

Supplement of The Cryosphere, 12, 2637–2652, 2018
<https://doi.org/10.5194/tc-12-2637-2018-supplement>
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Supplement of

Basal friction of Fleming Glacier, Antarctica – Part 1: Sensitivity of inversion to temperature and bedrock uncertainty

C. Zhao et al.

Correspondence to: Chen Zhao (chen.zhao@utas.edu.au)

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Supplementary Material

Table S1. The Root Mean Square Deviation (RMSD) between the observed and relaxed surface elevation for the fast-flowing region of the Fleming Glacier (>1500 m yr^{-1}) in each cycle of Experiment TEMP1, CTRL, TEMP2, TEMP3.

Experiment	RMSD (m)		
	Cycle1	Cycle2	Cycle3
CTRL	19.35	13.64	13.09
TEMP1	15.39	13.66	13.05
TEMP2	21.15	13.32	12.57
TEMP3	15.39	13.88	13.53

Table S2. The RMSD of the simulated basal friction coefficients C between Experiments TEMP1-3 and CTRL for each cycle for the fast-flowing region of the Fleming Glacier (>1500 m yr^{-1}).

RMSD (MPa m^{-1} yr)	CTRL		
	Cycle1	Cycle2	Cycle3
TEMP1	1.00e-2	1.55e-4	9.16e-5
TEMP2	6.30e-3	6.97e-5	1.56e-5
TEMP3	3.40e-3	4.86e-5	2.94e-5

Table S3. The RMSD of the magnitude of the simulated basal velocity between Experiments TEMP1-3 and CTRL for each cycle for the fast-flowing region of the Fleming Glacier (>1500 m yr^{-1}).

RMSD (m yr^{-1})	CTRL		
	Cycle1	Cycle2	Cycle3
TEMP1	438.50	196.65	118.36
TEMP2	244.21	68.70	18.99
TEMP3	230.54	62.91	30.68

Table S4. The RMSD between the simulated temperature and the initial temperature assumption for each cycle for the fast-flowing region of the Fleming Glacier (>1500 m yr^{-1}). For TEMP3, we took the linear temperature profile as the initial temperature assumption.

Experiment	RMSD ($^{\circ}\text{C}$)		
	Cycle1	Cycle2	Cycle3
CTRL	5.05	6.69	7.20
TEMP1	7.91	8.21	8.29
TEMP2	8.25	9.27	9.49
TEMP3	4.50	6.88	7.24

Table S5. The RMSD between the observed and simulated surface speed for the fast-flowing region of the Fleming Glacier ($>1500 \text{ m yr}^{-1}$).

Experiment	RMSD (m yr^{-1})		
	Cycle1	Cycle2	Cycle3
CTRL	86.49	75.75	75.12
TEMP1	88.52	80.78	80.65
TEMP2	86.03	79.27	78.07
TEMP3	87.16	79.10	78.48
EF1	x	x	86.35
EF2	x	x	89.38
EF3	x	x	993.20
BEDMC	x	x	62.60
BEDZC	x	x	61.78
IFP1	x	x	72.10
IFP2	x	x	75.12
IFBC1	x	x	79.38
IFBC2	x	x	72.68
IFBC3	x	x	249.64

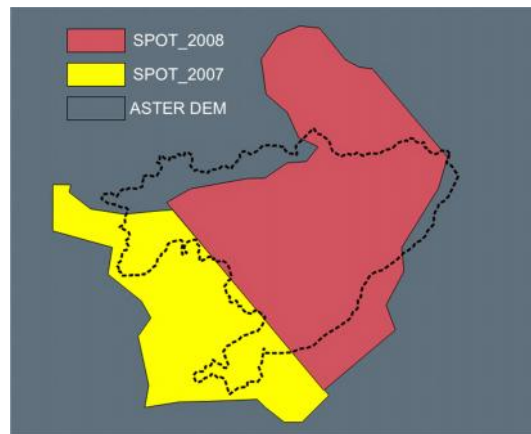


Figure S1. The masks of DEM products used to generate the surface topography in 2008. The polygons represent the SPOT DEM product acquired on 21st Feb, 2007 (yellow) and 10th Jan, 2008 (red) and an ASTER DEM product ranging from 2000 to 2009 (grey), respectively.

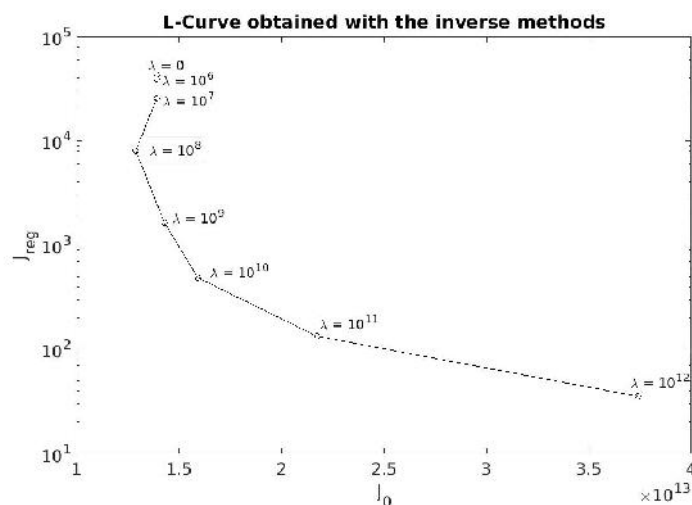


Figure S2. L-curve obtained with the inverse method of experiment CTRL.

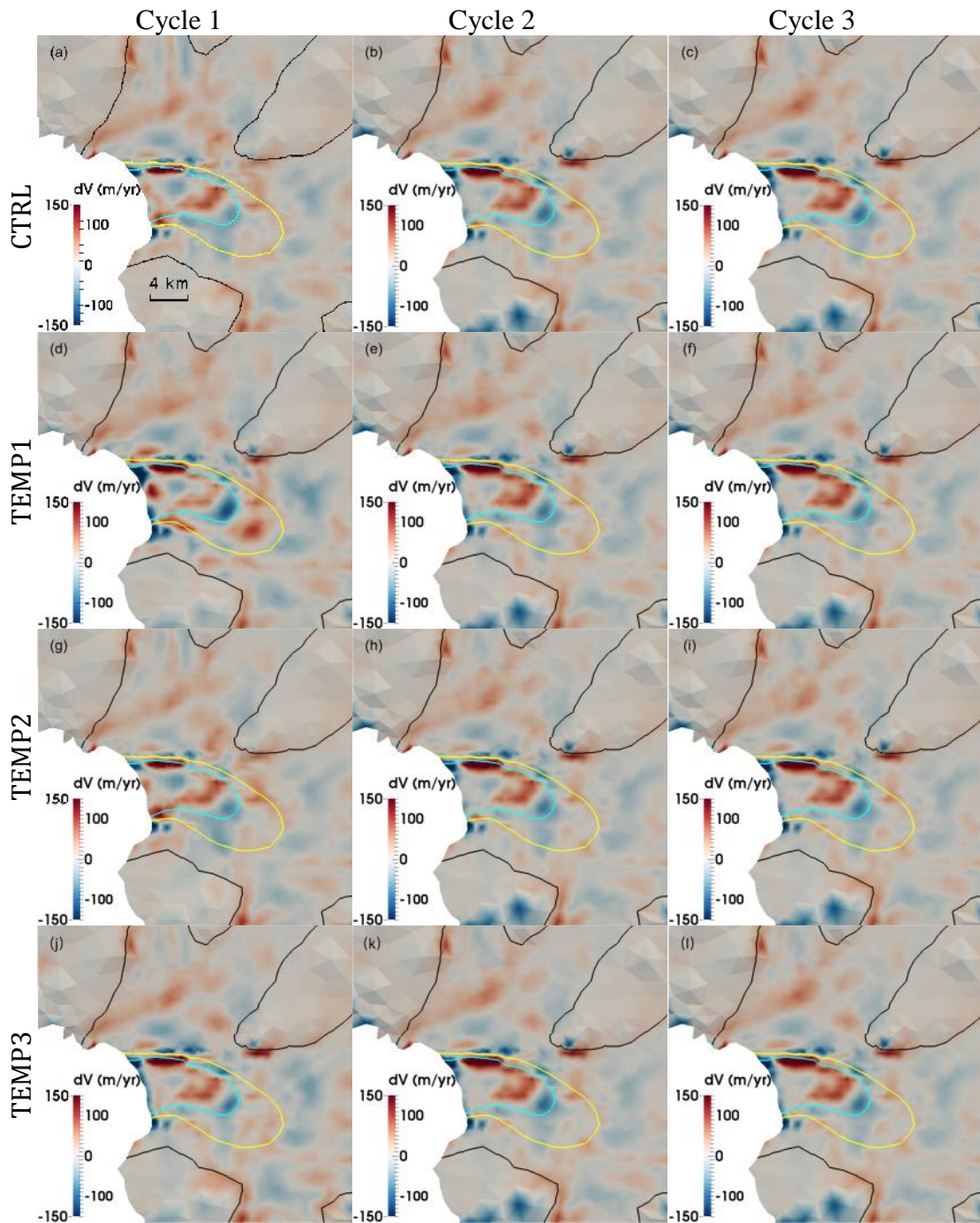


Figure S3. Mismatch between the observed and simulated surface speed in 2008 (observed minus simulated) from experiments: (a-c) CTRL (first row), (d-f) TEMP1 (second row), (g-i) TEMP2 (third row), and (j-l) TEMP3 (fourth row). The left (a, d, g, j), middle (b, e, h, k) and right columns (c, f, i, l) are from Cycle 1, Cycle 2 and Cycle 3, respectively. The black, yellow and cyan solid lines represent observed surface speed contours of 100 m yr^{-1} , 1000 m yr^{-1} , and 1500 m yr^{-1} , respectively.

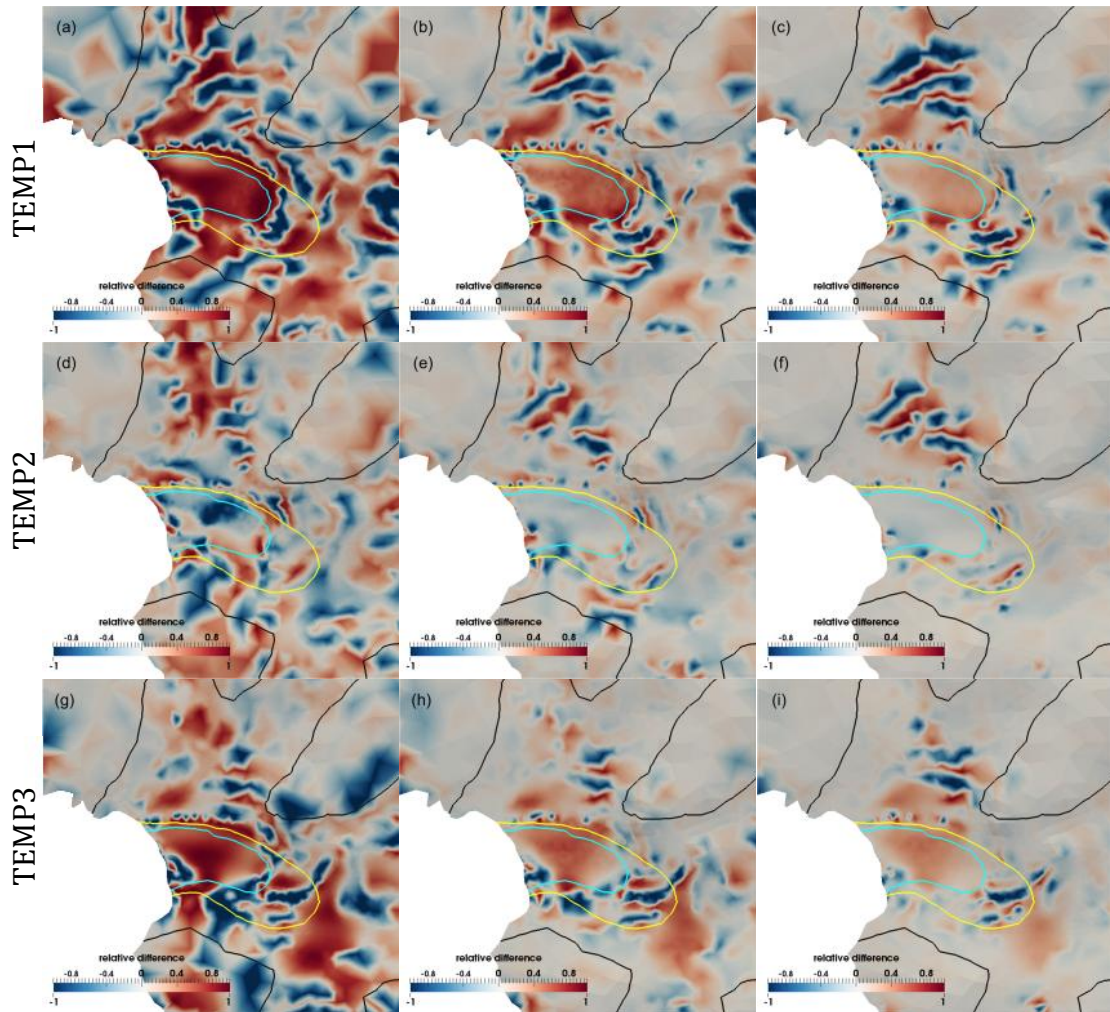


Figure S4. Normalised relative differences of basal drag coefficients C between experiments (a-c) TEMP1 (first row), (d-f) TEMP2 (second row), (g-i) TEMP3 (third row), and CTRL after Cycle 1 (left column), Cycle 2 (middle column), and Cycle 3 (right column). Taking (a) for example, the plot is the result of $(C_{CTRL} - C_{TEMP1})/C_{CTRL}$. The black, yellow and cyan solid lines represent observed surface speed contours of 100 m yr^{-1} , 1000 m yr^{-1} , and 1500 m yr^{-1} , respectively.

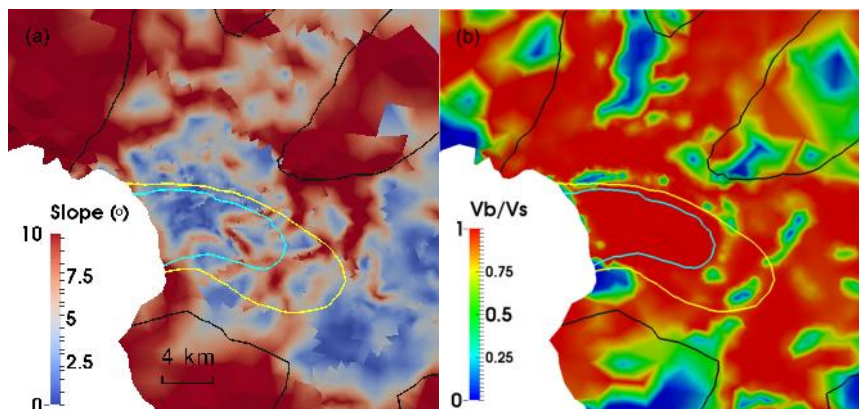


Figure S5. (a) The slope (in degrees) of the relaxed surface and (b) the ratio of magnitude of the modeled basal and surface velocity (basal over surface) after three-cycle spin-up scheme from experiment: CTRL. The maximum difference around the ice front is $\sim 2240 \text{ m yr}^{-1}$. The zigzag discontinuities in (a) are artefacts of the post-processing at partition boundaries only, and do not affect the simulations. The black, yellow, and cyan solid lines represent surface speed contours of 100 m yr^{-1} , 1000 m yr^{-1} , and 1500 m yr^{-1} respectively.

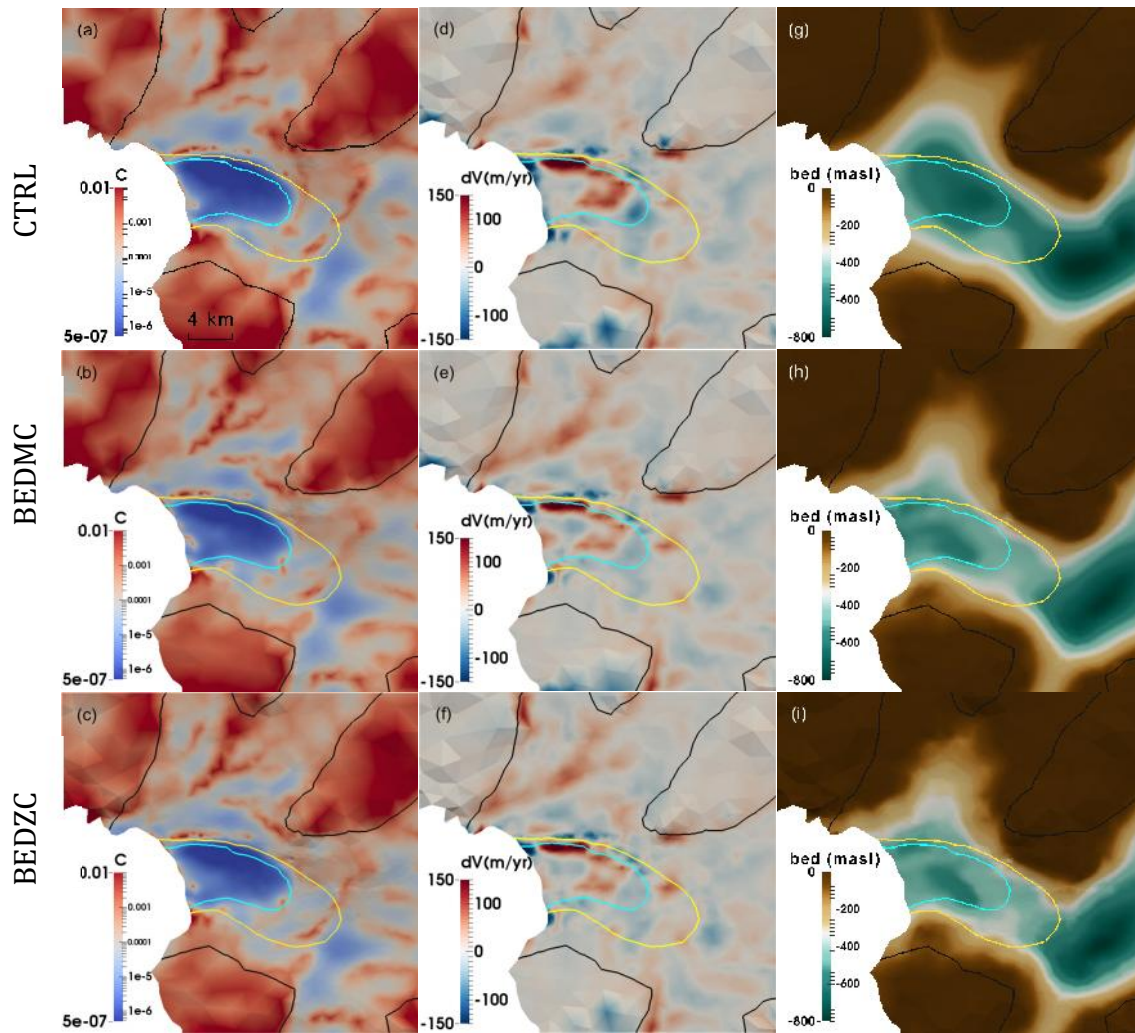


Figure S6. Distribution of basal friction coefficient C ($MPa\ m^{-1}\ yr$) (left column) and mismatch between the observed and modeled surface velocity (observed minus simulated; middle column) from experiments: (a, d) CTRL (first row), (b, e) BEDMC (second row), and (c, f) BEDZC (third row) with bedrock data (meters above sea level, masl) from (g) bed_bm; (h) bed_mc; (i) bed_zc, respectively. The black, yellow, and cyan solid lines represent observed surface speed contours of $100\ m\ yr^{-1}$, $1000\ m\ yr^{-1}$ and $1500\ m\ yr^{-1}$, respectively.

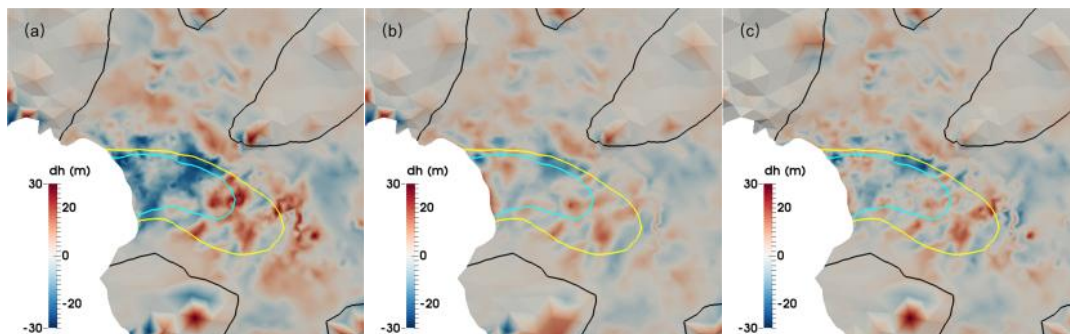


Figure S7. The mismatch between the observed and relaxed surface elevation (observed-relaxed) after the third cycle from experiments (a) CTRL, (b) BEDMC, and (c) BEDZC. The black, yellow, and cyan solid lines represent surface speed contours of $100\ m\ yr^{-1}$, $1000\ m\ yr^{-1}$, and $1500\ m\ yr^{-1}$, respectively.