

Supplementary material for

**Surface Icequakes and Basal Stick-Slip Events Reveal Daily
Grounding Line Migration and Seawater Intrusion at a Marine-
Terminating Glacier in East Antarctica**

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Text S1: Kriging methodology and parameters

Kriging method, as implemented in the Python function `OrdinaryKriging()` (Murphy et al., 2024). Input variables to the kriging-based interpolation include the (X, Y) coordinates of the seismic nodes and their respective icequake occurrence rates. We use a linear variogram model, with six distance bins to compute the experimental semivariogram, best fitting considering the station count ($N=50$). To ensure numerical stability, we solve the kriging system using a pseudo-inverted kriging matrix and average redundant points to avoid over-representation. Additionally, we apply a weighted semivariance approach, emphasizing smaller lag distances in the variogram fitting.

Table S1: Stick-slip clusters detected and located beneath the Astrolabe Glacier grounding zone. For each cluster is shown the initial number of events detected, the final number of events detected after manual screening and the longitude, latitude and depth of the cluster.

Cluster	Nb of initial detections	Nb of final detections	Longitude (°E)	Latitude (°N)	Depth (m)
1	1493	285	139.93408	-66.75864	400
2	1488	1012	139.86294	-66.72408	-
3	1198	1191	139.89303	-66.72970	1500
4	3513	1985	139.93345	-66.74838	1000
5	1509	366	139.87546	-66.74256	350
6	5941	258	139.95032	-66.75220	1000
7	742	578	139.93745	-66.72967	850
8	4254	500	139.91466	-66.75169	650
9	7304	4850	139.88351	-66.72904	-
10	3418	782	139.92027	-66.75055	950
11	2681	1179	139.92179	-66.74973	900
12	4546	767	139.89923	-66.74636	850
13	11103	4010	139.86644	-66.73185	750
14	475	347	139.86819	-66.73430	850
15	60	49	139.92789	-66.72787	1450
16	402	300	139.92037	-66.72652	-

17	538	376	139.94768	-66.751857	950
18	556	285	139.91064	-66.74988	750
19	587	569	139.90397	-66.71565	800
20	244	243	139.88486	-66.72779	1500
21	770	719	139.88206	66.72823	1450
22	182	148	139.87930	-66.72693	1400
23	1065	963	139.86892	-66.73778	-
24	624	622	139.89286	-66.71886	-
25	885	40	139.86648	-66.73199	250
26	761	740	139.91231	-66.72389	-
27	448	393	139.87760	-66.72510	1150
28	422	415	139.90035	-66.73335	-
29	205	203	139.89502	-66.73182	1375

Fig. S1: Contour map of depth estimate as a function of P- wave velocity (V_p) and S- wave velocity (V_s) from grid search on cluster 4 (see Table A1, depth estimate: 1000 m) to explain the measured delay between the P- and S-phase arrival times. For each (V_p , V_s) couple, the depth is estimated based on the minimum RMSE value obtained. The black rectangle delineates the velocity domain explored in the present study. Red line indicates the bedrock depth estimate based on radar data, expected to be around 700 m (Le Meur et al., 2014). A clear trade-off is observed between seismic velocities and estimated depth. The diagram shows that the stick-slip depth estimate is more sensitive to variations in V_s than in V_p and that lower shear velocities (1400 to 1500 m/s) may reconcile seismic and radar depth estimates. This highlights the importance of improving the seismic velocity structure of the Astrolabe Glacier to better constrain the absolute depth estimates of the stick-slips at the ice-bedrock interface.

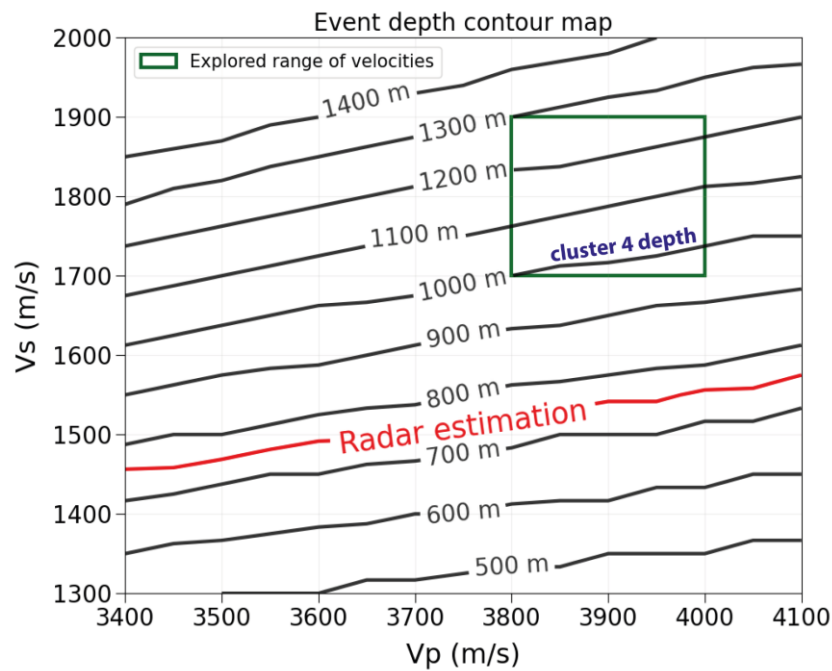


Fig S2: Individual stereonet (lower hemisphere) representing the upward (black circles) and downward (white circles) first P-wave motion of each stick-slip cluster detected by the dense seismic node array, numbered as in Table A1. Grey circles indicate unsure polarisation by at least one of the three analysts.

