**1 D model description and equations**

To estimate the effect of turbulence on G17OP estimations, we used a simple 1-D model, which simulated the water column to a depth of 300 m. The modeled water-column was constructed of 30 layers, of 10 m each. The upper layers were assigned as “mixed-layer” (ML) and lower layers were assigned as “seasonal thermocline”. These two types of layers differed in their eddy diffusivity coefficients (κ = 2.5×10-3 in the ML and κ = 1×10-4 in the seasonal thermocline), and the number of layers assigned to each category was determined according to the mixing depth. An additional layer at the top of the water column represented the ocean surface. In this layer [O2] and its isotopic composition were kept at air-sea equilibrium. In the bottom layer, [O2] concentrations were also kept constant.

The model was initialized with a uniform profile, with saturation concentration for each of the isotopolouges.

GOP was roughly estimated by multiplying 14C-incubation rates by three (similar to the 2.8 ratio calculated by *Marra*, [2000]). For simplicity, GOP rates were kept constant over time, and were assumed to decrease linearly with depth from a maximum of 3 mmol m-3 day-1 at the sea surface to zero at 150 m. The integrated GOP rate was 226 mmol m-2 day-1. The respiration flux in each layer was assumed to be 0.85\*GOP. For each layer, the concentration of each O2 isotopologue was estimated in time-steps of one day. Below is a list of all the parameters and equations used in the model.

## Constants

|  |  |  |
| --- | --- | --- |
| Parameter | Value | Reference |
| X17P, X18P, isotopic composition of photosynthetic produced O2 | 0.000380579, 0.002011967 | *Luz and Barkan*, [2011 *a*] |
| 18εR, 17εr,discrimination in respiration in the photic zone | 22 ‰, 1-(1-18 εr)θr | *Quay et al.,* [1993] *Hendricks et al.,* [2004] |
| 18εR(deep), 17εr(deep),discrimination in respiration below the photic zone | 21.5 ‰, 1-(1-18 εr)θr | Adjusted to produce the best fit with measured δ18O profiles in BATS. |
| θr, relationship between the discrimination against 17O and 18O relative to 16O | 0.516 | *Angert et al.,* [2003] |
| 17RAIR, 18RAIR | 0.000384473, .002053057 | *Luz and Barkan*, [2011 *b*] |
| 17RSMOW, 18RSMOW | 2\*379×10-6, 2\*2005×10-6 | *Coplen et al.,* [2002] |
| K, gas exchange coefficient (piston velocity) | 4 m day-1 |  |
| 32O2sat, saturation in the upper layer | 200 mmol m-3 |  |
| 33O2sat,saturation of 33O2 in the upper layer | =32O2sat \* 17RAIR\*1.00037529830 mmol m-3 | *B. Luz, Pers. com* |
| 34O2sat, saturation of 34O2 in the upper layer | = 18RAIR\*1.00069333006 mmol m-3 | *Knox,* [1992] |
| 32O2deep, 33O2deep, 34O2deep, O2 concentrations in the bottom layer | 184, 0.0708, 0.3789 mmol m-3 |  |
| κML, eddy-turbulence coefficient in the mixed layer | 2.5×10-3 m2 s-1 |  |
| κthermocline eddy-turbulence coefficient in the seasonal thermocline | 1×10-4 m2 s-1 |  |

## Eddy diffusion calculation

iF(z)= κ(z-10,t)/10·(iO(z-10)- iO (z))+ κ (z,t)/10·( iO (z+10)- iO (z))

Gross production calculation

16P(z)=GOP

18P(z)=GOP·18Rp

17P(z)=GOP·17Rp

## Respiration calculation

16Resp(z)=0.85\*GOP

18Resp(z)= 16Resp(z) \*(1-18αr /1000)\*(18O/16O)(z)

17Resp(z)= 16Resp(z) \*(1-17αr /1000)\*(17O/16O)(z)

Iteration

iO(z)= iO(z) +iF(z)/10·T + iP(z)·T- iResp(z)·T

References:

Angert, A., Rachmilevitch, S., Barkan, E., and Luz, B.: Effects of photorespiration, the cytochrome pathway, and the alternative pathway on the triple isotopic composition of atmospheric O2, Global Biogeochemical Cycles, 17, 10.1029/2002gb001933, 2003.

Coplen, T. B., Böhlke, J. K., De Bievre, P., Ding, T., Holden, N., Hopple, J., Krouse, H., Lamberty, A., Peiser, H., and Revesz, K.: Isotope-abundance variations of selected elements (IUPAC Technical Report), Pure and Applied Chemistry, 74, 1987-2017, 2002.

Hendricks, M. B., Bender, M. L., and Barnett, B. A.: Net and gross O2 production in the southern ocean from measurements of biological O2/Ar saturation and its triple isotope composition, Deep Sea Research Part I: Oceanographic Research Papers, 51, 1541-1561, 2004.

Knox, M., Quay, P., and Wilbur, D.: Kinetic isotopic fractionation during air-water gas transfer of O2, N2, CH4, and H2, Journal of Geophysical Research: Oceans (1978–2012), 97, 20335-20343, 1992.

Luz, B., and Barkan, E.: Oxygen isotope fractionation in the ocean surface and 17O/16O of atmospheric O2, Global Biogeochemical Cycles, 25, 10.1029/2011gb004178, 2011a.

Luz, B., and Barkan, E.: Proper estimation of marine gross O2 production with 17O/16O and 18O/16O ratios of dissolved O2, Geophysical Research Letters, 38, 10.1029/2011gl049138, 2011b.

Quay, P. D., Emerson, S., Wilbur, D. O., Stump, C., and Knox, M.: The 18O of dissolved O2 in the surface waters of the sub-arctic Pacific – a tracer of biological productivity, Journal of Geophysical Research-Oceans, 98, 8447-8458, 10.1029/92jc03017, 1993.