Supplementary Material

Global sensitivity analysis of a one-dimensional ocean biogeochemical model

A: REcoM2 Parameters

This table presents the parameters of the REcoM2 and their symbol, unit and default value.

Table A1: REcoM2 parameters, and their Symbol, unit, default value and probability

SL	Parameter	Symbol	Unit	Value
1	Default temperature	T_{ref}	Kelvin	188.15
2	Chlorophyll-a specific attenuation coefficient	α_{CHL}	$m^{-1}(mgCHL)^{-1}$	0.03
3	Light attenuation coefficient	K_W	m^{-1}	0.04
4	Nanophytoplankton half-saturation for nitrogen uptake	K^N_{Nano}	$mmolNm^{-3}$	0.55
5	Diatom half-saturation for nitrogen uptake	K^N_{Dia}	$mmolNm^{-3}$	1.0
6	Diatom half-saturation for silicate uptake	K^{Si}_{Dia}	$mmolSim^{-3}$	4.0
7	Nanophytoplankton half-saturation for iron uptake	K^{Fe}_{Nano}	$mmolFem^{-3}$	0.02
8	Diatom half-saturation for iron uptake	K^{Fe}_{Dia}	$mmolFem^{-3}$	0.12
9	Nanophytoplankton nitrogen to carbon uptake ratio	σ^N_{Nano}	$molN(molC)^{-1}$	0.20
10	Diatom nitrogen to carbon uptake ratio	σ^N_{Dia}	$molN(molC)^{-1}$	0.20
11	Diatom silicate to carbon uptake ratio	σ^{Si}_{Dia}	$molSi(molC)^{-1}$	0.20
12	Nanophytoplankton maximum nitrogen uptake	V^{Nmax}_{Nano}	dimensionless	0.7
13	Diatom maximum nitrogen uptake	V^{Nmax}_{Dia}	dimensionless	0.7
14	Iron scavenging rate	K^{Scav}_{Fe}	$(mmolCm^{-3})^{-1}$	0.0156
15	Nanophytoplankton initial slope of P-I curve	α_{Nano}	$mmolC(mgChl)^{-1}$	0.14
16	Diatom initial slope of P-I curve	α_{Dia}	$mmolC(mgChl)^{-1}$	0.19
17	Nanophytoplankton maximum photosynthesis rate	μ^{max}_{Nano}	d^{-1}	3.0
18	Diatom maximum photosynthesis rate	μ^{max}_{Nano}	d^{-1}	3.5
19	Redfield ratio of carbon and nitrogen	$q^{C:N}_{Redfield}$	$molC(molN)^{-1}$	6.625
20	Nanophytoplankton iron to nitrogen ratio	$q^{Fe:N}_{Nano}$	$molFe(molN)^{-1}$	0.033
21	Diatom iron to nitrogen ratio	$q^{Fe:N}_{Dia}$	$molFe(molN)^{-1}$	0.033
22	Calcite production ratio	Ψ	dimensionless	0.01
23	Nanophytoplankton minimum cell quota of nitrogen	$q^{N:Cmin}_{Nano}$	$molN(molC)^{-1}$	0.04
24	Nanophytoplankton Maximum cell quota of nitrogen	$q^{N:Cmax}_{Nano}$	$molN(molC)^{-1}$	0.20
25	Diatom minimum cell quota of nitrogen (N:C)	$q^{N:Cmin}_{Dia}$	$molN(molC)^{-1}$	0.04
26	Diatom maximum cell quota of nitrogen (N:C)	$q^{N:Cmax}_{Dia}$	$molN(molC)^{-1}$	0.20
27	Diatom minimum cell quota of silica	$q^{Si:Cmin}_{Dia}$	$molSi(molC)^{-1}$	0.04
28	Diatom maximum cell quota of silica	$q^{Si:Cmax}_{Dia}$	$molSi(molC)^{-1}$	0.80
29	Nanophytoplankton maximum of chl to nitrogen ratio	$q^{CHL:Nmax}_{Nano}$	$mgCHL(mmolN)^{-1}$	3.78
30	Diatom maximum of chl to nitrogen ratio	$q^{CHL:Nmax}_{Dia}$	$gCHL(molN)^{-1}$	4.2
31	Diatom minimum silica to nitrogen ratio	$q^{Si:Nmin}_{Dia}$	$molSi(molN)^{-1}$	0.30
32	Nanophytoplankton maintenance respiration rate	η_{Nano}	d^{-1}	0.01
33	Diatom maintenance respiration rate	η_{Dia}	d^{-1}	0.01

Table A1 (continued)

SL	**Parameter**	**Symbol**	**Unite**	**Value**
34	Nanophytoplankton cost of nitrogen biosynthesis	ζ_{Nano}^{N}	$molC(molN)^{-1}$	2.33
35	Diatom cost of nitrogen biosynthesis	ζ_{Dia}^{N}	$molC(molN)^{-1}$	2.33
36	Diatom cost of silica biosynthesis	ζ_{Dia}^{Si}	$molSi(molN)^{-1}$	0.5
37	Nanophytoplankton chl-a degradation rate	d_{Nano}^{CHL}	d^{-1}	0.1
38	Diatom chl-a degradation rate	d_{Dia}^{CHL}	d^{-1}	0.1
39	Nanophytoplankton excretion rate of carbon	ϵ_{Nano}^{C}	d^{-1}	0.05
40	Diatom excretion rate of carbon	ϵ_{Dia}^{C}	d^{-1}	0.05
41	Nanophytoplankton excretion rate of nitrogen	ϵ_{Nano}^{N}	d^{-1}	0.05
42	Diatom excretion rate of nitrogen	ϵ_{Dia}^{N}	d^{-1}	0.05
43	Maximum grazing rate by zooplankton	ξ	$mmolNm^{-3}d^{-1}$	2.4
44	Grazing efficiency of zooplankton	γ	dimensionless	0.4
45	Half-saturation constant for grazing	ϕ	$(mmolNm^{-3})^{2}$	0.35
46	Phytoplankton specific aggregation rate	φ_{Phy}	$(mmolNm^{-3})^{-1}$	0.015
47	Detritus specific aggregation rate	φ_{Det}	$(mmolNm^{-3})^{-1}$	0.165
48	Time-scale for restoring towards Redfield	K_{het}	d^{-1}	0.01
49	Quadratic mortality rate of zooplankton	m_{het}	$(mmolNm^{-3})^{-1}$	0.05
50	Zooplankton carbon excretion rate	ϵ_{Het}^{C}	d^{-1}	0.15
51	Zooplankton nitrogen excretion rate	ϵ_{Het}^{N}	d^{-1}	0.15
52	PON degradation rate of detritus	ρPON	d^{-1}	0.165
53	POC degradation rate of detritus	ρPOC	d^{-1}	0.15
54	Maximum silicate dissolution rate	ρSi	d^{-1}	0.02
55	Detritus sinking velocity	V_{Det}^{Sink}	d^{-1}	20.0
56	Stickiness for polysaccharides to polysaccharides	φ_{PCHO}	$(mmolCm^{-3})^{-1}$	0.0075
57	Stickiness for TEP to polysaccharides	φ_{TEP}	$(mgm^{-3})^{-1}$	-1.240
58	Total ligand concentration of iron	L_T	$\mu molm^{-3}$	1.0
59	Ligand stability constant of iron	K_FeL	$m^{3}\mu mol^{-1}$	200
60	Dissolved organic nitrogen remineralization rate	ρDON	d^{-1}	0.11
61	Dissolved organic carbon remineralization rate	ρDOC	d^{-1}	0.10
62	Extracellular organic carbon remineralization rate	ρEOC	d^{-1}	0.10
63	Benthos iron to nitrogen ration	$q_{Nano}^{Fe:N}$	$molFe(molN)^{-1}$	0.33
64	Particulate organic carbon degradation rate in sediment	d^{C}	d^{-1}	0.005
65	Particulate organic nitrogen degradation rate in sediment	d^{N}	d^{-1}	0.005
66	Silicate degradation rate in sediment	d^{Si}	d^{-1}	0.005
67	Calcium carbonate degradation rate in sediment	d^{CaCO_3}	d^{-1}	0.005
68	Linear slope of Arrhenius function	Ae	Kelvin	4500

B: First-order Sobol' indices

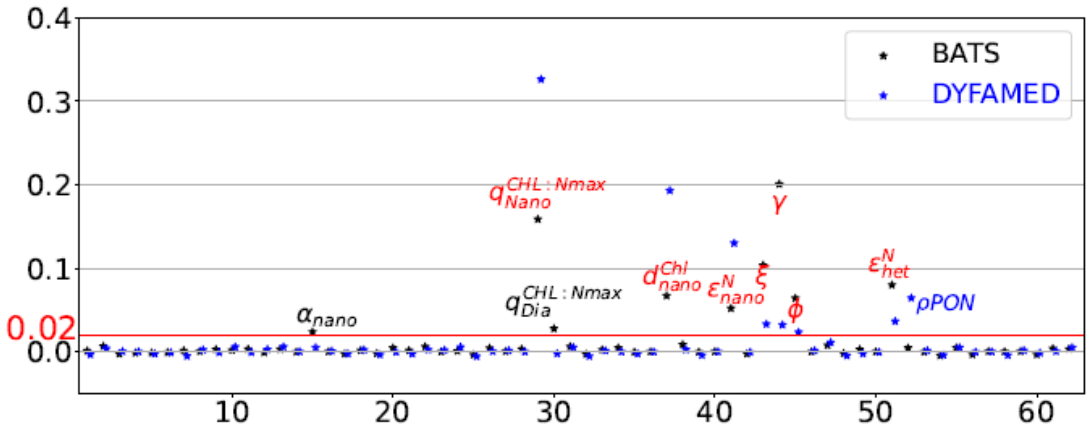


Figure B1: First-order Sobol' indices regarding mean surface total chl-a (SURF_TOTCHL) for all parameters. For parameters which the first-order Sobol' indices are greater than the threshold value at both stations are written in red, at only BATS in black, and at only DYFAMED in blue. For a description of the parameters, see Supplementary Material A. The x-axis labels are the serial no. of parameters in Supplementary Material A.

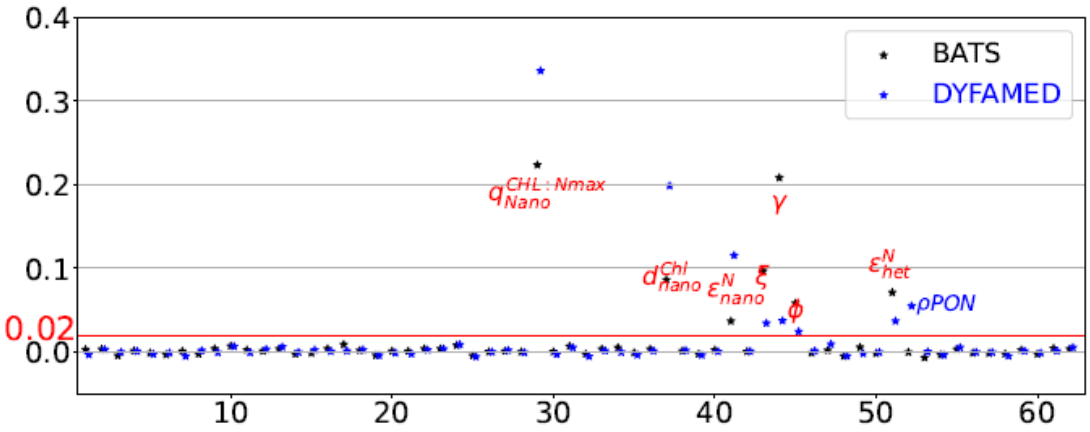


Figure B2: First-order Sobol' indices regarding mean surface nanophytoplankton chl-a (SURF_NANOCHL) for all 63 parameters. The legends and text color are analogous to Figure B1.

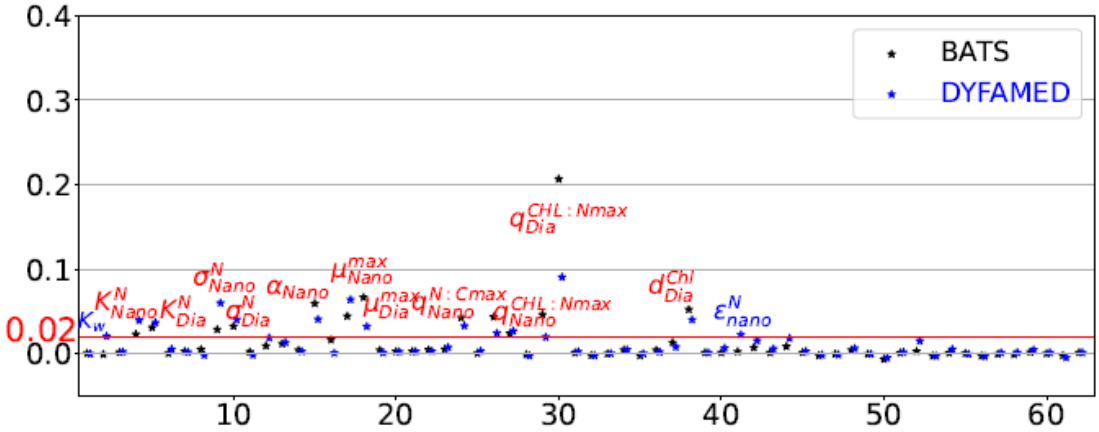


Figure B3: First-order Sobol' indices regarding mean surface diatom chl-a (SURF_DIACHL) for all 63 parameters. The legends and text color are analogous to Figure B1.

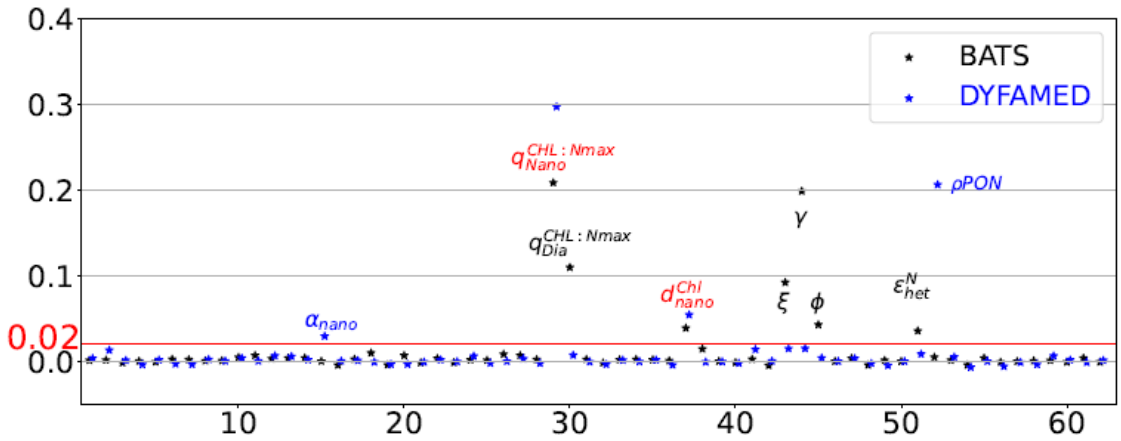


Figure B4: First-order Sobol' indices regarding annual peak surface total chl-a (MBP_TOTCHL) for all 63 parameters. The legends and text color are analogous to Figure B1.

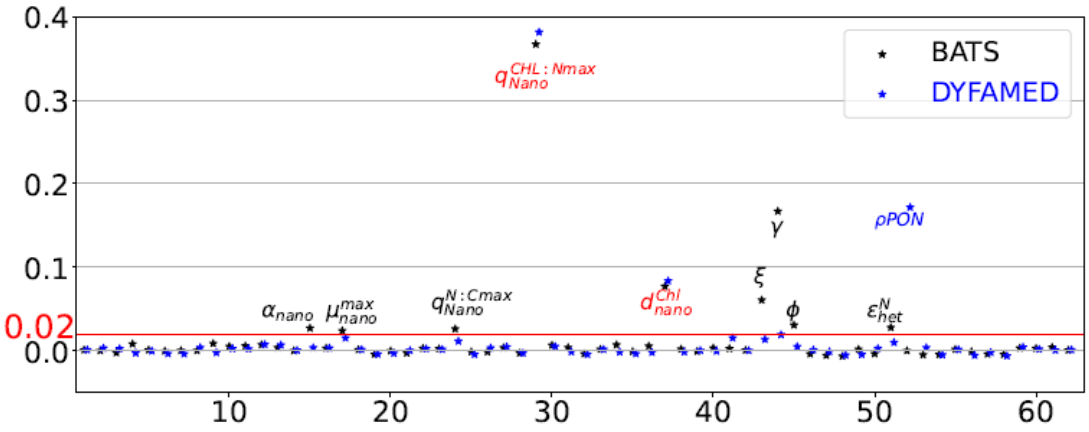


Figure B5: First-order Sobol' indices regarding annual peak surface nanophytoplankton chl-a (MBP_NANOCHL) for all 63 parameters. The legends and text color are analogous to Figure B1.

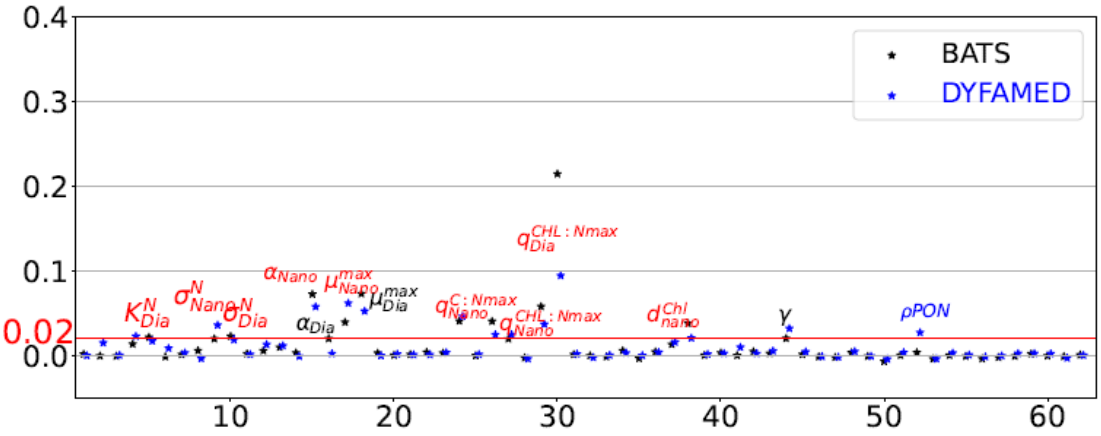


Figure B6: First-order Sobol' indices regarding annual peak surface diatom chl-a (MBP_DIACHL) for all 63 parameters. The legends and text color are analogous to Figure B1.

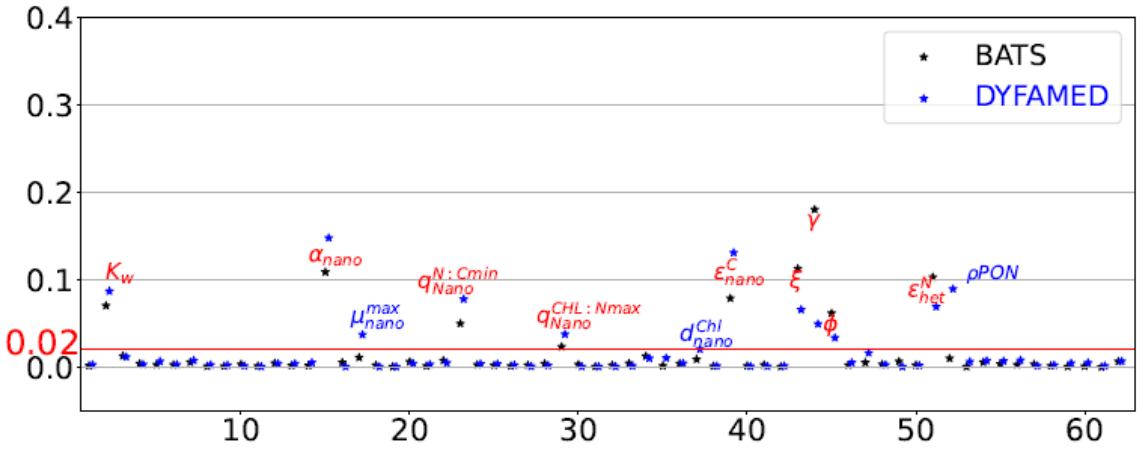


Figure B7: First-order Sobol' indices regarding mean net primary production (TOTNPP) for all 63 parameters. The legends and text color are analogous to Figure B1.

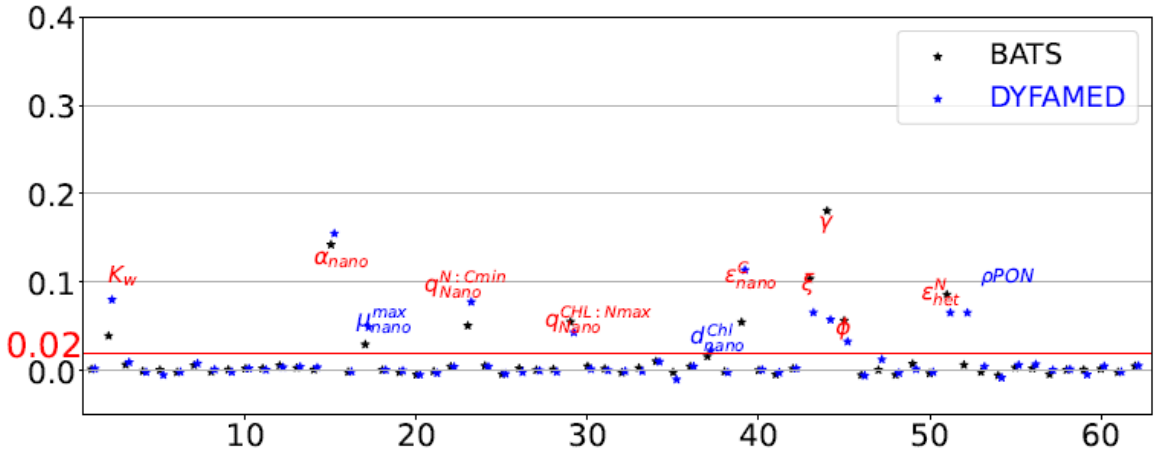
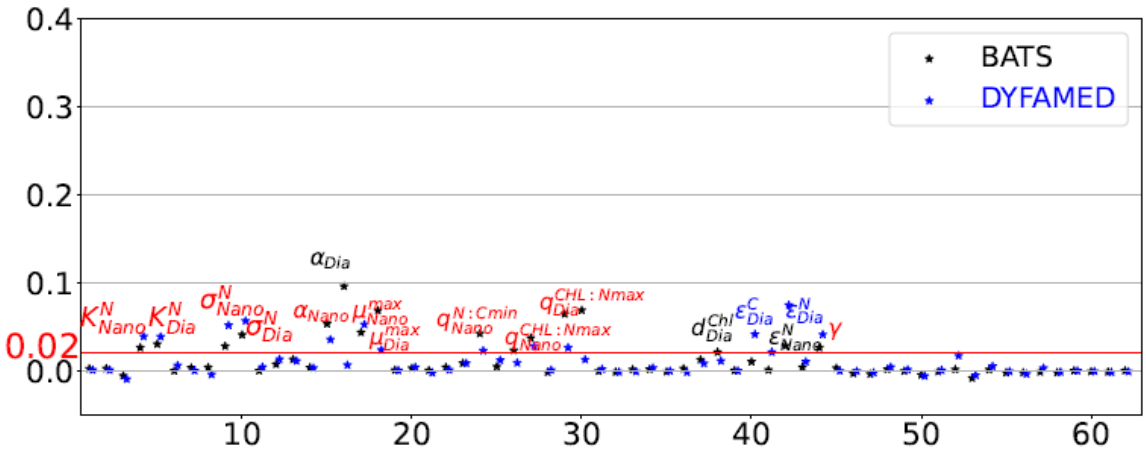


Figure B8: First-order Sobol' indices regarding mean nanophytoplankton npp (NANONPP) for all 63 parameters. The legends and text color are analogous to Figure B1.



FigureB9: First-order Sobol' indices regarding the mean diatom npp (DIANPP) for all 63 parameters. The legends and text color are analogous to Figure B1.

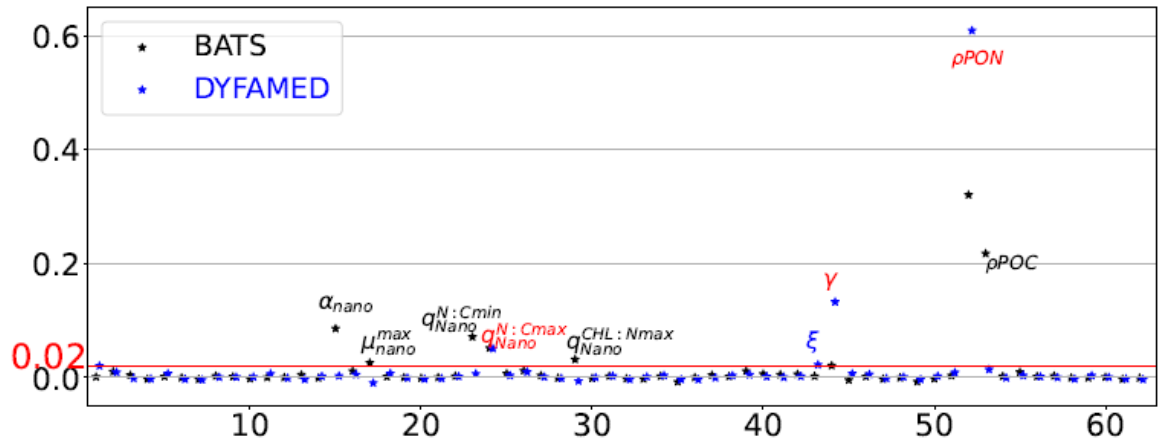


Figure B10: First-order Sobol' indices regarding the mean export production of carbon (EXPORTC) for all 63 parameters. The legends and text color are analogous to Figure B1.

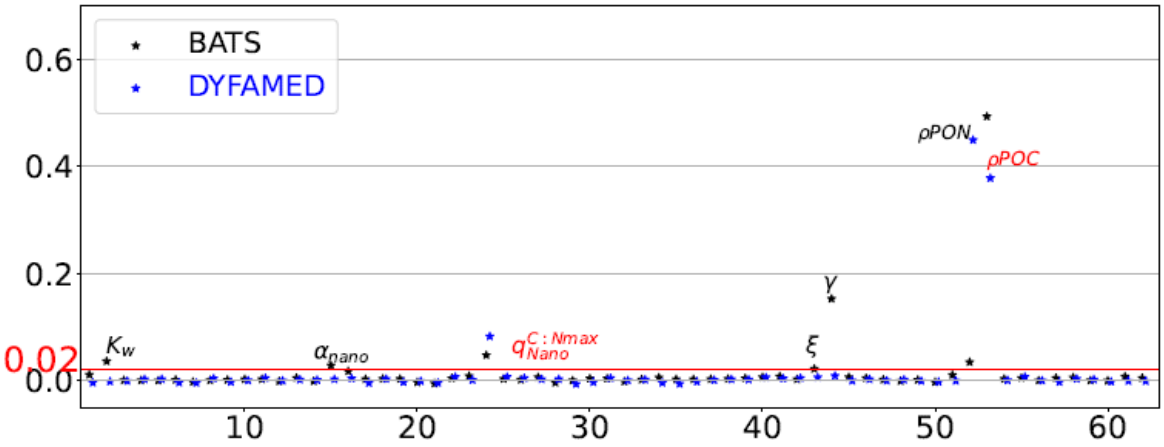


Figure B11: First-order Sobol' indices regarding the mean surface flux of CO2 (CO2Flux) for all 63 parameters. The legends and text color are analogous to Figure B1.

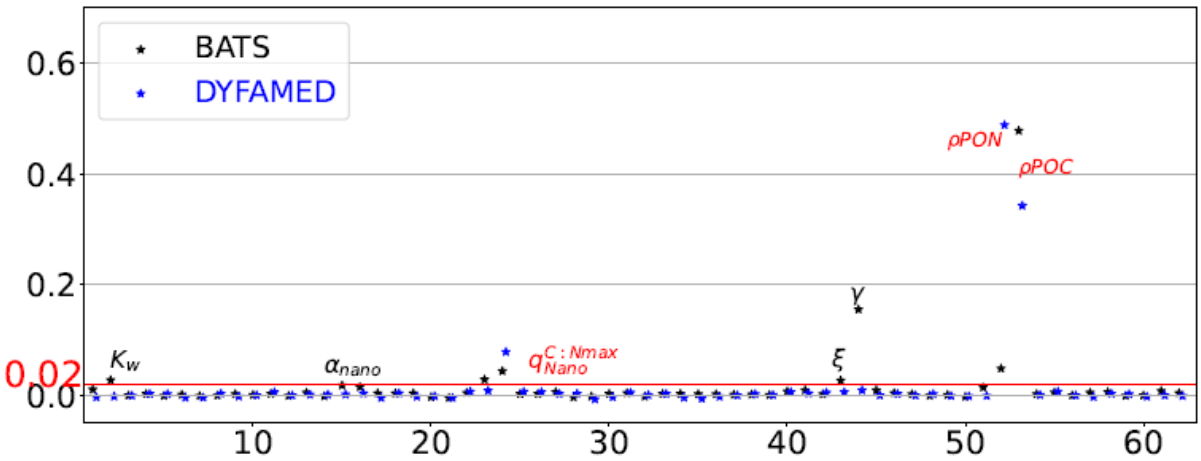


Figure B12: First-order Sobol' indices regarding the mean partial pressure of CO2 (pCO2) for all 63 parameters. The legends and text color are analogous to Figure B1.