1	Supporting Information for
2	Deep-Sea Research Part I
3	Summer circulation and water masses transport in Bransfield
4	Strait, Antarctica: An evaluation of their response to combined
5	effects of Southern Annular Mode and El Niño-Southern
6	Oscillation
7	
8 9 10	Brendon Yuri Damini ^{1,2,*} , André L. Brum ^{1,2} , Rob A. Hall ³ , Tiago S. Dotto ^{3,4} , José Luiz L. Azevedo ^{1,2} , Karen J. Heywood ³ , Mauricio M. Mata ^{1,2} , Carlos A. E. Garcia ^{1,2} , and Rodrigo Kerr ^{1,2,*}
11 12 13	¹ Laboratório de Estudos dos Oceanos e Clima – LEOC, Instituto de Oceanografia, Universidade Federal do Rio Grande – FURG, Av. Itália km 8, s/n, Rio Grande, RS, 96203–900, Brazil.
14 15	² Programa de Pós-Graduação em Oceanologia, Instituto de Oceanografia, Universidade Federal do Rio Grande – FURG, Av. Itália km 8, s/n, Rio Grande, RS, 96203–900, Brazil.
16 17	³ Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich, NR4 7TJ, UK.
18	⁴ National Oceanography Centre, Southampton, SO14 3ZH, UK
19	
20	*Corresponding authors
21 22 23	Address: CEOCEAN, Instituto de Oceanografia, Universidade Federal do Rio Grande – FURG, Av. Itália km 8 s/n°, Rio Grande, RS, Brazil, 96203-900.
24 25	E-Mail: brendon.oceano@furg.br E-Mail: rodrigokerr@furg.br
26 27	
28 29	Contents of this file
30 31 32 33 34 35	Figure S1. Hydrographic CTD measurements positions across the two repetitive sections over 2003–2019

```
36
     Figure S3. (a) Temporal evolution of the Southern Annular Mode-El Niño-Southern
37
     Oscillation (SEI) indices during austral summer periods (January–March) from 1979 to 2019.
38
     The red circles represent the SEI+ years, while the blue circles indicate the SEI- years. (b)
39
     The correlations between the normalized and detrended summer wind stress curl (WSC) over
40
     the northern Antarctic Peninsula and the summer SEI indices are presented, with the
41
     Spearman's correlation coefficient (r) and p-value (p) indicating the coefficient and statistical
42
     significance of the relationship, respectively. The summertime (January–march) composite
43
     maps of the anomaly of 10-m wind vector (black arrows), where (c) represents the average of
44
     yearly wind anomaly patterns during SEI + periods, and (d) represents the average of yearly
45
     wind anomaly patterns during SEI- periods. The yearly anomaly wind pattern was calculated
46
     from the time-average over the full period (1979-2019) minus each year's wind pattern......6
47
     Figure S4. Surface (~50 m) horizontal distribution of averaged conservative temperature – Θ
48
     showing the close match between the 0 cm s-1 isoline (blue) and 0.5 °C isotherm (dark gray)
49
     depicting the Peninsula Front. The thick black lines represent the positions of hydrographic
50
     sections 1 (S1) and 2 (S2) analyzed in this study. The acronyms stand for D'Urville Island
51
     52
     Figure S5. Annual cross–section conservative temperature in Section 1 (Θ in °C), between
53
     King George and D' Urville Islands. The thin black lines indicate the -0.5 and 0 isolines. The
     topographic feature along the sections is shown in black and is based on IBCSO v1.0 data
54
55
     56
     Figure S6. As Figure S4 but for section 2, between Elephant (E.Is.) and Joinville Islands. .....9
     Figure S7. Annual cross–section absolute salinity in Section 1 (S<sub>A</sub> in g kg<sup>-1</sup>), between King
57
58
     George and D' Urville Islands. The thin black lines indicate the 34.3, 34.4 and 34.7 isolines.
59
     The topographic feature along the sections is shown in black and is based on IBCSO v1.0
     60
61
     Figure S8. As Figure S6 but for section 2, between Elephant (E. Is.) and Joinville Islands ...11
62
     Figure S9. Bathymetry of the Northern Antarctica Peninsula extracted from (a) IBCSO v1.0;
63
     and (b) GLORYS12v1. The thin gray lines indicate the 200 m, 500 m, 800 m, and 2000 m
64
     isobaths. The red (purple) arrows represent the pathways of the Circumpolar Deep Water
     (Dense Shelf Water, via Antarctic Coastal Current – ACoC) entering Bransfield Strait. The
65
     orange arrows depict Bransfield Current and its recirculation around the South Shetland
66
     Islands (S.S.Is.). Light blue arrows indicate the position of Antarctic Slope Front bifurcation
67
68
     (ASFb) eddy. The black line represents the mean location of Antarctic Slope Front (ASF).
     The acronyms stand for: D'Urville Island (D'U.Is.), Clarence Island (C. Is.), Elephant Island
69
     (E. Is.), and Joinville Island (J.Is.).
70
71
     Figure S10. Time-average of vertical cross-sections of velocities derived from
72
     GLORYS12v1 reanalysis product for the same period (i.e., January–March, 2003–2019) at
73
     (a) Section 1 (between King George Island and D' Urville Island – D' U. Is.) and (b) Section
74
     75
     Figure S11. Distribution of average Circumpolar Deep Water (CDW) thickness layer (colour)
     during (a) the entire study period (2003-2019), (b) positive Southern Annular Mode–El
76
     Niño-Southern Oscillation Index (SEI+) phases (i.e., 2008, 2009, 2011, 2013, 2014, 2015,
77
78
     and 2018) and (c) negative SEI (SEI-) phases (i.e., 2004, 2010, 2016, and 2019. Elephant and
79
     80
     Figure S12. Depth–averaged (50–500 m) of conservative temperature – \Theta (colour–coded)
     and the depth-integrated (50-500 m) geostrophic velocity (vectors) of (a) SEI+ phase
81
82
     summers (i.e., 2006, 2008, 2009, 2011, 2012, 2013, 2014, 2015, and 2018) and (b) SEI-phase
83
     summers (i.e., 2010, 2016, and 2019). The acronyms stand for: D' Urville Island (D'U.Is.),
     84
```

85	Figure S13. (a) Time–series of Transitional Zonal Water with Bellingshausen influence
86	(TBW) transports. The green circles represent the SEI+ years, while the blue circles indicate
87	the SEI- years. Positive (negative) values indicate TBW inflow (outflow) to Bransfield Strait
88	Panels (b) and (c) show the surface horizontal distribution of the wind stress curl anomaly
89	(colour-coded) during positive SEI phase (i.e., 2012 and 2018, respectively), while panels (d)
90	and (f) represent negative SEI phase (i.e., 2010 and 2016, respectively). The years were
91	selected to represent a year of highest and lowest TBW intrusion for each SEI period (e.g.,
92	SEI+ and SEI-).
93	Figure S14. Potential density anomaly ($\sigma\theta$, in kg m ⁻³), conservative temperature (Θ °C) and
94	absolute salinity (S _A g kg ⁻ 1) within the Bransfield Strait system at sections 1 (between
95	Elephant Island – E. Is. and Joinville Islands – J. Is.) and 2 (between King George and D'
96	Urville Island – D'U. Is.). Panels (a), (b), (e), (f), (i), and (j) represent the time-averaged
97	conditions during SEI+ phase summers (2006, 2008, 2009, 2011, 2012, 2013, 2014, 2015,
98	and 2018), while panels (c), (d), (g), (h), (k) and (i) represent the time-averaged conditions
99	during SEI– phase summers (2010, 2016, and 2019)
100	

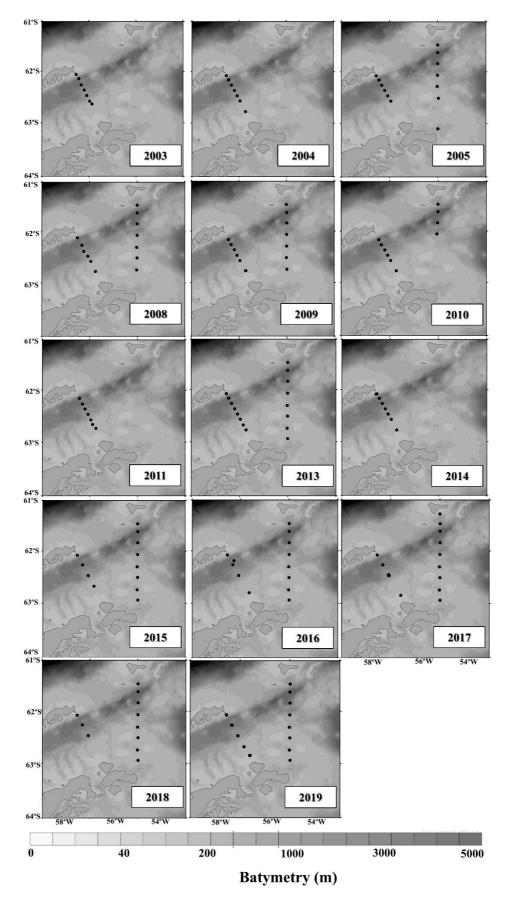


Figure S1. Hydrographic CTD measurements positions across the two repetitive sections over 2003–2019.

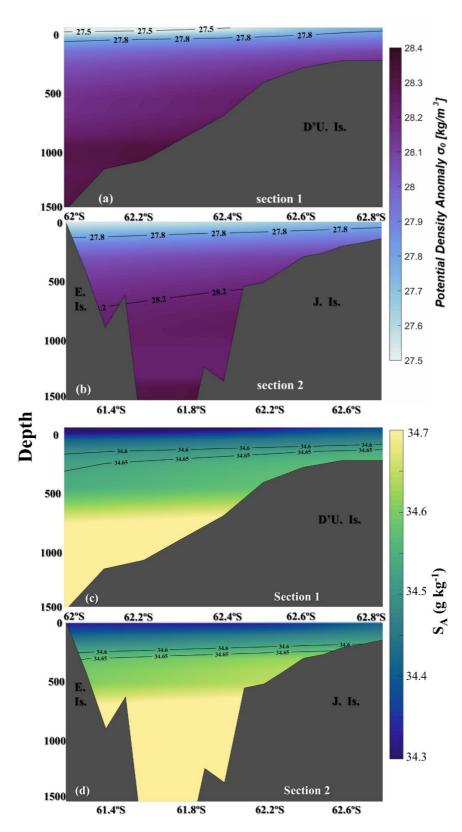


Figure S2. Time–averaged (2003–2019) of potential density anomaly ($\sigma\theta$ in kg m⁻³) and Absolute Salinity () within Bransfield Strait system (**a**) and (**c**) for Section 1, between King George and D' Urville Island (D' U. Is.), and (**b**) and (**d**) for Section 2 between Elephant (E. Is.) and Joinvile Islands (J. Is.).

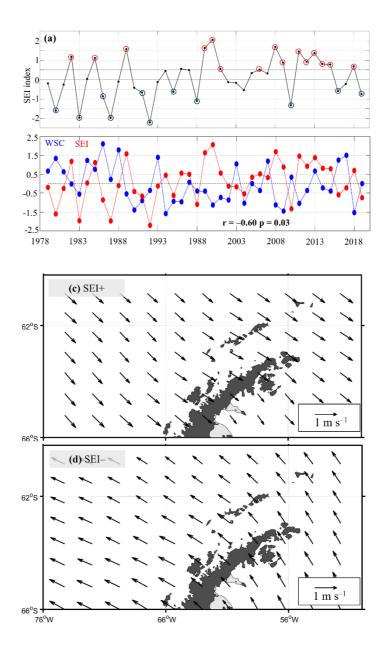


Figure S3. (a) Temporal evolution of the Southern Annular Mode-El Niño-Southern Oscillation (SEI) indices during austral summer periods (January–March) from 1979 to 2019. The red circles represent the SEI+ years, while the blue circles indicate the SEI– years. (b) The correlations between the normalized and detrended summer wind stress curl (WSC) over the northern Antarctic Peninsula and the summer SEI indices are presented, with the Spearman's correlation coefficient (r) and p-value (p) indicating the coefficient and statistical significance of the relationship, respectively. The summertime (January–march) composite maps of the anomaly of 10–m wind vector (black arrows), where (c) represents the average of yearly wind anomaly patterns during SEI + periods, and (d) represents the average of yearly wind anomaly patterns during SEI– periods. The yearly anomaly wind pattern was calculated from the time-average over the full period (1979-2019) minus each year's wind pattern.

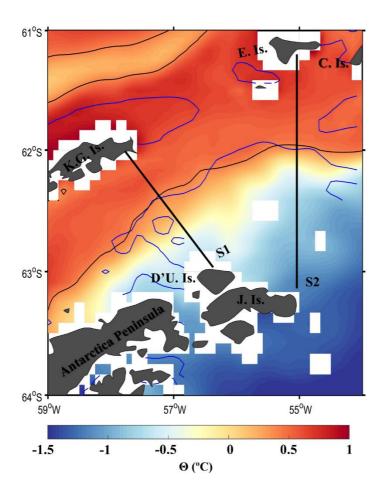


Figure S4. Surface (\sim 50 m) horizontal distribution of averaged conservative temperature – Θ showing the close match between the 0 cm s-1 isoline (blue) and 0.5 °C isotherm (dark gray) depicting the Peninsula Front. The thick black lines represent the positions of hydrographic sections 1 (S1) and 2 (S2) analyzed in this study. The acronyms stand for D'Urville Island (D'U.Is.), Clarence Island (C. Is.), Elephant Island (E. Is.), and Joinville Island (J.Is.).

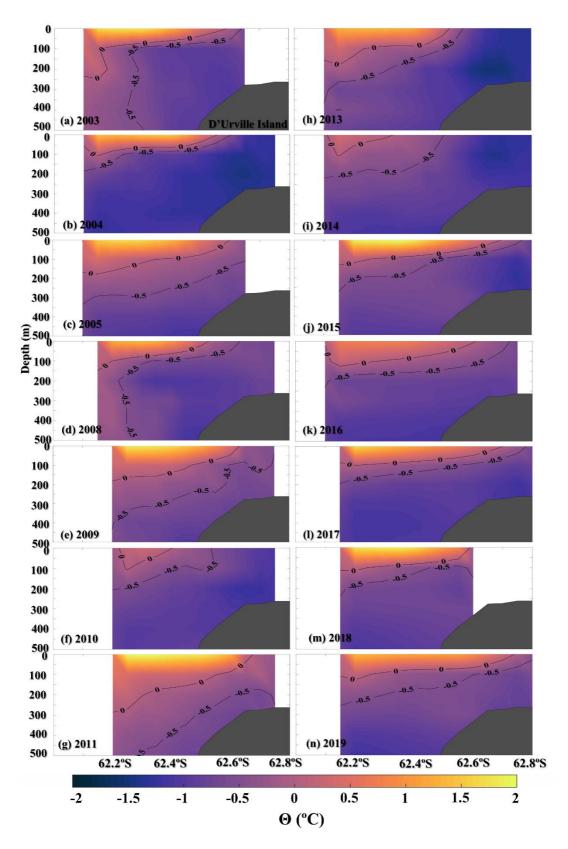


Figure S5. Annual cross–section conservative temperature in Section 1 (Θ in °C), between King George and D' Urville Islands. The thin black lines indicate the –0.5 and 0 isolines. The topographic feature along the sections is shown in black and is based on IBCSO v1.0 data (https://www.scar.org/science/ibcso/ibcso/).

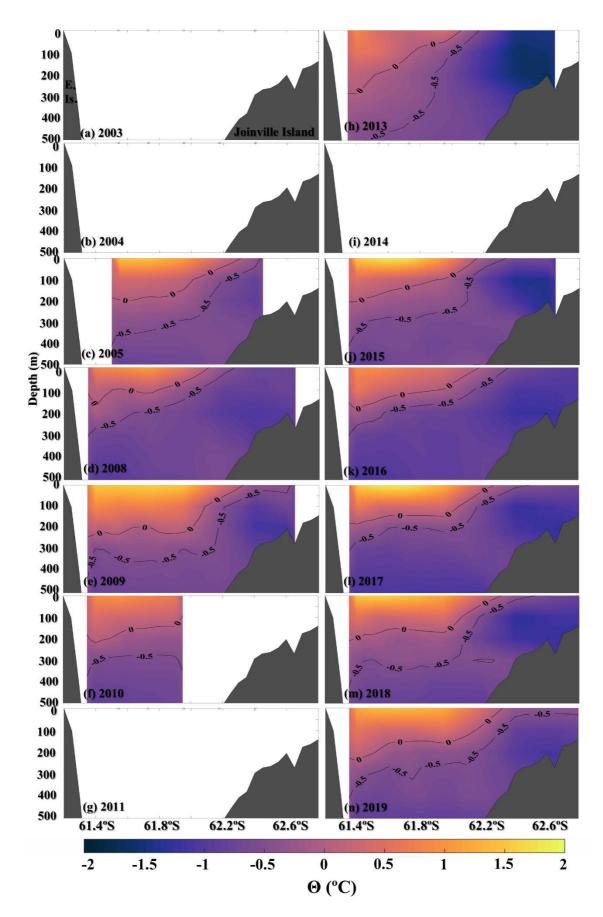


Figure S6. As Figure S4 but for section 2, between Elephant (E.Is.) and Joinville Islands.

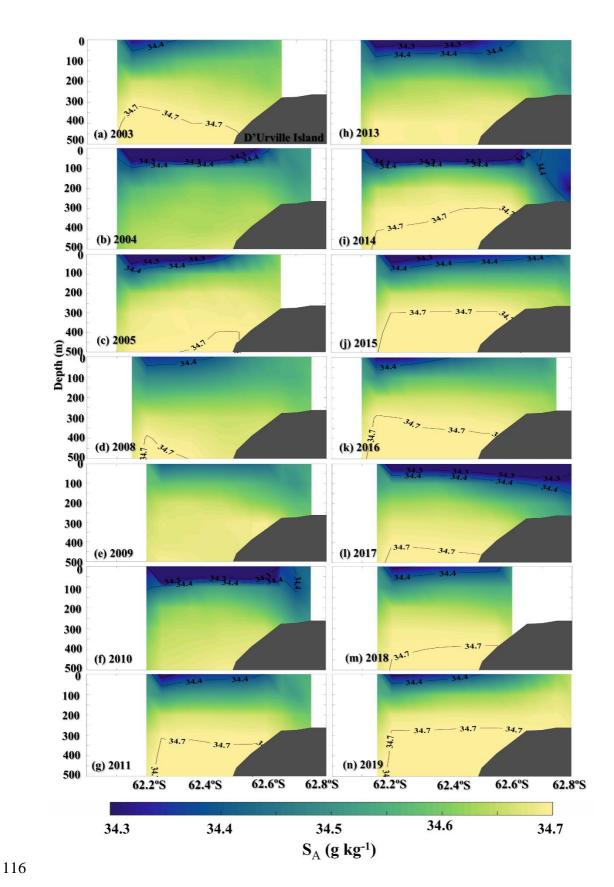


Figure S7. Annual cross—section absolute salinity in Section 1 (S_A in g kg⁻¹), between King George and D' Urville Islands. The thin black lines indicate the 34.3, 34.4 and 34.7 isolines. The topographic feature along the sections is shown in black and is based on IBCSO v1.0 data (https://www.scar.org/science/ibcso/ibcso/).

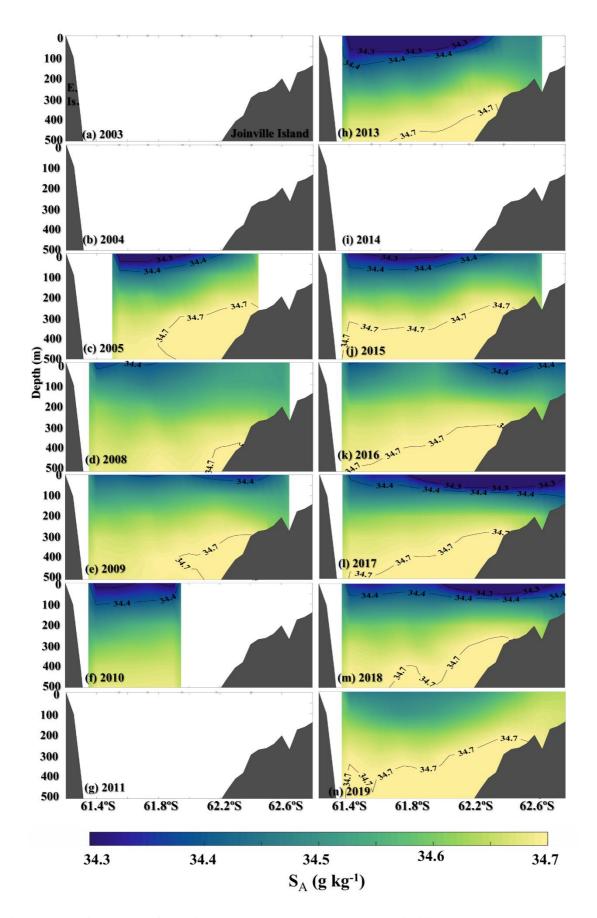


Figure S8. As Figure S6 but for section 2, between Elephant (E. Is.) and Joinville Islands

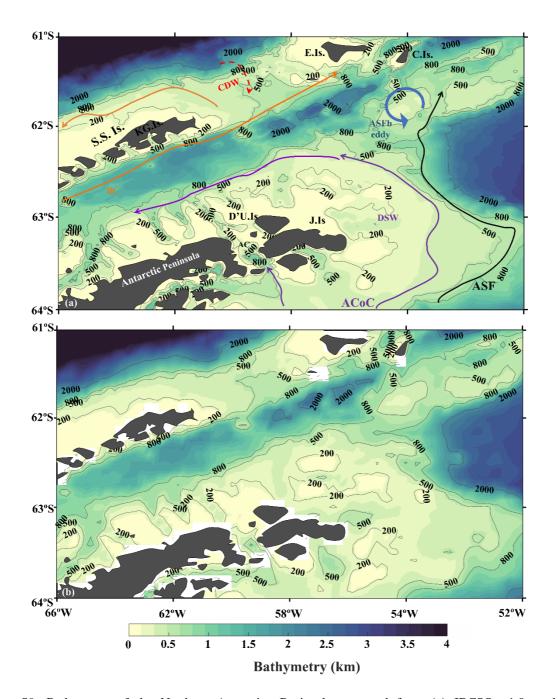


Figure S9. Bathymetry of the Northern Antarctica Peninsula extracted from (a) IBCSO v1.0; and (b) GLORYS12v1. The thin gray lines indicate the 200 m, 500 m, 800 m, and 2000 m isobaths. The red (purple) arrows represent the pathways of the Circumpolar Deep Water (Dense Shelf Water, via Antarctic Coastal Current – ACoC) entering Bransfield Strait. The orange arrows depict Bransfield Current and its recirculation around the South Shetland Islands (S.S.Is.). Light blue arrows indicate the position of Antarctic Slope Front bifurcation (ASFb) eddy. The black line represents the mean location of Antarctic Slope Front (ASF). The acronyms stand for: D'Urville Island (D'U.Is.), Clarence Island (C. Is.), Elephant Island (E. Is.), and Joinville Island (J.Is.).

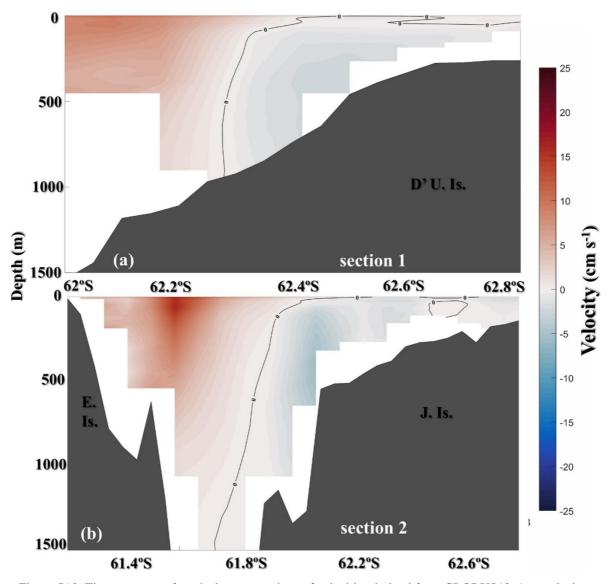


Figure S10. Time–average of vertical cross–sections of velocities derived from GLORYS12v1 reanalysis product for the same period (i.e., January–March, 2003–2019) at (a) Section 1 (between King George Island and D' Urville Island – D' U. Is.) and (b) Section 2 (between Elephant Island – E. I.s and Joinville Island – J. I.s).

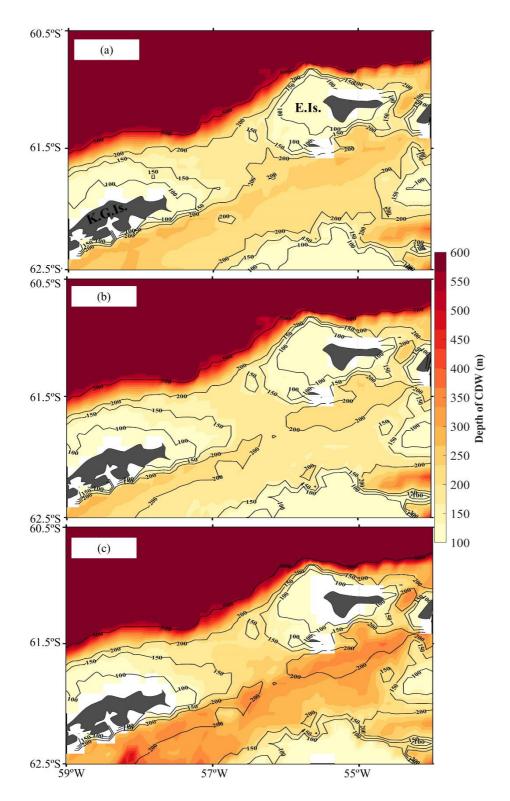


Figure S11. Distribution of average Circumpolar Deep Water (CDW) thickness layer (colour) during (a) the entire study period (2003-2019), (b) positive Southern Annular Mode–El Niño–Southern Oscillation Index (SEI+) phases (i.e., 2008, 2009, 2011, 2013, 2014, 2015, and 2018) and (c) negative SEI (SEI–) phases (i.e., 2004, 2010, 2016, and 2019. Elephant and King George Islands are labelled as E. Is., and K.G. Is., respectively.

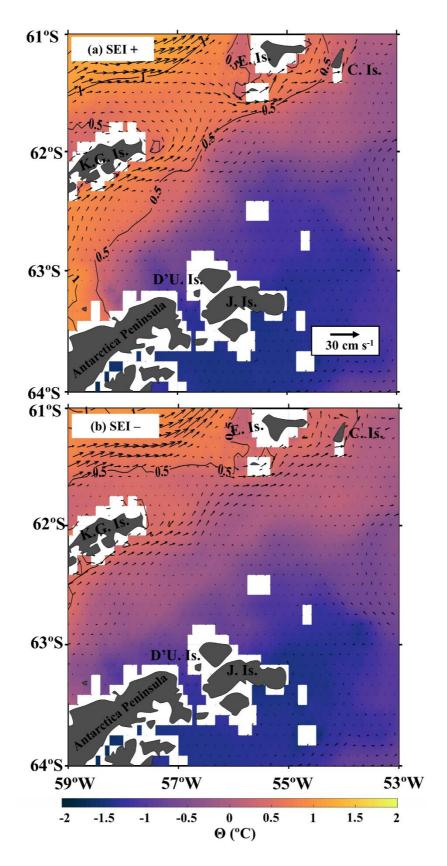


Figure S12. Depth–averaged (50–500 m) of conservative temperature – Θ (colour–coded) and the depth–integrated (50–500 m) geostrophic velocity (vectors) of (a) SEI+ phase summers (i.e., 2006, 2008, 2009, 2011, 2012, 2013, 2014, 2015, and 2018) and (b) SEI–phase summers (i.e., 2010, 2016, and 2019). The acronyms stand for: D' Urville Island (D'U.Is.), Clarence Island (C. Is.), Elephant Island (E. Is.), and Joinville Island (J.Is.).

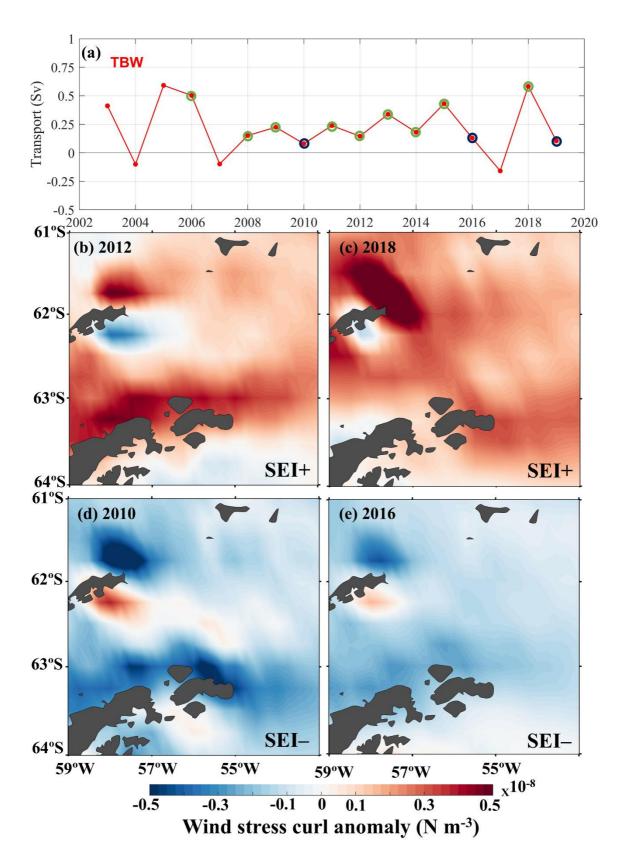


Figure S13. (a) Time–series of Transitional Zonal Water with Bellingshausen influence (TBW) transports. The green circles represent the SEI+ years, while the blue circles indicate the SEI- years. Positive (negative) values indicate TBW inflow (outflow) to Bransfield Strait Panels (b) and (c) show the surface horizontal distribution of the wind stress curl anomaly (colour–coded) during positive SEI phase (i.e., 2012 and 2018, respectively), while

panels (d) and (f) represent negative SEI phase (i.e., 2010 and 2016, respectively). The years were selected to represent a year of highest and lowest TBW intrusion for each SEI period (e.g., SEI+ and SEI-).

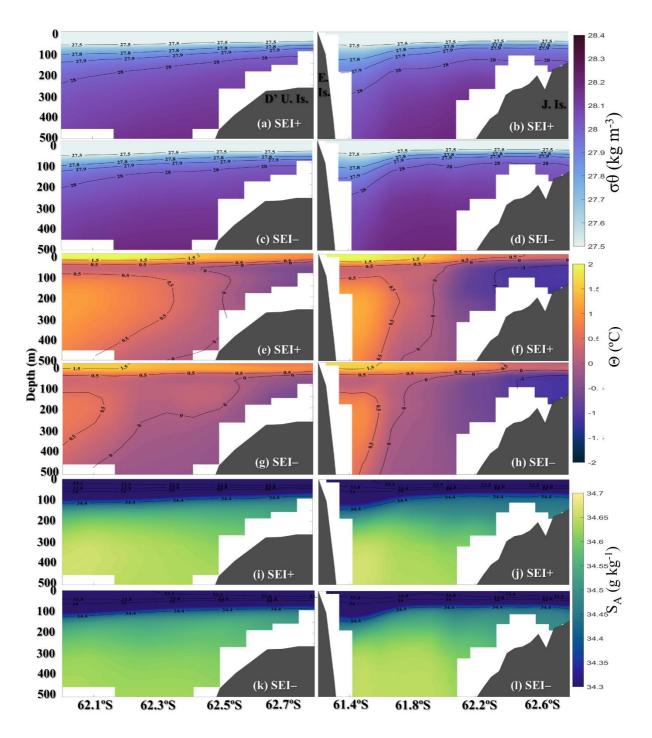


Figure S14. Potential density anomaly $(\sigma\theta, \text{ in kg m}^{-3})$, conservative temperature $(\Theta \, ^{\circ}\text{C})$ and absolute salinity $(S_A \, \text{g kg}^{-1})$ within the Bransfield Strait system at sections 1 (between Elephant Island – E. Is. and Joinville Islands – J. Is.) and 2 (between King George and D' Urville Island – D'U. Is.). Panels (\mathbf{a}) , (\mathbf{b}) , (\mathbf{e}) , (\mathbf{f}) , (\mathbf{i}) , and (\mathbf{j}) represent the time-averaged conditions during SEI+ phase summers (2006, 2008, 2009, 2011, 2012, 2013, 2014, 2015, and 2018), while panels (\mathbf{c}) , (\mathbf{d}) , (\mathbf{g}) , (\mathbf{h}) , (\mathbf{k}) and (\mathbf{i}) represent the time-averaged conditions during SEI– phase summers (2010, 2016, and 2019).