

Supporting Information for

Modelling the impacts of marine heatwaves on plankton in the Salish Sea

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Contents of this file

Table S1 to S9

Figures S1 to S7

Table S1. Parameter values for photosynthetic growth of diatoms (DIAT) and nanoflagellates (FLAG) in the SalishSeaCast model v202111. See Olson et al. (2020) for equations and definitions of parameters.

Parameter	Current Value	v201905 Value	Units
μ_{max}^{DIAT}	5.8e-05	5.45e-05	s ⁻¹
μ_{max}^{FLAG}	1.8e-05	1.90e-05	s ⁻¹
Θ_{max}^{DIAT}	26.0	26.0	°C
Θ_{max}^{FLAG}	31.0	31.0	°C
Θ_{range}^{DIAT}	14.0	14.0	°C
Θ_{range}^{FLAG}	13.0	13.0	°C
I_{opt}^{DIAT}	75.0	45.0	W m ⁻²
I_{opt}^{FLAG}	20.0	10.0	W m ⁻²
k_{Si}^{DIAT}	1.2	2.2	μM Si
k_{Si}^{FLAG}	0.0	0.0	μM Si
K^{DIAT}	1.0	1.0	
K^{FLAG}	0.3	0.2	
K_N^{DIAT}	2.0	2.0	μM N
K_N^{FLAG}	0.1	0.2	μM N
$a_{Si:N}^{DIAT}$	1.8	1.8	μM Si (μM N)
$a_{Si:N}^{FLAG}$	0.0	0.0	μM Si (μM N)

Table S2. Parameter values for grazing by the Z1 zooplankton class in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
ν_{max}^{Z1}	2.289e-05	2.48e-05	s ⁻¹
α^{Z1}	0.2	0.2	μM N
K^{Z1}	1.25	1.25	μM N
ρ_{DIAT}^{Z1}	0.26	0.27	
ρ_{FLAG}^{Z1}	0.3	0.295	
ρ_{PON}^{Z1}	0.09	0.09	
ρ_{Z1}^{Z1}	0.18	0.18	
α_{DIAT}^{Z1}	0.3	0.1	μM N
α_{FLAG}^{Z1}	0.1	0.05	μM N
α_{PON}^{Z1}	0.6	0.5	μM N
α_{Z1}^{Z1}	0.3	0.2	μM N
K_{DIAT}^{Z1}	1.0	1.0	μM N
K_{FLAG}^{Z1}	1.0	1.0	μM N
K_{PON}^{Z1}	2.0	2.0	μM N
K_{Z1}^{Z1}	0.5	0.5	μM N
ε^{Z1}	0.6	0.6	

Table S3. Parameter values for grazing by the Z2 zooplankton class in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
ν_{max}^{Z2}	1.54e-05	1.37e-05	s ⁻¹
α^{Z2}	0.5	0.2	μM N
K^{Z2}	1.0	1.0	μM N
ρ_{DIAT}^{Z2}	0.285	0.28	
ρ_{FLAG}^{Z2}	0.1	0.105	
ρ_{PON}^{Z2}	0.15	0.15	
ρ_{Z1}^{Z2}	0.285	0.28	
α_{DIAT}^{Z2}	0.0	0.0	μM N
α_{FLAG}^{Z2}	0.05	0.0	μM N
α_{PON}^{Z2}	0.0	0.0	μM N
α_{Z1}^{Z2}	0.5	0.2	μM N
K_{DIAT}^{Z2}	0.2	0.3	μM N
K_{FLAG}^{Z2}	0.4	0.4	μM N
K_{PON}^{Z2}	0.4	0.4	μM N
K_{Z1}^{Z2}	1.2	1.2	μM N
ε^{Z2}	0.0	0.0	

Table S4. Parameter values for the Z2 zooplankton class in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
Y_w	0.41	0.38	$\mu\text{M N}$
$[Y_1, Y_2, Y_3]$	[0.50, 0.57, 0.35]	[0.55, 0.55, 0.36]	$\mu\text{M N}$
$[\sigma_1, \sigma_2, \sigma_3]$	[35, 65, 44]	[40, 70, 43]	days
$[t_{01}, t_{02}, t_{03}]$	[140, 208, 296]	[130, 206, 290]	year day

Table S5. Parameter values for mortality and excretion/egestion in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
m_{DIAT}	0.0667e-05	0.060e-05	s ⁻¹
m_{FLAG}	0.0489e-05	0.044e-05	s ⁻¹
m_{Z1}	0.556e-06	0.5e-06	s ⁻¹
m_{Z2}	0.0	0.0	s ⁻¹
e_{Z1}	0.556e-07	5.0e-07	s ⁻¹
e_{Z2}	0.0	0.0	s ⁻¹

Table S6. Parameter values for remineralization in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
$b_{\text{NH}}^{\text{NO}}$	4.44e-07	4.0e-07	$\text{s}^{-1} (\mu\text{M N})^{-1}$
$b_{\text{DON}}^{\text{NH}}$	2.56e-07	2.3e-06	s^{-1}
$b_{\text{PON}}^{\text{NH}}$	2.56e-07	2.3e-06	s^{-1}
$b_{\text{bsi}}^{\text{dSi}}$	1.221e-06	1.1e-06	s^{-1}

Table S7. Parameter values for optical model in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
γ	0.091	0.091	m^{-1}
β	0.0433	0.0433	m^{-1}
λ	0.445	0.445	m^{-1}
δ	2.56	2.56	m
$\alpha_{\text{Chl:N}}$	2.0	2.0	g Chl (mol N) ⁻¹

Table S8. Parameter values for sinking and bottom boundary condition in the SalishSeaCast model v202111.

Parameter	Current Value	v201905 Value	Units
ω_{smin}^{DIAT}	5.8e-06 [0.5]	5.8e-06 [0.5]	m s ⁻¹ [m d ⁻¹]
ω_{smax}^{DIAT}	1.4e-05 [1.2]	1.4e-05 [1.2]	m s ⁻¹ [m d ⁻¹]
ω_s^{PON}	1.0e-04 [8.64]	1.0e-04 [8.64]	m s ⁻¹ [m d ⁻¹]
ω_s^{bSi}	2.5e-04 [21.6]	2.8e-04 [24.2]	m s ⁻¹ [m d ⁻¹]
α_s^{Si}	0.92	0.92	
α_s^N	0.45	0.45	

Table S9. Parameter values for detrital transfer coefficients, $X_{j \rightarrow k}^i$, in the SalishSeaCast model v202111.

$j \rightarrow k$	Current Value				v201905 Value			
	$i=\text{NH}_4^+$	$i=\text{DON}$	$i=\text{PON}$	$i=\text{bSi}$	$i=\text{NH}_4^+$	$i=\text{DON}$	$i=\text{PON}$	$i=\text{bSi}$
$DIAT \rightarrow Z1$	0.05	0.47	0.47	1.0	0.05	0.47	0.47	1.0
$FLAG \rightarrow Z1$	0.05	0.47	0.47	1.0	0.05	0.47	0.47	1.0
$Z1 \rightarrow Z1$	0.05	0.47	0.47	-	0.05	0.47	0.47	-
$PON \rightarrow Z1$	0.0	0.0	1.0	-	0.0	0.0	1.0	-
$Z1 \rightarrow MORT$	0.05	0.47	0.47	-	0.05	0.47	0.47	-
$Z1 \rightarrow EXCR$	0.25	0.25	0.5	-	0.25	0.25	0.5	-
$DIAT \rightarrow Z2$	0.05	0.47	0.47	1.0	0.05	0.47	0.47	1.0
$FLAG \rightarrow Z2$	0.05	0.47	0.47	1.0	0.05	0.47	0.47	1.0
$Z1 \rightarrow Z2$	0.05	0.47	0.47	-	0.05	0.47	0.47	-
$PON \rightarrow Z2$	0.0	0.0	1.0	-	0.0	0.0	1.0	-
$Z2 \rightarrow MORT$	0.05	0.47	0.47	-	0.05	0.47	0.47	-
$Z2 \rightarrow EXCR$	0.25	0.25	0.5	-	0.25	0.25	0.5	-

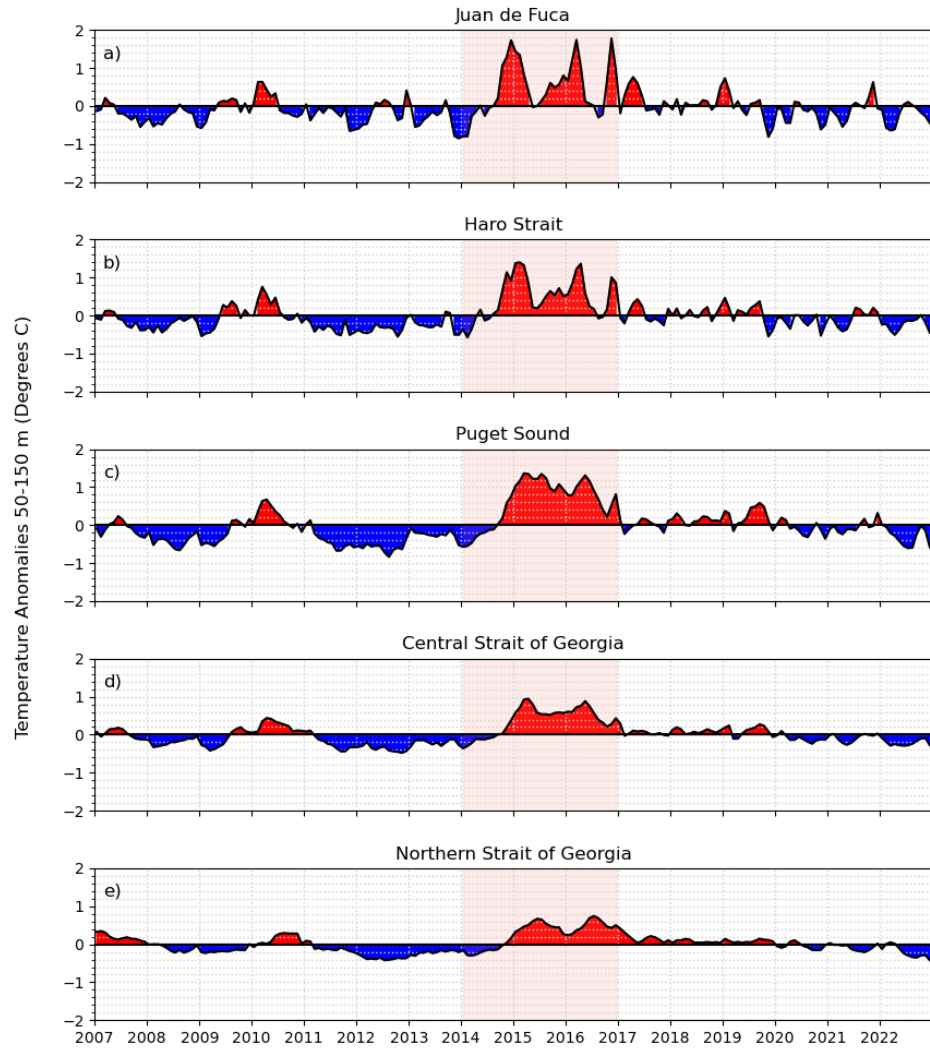


Figure S1. Mean model-based 50-150 m temperature anomalies in the different sub-regions of the Salish Sea from 2007 to 2022.

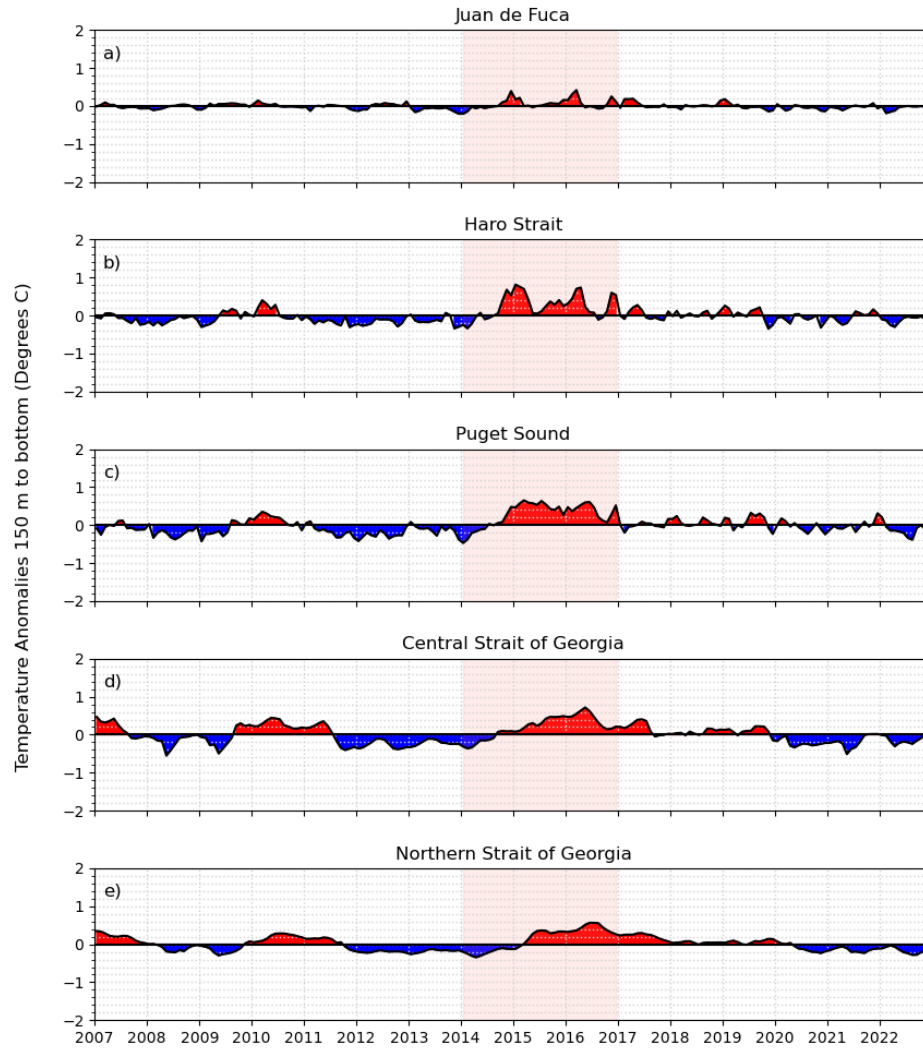


Figure S2. Mean model-based 150 m to bottom temperature anomalies in the different sub-regions of the Salish Sea from 2007 to 2022.

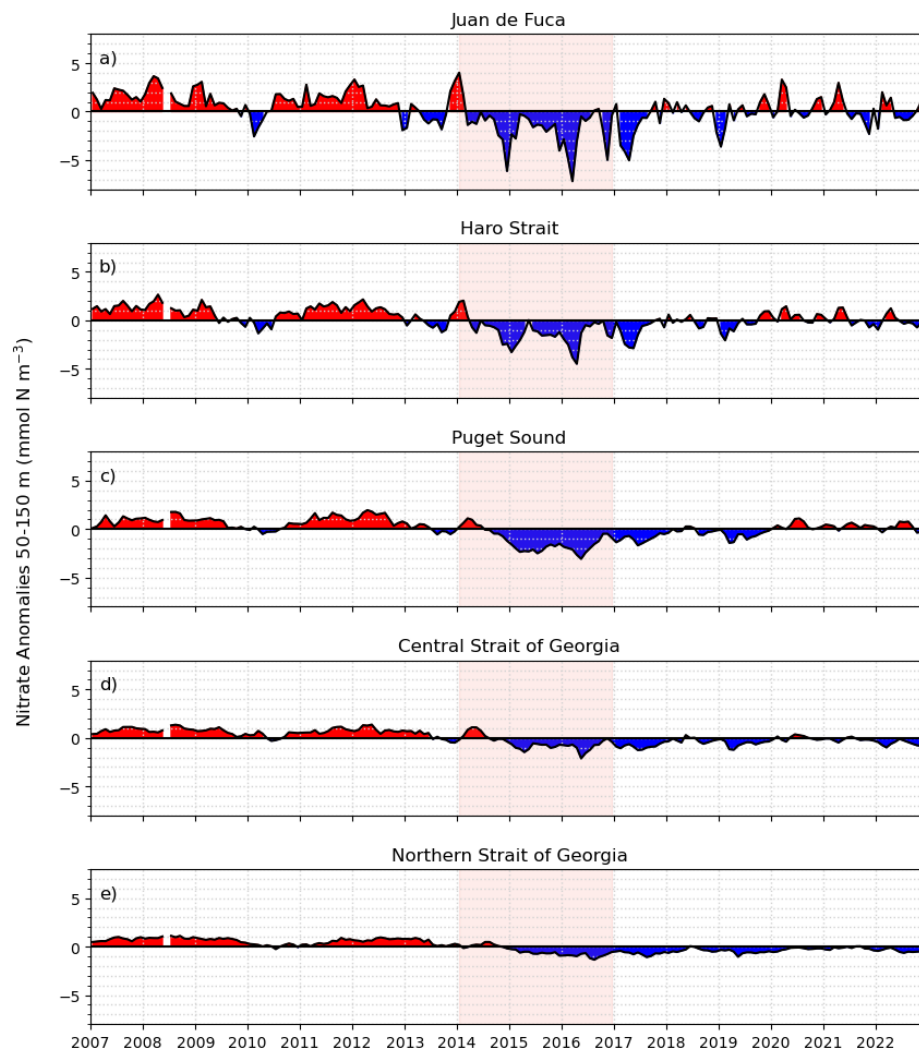


Figure S3. Mean model-based 50-150 m nitrate anomalies in the different sub-regions of the Salish Sea from 2007 to 2022.

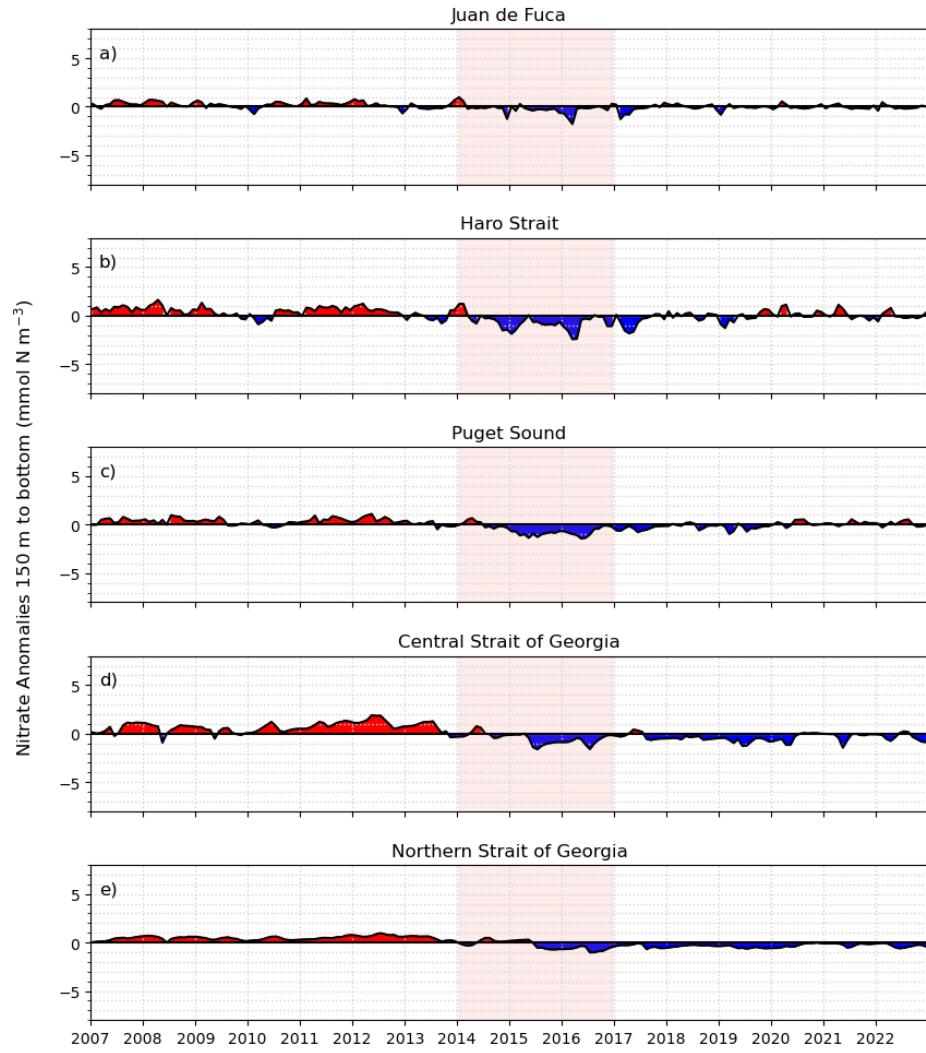


Figure S4. Mean model-based 150 m to bottom nitrate anomalies in the different sub-regions of the Salish Sea from 2007 to 2022.

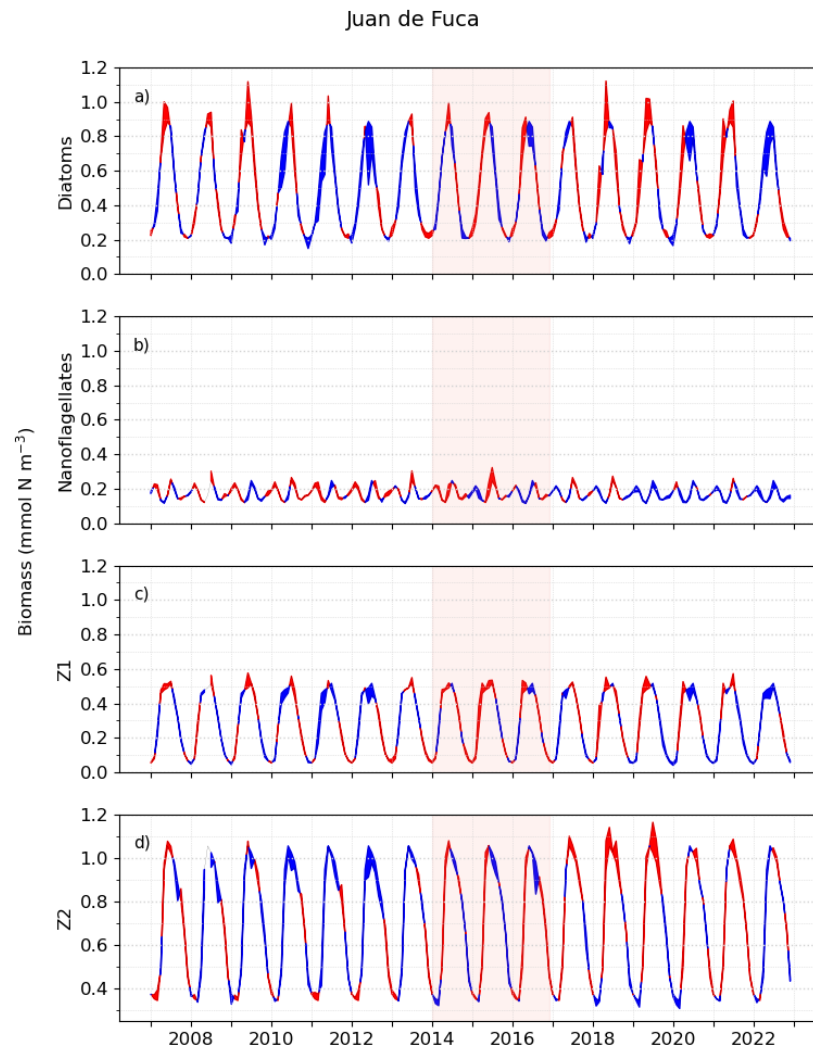


Figure S5. Monthly model-based 0-50 m biological parameters (diatoms, nanoflagellates, Z1, and Z2 zooplankton) compared to interannual mean in the Juan de Fuca region from 2007 to 2022. Positive differences are in red; negative differences in blue.

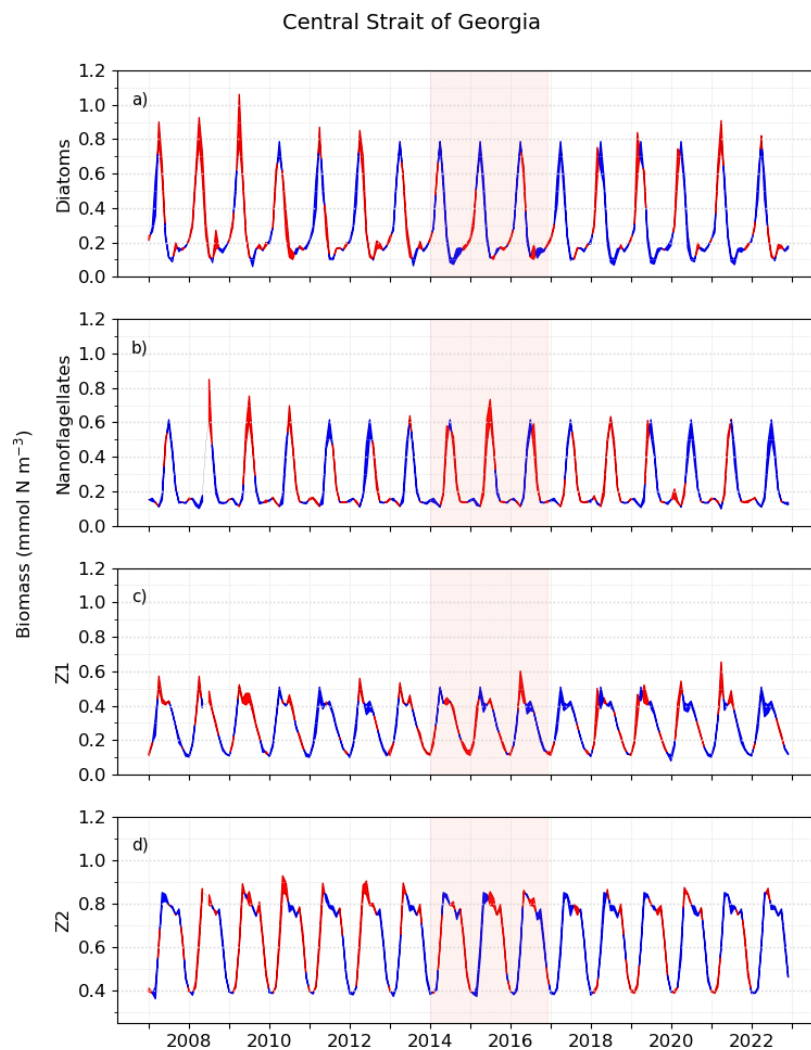


Figure S6. Monthly model-based 0-50 m biological parameters (diatoms, nanoflagellates, Z1, and Z2 zooplankton) compared to interannual mean in the Central Strait of Georgia region from 2007 to 2022. Positive differences are in red; negative differences in blue.

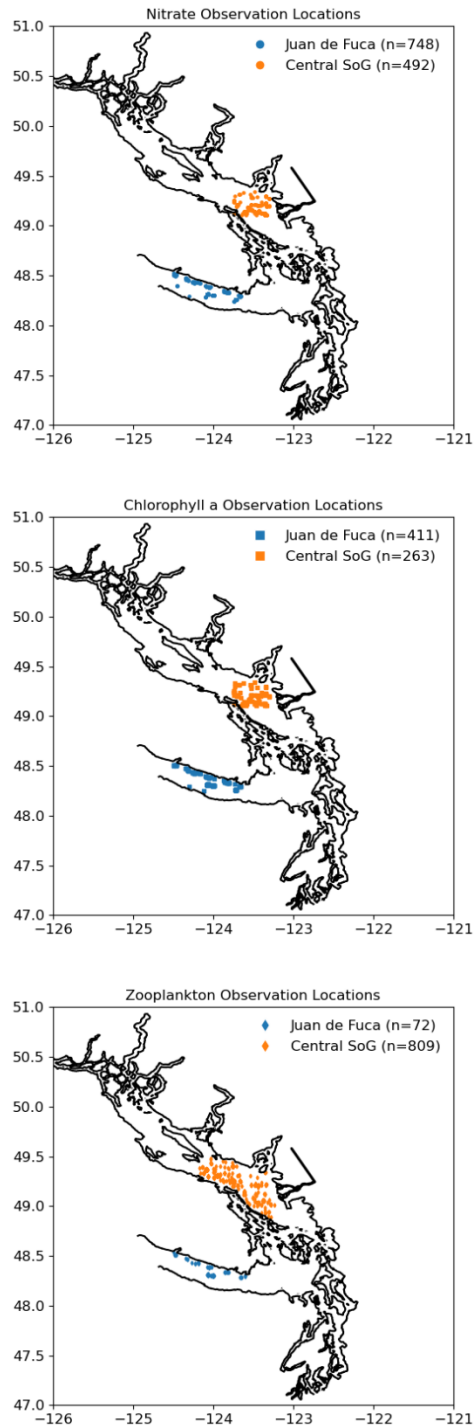


Figure S7. Observation sampling locations for nitrate, chlorophyll a, and zooplankton in the Juan de Fuca and Central Strait of Georgia regions for comparison with model output.