

Supplement to: A glacial systems model configured for large ensemble analysis of Antarctic deglaciation

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1. supplementary figures and tables

Temperature and precipitation fields used for the climate forcing along with data used to tune and validate the SSM model are presented below.

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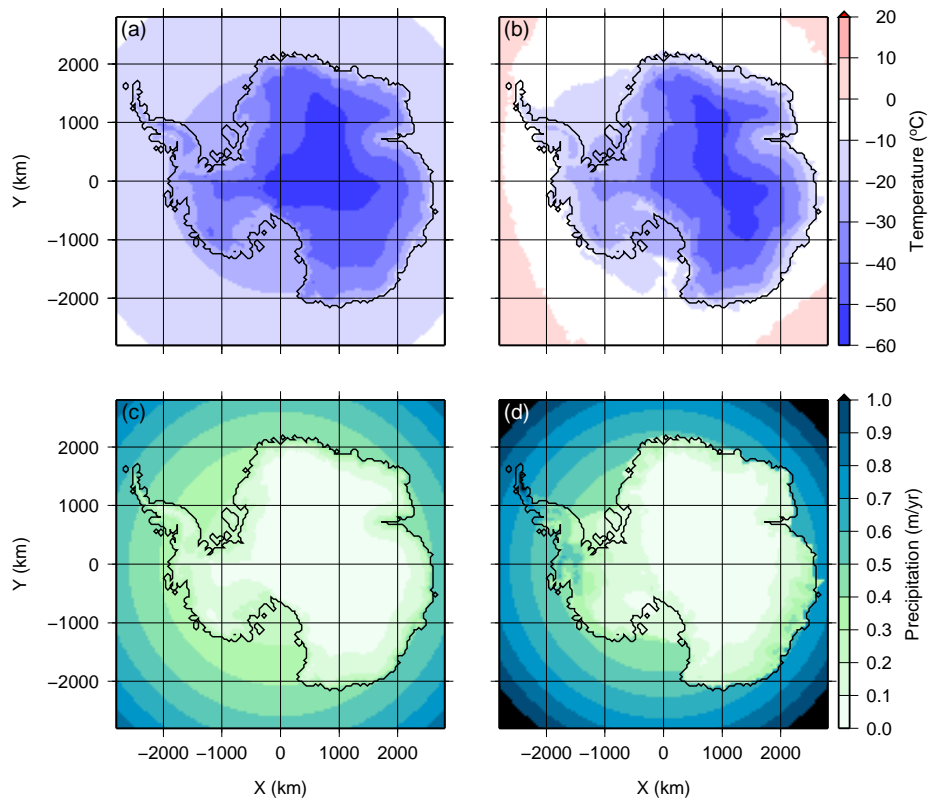


Figure 1: Present day climate forcing fields for (a) $Tf1$, (b) $Tf2$, (c) $Pf1$, and (d) $Pf2$.

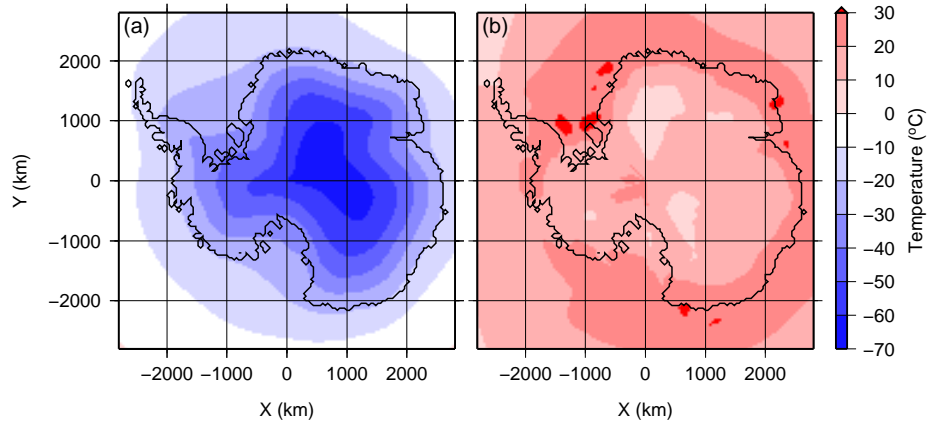


Figure 2: LGM temperature forcing fields, (a) shows $T_{ave_{LGM}}$ and (b) the associated EOF, $T_{eof_{LGM}}$.

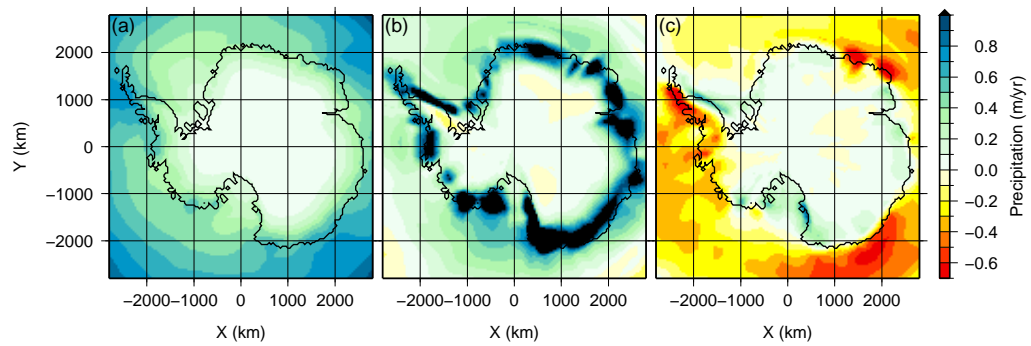


Figure 3: LGM precipitation forcing fields, (a) shows $P_{ave_{LGM}}$, (b) shows the associated EOF $P_{eof1_{LGM}}$, and (c) $P_{eof2_{LGM}}$.

Table 1: Table of thickness (H) and melt rates for the AMY ice shelf. The data was extracted from Fig. 4 and Fig. 6 in Wen et al. (2007).

(a)			(b)		
Distance from grounding line (km)	H (m)	Melt rate (m yr ⁻¹)	Distance from grounding line (km)	H (m)	Melt rate (m yr ⁻¹)
0	1600	-1	325	660	0.25
25	1540	-4.5	350	650	-0.1
50	1400	-4.5	375	640	0.0
75	1220	-2.5	400	590	0.25
100	1200	-0.65	425	575	0.25
125	1150	-0.45	450	530	0.25
150	1020	-0.7	475	510	0.2
170	1010	-0.1	510	490	0.0
185	980	-0.5	550	480	0.25
210	930	-1.25	590	450	0.05
230	900	-0.75	640	450	0.0
260	860	-0.4	680	420	-0.05
280	750	-0.5	720	400	-1.6
310	700	0.15	750	250	-6

Table 2: Table of thickness (H) and melt rates for the RON ice shelf. The data was extracted from Fig 9. and Fig. 10 in Jenkins and Doake (1991).

(a)			(b)		
Distance from grounding line (km)	H (m)	Melt rate (m yr ⁻¹)	Distance from grounding line (km)	H (m)	Melt rate (m yr ⁻¹)
0	2300	-	345	640	-
20	-	-22.5	335	-	0.5
40	2000	-	360	-	1
60	-	-11	375	600	-
75	1640	-	390	-	1.5
90	-	-6.5	410	520	-
110	1300	-	430	480	-
130	-	-3	420	-	0.5
140	1040	-	430	480	-
165	-	-2.5	450	-	0
180	920	-	470	440	-
200	-	-1.5	485	-	1.5
220	840	-	495	380	-
235	-	-1.5	505	-	1.5
255	760	-	510	360	-
265	-	-1	520	-	1.5
280	720	-	525	300	-
300	-	-0	530	-	-2.0
315	700	-	540	280	-

Table 3: SSM observations as extracted from the literature

Shelf	Reference	Type of data	Value	Method
AMY				
	Jacobs et al. (1996)	Average rate (all Jacobs et al. (1996) estimates \pm 50%)	0.65 m yr^{-1}	Measurement
	Jacobs et al. (1996)	Net melt	23 Gt yr^{-1}	”
	Williams et al. (2001)	Total melt	5.8 Gt yr^{-1} and 18.0 Gt yr^{-1}	Model
	Rignot and Jacobs (2002)	at grounding line	31.5 m yr^{-1}	InSAR
	Wen et al. (2007)	Mean melt near the southern grounding line	$23.0 \pm 3.5 \text{ m yr}^{-1}$	In-situ and remote sensing
	Wen et al. (2007)	Freezing rates	0.5 ± 0.1 to $1.5 \pm 0.2 \text{ m yr}^{-1}$	”
	Wen et al. (2007)	Total basal melting	$50.3 \pm 7.5 \text{ Gt yr}^{-1}$	”
	Wen et al. (2007)	Total refreezing	$7.0 \pm 1.1 \text{ Gt yr}^{-1}$	”
	Wen et al. (2007)	Net basal melting	$43.3 \pm 6.5 \text{ Gt yr}^{-1}$	”
	Yu et al. (2010)	Net basal melting	$27.0 \pm 7.0 \text{ Gt yr}^{-1}$	In-situ and remote sensing
ROS				
	Jacobs et al. (1996)	Average rate (excluding 100 km of shelf front)	0.22 m yr^{-1}	Measurement
	Jacobs et al. (1996)	Net melt (excluding 100 km of shelf front)	81 Gt yr^{-1}	”

Table 3: SSM observations as extracted from the literature

Holland et al. (2003)	Estimated from Fig 10, max melt at GL	0.12 m yr ⁻¹	Model
Holland et al. (2003)	Estimated from Fig 10, average freeze cm	0.02 m yr ⁻¹	”
Loose et al. (2009)	average basal melt rate of	33-50 km ³ /a	Noble gases, stable isotopes, and CFC transient tracers
Reddy et al. (2010)	average basal melt rates of (including a seasonal signal)	0.1 m yr ⁻¹	CFC tracers
Horgan et al. (2011)	Melt law for shelf front (40 km by 760 km) within the front km	16 km ³ /a 2.8 ± 1.0 m yr ⁻¹	Remote sensing ”
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FIL-RON			
Jacobs et al. (1996)	Average rate (excluding 100 of shelf front)	0.55 m yr ⁻¹	Measurement
Jacobs et al. (1996)	Net melt (excluding 100 of shelf front)	202 Gt yr ⁻¹	”
Grosfeld et al. (1998)	Net melt for FIL	0.35 m yr ⁻¹	Model
Rignot and Jacobs (2002)	at grounding line	2-14 m yr ⁻¹	InSAR
Joughin and Padman (2003)	Total net melt rate for FIL-RON	83.4 ± 24.8 Gt yr ⁻¹	Remote-sensing data sets
Joughin and Padman (2003)	RON grounding line melt	50.4 Gt yr ⁻¹	”
Joughin and Padman (2003)	RON freeze-on	55.6 Gt yr ⁻¹	”

Table 3: SSM observations as extracted from the literature

Joughin and Padman (2003)	RON front melt	54.8 Gt yr ⁻¹	”
Joughin and Padman (2003)	FIL melt	20.6 Gt yr ⁻¹	”
Joughin and Padman (2003)	FIL freeze-on	16.1 Gt yr ⁻¹	”
Joughin and Padman (2003)	Downstream of Foundation Ice Stream	24.8 Gt yr ⁻¹	”
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Other shelves			
Jacobs et al. (1996)	Total estimate - (AMY+ROS+FIL+RON)	450 Gt yr ⁻¹	Measurement

Table 4: Processed SSM observational data used for verification purposes. Values in italics for RON-FIL shelf system are converted or derived quantities (density of ice = 917 kg m^3 , area of RON= $341.4 \times 10^3 \text{ km}^2$, FIL= $71.7 \times 10^3 \text{ km}^2$ and assuming the 24.8 Gt yr^{-1} downstream of Foundation Ice Stream is split between RON and FIL). Melt rate or magnitude estimations for grounding line area melt or freeze-on are not calculated because of the uncertainties in estimating the area over which it occurs

Shelf	Melt type	Rate m yr^{-1}	\pm	Mass loss Gt yr^{-1}	\pm	Notes	Reference
AMY	net melt	0.65	0.325	23.3	11.5		Jacobs et al. (1996)
	net melt			43.0	6.5		Wen et al. (2007)
	net melt	0.51	0.13	27.0	7.0		Yu et al. (2010)
	freeze on	0.5 \rightarrow 1.5		7.0	1.1		Wen et al. (2007)
ROS	net melt	0.22	0.11	81	40.5		Jacobs et al. (1996)
	net melt			48.5	18.6		Loose et al. (2009)
	net melt	0.1					Reddy et al. (2010)
	grounding area	0.12				max	Holland et al. (2003)
	freeze-on	0.02				ave	Holland et al. (2003)
	freeze-on	0 \rightarrow 0.24				ave	Reddy et al. (2010)
	freeze-on	0 \rightarrow 0.48				max	Reddy et al. (2010)
	shelf front	2.8	1	14.67		40 x 760 km	Horgan et al. (2011)
RON-FIL							
	net melt	0.55		202	101		Jacobs et al. (1996)
	net melt	0.20		83.4	24.8		Joughin and Padman (2003)
RON							
	net melt	0.19		62.0	24.8		Joughin and Padman (2003)
	grounding area			50.4			Joughin and Padman (2003)
	freeze on			55.6+1.1			Joughin and Padman (2003)
	shelf front			55.9			Joughin and Padman (2003)
FIL							
	net melt	0.35		22.8			Grosfeld et al. (1998)
	net melt	0.25		16.9	24.8		Joughin and Padman (2003)
	grounding area			20.6			Joughin and Padman (2003)
	freeze-on			16.1			Joughin and Padman (2003)
OTHERS							
	net melt			450	225 ¹		Jacobs et al. (1996)

¹ 50 % error reported for all the shelves (Jacobs et al., 1996) is repeated here.

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