Supplement of

Controls on nitrite oxidation in the upper Southern Ocean: insights from winter kinetics experiments in the Indian sector

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Figure S1: The two kinetics curves fitted using two different kinetics models (see section 2.2.3 of the main text). Panel a) St 01: 37°S (STZ), b) St 02: 42°S (STF), c) St 03: 45°S (SAZ), d) St 04: 51°S (PFZ), e) St 05: 55°S (AZ), f) St 06: 62°S (MIZ), and g) St 07: 62°S (MIZ). The solid lines show the Michaelis-Menten (MM) fits – the red line is the MM curve fit using the traditional model (equation 2) while the blue line is the modified MM curve defined by equation 3. For the derived kinetic parameters associated with both models, see Table S1. Error bars indicate the standard error of replicate experiments, each measured at least twice. Where errors bars are not visible, they are smaller than the data markers. The red and green shaded areas are the 95% confidence intervals associated with the models described by equations 2 and 3, respectively.
Figure S2: a) Ambient surface nitrite concentrations ([NO$_2^-$]$\text{amb}$), b) Ambient surface ammonium concentration ([NH$_4^+$]$\text{amb}$) measured every four hours across the transect (Leg 1) between 34°S and 59°S.

Figure S3: Upper 75 m- a) rates of NO$_3^-$ uptake (pNO$_3^-$) and b) concentrations of particulate organic nitrogen (PON) for samples collected at the depth-profile stations (St 08 to St 11; Leg 2). Error bars indicate the standard error of replicate experiments/collections, each measured at least twice. Where errors bars are not visible, they are smaller than the data markers. The dashed lines connecting the data points are included only to guide the eye and should not be taken to indicate interpolation with depth.
**Figure S4:** Depth profile (0-500 m) rates (St 08 to St 11) of NH₄⁺ oxidation (nM d⁻¹) plotted against coincident measurements of the ambient NO₂⁻ concentration (nM). Error bars show the standard error of replicate experiments or collections, each measured at least twice.
Table S1: Kinetic parameters calculated for each NO3- oxidation kinetics experiment using two different models. The values shaded in grey were computed using the traditional Michaelis-Menten (MM) model (equation 2 in the main text), while the values on a white background were derived using a modified form of the MM model (equation 3 in the main text). The numbers in red are the values used throughout the main text.

| Station | Equation# | Kinetic parameter | Confidence interval | 
|---------|-----------|-------------------|---------------------|
|         |           | 99.73% | 95.45% | 68.27% | Best fit | 68.27% | 95.45% | 99.73% |
| 1       | 2         | $V_{max}$ | 5.0 | 7.6 | 9.4 | 11.1 | 13.1 | 16.5 | 28.6 |
| 1       | 2         | $K_m$     | 11 | 156 | 277 | 400 | 564 | 890 | 2335 |
| 1       | 3         | $V_{max}$ | 6.7 | 7.9 | 8.6 | 9.1 | 9.6 | 10.4 | infinity |
| 1       | 3         | C         | -829 | 144 | 182 | 193 | 199 | 206 | 214 |
| 1       | 3         | $K_m^*$   | 31 | 48 | 59 | 70 | 88 | 145 | infinity |
| 1       | 3         | $K_m$     | -798 | 192 | 201 | 263 | 287 | 350 | infinity |
| 2       | 2         | $V_{max}$ | 3.5 | 4.5 | 5.2 | 5.8 | 6.5 | 7.8 | 12.1 |
| 2       | 2         | $K_m$     | -43 | 6 | 56 | 112 | 191 | 353 | 1052 |
| 2       | 3         | $V_{max}$ | 4.5 | 4.8 | 5.0 | 5.2 | 5.3 | 5.5 | 6.0 |
| 2       | 3         | C         | 72 | 105 | 112 | 115 | 117 | 119 | 124 |
| 2       | 3         | $K_m^*$   | 0 | 4 | 11 | 18 | 28 | 43 | 87 |
| 2       | 3         | $K_m$     | 72 | 109 | 123 | 134 | 145 | 163 | 212 |
| 3       | 2         | $V_{max}$ | 6.0 | 7.2 | 8.0 | 8.7 | 9.6 | 11.2 | 18.3 |
| 3       | 2         | $K_m$     | -47 | 21 | 88 | 162 | 269 | 500 | 1706 |
| 3       | 3         | $V_{max}$ | 6.5 | 7.4 | 7.9 | 8.3 | 8.7 | 9.3 | infinity |
| 3       | 3         | C         | neg infinity | -11 | 117 | 139 | 152 | 169 | 180 |
| 3       | 3         | $K_m^*$   | neg infinity | 26 | 47 | 67 | 96 | 204 | infinity |
| 3       | 3         | $K_m$     | 0 | 15 | 164 | 206 | 248 | 373 | infinity |
| 4       | 2         | $V_{max}$ | 9.7 | 11.7 | 13.3 | 14.9 | 17.4 | 23.3 | 100.9 |
| 4       | 2         | $K_m$     | -15 | 99 | 223 | 374 | 619 | 1263 | 10118 |
| 4       | 3         | $V_{max}$ | 10.2 | 11.4 | 12.2 | 12.8 | 13.6 | 15.2 | infinity |
| 4       | 3         | C         | -1646 | 68 | 148 | 172 | 186 | 204 | 243 |
| 4       | 3         | $K_m^*$   | 6 | 36 | 75 | 117 | 176 | 335 | infinity |
| 4       | 3         | $K_m$     | -1640 | 104 | 223 | 288 | 363 | 538 | infinity |
| 5       | 2         | $V_{max}$ | 11.1 | 12.7 | 13.9 | 14.9 | 16.1 | 18.2 | 25.0 |
| 5       | 2         | $K_m$     | -15 | 93 | 185 | 279 | 401 | 631 | 1441 |
| 5       | 3         | $V_{max}$ | 11.8 | 12.6 | 13.1 | 13.5 | 13.9 | 14.6 | infinity |
| 5       | 3         | C         | neg infinity | 138 | 221 | 245 | 259 | 272 | 292 |
| 5       | 3         | $K_m^*$   | 20 | 45 | 64 | 84 | 112 | 186 | infinity |
| 5       | 3         | $K_m$     | 20 | 183 | 285 | 329 | 371 | 458 | infinity |
| 6       | 2         | $V_{max}$ | 7.7 | 8.5 | 9.2 | 9.7 | 10.3 | 11.3 | 13.5 |
| 6       | 2         | $K_m$     | 294 | 421 | 519 | 609 | 718 | 897 | 1359 |
| 6       | 3         | $V_{max}$ | 7.6 | 7.9 | 8.1 | 8.2 | 8.3 | 8.6 | 9.2 |
| 6       | 3         | C         | 70 | 129 | 151 | 163 | 174 | 187 | 204 |
| 6       | 3         | $K_m^*$   | 154 | 191 | 217 | 239 | 266 | 312 | 448 |
| 6       | 3         | $K_m$     | 224 | 320 | 368 | 403 | 440 | 499 | 652 |
| 7       | 2         | $V_{max}$ | 4.3 | 5.7 | 6.8 | 7.7 | 8.9 | 10.9 | 16.8 |
| 7       | 2         | $K_m$     | -50 | 79 | 191 | 304 | 450 | 722 | 1636 |
| 7       | 3         | $V_{max}$ | 5.4 | 6.0 | 6.3 | 6.6 | 6.9 | 7.4 | 8.6 |
| 7       | 3         | C         | -47 | 190 | 223 | 237 | 246 | 255 | 269 |
| 7       | 3         | $K_m^*$   | 19 | 45 | 64 | 80 | 101 | 140 | 396 |
| 7       | 3         | $K_m$     | -28 | 234 | 287 | 317 | 346 | 395 | 664 |

*Note: the equation number corresponds to the numbering in the methods section of the main text.*
Table S2: Upper 75 m- average particulate organic N (PON) concentrations, integrated rates of NO$_3^-$ uptake and NO$_2^-$ oxidation, and the ratio of NO$_2^-$ oxidation to NO$_3^-$ uptake. The numbers in parentheses are the propagated standard errors.

| Station name | Avg PON (µM) | NO$_2^-$Ox (mmol m$^{-2}$ d$^{-1}$) | $\rho$NO$_3^-$ (mmol m$^{-2}$ d$^{-1}$) | NO$_2^-$Ox/$\rho$NO$_3^-$ |
|--------------|--------------|-------------------------------------|-------------------------------------|--------------------------|
| St 08: 59°S  | 0.27 (0.08)  | 0.61 (0.00)                         | 0.26 (0.03)                         | 2.37 (0.24)              |
| St 09: 54°S  | 0.38 (0.04)  | 0.19 (0.00)                         | 0.30 (0.05)                         | 0.63 (0.11)              |
| St 10: 48°S  | 0.47 (0.09)  | 0.52 (0.04)                         | 0.71 (0.01)                         | 0.73 (0.07)              |
| St 11: 43°S  | 0.44 (0.09)  | 1.65 (0.61)                         | 1.44 (0.06)                         | 1.15 (0.48)              |