Methods

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Model

We use the model developed by Shoemaker & Melbourne (2016); Wisnoski *et al.* (2019), and previous findings in Picoche & Barraquand (2019a,b).

We consider two steps in the discrete-time model: species first grow following a Beverton-Holt model for the coastal and oceanic cells, while seeds are only subject to a small mortality. Then, we take into account exchanges between the coast and the open-ocean, and between the water column and the benthos.

$$\begin{cases} N_{t+h,i,c/o} = \frac{e^{r_i(T)} N_{t,i,c/o}}{1+\sum_j \alpha_{ij,c/o} N_{t,j,c/o}} \\ N_{t+h,i,b} = N_{t,i,b}(1-m_i) \end{cases} \tag{1}$$

$$\begin{cases} N_{t+1,i,c} = N_{t+h,i,c}(1-s_i-e) + \gamma_i N_{t+h,i,b} + e N_{t+h,i,o} \\ N_{t+1,i,o} = N_{t+h,i,o}(1-e) + e N_{t+h,i,c} \\ N_{t+1,i,b} = N_{t+h,i,b}(1-\gamma_i) + s_i N_{t+h,i,c} \end{cases} \tag{2}$$

with growth rate defined according to Scranton & Vasseur (2016) (eq. 3).

$$\begin{aligned} r_i(T) &= a_r(\tau_0) e^{E_r \frac{(T-\tau_0)}{kT\tau_0}} f_i(T) \\ \text{where } f_i(T) &= \begin{cases} e^{-|T-T_i^{opt}|^3/b_i}, & T \leq T_i^{opt} \\ e^{-5|T-T_i^{opt}|^3/b_i}, & T > T_i^{opt} \end{cases} \\ \text{and} \quad b_i \text{ is defined by numerically solving } & \int r_i(\tau) d\tau = A \end{aligned} \tag{3}$$

Parameters and state variables definitions are given in Table 1.

Param	Name	Value (unit)
$N_{t,i,c/o/b}$	Abundances of species i at time t in the coast (c) or ocean (o) water column, or in the benthos (b)	NA (Number of cells)
T	temperature	NA (K)
r_i(T)	growth rate of species i	NA
b_i	Normalization constant for the thermal decay rate	(K^3)
τ_0	Reference temperature	293 (K) / 20 (˚C)
$a_r(\tau_0)$	Growth rate at reference temperature	$386(\frac{\text{kg}}{\text{kg}\times\text{year}})$[1]
E_r	Activation energy	0.467 (eV)
k	Boltzmann's constant	$8.6173324.10^{-5}$(eV.K^{-1})
$f_i(T)$	Fraction of the maximum rate achieved for the i^{th} species	(NA)
$T_{\min}$	Minimum thermal optimum	288 (K)
$T_{\max}$	Maximum thermal optimum	298 (K)
T_i^{opt}	Optimal temperature for species i	Adapted from Picoche & Barraquand (2019b)
$\alpha_{ij,c/o}$	interaction strength of species j on i	$\mathcal{N}(\mu,\sigma)$, $\mu = 0.0$, $\sigma = 0.01$; adapted from Picoche & Barraquand (2019b)
m_i	seed mortality of species i	$\approx 10^{-4}/10^{-5}$Values from on McQuoid *et al.* (2002)
s_i	sinking rate of species i	$30\beta(0.55, 1.25)$ from values given in Passow (1991)
e	exchange rate between ocean and coast	0.64 d^{-1} from Plus *et al.* (2009)
γ_i	germination + resuspension rate of species i	[0.1,0.01,0.001] * 0.5 * s_i (abitrary)

Table 1: Definition of variable states and parameters

[1] As the final dimension of this variable is year-1, I don't think we have to convert to number of cells but I am still wondering about the usability of this parameter + we have to convert from year to day

Parameter definition

Interactions Assuming that nutrients are rarer in the ocean than in the coast [ref], $\alpha_{ij,c} << \alpha_{ij,o}$, with a fixed coefficient k such that $\alpha_{ij,c} = k\alpha_{ij,o}$[2].

According to Picoche & Barraquand (2019b), impact as a function of self-regulation, $\alpha_{ii} \sim 10|\bar{\alpha_{.j}}|$ and $\alpha_{ij} \sim \mathcal{N}(\mu, \sigma)$ with μ and σ around 0.0 and 0.01[3] for coastal interactions.

Optimal temperature To define each species growth rate according to daily temperature, species are defined according to their optimal temperature. In the toy model of Picoche & Barraquand (2019a), optimal temperatures followed a uniform law between 15 and 25°C. This does not seem realistic, especially if we look at the effect of temperature in Picoche & Barraquand (2019b). We can define two species preferring the cold (around 15°C), as we had Asterionellopsis and Skeletonema in our datasets, and the other preferring warmer temperatures (uniform law between 20 and 25°C).

Note that these temperature values are 5 degrees above the observed mean in the REPHY dataset, but they are in the domain of application of the model from Scranton & Vasseur (2016).

Exchange rate This parameter depends on the estuary. In the Arcachon Bay, the exchange rate for each tide has been estimated around 64% (Plus *et al.*, 2009). If we take a daily time-step and consider only the tide that takes place during the day, there is only one tide and then, e=0.64[4].

Seed mortality McQuoid *et al.* (2002) present maximum and mean depth at which germination of diatoms and dinoflagellates occurred in sediments. They also present sediment datation according to depth. Depth can therefore be related to maximum and mean age of phytoplankton before death.

Assuming m is the probability of mortality, m follows a geometric law, i.e., m is the probability distribution of the number of days needed for a phytoplankon spore to die. The expectancy for the life duration (the number of days without dying) is $\frac{1}{m} \Leftrightarrow m = \frac{1}{L_{mean}}$where L_{mean} is the average life duration.

Another way to look at the process is that life expectancy L follows the distribution $p(L > l) = e^{-ml}$.With maximum values, we can arbitrarily choose that for these values $p(L > l_{max}) = 0.05$. In this, $m = -\frac{ln(p(L>l_{max}))}{l_{max}}$.

In both cases, $m \propto 10^{-4}\mathrm{d}^{-1}$.

Sinking rate According to Passow (1991) (who measured sinking rates in real conditions), rates can vary between 1 and 30% for the same species (Chaetoceros spp.), with a mean value for two diatom species of 10 (Chaetoceros and Thalassiosira). Values are much for the others, around 1% for the others.

Sinking rate values around 10% are consistent with the loss rate values in Wiedmann *et al.* (2016).

We can arbitrarily fix a beta distribution with mean value close to the one observed in both papers (between 9 and 10), and maximum around 30%, that is $s \backsim \beta(0.55, 1.25) * 30$.

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[2]This must be true for competition, but what happens for apparent facilitation? Does it change sign? Does it just decrease? Maybe positive interactions are reduced to 0 when in the ocean, that is why many interactions were removed in the oceanic site Griffiths *et al.* (2015)

[3]I know it is not the same model, I am just starting with some values here...

[4]We need to have very good arguments to take into account only one tide per day.

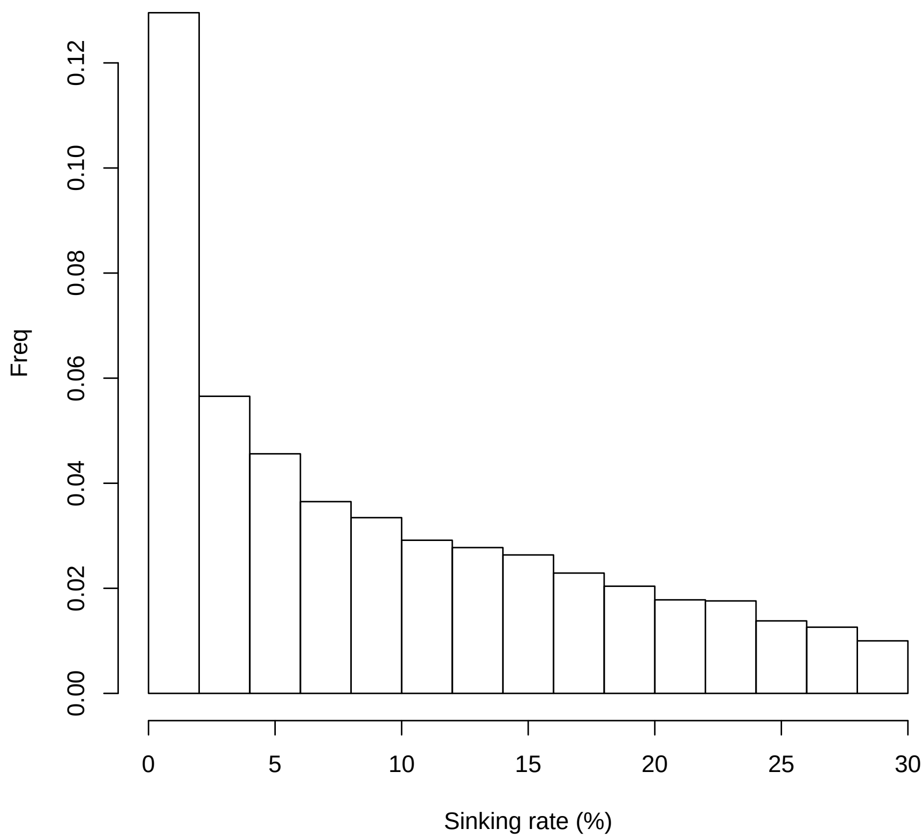

Figure 1: Possible distribution of sinking rates

We may have to force the values for species like Chaetoceros, Thalassiosira, to have higher sinking rates.

Germination/resuspension Germination and resuspension might be difficult to differentiate, they are defined by the same parameters (γ = resuspension*germination).Even though we have no estimation of germination and resuspension rate, we can try several values. Germination can be 1%, 0.1%, 0.01%. Resuspension can be half sinking rate (maybe ?). Resuspension will not really matter with these low values of germination.

Additional information regarding germination: from McQuoid *et al.* (2002), we can assume that there is a temperature threshold for germination (but this cannot explain a lot of long-term dormancy) and the existence of such threshold is confirmed by the review by Agrawal (2009). Photoperiodicity does not seem to have a strong effect according to this review (but see Eilertsen *et al.* (1995)). We could use a temperature threshold at 15°C, as we already take this temperature for the growth rate (Scranton & Vasseur, 2016).

Species definition

The composition of the community is based on Picoche & Barraquand (2019b), with somes changes to remain close to species present in McQuoid *et al.* (2002).

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