Response to Editor

We thank the Editor for the careful reading and the suggestions to improve the quality and readability of the manuscript. We have followed your suggestions and revised the manuscript accordingly. Please find our responses below.

Dear authors,

After receiving one follow up review and reviewing the article myself, I am willing to accept the article for publication but only on the basis that the following revisions be completed:

1. *Please describe more fully the physical meaning of ψ and φ indices. Can you explain them intuitively to the reader.*

Answer. Thank you for the suggestion. The text was added accordingly

L. 125 "Solutions (11) and (12) describe the vertical distribution of $W_{p,d}$ and d in the layer of finite thickness $h_0 = \psi^{-1}$ below which there are only trivial solutions $W_{p,d}$=0 and d = 0."

L. 167 "The parameter ϕ [m^{-1}] characterizes the vertical scale of attenuation $W_{p,d}(z')$, $\gamma(z')$ and $d(z')$ with depth."

2. *Please explain more intuitively in words what is happening in Eq. 9, Eq. 13, Eq.15, Eq. 27, so that a less quantitative reader can follow.*

Answer. We reworked the text for these equations according to your suggestions:

Assuming the quasiequilibrium sinking of the particle in the Stokes regime, as described by Eq. (4), and taking into account that particle trajectory in Lagrangian system of coordinates is described as $\partial z'/\partial t = W_{p,d}$, we estimate the dependence of the particle depth z' on t using Eqs. (4) and (8):

$$\frac{\partial z'}{\partial t} = c_w d_0^\eta \exp\left(-\frac{\eta\gamma_0 t}{\zeta}\right). \tag{9}$$

By integrating Eq. (9) from the initial particle depth $z' = 0$ at $t = 0$, we find the vertical path travelled by the particle:

$$z' = \frac{\zeta c_w d_0^\eta}{\eta\gamma_0}\left[1 - \exp\left(-\frac{\eta\gamma_0 t}{\zeta}\right)\right]. \tag{10}$$

By eliminating time from Eqs. (8) by using Eq. (10) and then substituting Eq. (8) to Eq. (4), we obtain $W_{p,d}$ and d as functions of z':

L. 122 See the reply to the previous comment.

L. 135 "Then, the distribution $C_{p,d}(0)$ can be represented as a product of particle size distribution $N(d_0)$ and mass of particle $m_{0,d}$:…"

L. 166 See the reply to the previous comment.

3. *Please label the equation on line 128 and explain what your assumptions are: i.e., that particle number decreases with particle size according to some power law scaling.*

Answer. Thank you for the suggestion. The text was clarified accordingly:

L. 131 "The distribution $N(d_0)$ was approximated in such a way that the number of particles decreased with increasing particle size according to power law scaling."

4. *What is AIDR and ADDR? You must explain what these are.*

Answer. We have corrected both AIDR and ADDR to AID and ADD.

5. *Please add the results from your sensitivity analysis to the main paper as a figure.*

Answer. We added the results of the sensitivity analysis in the paper as Fig. 7.

6. *Line 348 - please be clear that you also make assumptions about the size spectrum obeying a power law.*

Answer. We have clarified the text accordingly:

L. 353 "In contrast to other approaches, our approach does not solve particle size spectrum equations (e.g., DeVries et al., 2014) explicitly or introduce power-law particle size distribution assumptions below the euphotic layer (e.g., Kriest and Evans , 1999; Maerz et al., 2020). Note that the particular form of size spectrum dependence $N(d_0)$ may differ from the power law (15)."

7. *Line 356 - Please give a more concrete example of how this formulation would be advantageous to ocean biogeochemical models. What would implementing your approach allow? What questions might it provide answers to?*

Answer. We added text accordingly.

L. 362 "As shown in Table 3 from the review (Burd, 2024), the sinking velocity in CMIP6 Eulerian biogeochemical models is either assumed to be constant or it increases linearly with depth. Our hybrid approach considers the interaction between the sinking and degradation processes of POM particles in Lagrangian variables and POM concentration in the Eulerian coordinate system, making particle transport models compatible with large-scale Eulerian biogeochemical models. It also provides an opportunity to solve the non-stationary problem in the future using Eq. (1) complemented by the time derivative of $C_{p,d}$ and necessary parameterizations of the POM sinking processes."