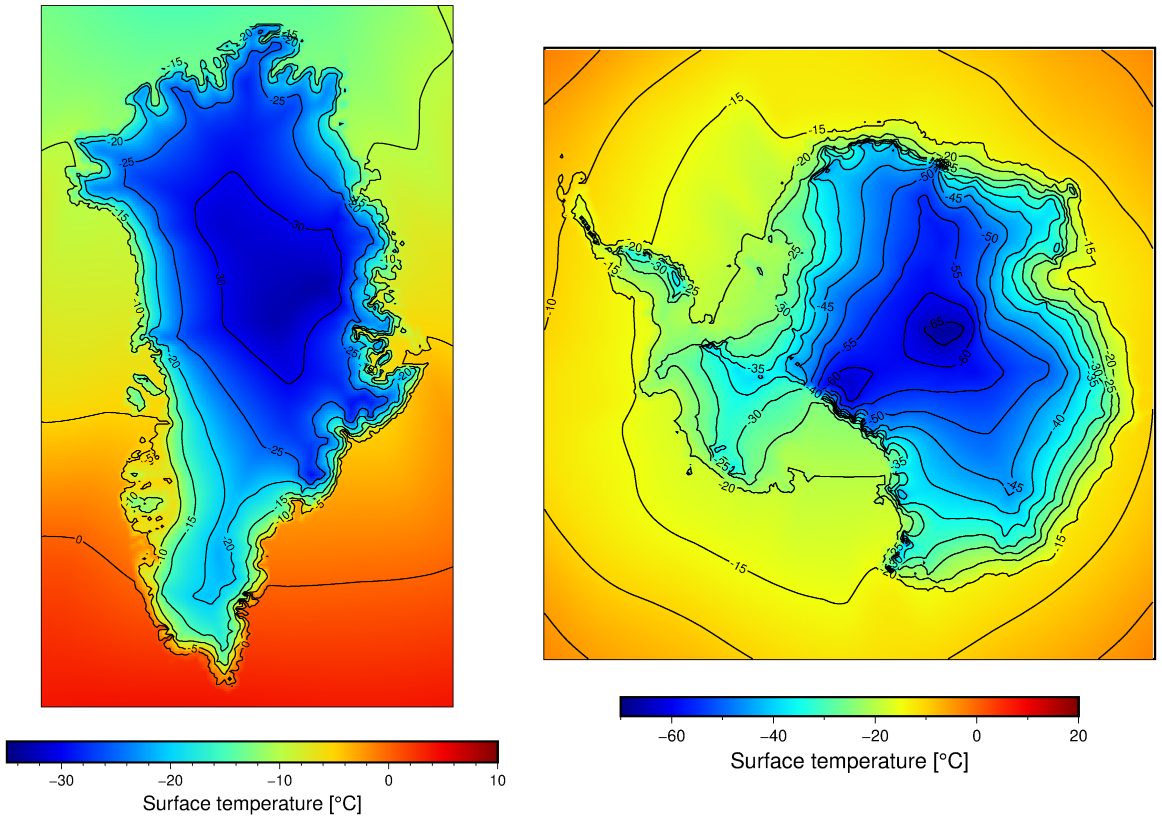

Figure S2: Reference mean annual SAT at the start of the simulations (2000 AD) for the Greenland ice sheet and the Antarctic ice sheet.

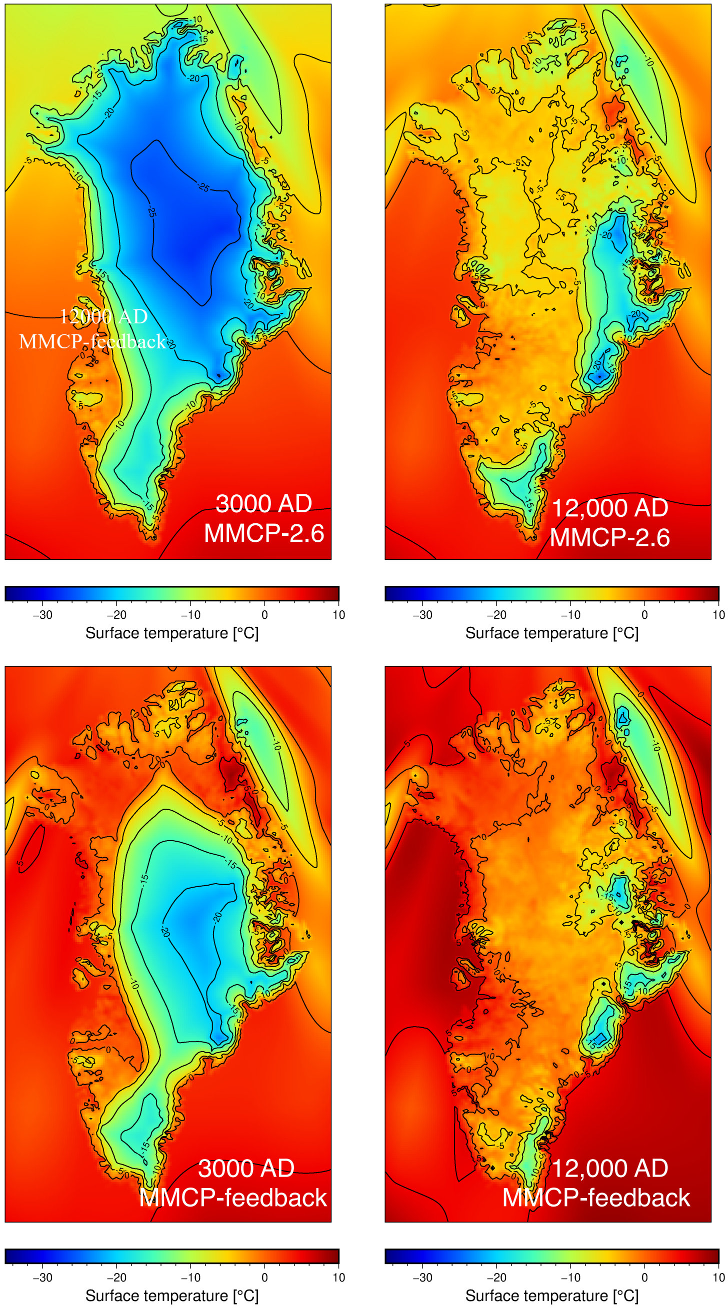

Figure S3: Mean annual SAT for Greenland at 3000 AD and 12,000 AD for MMCP2.6 and MMCP-feedback.

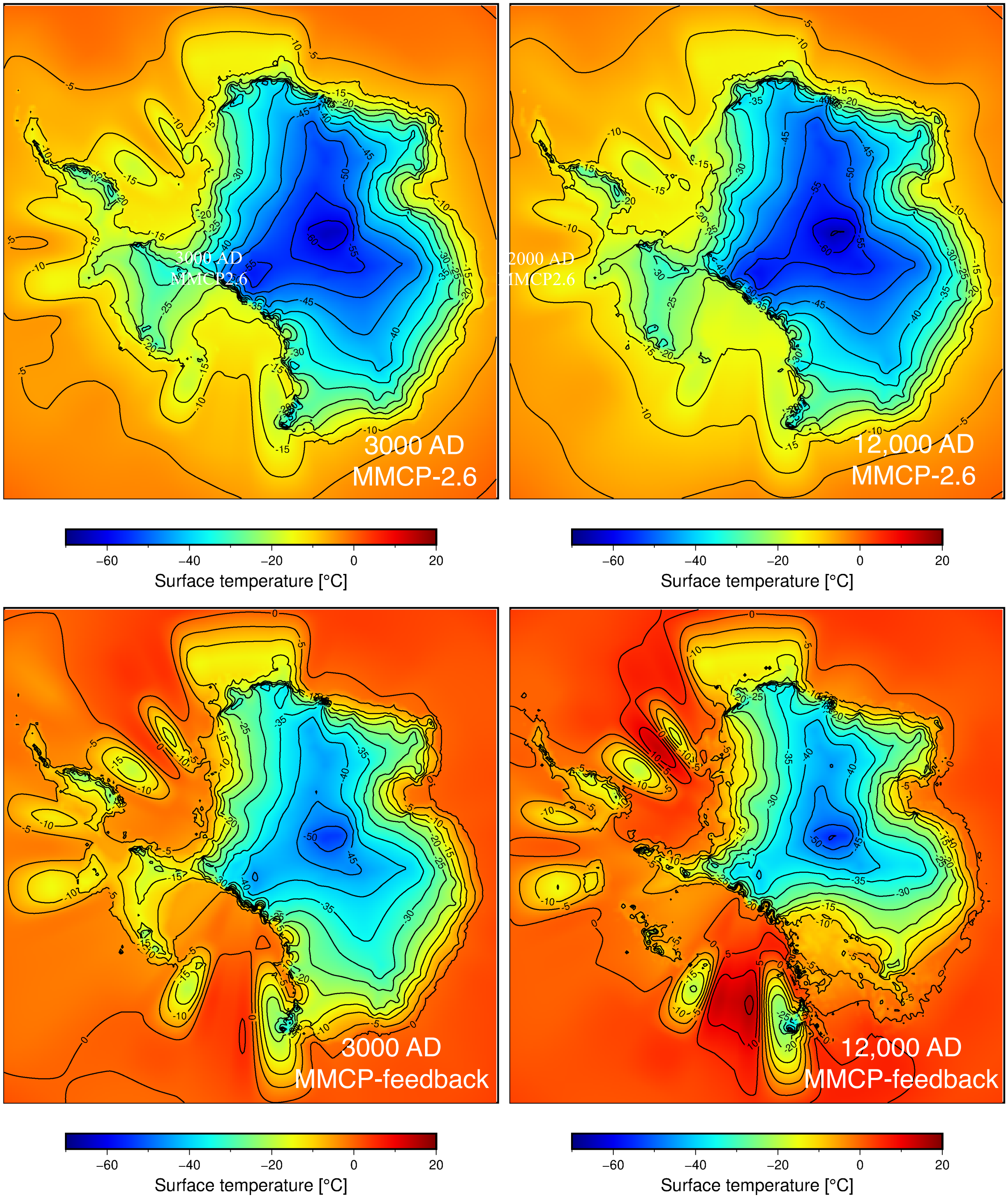

Figure S4: Mean annual SAT for Antarctica at 3000 AD and 12,000 AD for MMCP2.6 and MMCP-feedback.