

## Supplementary materials

### The $\delta^{15}\text{N}$ of chlorophyll to reconstruct the nitrate cycle in Adélie Land, East Antarctica, over the last 2000 years

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15 **Supplementary table****Table S1: Records of  $\delta^{15}\text{N}_{\text{bulk}}$ ,  $\delta^{15}\text{N}_{\text{Chl-a}}$  and TOC content from IODP U1357B site core, over the last 2000 years**

The data below was measured in 2012 by the Biogeochemistry Research group in JAMSTEC (Yokosuka, Japan) on bulk sediment and purified chlorophyll extracted from IODP U1357B core site samples. U1357B sediment core (located in 66°24.7990'S, 140°25.5705'E, 1028 m water depth) is 170.7 m long and was collected in February 2010 during the IODP Expedition 318 (Escutia *et al.*, 2011). The age model displayed here is from Ashley *et al.*, 2021 ([doi:10.5194/cp-17-1-2021](https://doi.org/10.5194/cp-17-1-2021)), with corresponding depth described in Johnson *et al.*, 2021 ([doi:10.1038/s41561-021-00816-y](https://doi.org/10.1038/s41561-021-00816-y)).

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| cfs-b depth<br>(m) | Age Ashley 2021<br>(yrs BP) | d15Nbulk<br>(‰ air) | d15Nchl<br>(‰ air) | TOC<br>(%) | LSR<br>(cm/yr) | Density<br>(g/cm <sup>3</sup> ) | MAR TOC<br>(g/cm <sup>2</sup> /yr) |
|--------------------|-----------------------------|---------------------|--------------------|------------|----------------|---------------------------------|------------------------------------|
| 1.56               | 46.7                        | 1.7                 | -0.8               | 2.08       | NaN            | NaN                             | NaN                                |
| 2.92               | 128.9                       | 2.87                | -4.2               | 2.03       | 1.649          | NaN                             | NaN                                |
| 3.97               | 189.1                       | 1.43                | -2.3               | 1.69       | 1.899          | 1.115                           | 0.036                              |
| 5.61               | 272.2                       | 1.84                | -5.5               | 1.76       | 2.026          | 1.116                           | 0.04                               |
| 6.78               | 329.6                       | 3.17                | -4                 | 1.78       | 1.991          | 1.117                           | 0.04                               |
| 7.85               | 385.5                       | 3.42                | NA                 | 1.5        | 1.95           | 1.117                           | 0.033                              |
| 8.91               | 441.8                       | 4.39                | -2.6               | 1.95       | 1.941          | 1.118                           | 0.042                              |
| 9.965              | 497.7                       | 5.25                | -3.1               | 1.76       | 1.884          | 1.118                           | 0.037                              |
| 10.94              | 547.9                       | 4.14                | -2.9               | 1.35       | 1.652          | 1.119                           | 0.025                              |
| 12.01              | 617.3                       | 5.05                | -1.4               | 1.84       | 1.436          | 1.119                           | 0.03                               |
| 12.75              | 670.5                       | 4.13                | NA                 | 1.52       | 1.497          | 1.12                            | 0.025                              |
| 13.58              | 722.5                       | 3.62                | NA                 | 1.58       | 1.589          | 1.12                            | 0.028                              |
| 14.51              | 779.7                       | 3.92                | NA                 | 1.6        | 1.709          | 1.121                           | 0.031                              |
| 15.33              | 824.1                       | 4.29                | NA                 | 1.52       | 1.83           | 1.121                           | 0.031                              |
| 16.07              | 862.4                       | 3.93                | -2.4               | 1.67       | 2.097          | 1.121                           | 0.039                              |
| 16.91              | 897.7                       | 4.28                | NA                 | 1.71       | 2.277          | 1.122                           | 0.044                              |
| 17.73              | 934.1                       | 4.11                | -3.2               | 1.48       | 2.226          | 1.122                           | 0.037                              |
| 18.66              | 978.6                       | 4.01                | -4.4               | 1.62       | 2.243          | 1.122                           | 0.041                              |
| 19.31              | 1007.7                      | 4.64                | NA                 | 1.66       | 2.319          | 1.123                           | 0.043                              |
| 20.33              | 1051.9                      | 4.31                | NA                 | 1.64       | 2.432          | 1.123                           | 0.045                              |
| 20.51              | 1059.7                      | 5.99                | NA                 | 1.64       | 2.442          | 1.123                           | 0.045                              |
| 21.6               | 1075.7                      | 5.36                | -1.3               | 1.37       | 2.455          | 1.124                           | 0.038                              |
| 22.07              | 1091.8                      | 5.18                | -2.7               | 1.64       | 2.434          | 1.124                           | 0.045                              |
| 22.81              | 1152.5                      | 3.33                | -5                 | 2.14       | 2.377          | 1.124                           | 0.057                              |
| 23.655             | 1188.1                      | 4.3                 | -5.6               | 1.79       | 2.279          | 1.124                           | 0.046                              |
| 24.3               | 1217.4                      | 5.09                | -4.4               | 2.13       | 2.09           | 1.125                           | 0.05                               |
| 25.045             | 1254.7                      | 4.94                | 1.5                | 1.92       | 1.868          | 1.125                           | 0.04                               |
| 25.7               | 1293                        | 5.95                | NA                 | 1.71       | 1.696          | 1.125                           | 0.033                              |
| 26.26              | 1326.1                      | 5.43                | -2.3               | 1.8        | 1.699          | 1.126                           | 0.034                              |
| 27.06              | 1369.4                      | 5.2                 | NA                 | 2.45       | 1.824          | 1.126                           | 0.05                               |
| 27.66              | 1404.6                      | 5.14                | -3.5               | 1.92       | 1.88           | 1.126                           | 0.041                              |
| 28.22              | 1433.9                      | 5.45                | -2.4               | 1.81       | 1.897          | 1.127                           | 0.039                              |
| 29.06              | 1477.9                      | 6.02                | -4.5               | 1.81       | 1.807          | 1.127                           | 0.037                              |
| 29.62              | 1509.7                      | 4.98                | -2.8               | 1.61       | 1.645          | 1.127                           | 0.03                               |
| 30.28              | 1553.6                      | 7.2                 | -3.9               | 1.5        | 1.416          | 1.128                           | 0.024                              |
| 30.92              | 1603                        | 5.03                | -2.4               | 1.8        | 1.239          | 1.128                           | 0.025                              |
| 31.56              | 1664.5                      | 6.29                | NA                 | 1.62       | 1.272          | 1.129                           | 0.023                              |
| 32.3               | 1712.6                      | 6.2                 | -4.5               | 2.13       | 1.524          | 1.129                           | 0.037                              |
| 32.94              | 1750.3                      | 5.27                | NA                 | 1.86       | 1.637          | 1.129                           | 0.034                              |

TOC: Total Organic Carbon, LSR: Linear Sedimentation Rate, BD: Bulk Density, MAR: Mass Accumulation Rate.

25 **Table S2: Relative abundance of Chaetoceros Hyalochaete resting spores (CRS)**

| csf-d (depth)<br>(m) | Age Ashley 2021<br>(yrs BP) | CRS<br>(%) |
|----------------------|-----------------------------|------------|
| 1.56                 | 46.70                       | 11.29      |
| 1.61                 | 49.20                       | 16.76      |
| 1.66                 | 51.70                       | 11.83      |
| 1.76                 | 56.7                        | 18.31      |
| 1.81                 | 59.5                        | 13.19      |
| 1.86                 | 62.4                        | 15.74      |
| 1.96                 | 68.2                        | 13.84      |
| 2.01                 | 71.1                        | 7.65       |
| 2.06                 | 74.2                        | 22.87      |
| 2.16                 | 80.5                        | 15.53      |
| 2.21                 | 83.6                        | 15.47      |
| 2.26                 | 86.8                        | 15.98      |
| 2.36                 | 93                          | 12.53      |
| 2.41                 | 96.2                        | 12.89      |
| 2.46                 | 99.3                        | 11.54      |
| 2.51                 | 102.4                       | 16.96      |
| 2.56                 | 105.6                       | 32.08      |
| 2.61                 | 108.7                       | 19.61      |
| 2.66                 | 111.9                       | 23.55      |
| 2.71                 | 115                         | 16.41      |
| 2.82                 | 122                         | 31.76      |
| 2.92                 | 128.3                       | 37.97      |
| 3.07                 | 137.5                       | 33.02      |
| 3.26                 | 148.7                       | 15.09      |
| 3.51                 | 163.4                       | 52.75      |
| 3.61                 | 169.4                       | 19.08      |
| 3.66                 | 172.4                       | 19.42      |
| 3.91                 | 186.8                       | 37.47      |
| 3.95                 | 189.1                       | 28.41      |
| 4.05                 | 194.5                       | 22.85      |
| 4.20                 | 201.6                       | 46.69      |
| 4.40                 | 211.2                       | 15.38      |
| 4.60                 | 220.9                       | 46.77      |
| 4.80                 | 230.7                       | 33.44      |
| 5.00                 | 240.4                       | 28.71      |
| 5.20                 | 250.1                       | 20.42      |
| 5.35                 | 257.4                       | 31.82      |
| 5.45                 | 262.4                       | 22.82      |
| 5.65                 | 272.2                       | 19.05      |
| 5.85                 | 282                         | 20.59      |
| 6.25                 | 301.9                       | 35.49      |
| 6.60                 | 319.6                       | 39.28      |
| 6.80                 | 329.6                       | 14.11      |
| 6.90                 | 334.5                       | 13.23      |
| 7.50                 | 364.9                       | 23.65      |
| 7.70                 | 375.2                       | 23.10      |
| 7.90                 | 385.5                       | 39.81      |
| 8.10                 | 395.8                       | 26.73      |
| 8.40                 | 411.1                       | 21.14      |
| 8.60                 | 421.4                       | 24.22      |
| 8.80                 | 431.6                       | 32.74      |
| 9.00                 | 441.8                       | 16.86      |

|       |        |       |
|-------|--------|-------|
| 9.20  | 452.2  | 10.57 |
| 9.40  | 462.6  | 32.87 |
| 9.60  | 473    | 31.06 |
| 9.80  | 483.4  | 33.14 |
| 9.90  | 488.5  | 14.55 |
| 10.10 | 498.7  | 13.51 |
| 10.27 | 507.5  | 13.20 |
| 10.65 | 527.4  | 15.61 |
| 10.85 | 537.9  | 14.25 |
| 11.05 | 549.3  | 10.82 |
| 11.21 | 560.5  | 12.39 |
| 11.31 | 567.6  | 18.50 |
| 11.51 | 581.8  | 8.93  |
| 11.71 | 596    | 13.23 |
| 12.01 | 617.3  | 14.47 |
| 11.99 | 633.8  | 39.49 |
| 12.40 | 644.1  | 14.86 |
| 12.59 | 657.3  | 13.79 |
| 12.78 | 670.5  | 26.13 |
| 12.95 | 681.7  | 15.41 |
| 13.16 | 695.9  | 13.20 |
| 13.30 | 704.8  | 7.58  |
| 13.38 | 710.5  | 15.61 |
| 13.58 | 722.5  | 19.02 |
| 13.77 | 734.5  | 15.81 |
| 13.96 | 746.4  | 13.56 |
| 14.16 | 757.7  | 11.45 |
| 14.33 | 768.5  | 40.11 |
| 14.52 | 779.7  | 8.13  |
| 14.67 | 788.5  | 11.18 |
| 14.72 | 790.8  | 14.63 |
| 14.91 | 802.6  | 21.73 |
| 15.10 | 813.2  | 29.97 |
| 15.30 | 824.1  | 10.06 |
| 15.49 | 834.2  | 15.00 |
| 15.63 | 842.2  | 8.10  |
| 15.83 | 852.4  | 30.82 |
| 16.02 | 862.4  | 26.11 |
| 16.05 | 863.7  | 27.44 |
| 16.29 | 874.1  | 38.62 |
| 16.58 | 886.8  | 21.01 |
| 16.82 | 897.7  | 20.38 |
| 17.02 | 905.5  | 15.47 |
| 17.21 | 914.2  | 22.60 |
| 17.40 | 922.6  | 38.32 |
| 17.47 | 925.7  | 17.55 |
| 17.66 | 934.1  | 23.51 |
| 17.86 | 942.5  | 20.38 |
| 18.05 | 951.6  | 17.41 |
| 18.24 | 960.5  | 41.99 |
| 18.63 | 978.6  | 11.46 |
| 18.82 | 987.8  | 18.21 |
| 18.90 | 990.9  | 9.32  |
| 19.09 | 999.8  | 20.12 |
| 19.29 | 1007.7 | 27.50 |
| 19.48 | 1015.7 | 26.67 |
| 19.67 | 1023.7 | 34.77 |
| 20.06 | 1040.1 | 12.57 |
| 20.35 | 1051.9 | 10.27 |

|       |        |       |
|-------|--------|-------|
| 20.54 | 1059.7 | 16.40 |
| 20.83 | 1071.5 | 20.90 |
| 21.00 | 1078.1 | 7.35  |
| 21.14 | 1084.2 | 17.07 |
| 21.34 | 1091.8 | 23.33 |
| 21.60 | 1102.7 | 12.03 |
| 21.70 | 1106.7 | 12.58 |
| 21.88 | 1114   | 25.00 |
| 22.07 | 1121.6 | 18.79 |
| 22.25 | 1128.9 | 34.23 |
| 22.44 | 1137   | 32.41 |
| 22.63 | 1144.9 | 52.52 |
| 22.81 | 1152.5 | 53.50 |
| 22.91 | 1156.5 | 26.35 |
| 23.09 | 1164.1 | 34.14 |
| 23.28 | 1172.3 | 45.43 |
| 23.47 | 1180.4 | 28.36 |
| 23.65 | 1188.1 | 34.07 |
| 23.84 | 1196.2 | 34.19 |
| 24.02 | 1203.9 | 33.01 |
| 24.21 | 1212.9 | 34.59 |
| 24.30 | 1217.4 | 21.21 |
| 24.49 | 1226.6 | 35.09 |
| 24.68 | 1236   | 18.29 |
| 25.05 | 1254.7 | 24.06 |
| 25.42 | 1276.5 | 32.83 |
| 25.61 | 1287.7 | 33.02 |
| 25.70 | 1293   | 25.46 |
| 25.89 | 1304.2 | 20.00 |
| 26.07 | 1314.9 | 36.62 |
| 26.26 | 1326.1 | 19.08 |
| 26.45 | 1337.4 | 41.38 |
| 26.63 | 1348   | 44.07 |
| 27.00 | 1369.4 | 37.43 |
| 27.10 | 1374.8 | 29.39 |
| 27.28 | 1384.3 | 37.69 |
| 27.47 | 1394.5 | 34.51 |
| 27.66 | 1404.6 | 35.09 |
| 27.84 | 1414.1 | 48.41 |
| 28.03 | 1424   | 61.06 |
| 28.22 | 1433.9 | 43.61 |
| 28.40 | 1443.4 | 32.70 |
| 28.49 | 1448.2 | 23.58 |
| 28.87 | 1468.3 | 31.95 |
| 29.05 | 1477.9 | 51.41 |
| 29.24 | 1488.6 | 25.08 |
| 29.44 | 1500   | 22.53 |
| 29.61 | 1509.7 | 12.65 |
| 29.80 | 1520.7 | 18.95 |
| 29.91 | 1526.9 | 9.55  |
| 30.08 | 1538   | 26.81 |
| 30.28 | 1553.6 | 15.06 |
| 30.45 | 1566.8 | 21.04 |
| 30.64 | 1581.5 | 7.12  |
| 30.73 | 1588.4 | 23.08 |
| 30.92 | 1603   | 21.05 |
| 31.01 | 1610   | 39.88 |
| 31.20 | 1626.5 | 32.28 |
| 31.59 | 1660.1 | 15.15 |

|       |        |       |
|-------|--------|-------|
| 31.78 | 1676.5 | 15.08 |
| 31.93 | 1689.4 | 8.74  |
| 32.13 | 1702.8 | 15.20 |
| 32.28 | 1712.6 | 25.65 |
| 32.38 | 1718.6 | 17.48 |
| 32.56 | 1729.7 | 11.99 |
| 32.71 | 1738.9 | 8.59  |
| 32.90 | 1750.3 | 21.10 |
| 33.10 | 1762.6 | 32.10 |
| 33.29 | 1774.3 | 24.16 |
| 33.48 | 1786.7 | 23.57 |
| 33.64 | 1796   | 30.25 |
| 33.74 | 1801.4 | 6.27  |
| 33.93 | 1813.5 | 23.31 |
| 34.12 | 1825   | 18.51 |
| 34.32 | 1837.3 | 27.55 |
| 34.51 | 1849   | 42.54 |
| 34.71 | 1860.8 | 8.52  |
| 34.95 | 1876   | 27.38 |
| 35.09 | 1884.5 | 13.71 |
| 35.19 | 1891.4 | 30.70 |
| 35.39 | 1903.1 | 35.09 |
| 35.58 | 1914.8 | 19.39 |
| 35.77 | 1927.1 | 20.50 |
| 35.97 | 1938.9 | 25.95 |
| 36.16 | 1953.4 | 35.38 |
| 36.26 | 1960.1 | 58.19 |
| 36.36 | 1967.4 | 6.80  |
| 36.45 | 1974.1 | 25.71 |
| 36.55 | 1981.5 | 31.56 |
| 36.65 | 1988.9 | 22.08 |
| 36.81 | 2000.7 | 17.09 |
| 36.88 | 2006   | 14.33 |
| 36.92 | 2008.9 | 11.86 |
| 37.02 | 2015.4 | 18.24 |
| 37.08 | 2021.8 | 41.76 |
| 37.13 | 2025.1 | 26.42 |
| 37.18 | 2029.1 | 12.08 |
| 37.28 | 2037.2 | 11.00 |
| 37.38 | 2044.6 | 14.24 |
| 37.52 | 2056.9 | 9.39  |
| 37.62 | 2064.4 | 10.91 |
| 37.67 | 2069.4 | 18.53 |
| 37.81 | 2081   | 29.61 |
| 37.83 | 2082.7 | 10.83 |
| 37.93 | 2090.9 | 17.16 |