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Simple Eulerian–Lagrangian approach to solving equations for sinking particulate organic matter in the ocean

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Table S1 The relative maximal absolute errors [%] of calculated AID and ADD solutions for C_p and F_p at spectral resolution n_d=100 and n_d=10 with baseline calculation at n_d=990.

Model	C_p		F_p	
	n_d=100	n_d=10	n_d=100	n_d=10
AID	9.5	90.5	0.28	22.6
ADD	2.97	63.1	0.13	16.4

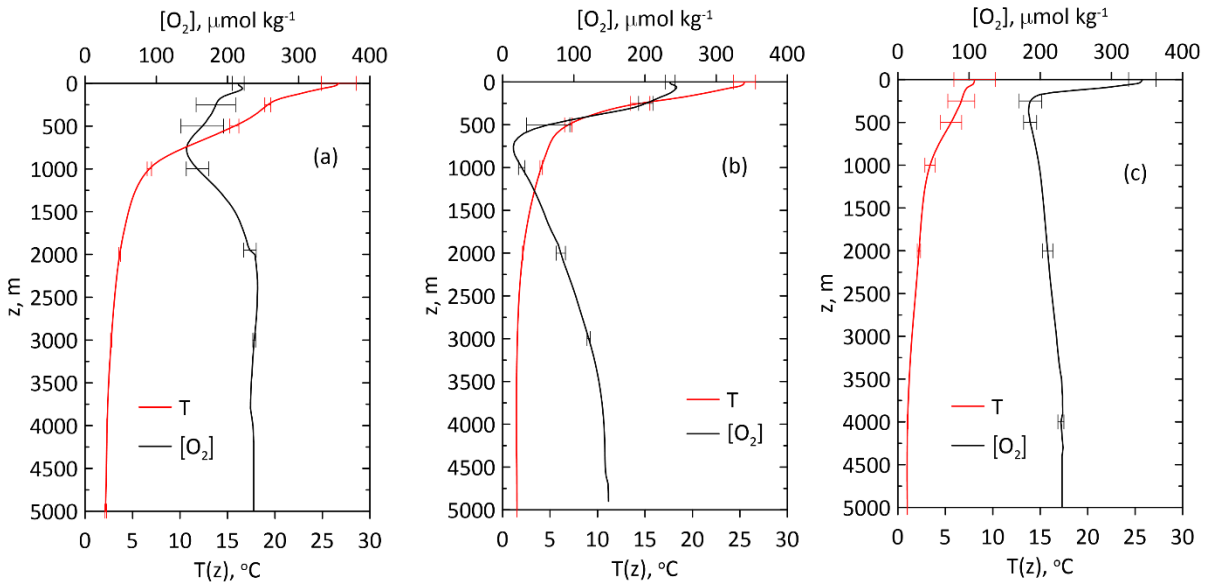

Figure S1. Averaged vertical profiles of temperature T and dissolved oxygen [O_2] along the latitude band of 20-30°N in the Atlantic and Pacific Oceans and 50-60°S in the Southern Ocean.

Sensitivity study using the One-At-a-Time method

The sensitivity study was carried out for the model parameters in Table 1. The one-at-a-time method was used to quantify the effect of the variation of a given parameter on the model output while all other parameters were kept at their initial values (Hamby, 1994; Lenhart et al., 2002; Soares, Calijuri, 2021).

The effects of variations in these parameters were estimated for the particle transfer efficiency (TE) (Cram et al., 2018)

$$TE_{1000} = \frac{F_p(1000\text{m})}{F_p(z_{euph})} \tag{S1}$$

and

$$TE_{5000} = \frac{F_p(5000\text{m})}{F_p(z_{euph})} \tag{S2}$$

The parameter TE_{1000} is the ratio of the POM flux at the lower boundary of the mesopelagic zone to the flux at the lower boundary of the euphotic layer, characterising the sequestration of

carbon in the mesopelagic zone, while TE_{5000} is the ratio of the POM flux at the bottom to the flux at the lower boundary of the euphotic layer, characterising carbon sequestration at the bottom.

The range for parameters is defined for a constant ratio $r>1$. The minimum parameter value $p_{\min}$ was set to be proportional to the reference value p_{ref} with a ratio value $1/r$, while the maximum value $p_{\max}$ was set to be proportional to the reference value p_{ref} with a ratio value r. For parameters in Table S2, the value of r was chosen to be the same (r=1.25), which satisfies the ranges of all parameters.

Model output sensitivity was estimated using a sensitivity index (SI)

$$SI(X) = \frac{X(p_{\max}) - X(p_{\min})}{X(p_{ref})} \tag{S3}$$

where $X(p_{\max})$ and $X(p_{\min})$ are the simulation outputs for maximal $p_{\max}$ and minimal $p_{\min}$ parameter values, respectively. This definition differs from the earlier interpretation of SI (Hamby, 1994) when

$$SI(X) = \frac{X(p_{\max}) - X(p_{\min})}{X(p_{\max})} \tag{S4}$$

and from a newer approach (Lenhart et al., 2002; Soares, Calijuri, 2021)

$$SI(X) = \frac{X(p_{\max}) - X(p_{\min})}{X(p_{ref})} \Big/ \frac{(p_{\max} - p_{\min})}{p_{ref}} \tag{S5}$$

However, relations (S3) and (S5) coincide to a constant $r + 1/r = 2.05$ when r=1.25.

Calculations were carried out for the Pacific Ocean using reference, maximal and minimal values of parameters given in Table S1. The sensitivity studies for AID and ADD models were carried out separately.

Table S2 The reference values and range of the modelling parameters.

Parameter	Parameter No.	Reference value	[units]	Maximal value	Minimal value
γ_0	1	0.03	[1/d]	0,0375	0,024
η	2	1.17	-	1,4625	0,936
ς	3	2.28	-	2,85	1,824
ε	4	4.2	-	5,25	3,36
T_{ref}	5	4	[ºC]	5	3,2
Q_{10}	6	2.5	-	3,125	2
K_0	7	8	[mM]	10	6,4
α	8	30	[d]	37,5	24
β	9	1	-	5/4	4/5

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