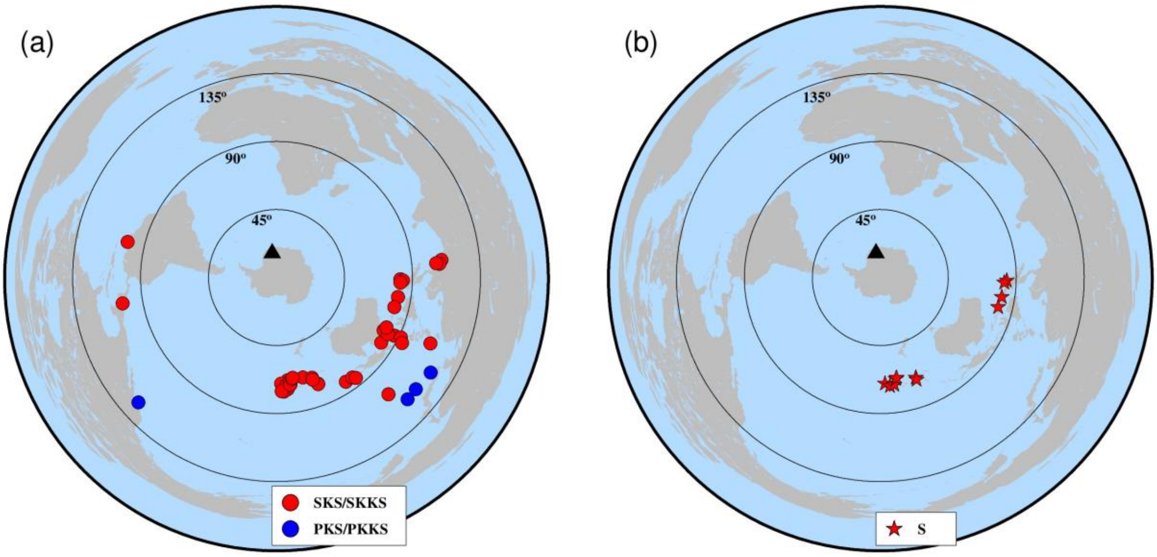
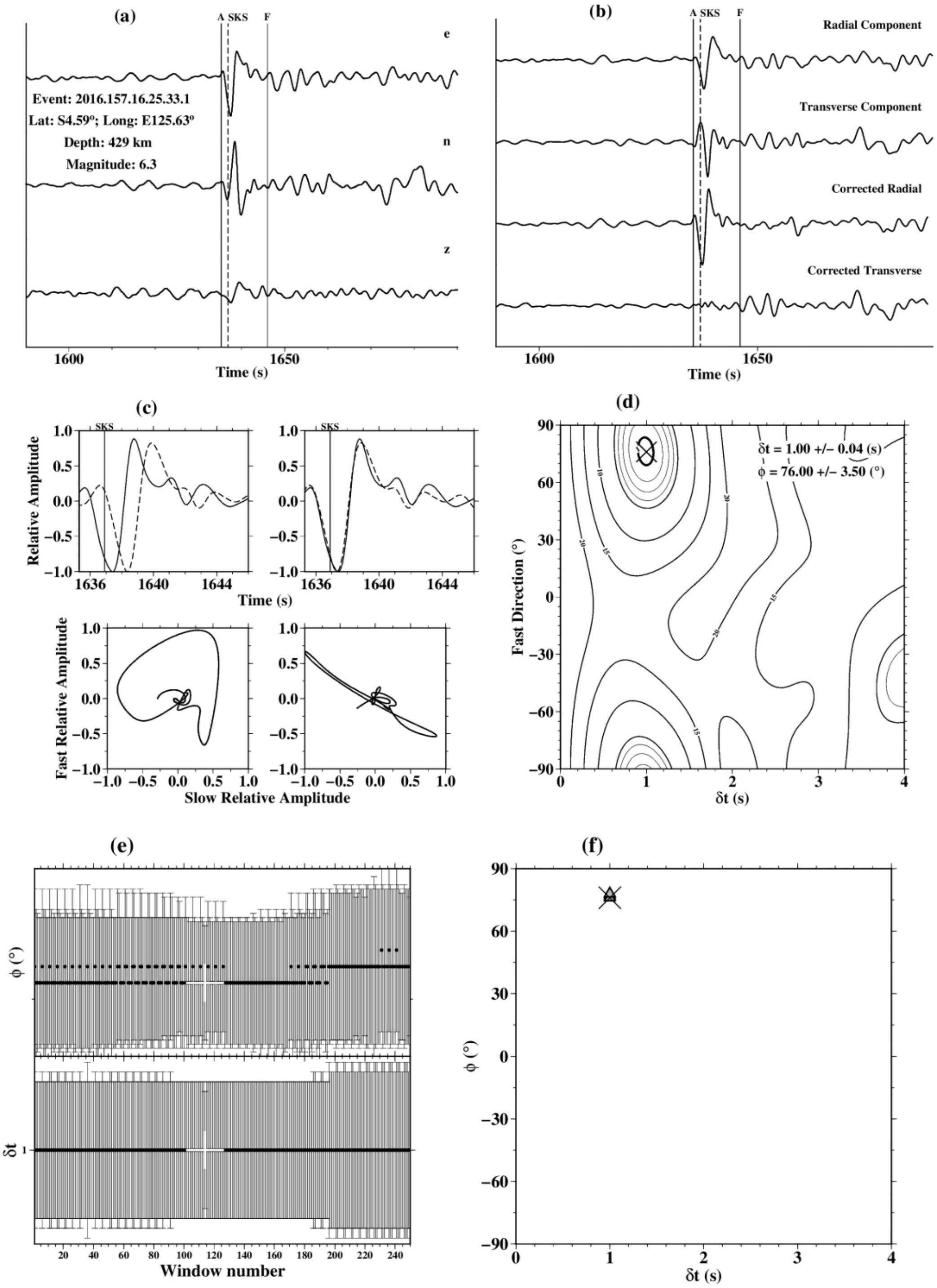
Supplementary material for: Sivaram K., Pavan Kumar V. & Srinivas D. 2025. Seismic anisotropy and mantle dynamics beneath Maitri Station in central Dronning Maud Land, East Antarctica: new insights from shear wave splitting analysis of core-refracted and direct S-phases. *Polar Research 44*. Correspondence: K. Sivaram, National Geophysical Research Institute, Council of Scientific & Industrial Research, Uppal Road, Hyderabad-500007, India. E-mail: sivaramk.ngri@csir.res.in

Abbreviations

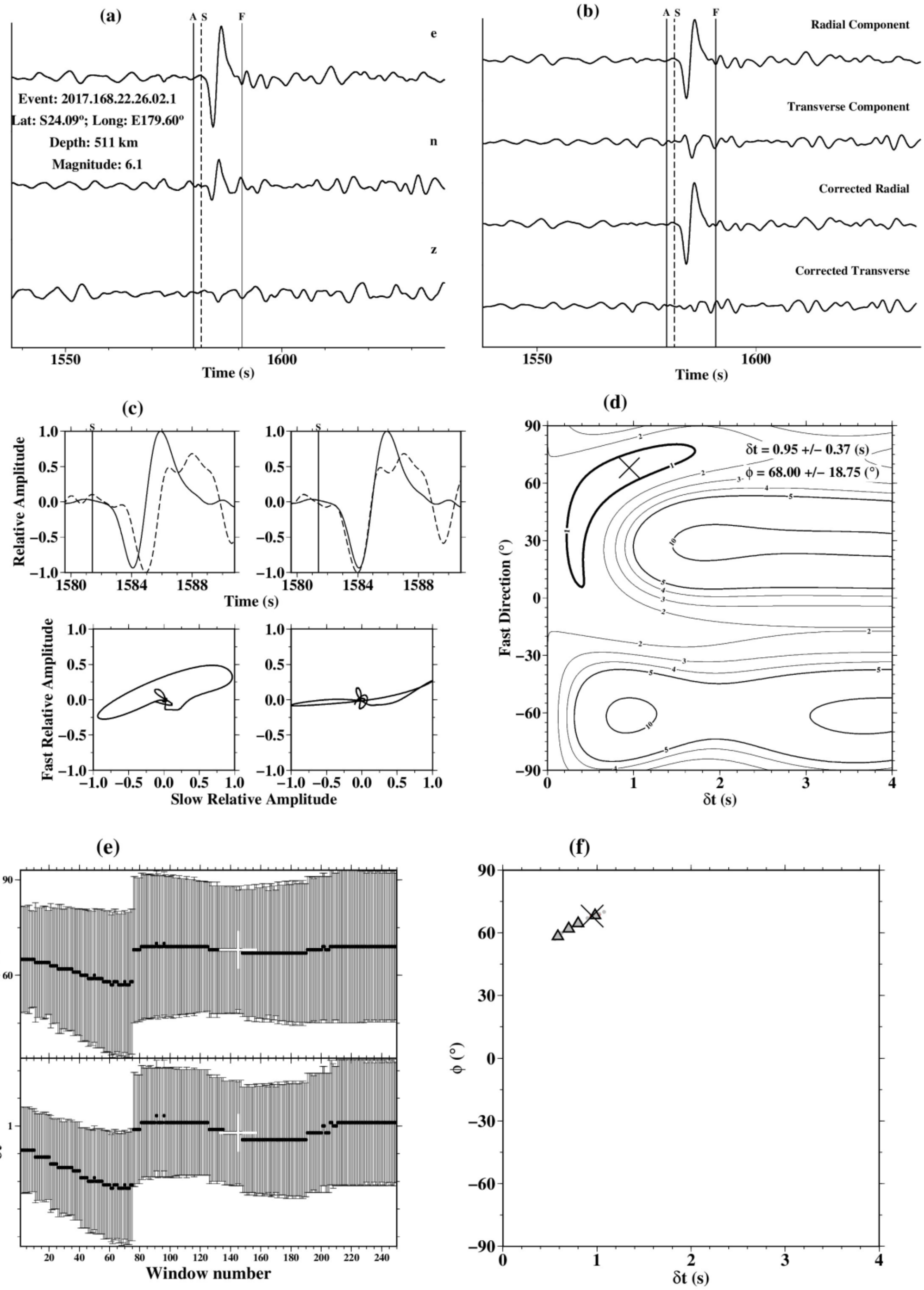
DML: Dronning Maud Land
MAI: Maitri Station, DML
PKKS: seismic phase in which a P-wave passes through the mantle, refracts twice within the liquid outer core and emerges as an S-wave.
PKS: seismic phase in which a P-wave travels through the mantle, then the liquid outer core, and converts to an S-wave upon re-entry into the mantle.
S-wave: shear/secondary wave
SWS: shear wave splitting
SKKS: seismic phase in which an S-wave travels through the mantle, refracts twice to a P-wave (K) in the outer core, and re-emerges as an S-wave in the mantle
SKS: seismic phase in which an S-wave travels through the mantle, refracts to a P-wave (K) in the outer core, and re-emerges as an S-wave in the mantle
XKS: core-refracted phases



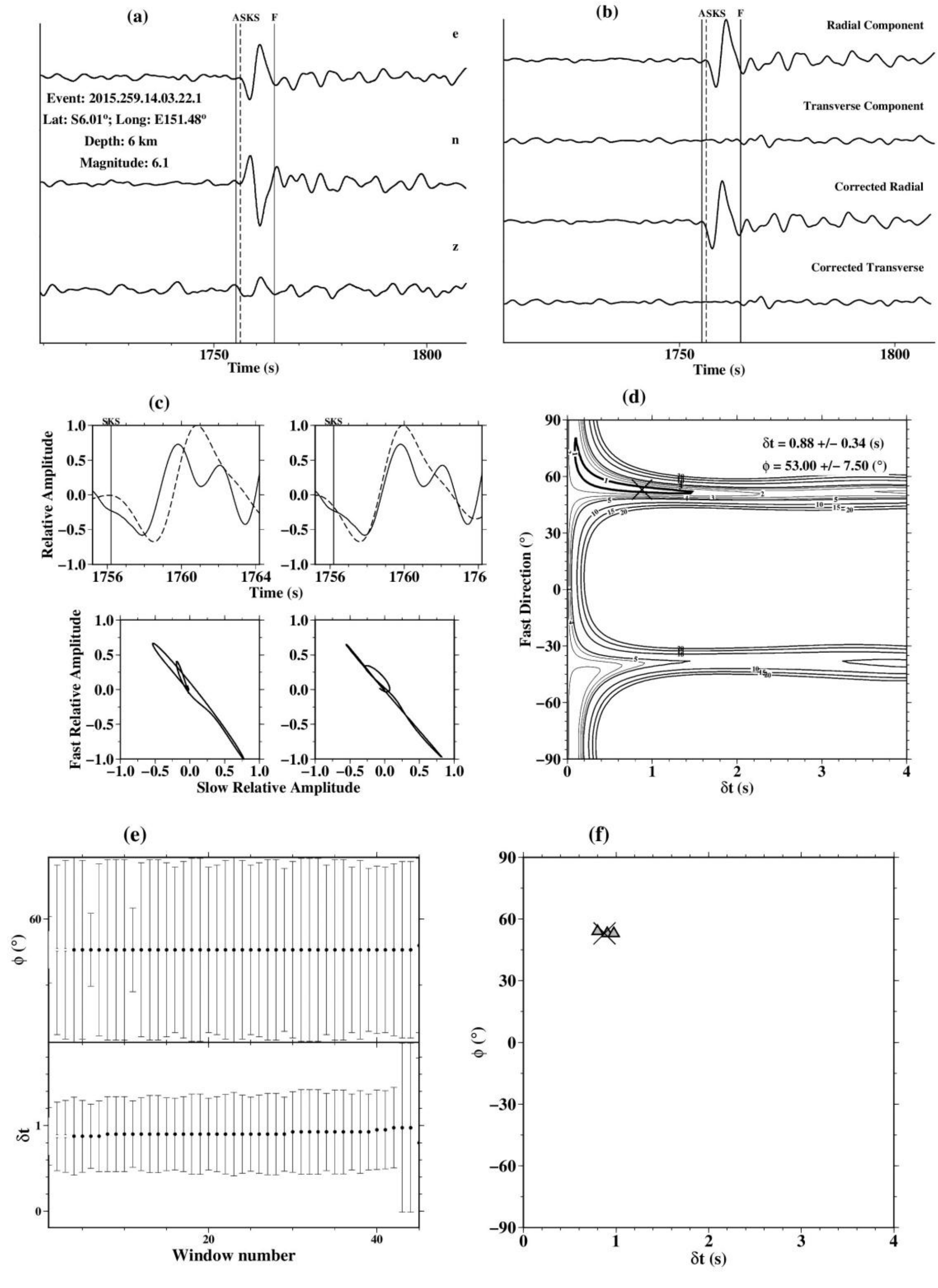
Supplementary Fig. S1. The global distribution of the teleseismic events used in this work, with magnitude M > 5.5 for (a) core refracted (XKS) phases from epicentral distances 80° to 145°, for SKS/SKKS and PKS/PKKS; (b) direct S-phases, from epicentral distances 30° to 90°.



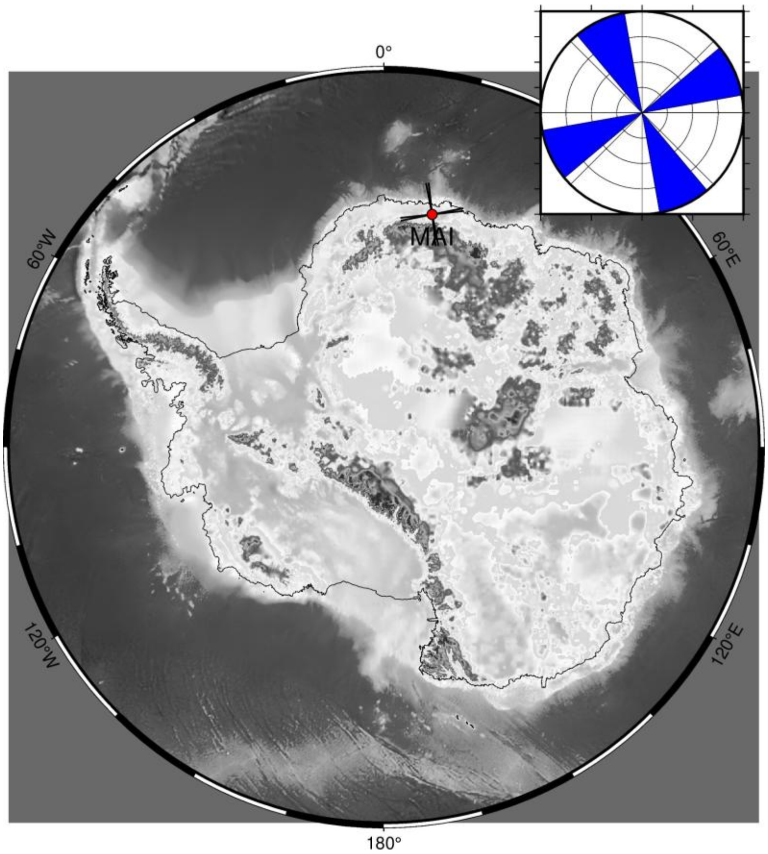
Supplementary Fig. S2. Representative plots showing the process of shear wave splitting analysis with good XKS phases at MAI: (a) raw three component waveforms of a teleseismic event; (b) the components (radial and transverse) before and after correction of anisotropy, where A and F denote the start and end of the shear-wave window, respectively, and SKS is the start time of the SKS phase; (c) waveforms and particle-motion before and after removal of anisotropy; (d) the error-surface of the estimated fast polarization direction, Φ; (e) Φ and δt (delay times) values obtained with the minimum error bars over the windows; and (f) the optimal solution of Φ and δt derived from cluster analysis.



Supplementary Fig. S3. An example showing the shear wave splitting analysis for S-phase. A and F denote the start and end of the shear-wave window, respectively, and S is the start-time of S-phase. The other details are the same as in Supplementary Fig. S2.



Supplementary Fig. S4. Example of null splitting measurement: (a) raw three component waveforms of a teleseismic event; (b) the components (radial and transverse) before and after correction of anisotropy, where A and F denote the start and end of the shear-wave window, respectively, and SKS is the start time of the SKS phase; (c) waveforms and particle-motion before and after removal of anisotropy; (d) the error-surface of the estimated fast polarization direction, Φ; (e) Φ and δt (delay times) values obtained with the minimum error bars over the windows and (f) the optimal solution of Φ and δt derived from cluster analysis.



Supplementary Fig. S5. Shear wave splitting results for null events at MAI, DML, East Antarctica.

Supplementary Table S1. Criteria for distinguishing good, fair and null measurements.

Criteria	Good	Fair	Null
SNR [a]	High SNR [a], allowing for clear identification of anisotropic features	Moderate SNR [a], anisotropic features visible but potentially masked by noise	Low SNR [a], difficult to discern anisotropic features
Particle motion before correction	Elliptical	Elliptical	Linear
Particle motion after correction	Linear	Linear to elliptical	Linear
Waveform coherence between fast and slow split shear waves	High coherence, waveform is clear	Acceptable but less reliable	No detectable splitting

Stability and least error surface of the measurement over the windows	Stable	Less stable	Not stable
Fast polarization direction (Φ)	Strong and consistent	Weakly consistent but shows some irregularities	No clear polarization direction detected

[a] Signal-to-noise ratio.

Supplementary Table S2. The results for good SWS measurements (XKS- and S-phases) used at MAI, with Φ and δt, along with their errors.

Event	Lat.	Long.	Depth (km)	GCARC[a]	BAZ[b]	MAG[c]	Φ ± error	δt ± error	Phase
2013.131.20.46.57	-17.96	-175.11	212	91	173	6.4	74.00±6.25	1.25±0.14	SKS
2013.134.00.32.25	18.73	145.29	602	121	127	6.8	88.00±4.75	0.90±0.10	SKS
2013.143.17.19.04	-23.01	-177.23	173	86	172	7.4	74.00±1.00	2.10±0.12	SKKS
2013.143.21.07.46	-20.58	-175.76	150	89	173	6.3	-90.00±6.25	1.73±0.20	SKS
2013.285.02.10.27	10.9	-62.31	63	95	289	6	-69.00±20.00	1.00±0.23	SKS
2013.327.07.48.32	-17.12	-176.54	371	92	172	6.5	-70.00±14.75	2.00±0.68	SKS
2014.200.12.27.10	-15.82	-174.45	227	94	174	6.2	72.00±8.25	1.90±0.33	SKS
2014.202.14.54.41	-19.8	-178.4	615	89	170	6.9	45.00±1.25	1.12±0.02	SKS
2014.247.05.33.50	-21.39	-173.32	35	88	175	6	61.00±3.50	1.50±0.11	SKS
2014.253.02.46.06	-0.24	125.1	35	97	112	6.2	71.00±4.75	1.15±0.09	SKS
2014.340.22.05.10	-6.11	130.48	116	93	119	6	86.00±5.25	1.00±0.04	SKS
2014.351.06.10.05	-3.83	100.14	10	86	90	5.9	49.00±11.00	0.97±0.19	SKS
2015.110.01.42.58	24.2	122.32	29	119	101	6.4	73.00±6.00	1.07±0.08	SKS
2015.144.14.38.59	-19.39	-175.96	10	90	173	6.2	42.00±3.00	0.85±0.03	SKS
2015.245.01.18.29	4.41	124.63	296	102	110	5.7	69.00±5.00	0.93±0.05	SKS
2015.291.16.18.35	-16.2	-173.26	12	93	175	6	38.00±7.25	1.07±0.11	SKS
2015.293.21.52.02	-14.86	167.3	135	93	156	7.1	32.00±6.50	1.27±0.23	SKS
2015.308.03.44.15	-8.34	124.88	20	90	115	6.5	69.00±12.00	0.93±0.16	SKS
2016.003.23.05.22	24.8	93.65	55	111	74	6.7	53.00±9.00	0.72±0.16	SKKS
2016.104.13.55.17	23.09	94.87	136	109	76	6.9	68.00±3.25	0.88±0.13	SKS
2016.106.16.25.06	32.79	130.75	10	130	106	7	53.00±12.00	1.30±0.18	PKS
2016.149.05.38.50	-21.97	-178.2	405	87	171	6.9	46.00±2.50	1.32±0.06	SKS
2016.153.22.56.00	-2.1	100.67	50	88	90	6.6	57.00±8.00	0.70±0.07	SKS
2016.157.16.25.33	-4.59	125.63	429	93	114	6.3	77.00±2.25	1.00±0.02	SKS
2016.171.09.47.23	-20.28	169.07	13	88	159	6.3	24.00±19.25	0.70±0.34	SKS

2016.238.17.04.43	30.61	137.85	456	130	114	5.9	62.00±7.50	1.07±0.11	PKS
2016.264.16.21.16	30.5	142.05	9	131	119	6.1	62.00±4.75	1.07±0.08	PKS
2016.267.22.53.10	6.57	126.49	65	104	111	6.3	65.00±8.50	1.20±0.09	SKS
2016.268.21.28.41	-19.78	-178.24	596	89	171	6.9	43.00±5.25	0.93±0.09	SKS
2016.292.16.36.41	-23.33	-179.84	540	86	169	5.9	18.00±13.50	0.90±0.19	SKKS
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	62.00±4.00	0.85±0.03	SKS
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	-52.00±1.50	1.65±0.06	SKKS
2017.168.22.26.02	-24.09	179.6	511	85	169	6.1	68.00±3.75	0.93±0.14	SKS
2017.225.03.08.10	-3.77	101.62	31	86	91	6.4	45.00±6.00	0.90±0.07	SKS
2017.263.20.09.49	-18.79	169.09	197	89	159	6.4	43.00±2.00	1.10±0.06	SKS
2017.263.20.09.49	-18.79	169.09	197	89	159	6.4	2.00±13.75	1.10±0.24	SKKS
2017.263.23.59.24	-6.11	113.02	588	88	103	5.7	78.00±9.00	1.02±0.12	SKS
2017.297.10.47.47	-7.22	123.07	553	90	112	6.7	71.00±3.25	1.02±0.04	SKS
2014.202.14.54.41	-19.8	-178.4	615	89	170	6.9	45.00±1.50	1.12±0.02	S
2014.247.05.33.50	-21.39	-173.32	35	88	175	6	55.00±5.75	1.38±0.13	S
2015.144.14.38.59	-19.39	-175.96	10	90	173	6.2	41.00±9.00	0.80±0.11	S
2016.153.22.56.00	-2.1	100.67	50	88	90	6.6	57.00±9.00	0.70±0.08	S
2016.171.09.47.23	-20.28	169.07	13	88	159	6.3	24.00±15.00	0.70±0.19	S
2016.268.21.28.41	-19.78	-178.24	596	89	171	6.9	45.00±6.00	0.93±0.12	S
2016.292.16.36.41	-23.33	-179.84	540	86	169	5.9	41.00±4.75	1.20±0.11	S
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	61.00±4.50	0.82±0.03	S
2017.168.22.26.02	-24.09	179.6	511	85	169	6.1	68.00±18.75	0.95±0.37	S
2017.225.03.08.10	-3.77	101.62	31	86	91	6.4	50.00±4.75	0.93±0.04	S
2017.263.20.09.49	-18.79	169.09	197	89	159	6.4	48.00±3.25	1.20±0.14	S
2017.263.23.59.24	-6.11	113.02	588	88	103	5.7	76.00±5.50	1.02±0.08	S

[a] Station to event great circle arc length in degrees. [b] Back azimuth.[c] Magnitude of event.

Supplementary Table S3. The complete results for good, fair and null SWS measurements (XKS- and S-phases) at MAI, with Φ and δt, along with their errors.

Event	Lat.	Long.	Depth (km)	GCARC[a]	BAZ[b]	MAG[c]	Φ ± error	δt ± error	Phase	Quality[d]
2012.349.10.36.01	31.09	-119.7	13	132	240	6.3	62.00±2.50	1.10±0.12	PKS	F
2013.131.20.46.57	-18	-175.1	212	91	173	6.4	74.00±6.25	1.25±0.14	SKS	G
2013.134.00.32.25	18.73	145.29	602	121	127	6.8	88.00±4.75	0.90±0.10	SKS	G
2013.134.00.32.25	18.73	145.29	602	121	127	6.8	-82.00±25.25	1.15±0.38	SKKS	F
2013.143.17.19.04	-23	-177.2	173	86	172	7.4	74.00±1.00	2.10±0.12	SKKS	G
2013.143.21.07.46	-20.6	-175.8	150	89	173	6.3	-90.00±6.25	1.73±0.20	SKS	G
2013.218.10.41.30	-22.5	173.81	10	86	163	5.8	48.00±2.75	1.10±0.04	SKS	F

2013.285.02.10.27	10.9	-62.31	63	95	289	6	-69.00±20.00	1.00±0.23	SKS	G
2013.327.07.48.32	-17.1	-176.5	371	92	172	6.5	-70.00±14.75	2.00±0.68	SKS	G
2014.101.07.07.23	-6.59	155.05	60	99	143	7.1	-57.00±5.00	1.62±0.11	SKS	F
2014.101.20.29.12	11.64	-85.88	135	103	267	6.6	45.00±7.00	1.02±0.09	SKKS	F
2014.200.12.27.10	-15.8	-174.5	227	94	174	6.2	72.00±8.25	1.90±0.33	SKS	G
2014.202.14.54.41	-19.8	-178.4	615	89	170	6.9	45.00±1.25	1.12±0.02	SKS	G
2014.247.05.33.50	-21.4	-173.3	35	88	175	6	61.00±3.50	1.50±0.11	SKS	G
2014.253.02.46.06	-0.24	125.1	35	97	112	6.2	71.00±4.75	1.15±0.09	SKS	G
2014.253.02.46.06	-0.24	125.1	35	97	112	6.2	70.00±17.50	0.80±0.17	SKKS	F
2014.340.22.05.10	-6.11	130.48	116	93	119	6	86.00±5.25	1.00±0.04	SKS	G
2014.351.06.10.05	-3.83	100.14	10	86	90	5.9	49.00±11.00	0.97±0.19	SKS	G
2015.110.01.42.58	24.2	122.32	29	119	101	6.4	73.00±6.00	1.07±0.08	SKS	G
2015.144.14.38.59	-19.4	-176	10	90	173	6.2	42.00±3.00	0.85±0.03	SKS	G
2015.245.01.18.29	4.41	124.63	296	102	110	5.7	69.00±5.00	0.93±0.05	SKS	G
2015.259.14.03.22	-6.01	151.48	6	99	139	6.1	53.00±7.50	0.88±0.34	SKS	N
2015.291.16.18.35	-16.2	-173.3	12	93	175	6	38.00±7.25	1.07±0.11	SKS	G
2015.293.21.52.02	-14.9	167.3	135	93	156	7.1	32.00±6.50	1.27±0.23	SKS	G
2015.308.03.44.15	-8.34	124.88	20	90	115	6.5	69.00±12.00	0.93±0.16	SKS	G
2016.003.23.05.22	24.8	93.65	55	111	74	6.7	53.00±9.00	0.72±0.16	SKKS	G
2016.104.13.55.17	23.09	94.87	136	109	76	6.9	68.00±3.25	0.88±0.13	SKS	G
2016.106.16.25.06	32.79	130.75	10	130	106	7	53.00±12.00	1.30±0.18	PKS	G
2016.149.05.38.50	-22	-178.2	405	87	171	6.9	46.00±2.50	1.32±0.06	SKS	G
2016.153.22.56.00	-2.1	100.67	50	88	90	6.6	57.00±8.00	0.70±0.07	SKS	G
2016.157.16.25.33	-4.59	125.63	429	93	114	6.3	77.00±2.25	1.00±0.02	SKS	G
2016.171.09.47.23	-20.3	169.07	13	88	159	6.3	24.00±19.25	0.70±0.34	SKS	G
2016.237.10.34.54	20.92	94.57	82	107	76	6.8	72.00±4.25	1.30±0.40	SKS	N
2016.238.17.04.43	30.61	137.85	456	130	114	5.9	62.00±7.50	1.07±0.11	PKS	G
2016.264.16.21.16	30.5	142.05	9	131	119	6.1	62.00±4.75	1.07±0.08	PKS	G
2016.267.22.53.10	6.57	126.49	65	104	111	6.3	65.00±8.50	1.20±0.09	SKS	G
2016.268.21.28.41	-19.8	-178.2	596	89	171	6.9	43.00±5.25	0.93±0.09	SKS	G
2016.289.08.03.38	-4.27	150.36	442	100	138	6.3	67.00±17.50	0.30±0.16	SKS	N
2016.292.16.36.41	-23.3	-179.8	540	86	169	5.9	18.00±13.50	0.90±0.19	SKKS	G
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	62.00±4.00	0.85±0.03	SKS	G
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	-52.00±1.50	1.65±0.06	SKKS	G
2017.129.13.52.10	-14.6	167.38	169	93	156	6.8	45.00±9.75	1.10±0.91	SKS	F
2017.168.22.26.02	-24.1	179.6	511	85	169	6.1	68.00±3.75	0.93±0.14	SKS	G
2017.225.03.08.10	-3.77	101.62	31	86	91	6.4	45.00±6.00	0.90±0.07	SKS	G
2017.263.20.09.49	-18.8	169.09	197	89	159	6.4	43.00±2.00	1.10±0.06	SKS	G
2017.263.20.09.49	-18.8	169.09	197	89	159	6.4	2.00±13.75	1.10±0.24	SKKS	G

2017.263.23.59.24	-6.11	113.02	588	88	103	5.7	78.00±9.00	1.02±0.12	SKS	G
2017.297.10.47.47	-7.22	123.07	553	90	112	6.7	71.00±3.25	1.02±0.04	SKS	G
2017.297.10.47.47	-7.22	123.07	553	90	112	6.7	-73.00±6.75	2.80±0.41	SKKS	F
2014.202.14.54.41	-19.8	-178.4	615	89	170	6.9	45.00±1.50	1.12±0.02	S	G
2014.247.05.33.50	-21.4	-173.3	35	88	175	6	55.00±5.75	1.38±0.13	S	G
2015.144.14.38.59	-19.4	-176	10	90	173	6.2	41.00±9.00	0.80±0.11	S	G
2016.153.22.56.00	-2.1	100.67	50	88	90	6.6	57.00±9.00	0.70±0.08	S	G
2016.171.09.47.23	-20.3	169.07	13	88	159	6.3	24.00±15.00	0.70±0.19	S	G
2016.268.21.28.41	-19.8	-178.2	596	89	171	6.9	45.00±6.00	0.93±0.12	S	G
2016.292.16.36.41	-23.3	-179.8	540	86	169	5.9	41.00±4.75	1.20±0.11	S	G
2016.293.00.26.01	-4.86	108.16	614	88	98	6.6	61.00±4.50	0.82±0.03	S	G
2017.168.22.26.02	-24.1	179.6	511	85	169	6.1	68.00±18.75	0.95±0.37	S	G
2017.225.03.08.10	-3.77	101.62	31	86	91	6.4	50.00±4.75	0.93±0.04	S	G
2017.263.20.09.49	-18.8	169.09	197	89	159	6.4	48.00±3.25	1.20±0.14	S	G
2017.263.23.59.24	-6.11	113.02	588	88	103	5.7	76.00±5.50	1.02±0.08	S	G

[a] Station to event great circle arc length in degrees. [b] Back azimuth. [c] Magnitude of event. [d] G – good, F – fair and N – null.

Supplementary Table S4. Comparative splitting results, Φ and δt, from previous studies in DML and eastern Antarctica.

Station code	Station name or location with lat./long.	ϕ (degrees)	ϕ error (±)	δt (s)	δt error (±)	Phases used	Study
VNA2[a]	Neumayer Station/ Halvfar Ryggen -70.925 / -7.393	60	-	1	-	37	Müller 2001
		110	-	0.5	-		
VNA3 [a]	Neumayer Station/Søråsen -71.243 / -9.67	60	-	0.8	-	36	Müller 2001
		90	-	0.4	-		
SNAA [a]	Sanae IV Station, Vesleskarvet -71.671 / -2.838	70	-	0.8	-	16	Müller 2001
		120	-	0.3	-		
AKR [a]	Lützow-Holm Bay region -68.458 / 41.442	56	-	1	-	-	Usui et al. 2007
		144	-	0.6	-		
BVLK	Beaver Lake -70.8034 / 68.1741	296	-	1.7	-	-	Reading & Heintz 2008
CRES	Mount Cresswell -72.6636 / 64.1736	347	-	1.3	-	-	Reading & Heintz 2008
DAVI	Davis -68.5747 / 77.9801	264	-	1.8	-	-	Reading & Heintz 2008
KOH1	Station across Heimefront shear zone -72.648 / -9.31	67	6	0.9	0.25	8	Bayer et al. 2007

KOH2	Station across Heimefront shear zone -73.563 / -9.713	77	6	0.9	0.16	6	Bayer et al. 2007
KOH4	Station across Heimefront shear zone -74.713 / -8.794	63	6	1.05	0.26	6	Bayer et al. 2007
KOH5	Station across Heimefront shear zone -75.004 / -6.055	3	1	1.2	0	5	Bayer et al. 2007
KOH6	Station across Heimefront shear zone -75.002 / 0.075	73	5	-	-	5	Bayer et al. 2007
KOT1	Station in Kottas Mountains -74.908 / -11.337	34	4	1.69	0.13	1	Bayer et al. 2007
KOT4	-do- -74.553 / -11.258	27	7	1.5	0.27	1	Bayer et al. 2007
NMES	North Mawson Escarpment -72.9275 / 68.6175	8	-	1.4	-	-	Reading & Heintz 2008
NOVO [a]	Novolazarevskaya -70.776 / 11.835	64.3	6.7	0.68	0.14	4	Bayer et al. 2007
		95.9	7.3	0.55	0.21		
REIN	Reinbolt Hills -70.4539 / 72.5512	275	-	1.8	-	-	Reading & Heintz 2008
SPA	South Pole Station -89.982 / 0	68	-	1.28	-	2	Müller 2001
TOT [a]	Lützow-Holm Bay region -68.912 / 39.828	48	-	1	-	-	Usui et al. 2007
		120	-	0.2	-		
WEIGEL	Weigel nunatak -74.275 / -9.622	86	5	0.94	0.256	13	Bayer et al. 2007

[a] Stations with two-layer anisotropy studies.