SUPPLEMENTARY TEXT

Table S1: Full Parameters used in the model

Model Parameters	Model Notation	Values	units	description	References
$\overline{flux}_{org}$	$CFlux$	150	$mmol\ m^{-2}d^{-1}$	total organic C deposition	Pastor et al 2011
pfast	pFast	0.5	-	part FDET in carbon flux	Pastor et al 2011
$\overline{flux}_{FeOO3}$	FeOH3flux	0.01	$mmol\ m^{-2}d^{-1}$	deposition rate of FeOH3	Assumed
rFast	rFast	0.1	d^{-1}	decay rate FDET	Ait Ballagh et al., 2021
rSlow	rSlow	0.0	d^{-1}	decay rate SDET	Ait Ballagh et al., 2021
NCrFdet	NCrFdet	0.1	$molN/molC$	NC ratio FDET	Pastor et al., 2011
NCrSdet	NCrSdet	0.1	$molN/molC$	NC ratio SDET	Pastor et al., 2011
BCupLiq	BCupLiq	2	-	upper boundary liq. 1:flux, 2:conc, 3:0-grad	
BCdownLiq	BCdownLiq	3	-	lower boundary liq. 1:flux, 2:conc, 3:0-grad	
$O_{2_{bw}}$	O2bw	197	$mmol\ m^{-3}$	upper boundary O2	Ait Ballagh et al., 2021
$NO_{3_{bw}}$	NO3bw	0.0	$mmol\ m^{-3}$	upper boundary NO3	Ait Ballagh et al., 2021
$NH_{3_{bw}}$	NH3bw	0.0	$mmol\ m^{-3}$	upper boundary NH3	Ait Ballagh et al., 2021
$CH_{4_{bw}}$	CH4bw	0.0	$mmol\ m^{-3}$	upper boundary CH4	Rasmann et al., 2016
DIC	DICbw	2360	$mmol\ m^{-3}$	upper boundary DIC	Pastor et al., 2018
$Fe^{2+}{}_{bw}$	Febw	0.0	$mmol\ m^{-3}$	upper boundary Fe2	Pastor et al., 2018
H_2S_{bw}	H2Sbw	0.0	$mmol\ m^{-3}$	upper boundary H2S	Pastor et al., 2018
$SO_{4_{bw}}$	SO4bw	30246	$mmol\ m^{-3}$	upper boundary SO4	Pastor et al., 2018
$O_{2_{dw}}$	O2dw	0	$mmol\ m^{-3}$	lower boundary O2	Assumed
$NO_{3_{dw}}$	NO3dw	0	$mmol\ m^{-3}$	lower boundary NO3	Assumed
$NO_{2_{dw}}$	NO2dw	0	$mmol\ m^{-3}$	lower boundary NO2	Assumed
$NH_{3_{dw}}$	NH3dw	0	$mmol\ m^{-3}$	lower boundary NH3	Assumed
$CH_{4_{dw}}$	CH4dw	0	$mmol\ m^{-3}$	lower boundary CH3	Assumed
DIC_{dw}	DICdw	0	$mmol\ m^{-3}$	lower boundary DIC	Assumed
$Fe^{2+}{}_{dw}$	Fedw	0	$mmol\ m^{-3}$	lower boundary Fe2	Assumed
H_2S_{dw}	H2Sdw	0	$mmol\ m^{-3}$	lower boundary H2S	Assumed

Model Parameters	Model Notation	Values	units	description	References
$SO_{4_{dw}}$	SO4dw	0	$mmol\ m^{-3}$	lower boundary SO4	Assumed
w	w	0.027	$cm\ d^{-1}$	advection rate	Pastor et al., 2011
D_0	biot	0.01	$cm^2\ d^{-1}$	bioturbation coefficient	Ait Ballagh et al., 2021
Z_L	biotdepth	5	cm	depth of mixed layer	Ait Ballagh et al., 2021
$biot_{att}$	biotatt	1.0	cm^{-1}	attenuation coeff below biotdepth	Ait Ballagh et al., 2021
Irr_0	irr	0.2	d^{-1}	bio-irrigation rate	Ait Ballagh et al., 2021
Z_{irr}	irrdepth	7	cm	depth of irrigated layer	Ait Ballagh et al., 2021
Irr_{att}	irratt	1.0	cm	attenuation coeff below irrdepth	Ait Ballagh et al., 2021
$temp$	temperature	16	℃	temperature	Ait Ballagh et al., 2021
sal	salinity	38	psu	salinity	Ait Ballagh et al., 2021
TOC_{ref}	TOC0	1.1	%	refractory Carbon conc	Pastor et al., 2018
ks_{Nitri}	ksO2nitri	10	$mmol\ O_2\ m^{-3}$	half-sat O2 in nitrification	Soetaert et al., 1996
ks_{o_2}	ksO2oxic	1.0	$mmol\ O_2\ m^{-3}$	half-sat O2 in oxic mineralisation	Soetaert et al., 1996
ks_{NO_3}	ksNO3denit	10	$mmol\ NO_3\ m^{-}$	half-sat NO3 in denitrification	Soetaert et al., 1996
k_{ino_2den}	kinO2denit	1.0	$mmol\ O_2\ m^{-3}$	half-sat O2 inhib denitrification	Soetaert et al., 1996
k_{inNO_3ano}	kinNO3anox	10	$mmol\ NO_3\ m^{-}$	half-sat NO3 inhib anoxic degr	Soetaert et al., 1996
k_{inO_2ano}	kinO2anox	1.0	$mmol\ O_2\ m^{-3}$	half-sat O2 inhib anoxic min	Soetaert et al., 1996
ks_{FeOH_3}	ksFeOH3	12500	$mmol\ FeOH_3$	half-sat FeOH3 conc in iron reduction	Wang and Van Cappellen, 1996
ks_{inFeOH_3ano}	kinFeOH3	12500	$mmol\ FeOH_3$	half-sat FeOH3 inhibition S reduction	Wang and Van Cappellen, 1996
ks_{SO_4}	ksSO4BSR	800	$mmol\ S\ m^{-3}$	half-sat SO4 conc in sulphate reduction	Wang and Van Cappellen, 1996
k_{inSO_4ano}	kinSO4Met	1000	$mmol\ S\ m^{-3}$	half-sat SO4 inhibition methanogenesis	Wang and Van Cappellen, 1996

Model Parameters	Model Notation	Values	units	description	References
R_{FeOH_3}	rFeox	0.3	$(mmol\ m^{-3})^{-}$	Max rate Fe oxidation	Berg et al. 2003
R_{H_2S}	rH2Sox	5×10^{-5}	$(mmol\ m^{-3})^{-}$	Max rate H2S oxidation	Assumed
$R_{FeSprod}$	rFeS	1×10^{-3}	$(mmol\ m^{-3})^{-}$	maximum rate FeS production	Assumed
R_{CH_4}	rCH4ox	27	$(mmol\ m^{-3})^{-}$	Max rate CH4 oxidation with O2	Berg et al. 2003
R_{AOM}	rAOM	3×10^{-5}	$(mmol\ m^{-3})^{-}$	Max rate anaerobic oxidation Methane	Assumed
$\emptyset_0$	por0	0.8	-	surface porosity	Ait Ballagh et al., 2021
$\emptyset_\infty$	pordeep	0.6	-	deep porosity	Ait Ballagh et al., 2021
δ	porcoeff	2	cm	porosity decay coefficient	Ait Ballagh et al., 2021
F	formationtype	1.0	-	formationfactor, 1=sand,2=fine sand,3=general	Pastor et al., 2011

Table S2: Estimate of relaxation timescale (days) with uncertainty in estimate derived from non-parametric bootstrapping

	O_2	SO_4^{2-}	DIC
EM1 Scenario			
	5 ± 3	117 ± 6	142 ± 23
EM2 Scenario			
	2 ± 2	91 ± 6	103 ± 9

A2 Model Grid

As explained in the main text, the event routine was modified the model grid at the specific time during its runtime. A certain depth of deposition Z_{pert} result to N_{pert} layer added to the model grid N. Afterward, regridding of this layer together with the cell content is performed via interpolation of the grid $N + N_{pert}$ into the model grid. Figure A1 showed the difference in the spacing of the grid Δz and number of layer before and deposition.

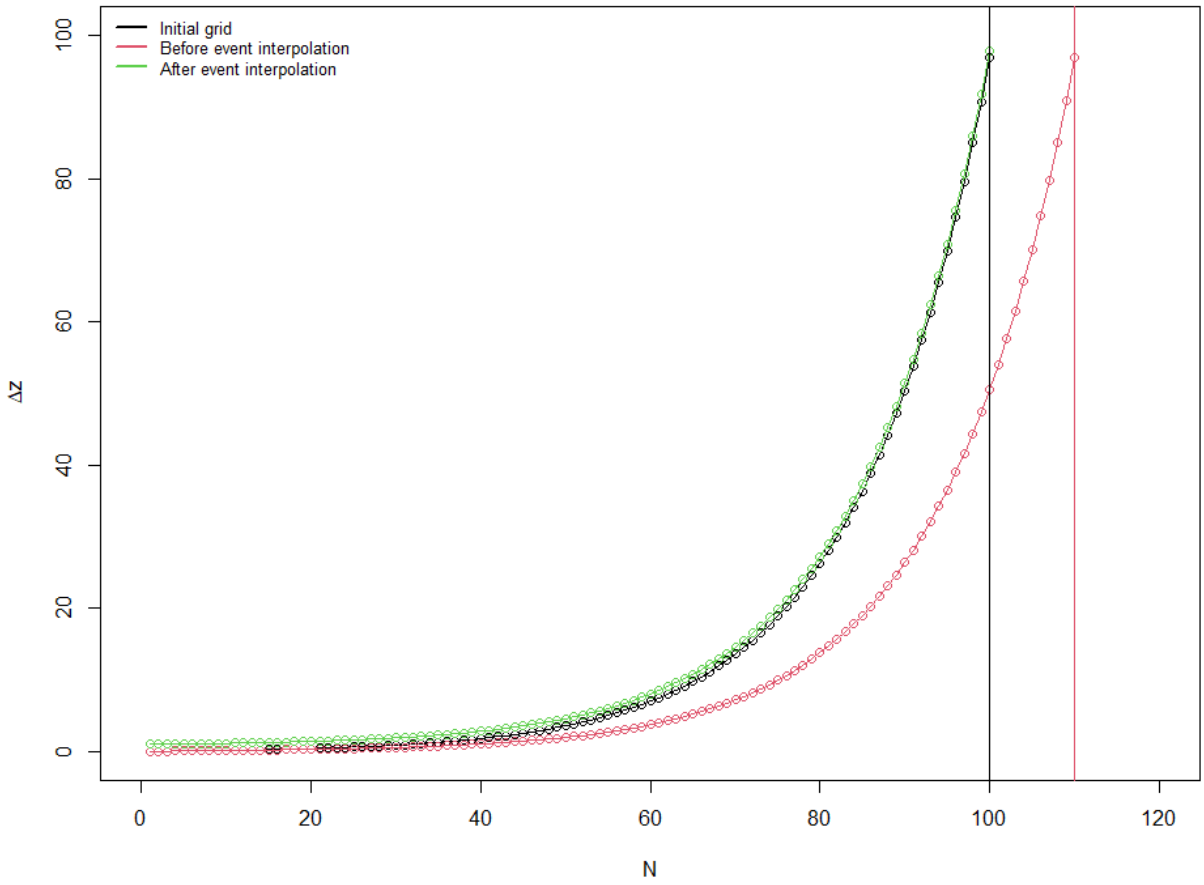

Figure S1: Grid layer in the event routine.