

# The dimethylsulfide cycle in the eutrophied Southern North Sea: a model study integrating phytoplankton and bacterial processes

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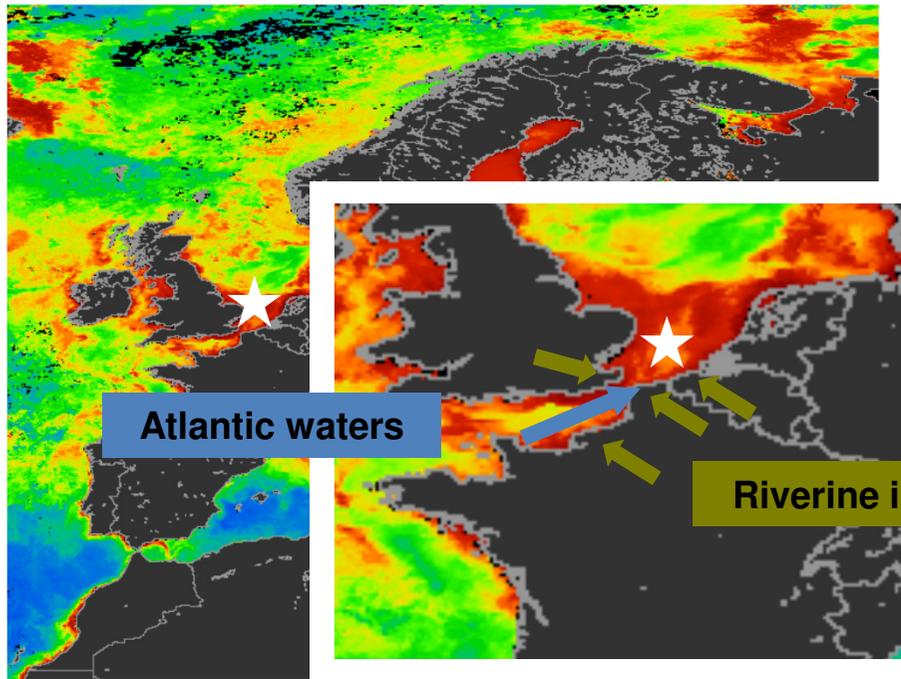
<sup>2</sup> Université de Liège, Belgium

**Objective:** To investigate the link between ecosystem structure and DMS emission

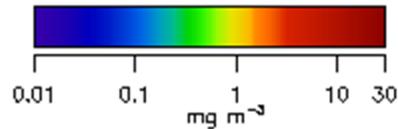
- What is the **seasonal** variability of DMS emissions? What is the importance of **phytoplankton succession** on DMSP production and DMS emission?
- What is the relative importance of **phytoplankton and bacterial processes** on DMS emission?
- What is the **impact of anthropogenic pressure** (C and nutrient river loads, atmospheric CO<sub>2</sub> increase) on DMS emission?

**Methodology:** MIRO-DMS model applied to the Southern North Sea

# The Southern Bight of the North Sea

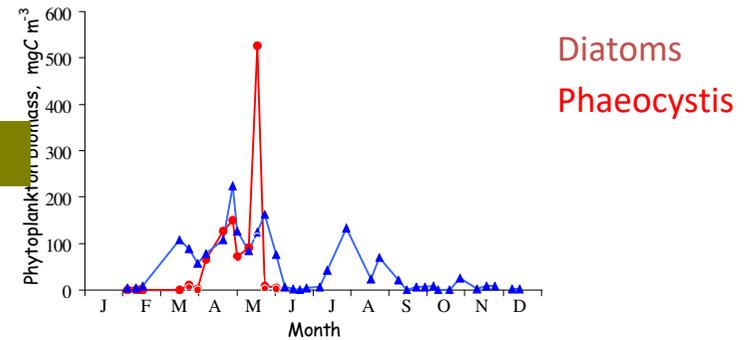


Chl a in 2005 May

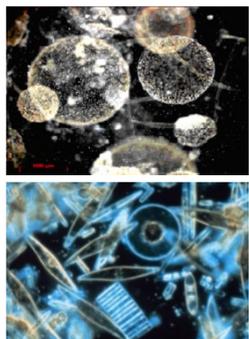


Source:  
ECOMAR  
GEM-IES

- ✓ High nutrients loads
- ✓ Eutrophied area
- ✓ High primary production



→ Ecosystem disturbance

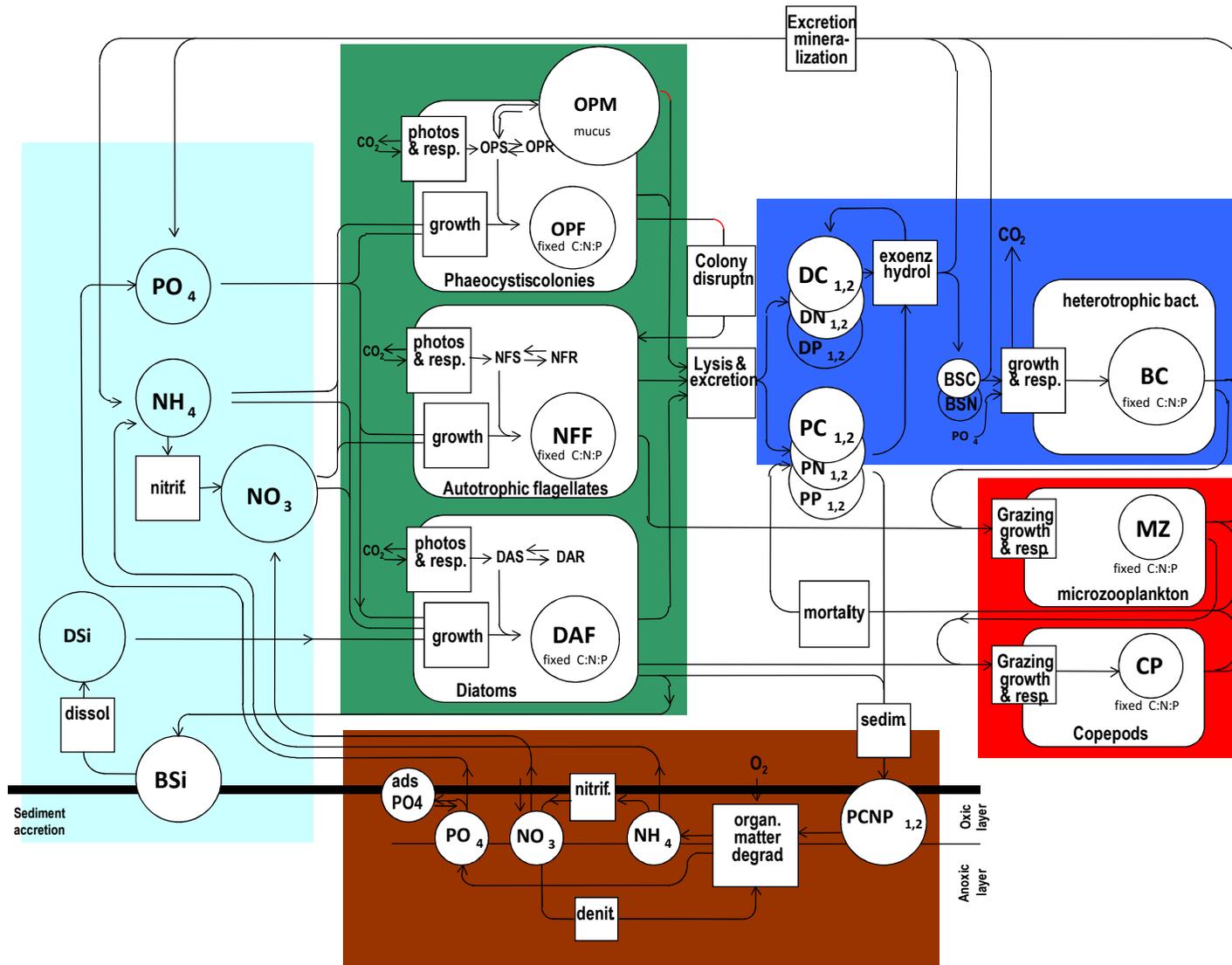


→ *Phaeocystis* (Haptophyceae)  
High DMSP producers

→ Diatoms  
Low DMSP producers

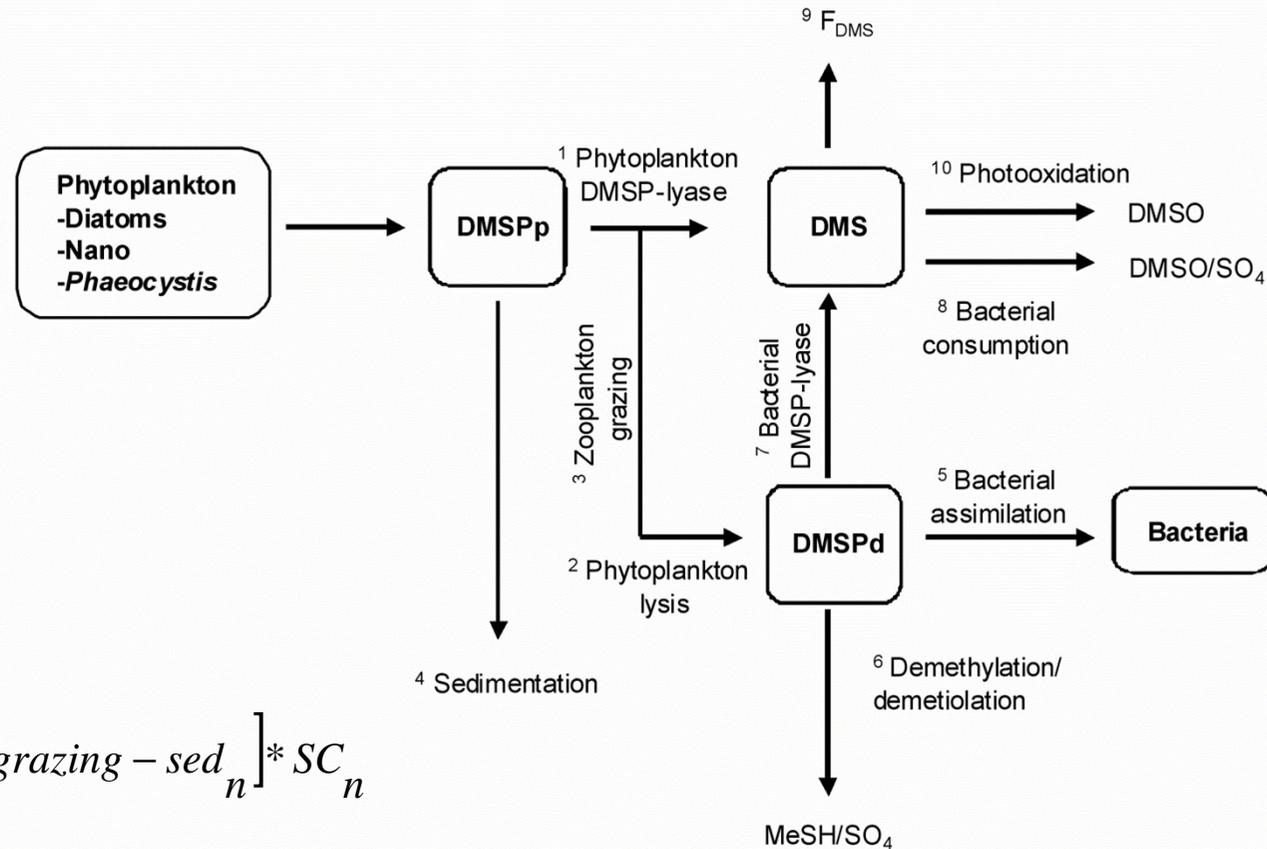


# Mathematical tool: the MIRO model



Lancelot et al., 2005

Gypens et al., 2014

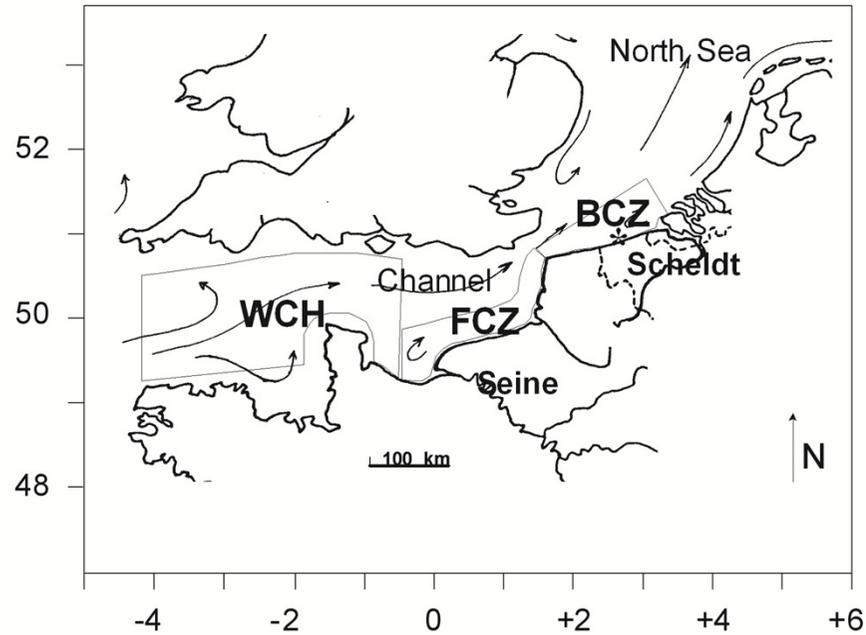


For  $n=DA, NF$  and  $OP$

$$\frac{dDMSPp}{dt} = [\mu_n - lysis_n - grazing - sed_n] * SC_n$$

$$\frac{dDMSPd}{dt} = (1 - y_{DMS}^n) * lysis_n * SC_n + grazing * SC_n - DMSPd_{uptake}$$

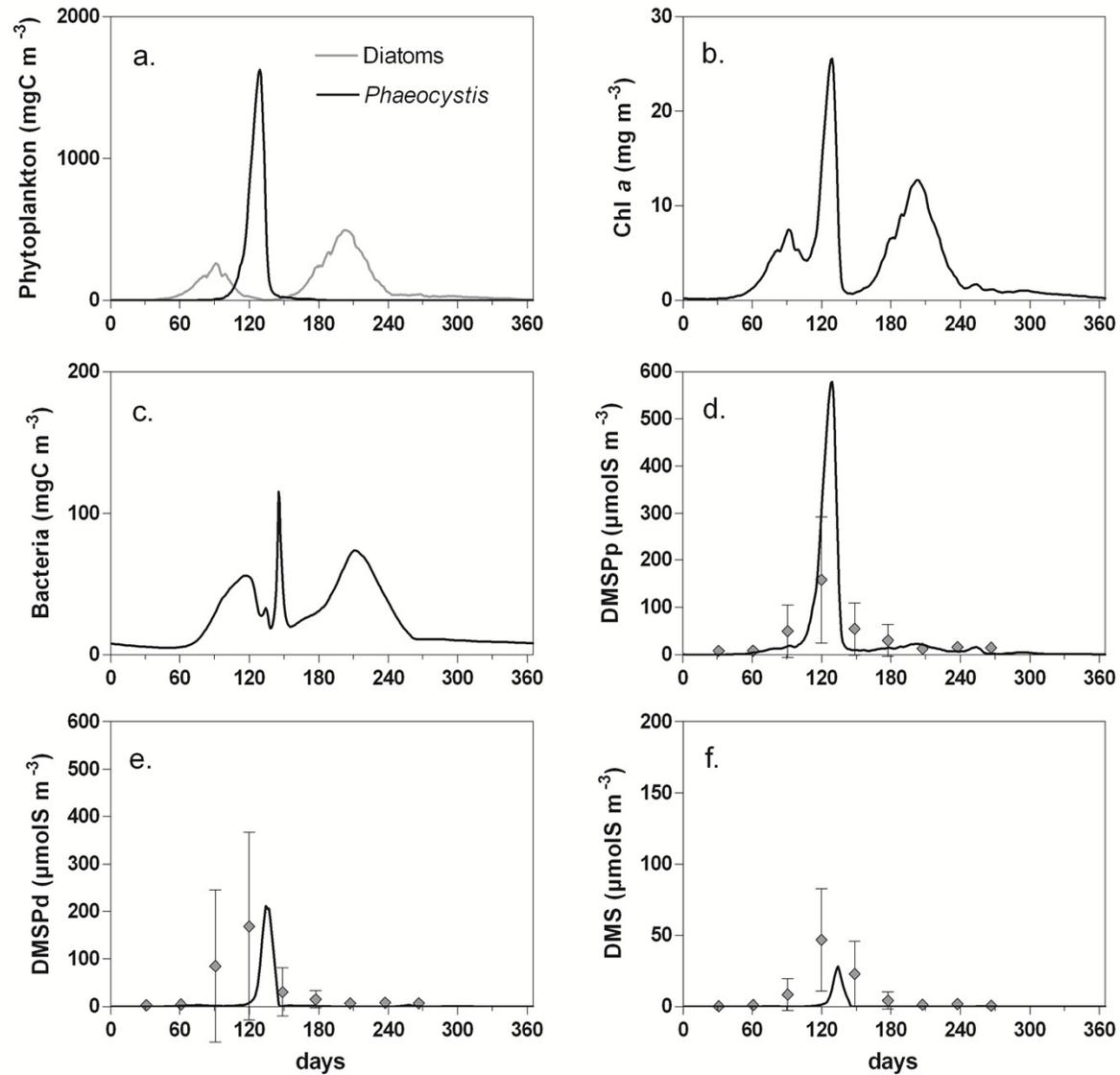
$$\frac{dDMS}{dt} = y_{DMS}^n * lysis_n * SC_n + bacterial\_hydrolysis - DMS_{uptake} - photooxydation - F_{DMS}$$



Seasonal cycle: METTRE CONDITIONS DE SIMULATION

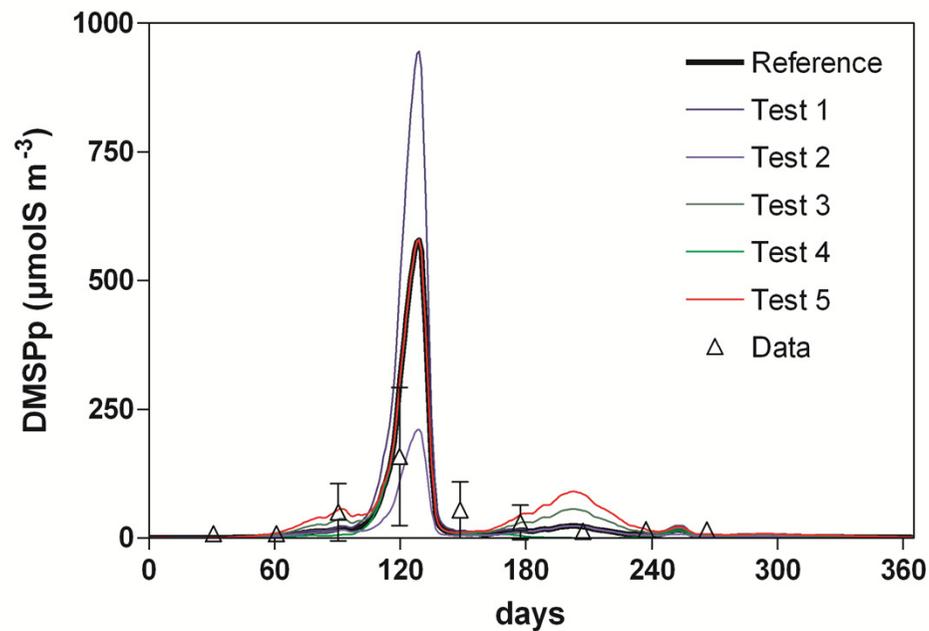
Long-term simulation: METTRE CONDITIONS DE SIMULATION

# The DMS(P) seasonal evolution

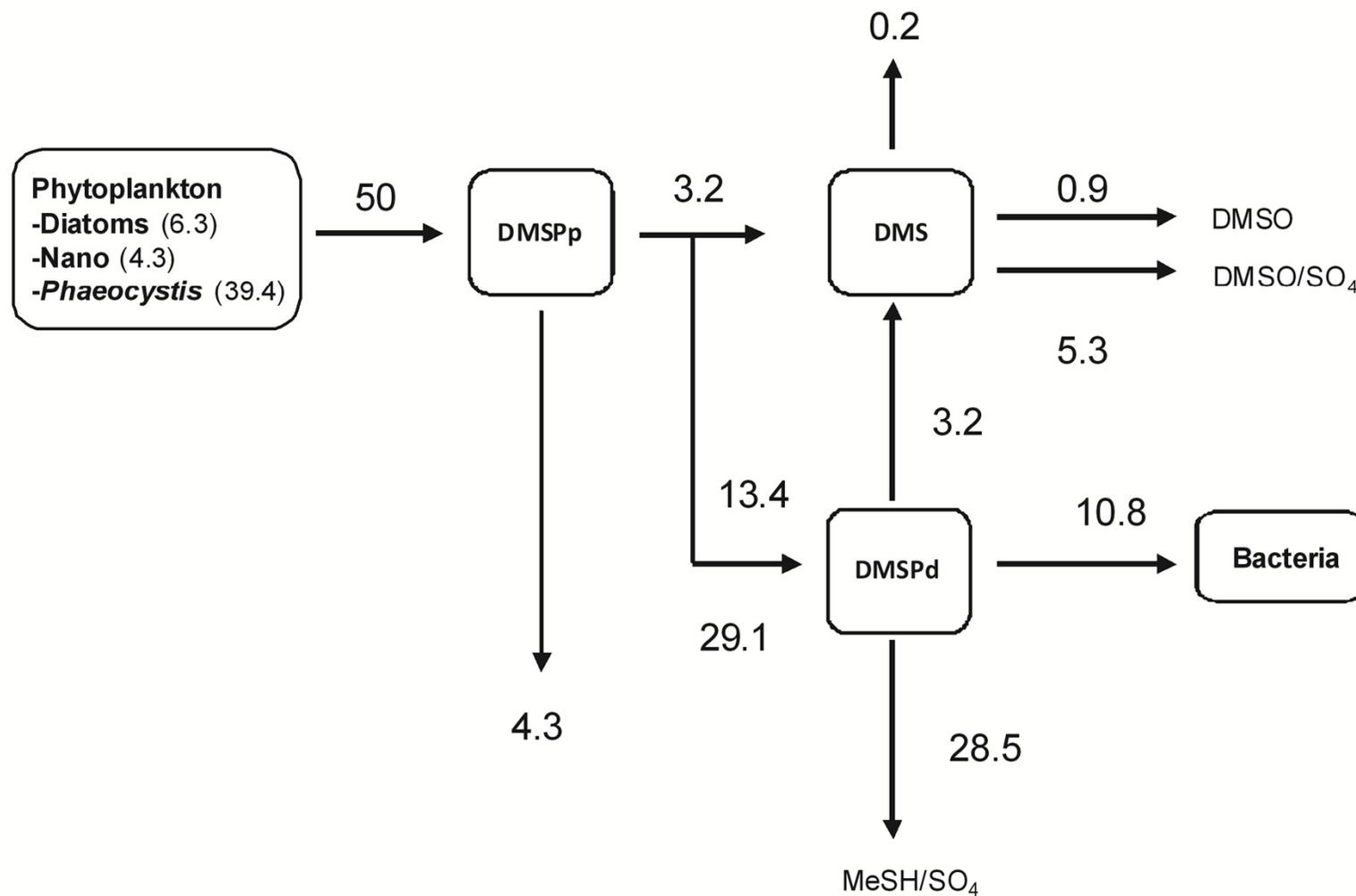


## Sensitivity to phytoplankton DMSP:C content

	Parameters	Units	Values	Annual mean [DMS] ( $\mu\text{molS m}^{-3}$ )	$F_{\text{DMS}}$ ( $\text{mmolS m}^{-2} \text{y}^{-1}$ )
<b>REFERENCE</b>				<b>0.9</b>	<b>0.19</b>
Test 1	$SC_{\text{NF}}, SC_{\text{OP}}$	mol S:molC	0.018	1.5	0.32
Test 2	$SC_{\text{NF}}, SC_{\text{OP}}$	mol S:molC	0.004	0.3	0.07
Test 3	$SC_{\text{DA}}$	mol S:molC	0.00212	0.9	0.21
Test 4	$SC_{\text{DA}}$	mol S:molC	0	0.8	0.18
Test 5	$SC_{\text{DA}}$	mol S:molC	0.0034	1.0	0.23



# Phytoplankton vs bacterial processes

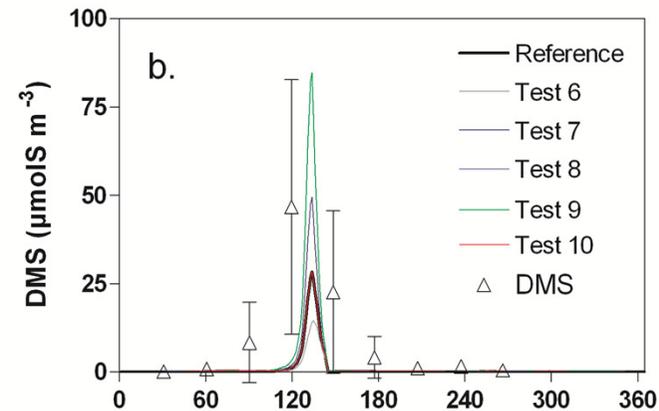
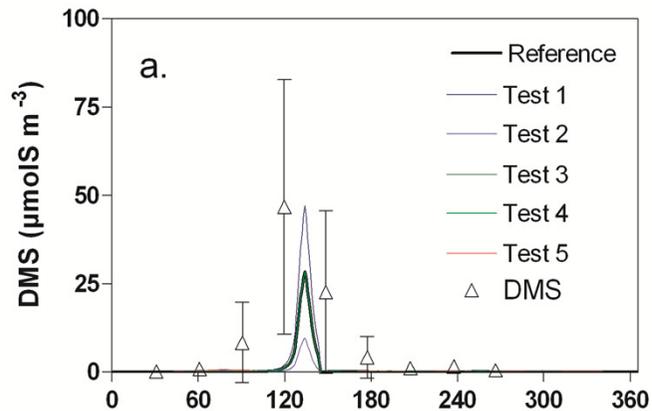


## Sensitivity to phytoplankton, bacterial and physical parameters

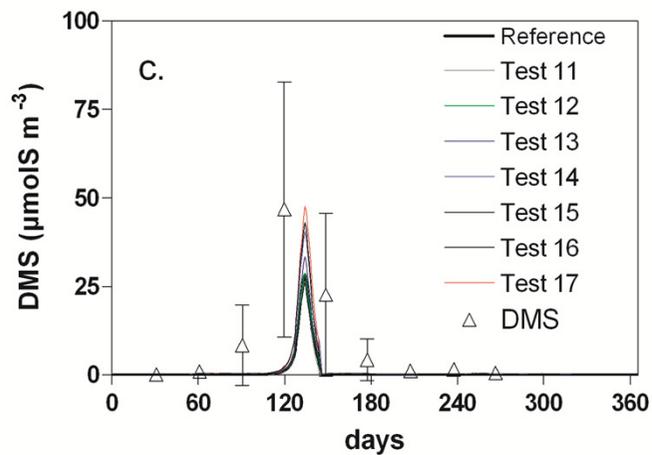
	Parameters	Units	Values	Annual mean [DMS] ( $\mu\text{molS m}^{-3}$ )	$F_{\text{DMS}}$ ( $\text{mmolS m}^{-2} \text{y}^{-1}$ )
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				<b>0.9</b>	<b>0.19</b>
<b>Sensitivity to phytoplankton parameters</b>					
Test 1	$SC_{\text{NF}}, SC_{\text{OP}}$	mol S:molC	0.018	1.5	0.32
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Test 4	$SC_{\text{DA}}$	mol S:molC	0	0.8	0.18
Test 5	$SC_{\text{DA}}$	mol S:molC	0.0034	1.0	0.23
Test 6	$y_{\text{DMS}}^{\text{DA}}, y_{\text{DMS}}^{\text{NF}}, y_{\text{DMS}}^{\text{OP}}$	-	0	0.5	0.11
Test 7	$y_{\text{DMS}}^{\text{DA}}, y_{\text{DMS}}^{\text{NF}}, y_{\text{DMS}}^{\text{OP}}$	-	0.25	1.4	0.32
Test 8	$y_{\text{DMS}}^{\text{DA}}, y_{\text{DMS}}^{\text{NF}}, y_{\text{DMS}}^{\text{OP}}$	-	0.5	2.4	0.53
Test 9	$y_{\text{DMS}}^{\text{NF}}, y_{\text{DMS}}^{\text{OP}}$	-	0.5	2.3	0.51
Test 10	$y_{\text{DMS}}^{\text{DA}}$	-	0.5	0.9	0.21
<b>Sensitivity to bacteria parameters</b>					
Test 11	$SC_{\text{BC}}$	mol S:molC	1:37	0.8	0.17
Test 12	$SC_{\text{BC}}$	mol S:molC	1:196	0.9	0.2
Test 13	$\text{Ratio}_{\text{BC}}$	-	0.75	1.1	0.24
Test 14	$\text{Ratio}_{\text{BC}}$	-	0.5	1.4	0.32
Test 15	$\text{Ratio}_{\text{BC}}$ for DMSPd	-	0.5	0.9	0.2
Test 16	$\text{Ratio}_{\text{BC}}$ for DMS	-	0.5	1.4	0.32
Test 17	hydrolysis	-	0.25	1.6	0.35
<b>Sensitivity to wind speed and k parameterization</b>					
Test 18	wind forcing	$\text{m s}^{-1}$	3.9	0.9	0.24
Test 19	wind forcing	$\text{m s}^{-1}$	-25%	0.9	0.13
Test 20	wind forcing	$\text{m s}^{-1}$	+ 25%	0.9	0.26
Test 21	k parameterization	$\text{cm h}^{-1}$	Nightingale et al., 2002	0.9	0.19

## Sensitivity to phytoplankton, bacterial and physical parameters

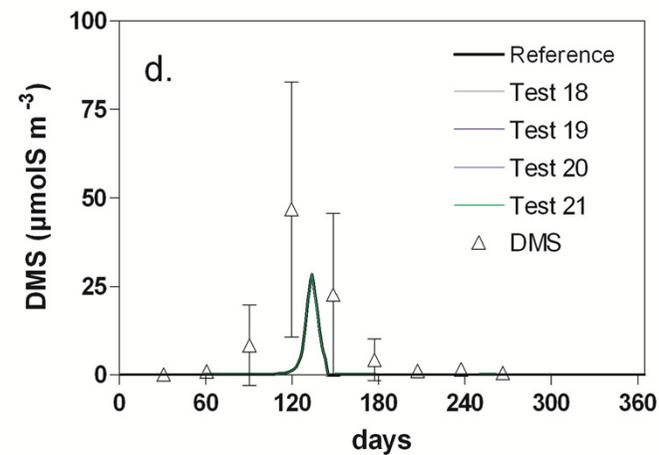
### Phytoplankton parameters



### Bacterial parameters

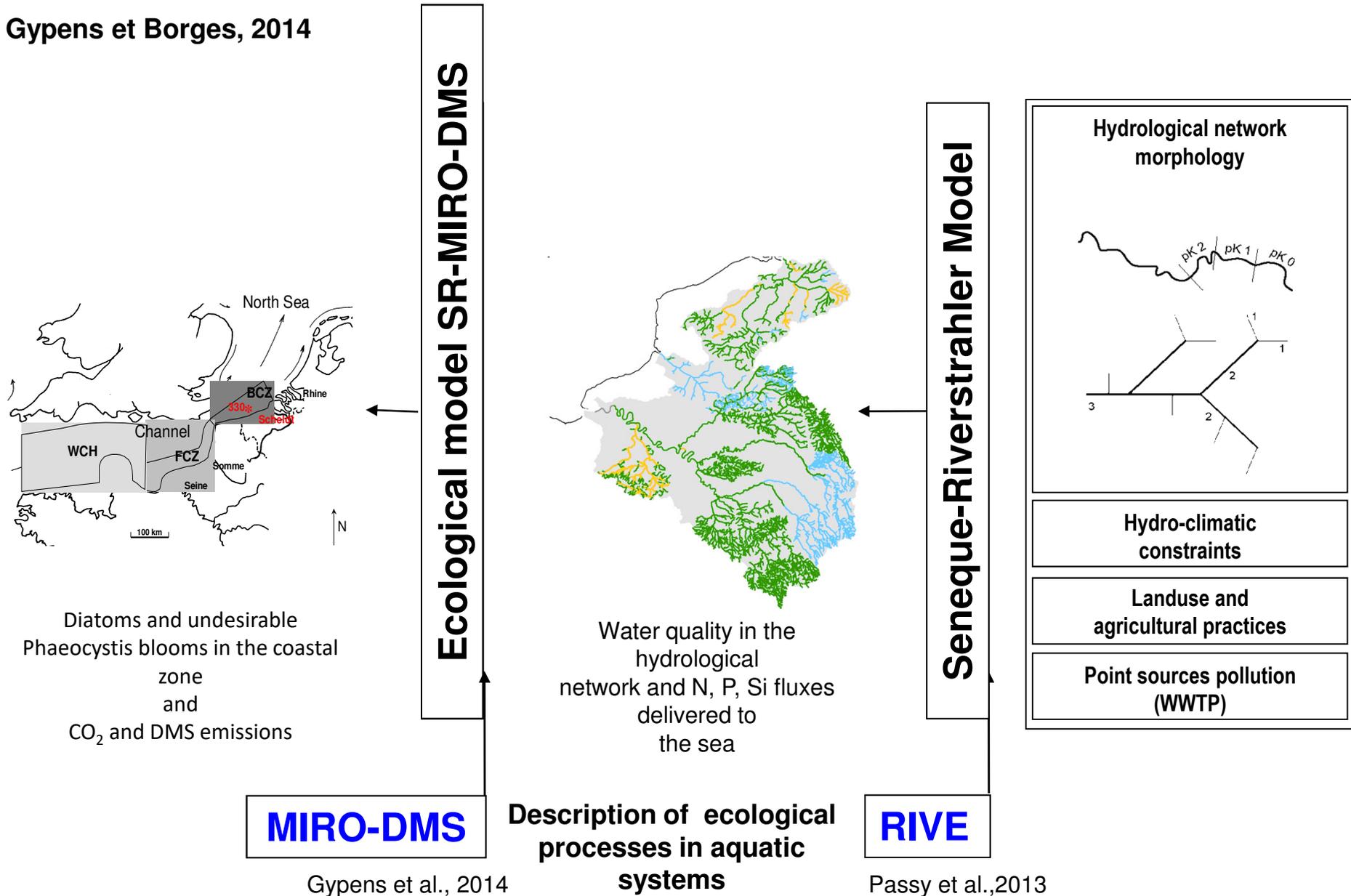


### Physical parameters

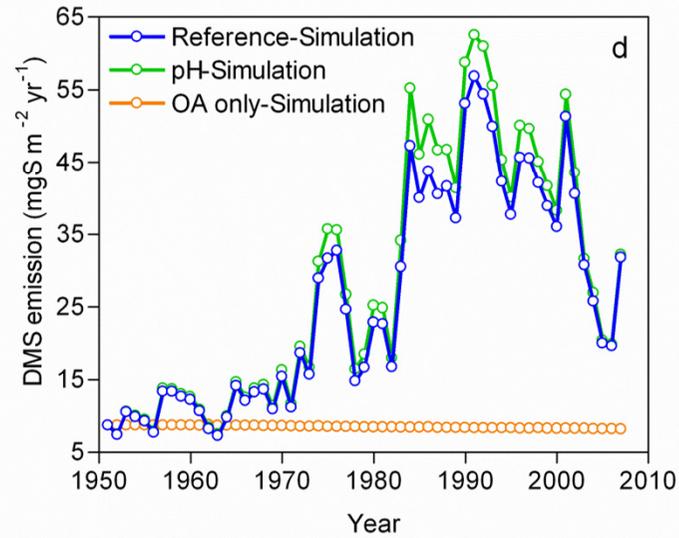
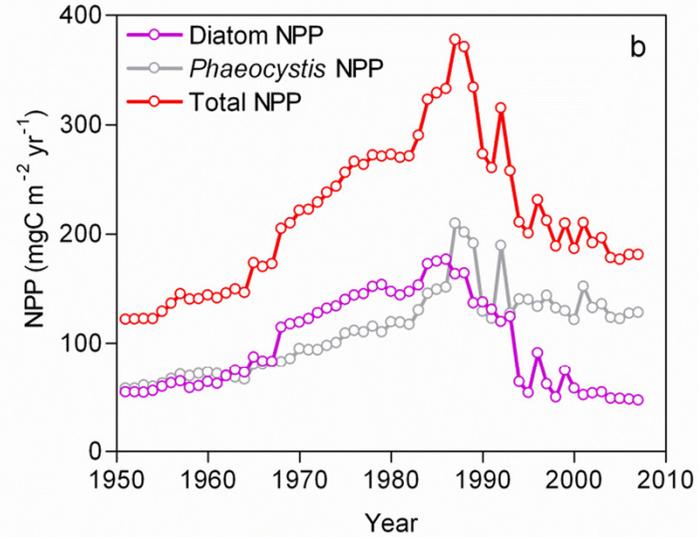
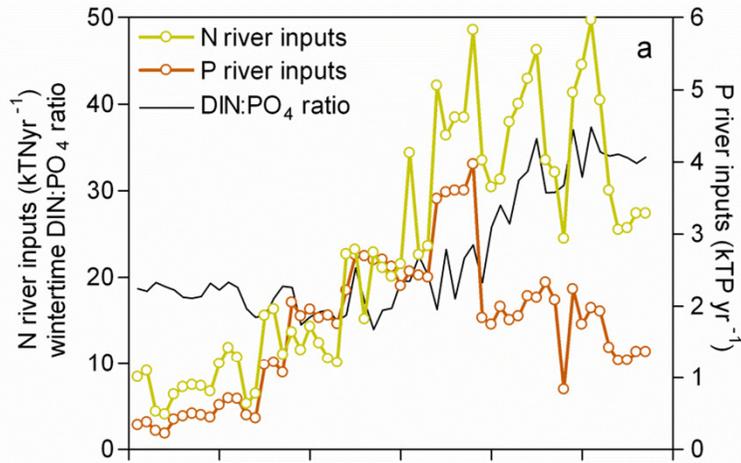


# Impact of anthropogenic pressure

Gypens et Borges, 2014



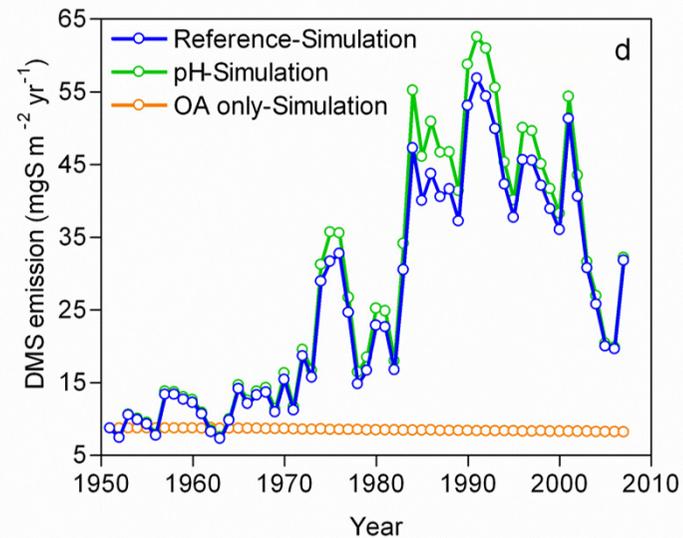
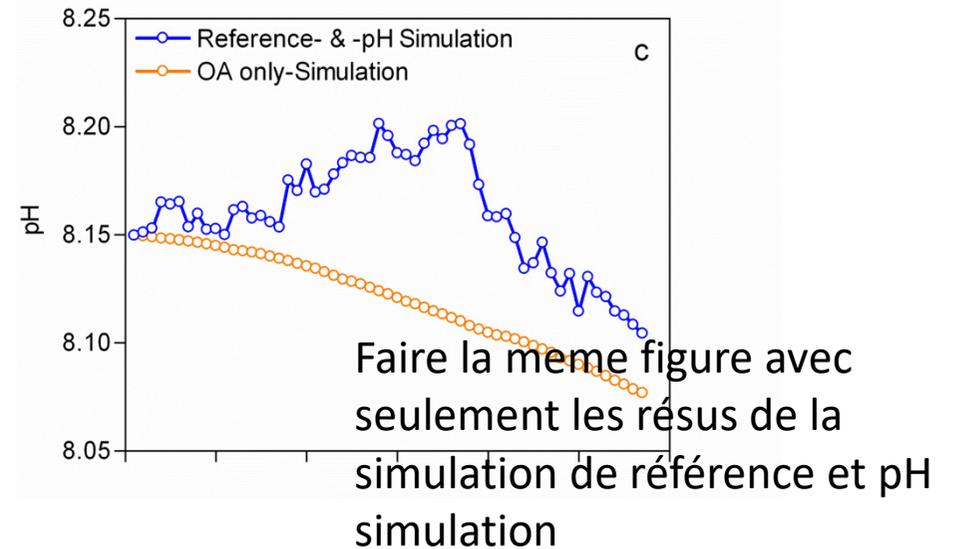
# Impact of anthropogenic pressure



Faire la meme figure avec  
seulement les résus de la  
simulation de référence

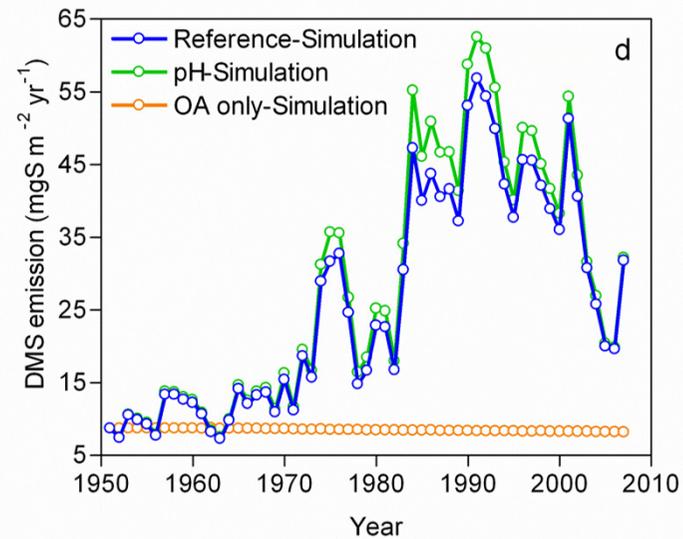
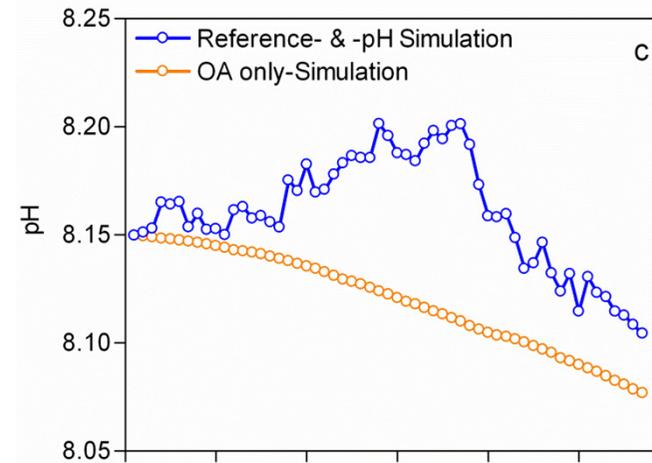
# Impact of anthropogenic pressure

Mettre graphe evolution pCO2  
atm



# Impact of anthropogenic pressure

Mettre graphe evolution pCO<sub>2</sub>  
atm



Faire la meme figure avec  
seulement les résus de la  
simulation de référence et pH  
simulation

# Now OU To Conclude OU ???

