Precising target NO3 concentrations to limit green algae blooms in Brittany

Patrick Durand, Sylvain Ballu, Francois Oehler, Pierre-Emmanuel Oms, Thierry Perrot, Lea Sgro, Pavlo Georgakis, Jordy Salmon-Monviola

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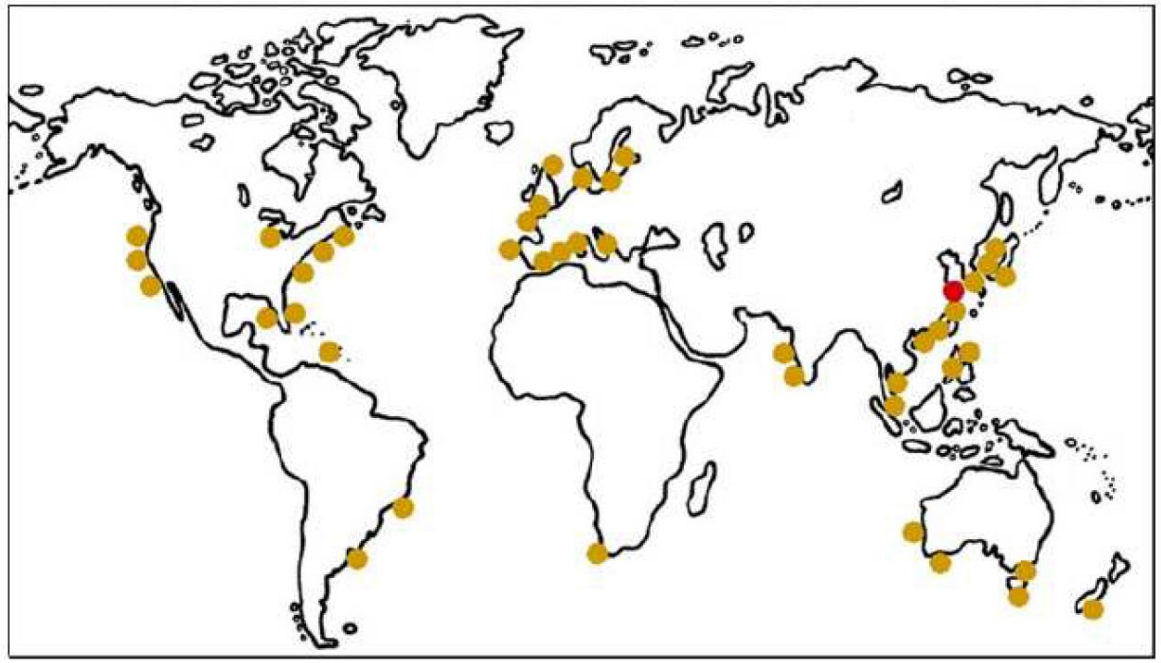
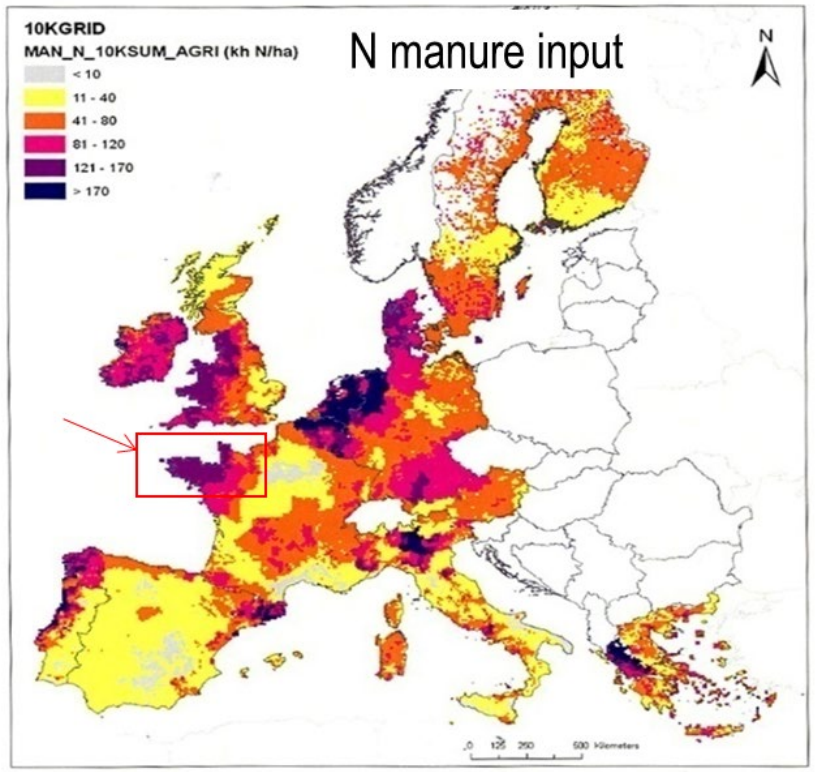
Project funded by PLAV2 : 2nd remediation plan for green tides (*Plan de Lutte contre les Algues Vertes*)

Introduction

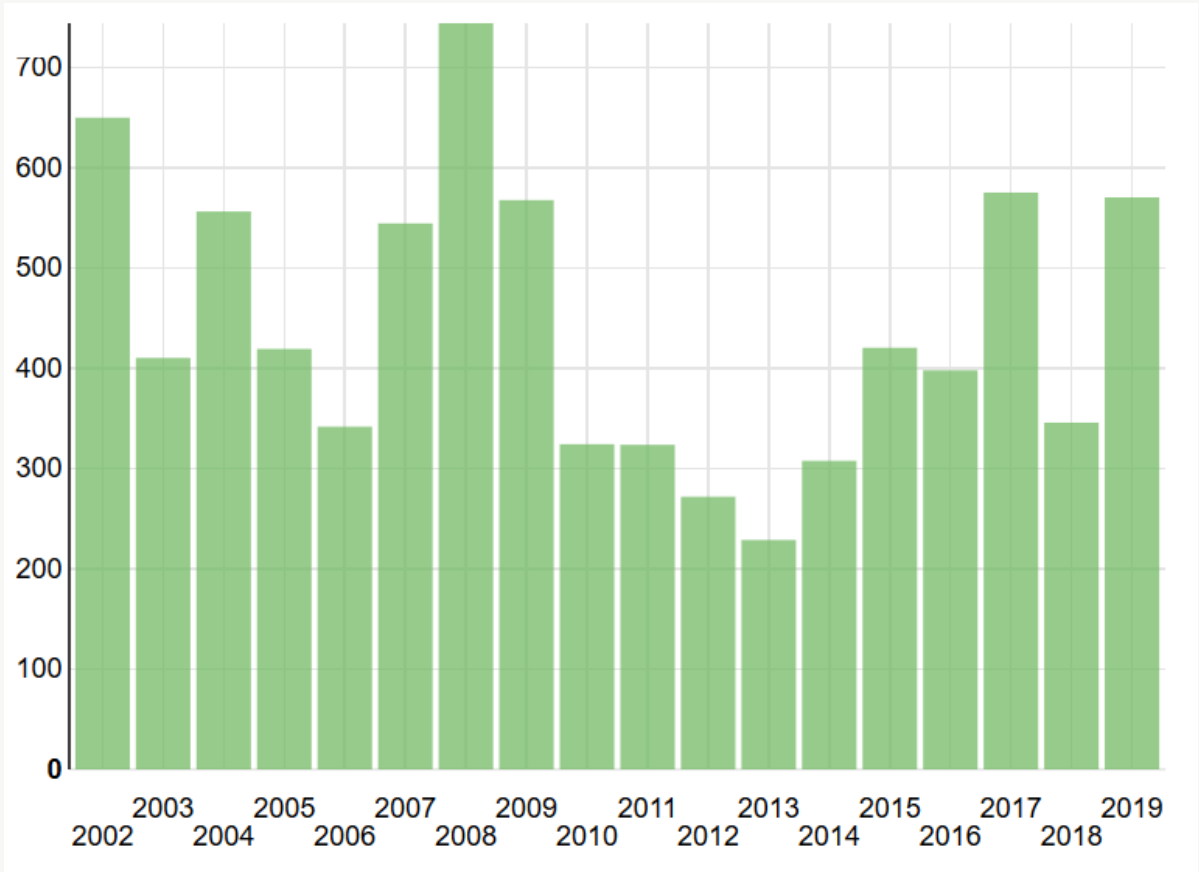
Green Tides (GT):
Macroalgal blooms (*Ulva* sp.)
Closed bays with shallow waters enriched in N,P, usually from river loads



Introduction (2)

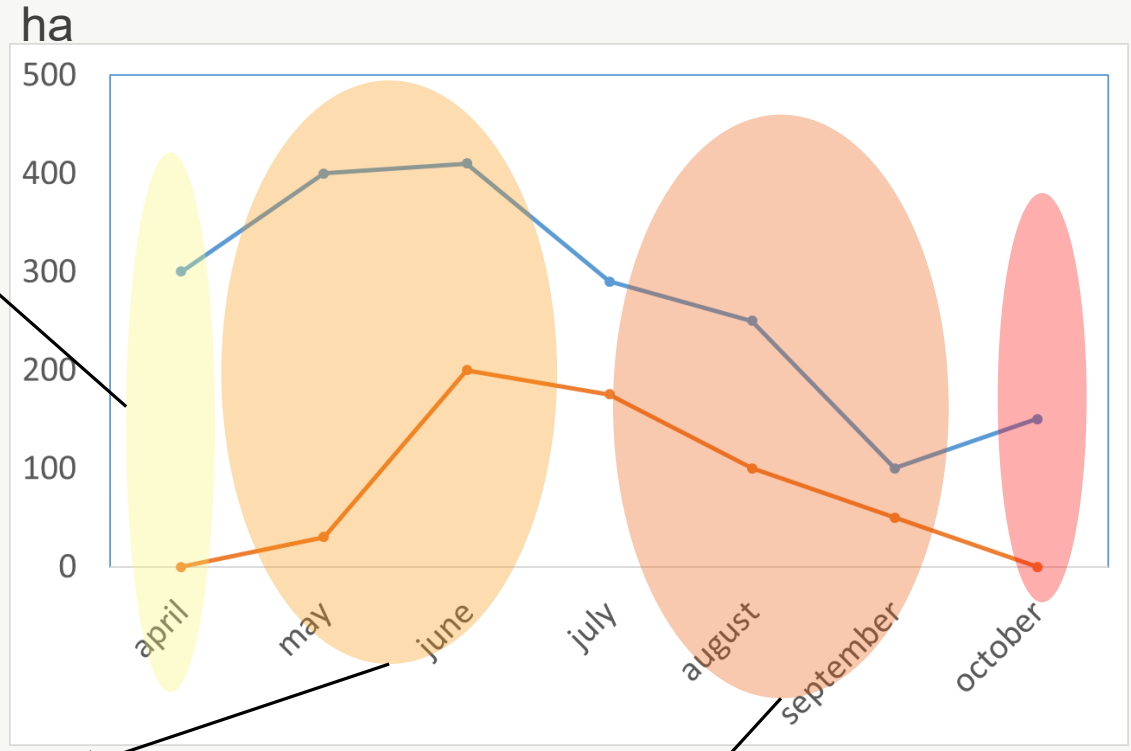


Western France suffers form GT since the 1970's, mainly due to intensive agriculture
Large variations of beached biomass since 2000



Introduction (3)

Beaching areas for 2 contrasting years



Initial pool:
Antecedent autumn pool,
Winter storms

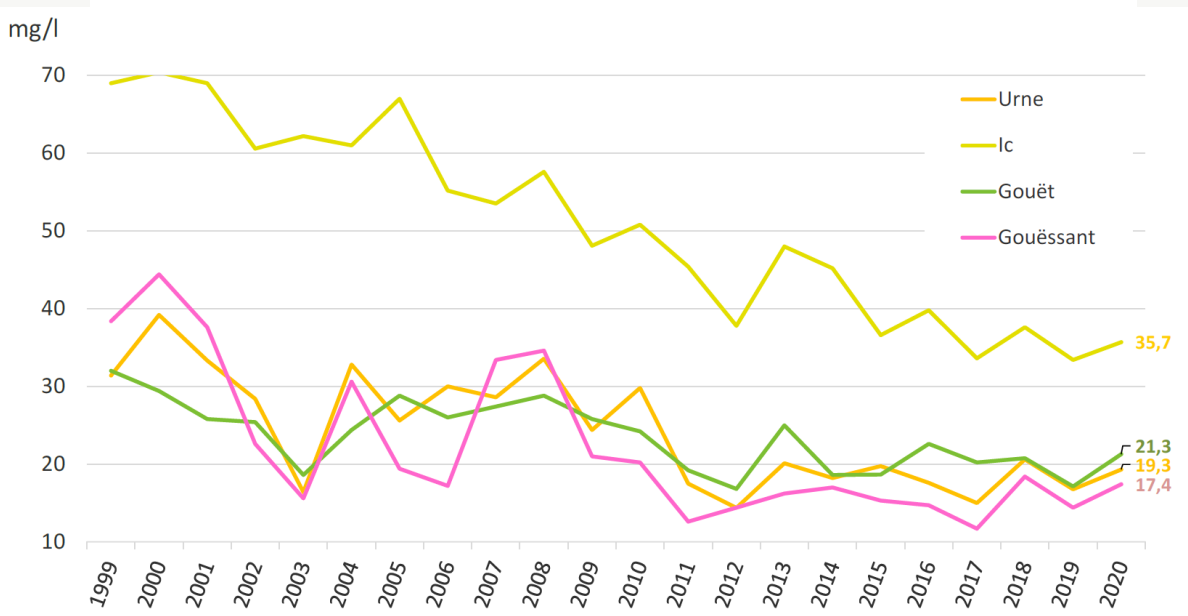
Autumn residual pool
Light, temperature, storms

Spring growth:
Sea temperature, light

Late summer growth
N supply

Agricultural practices
Spring rainfall

Hypotheses and questions

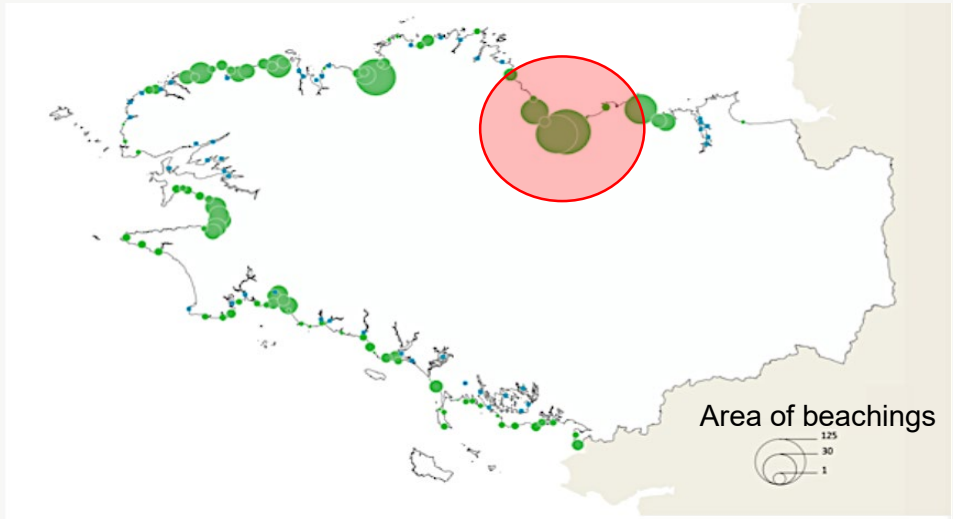


1. Does NO_3 decrease responsible for increasing variations of GT, or only climate variations?

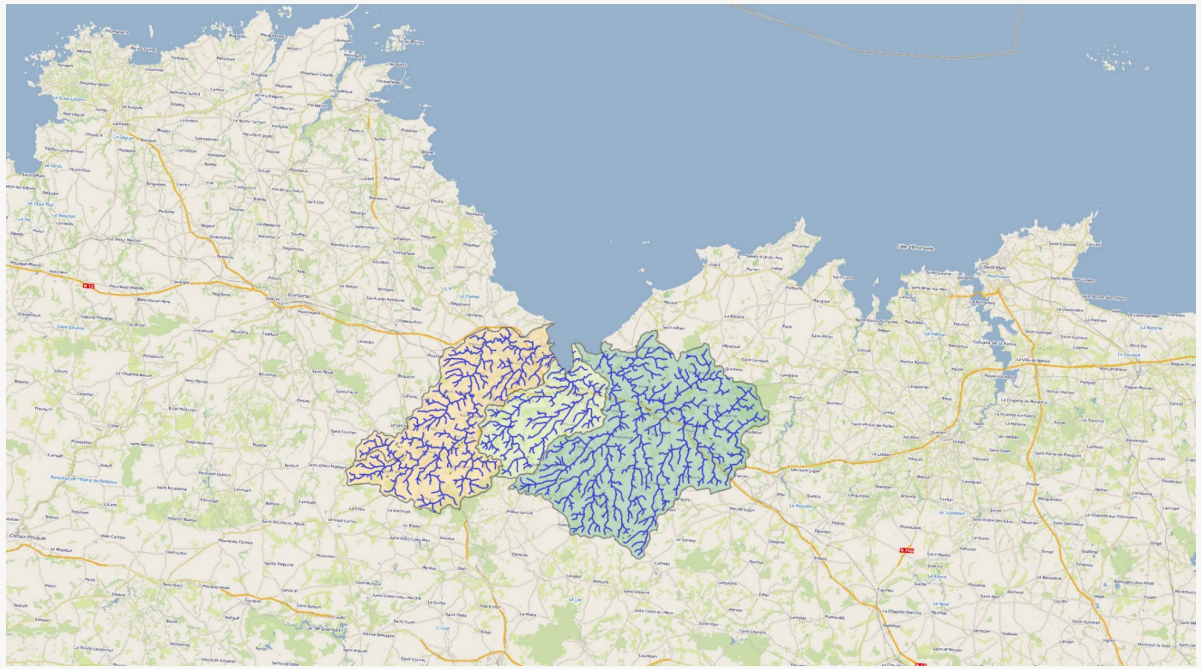
2. Would further NO_3 decrease avoid large GT when other factors favorable for algal growth?

3. Would future climate scenarios increase or decrease the risk of GT?

Study site



Bay of St Brieuc : Largest GT in Brittany.
Contributing catchments: 825 km²
Climate: oceanic temperate
Rainfall: 800 mm/year
Mean temperature: 9°C
Mean N-NO_3 ~ 6mg/L



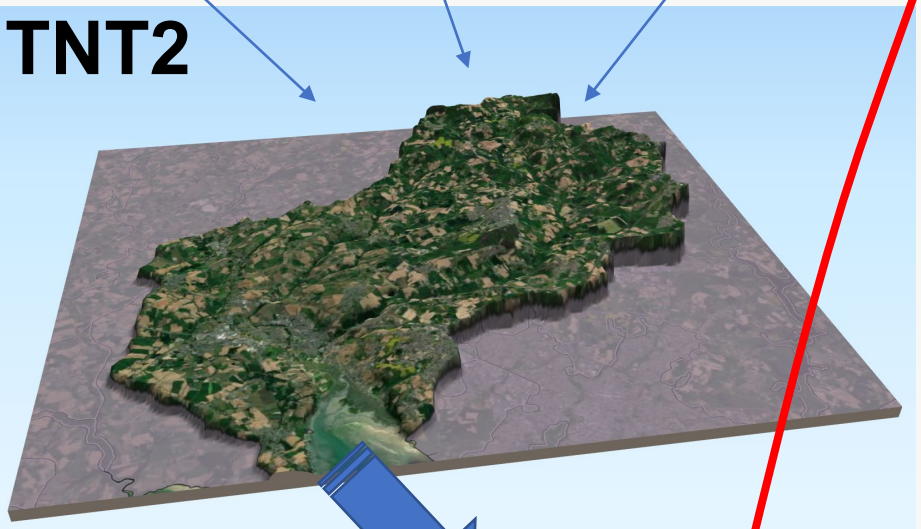
Methods (1)

P, PET, T°

DTM, soils

Crops, fertilization…

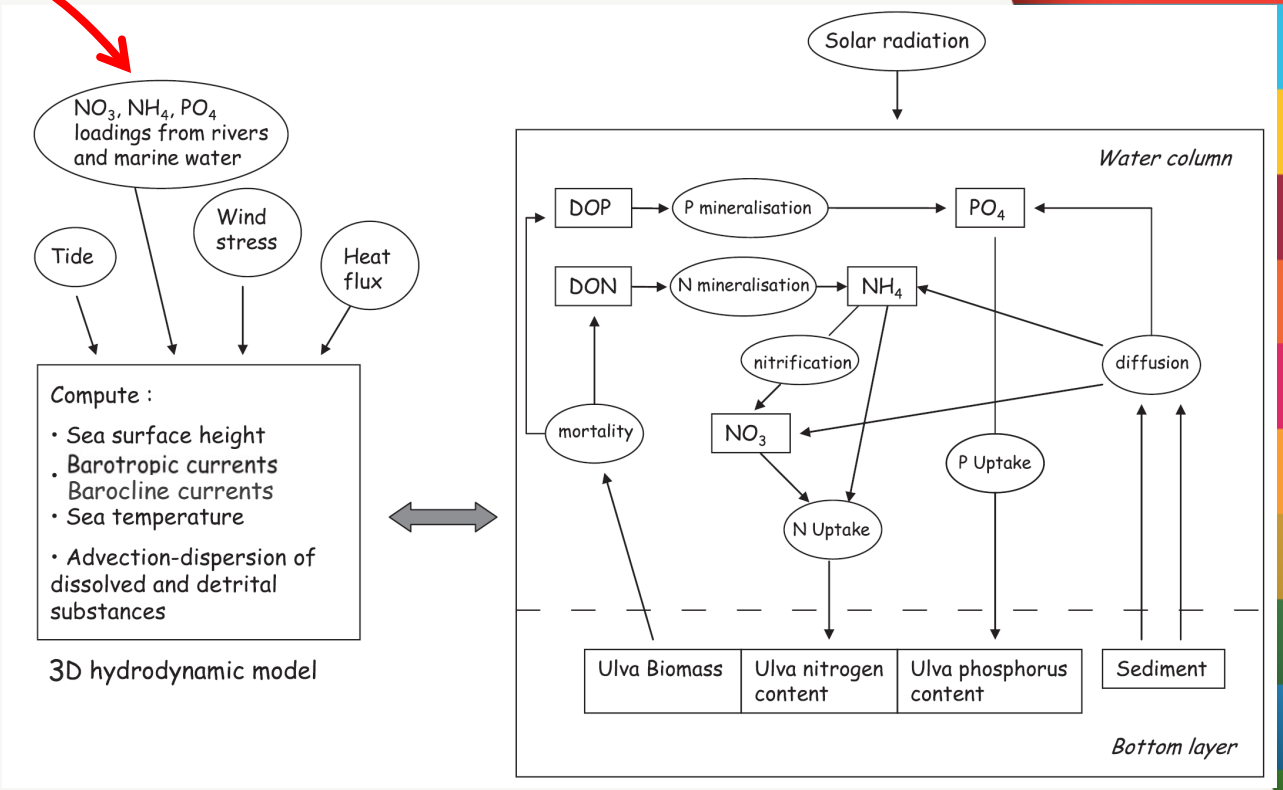
TNT2



Stream discharge

Stream NO_3, NH_4 concentrations

ECO-MARS-ULVES



Methods (2)

Step 1: Simulation of observed period : 2008-2018

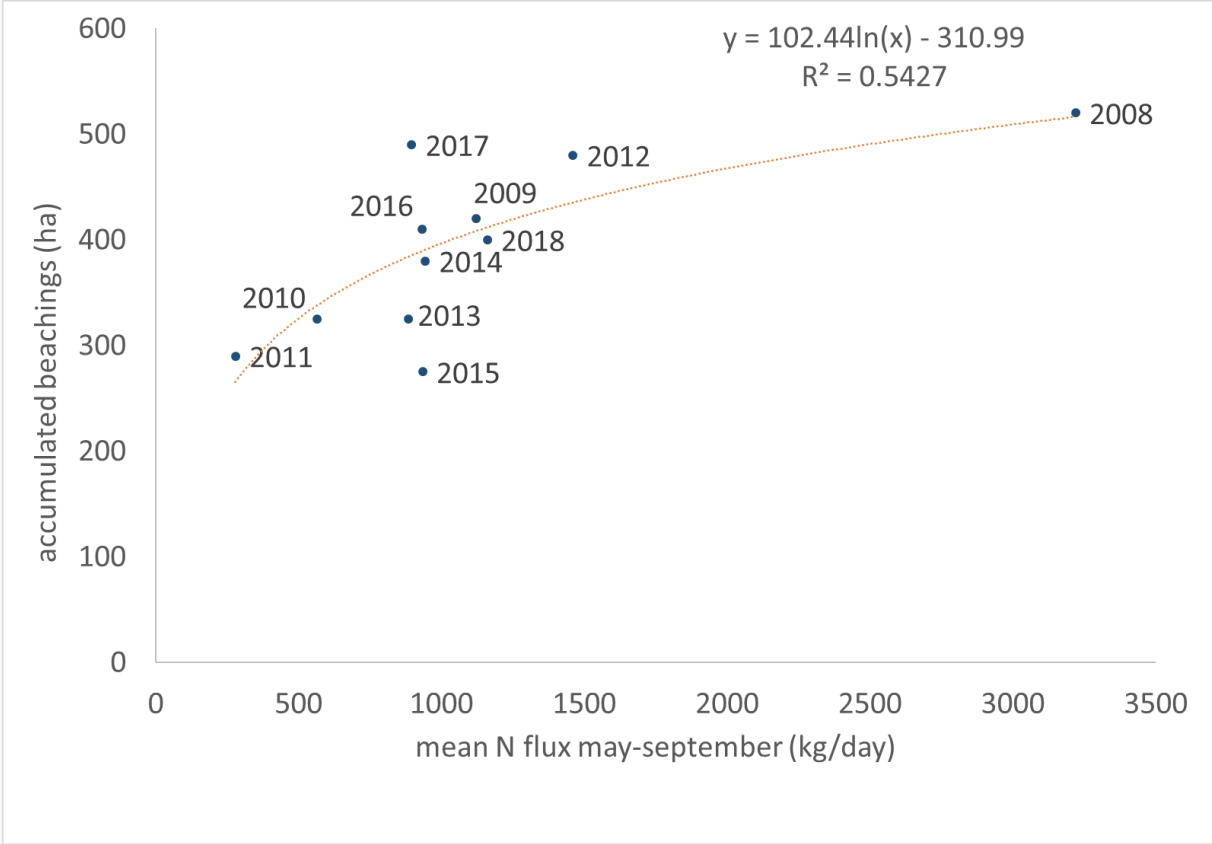
Step 2: Simulation of reduced N loads with same climate

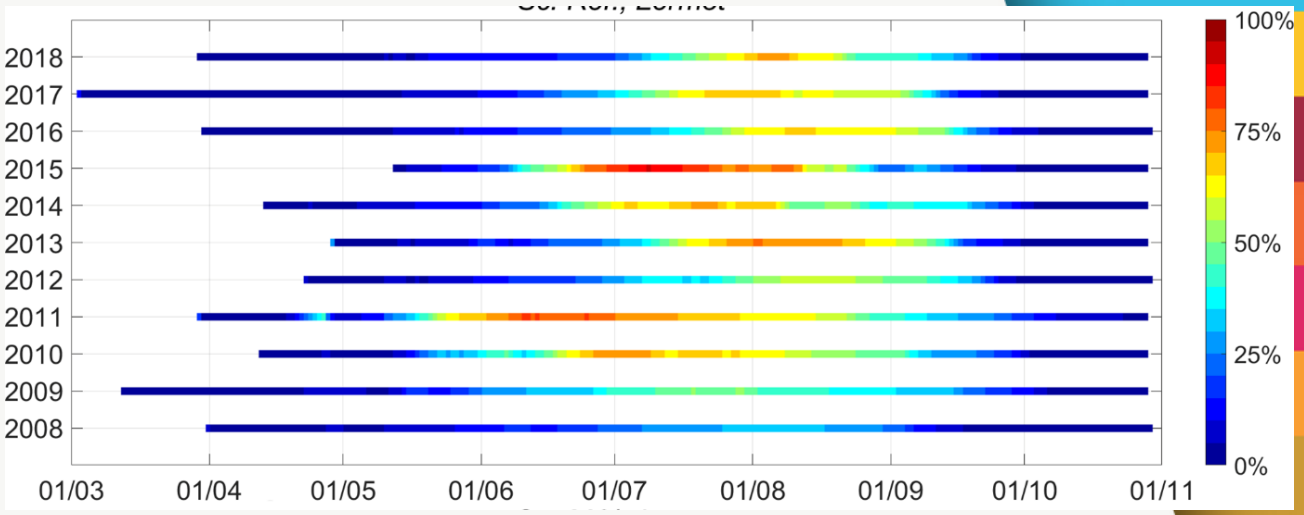
Step 3 : Simulation of past (higher) N loads with same climate

Step 4: simulation of present and reduced N loads with climate projections

Results

N fluxes vs. area of beach covered by algae

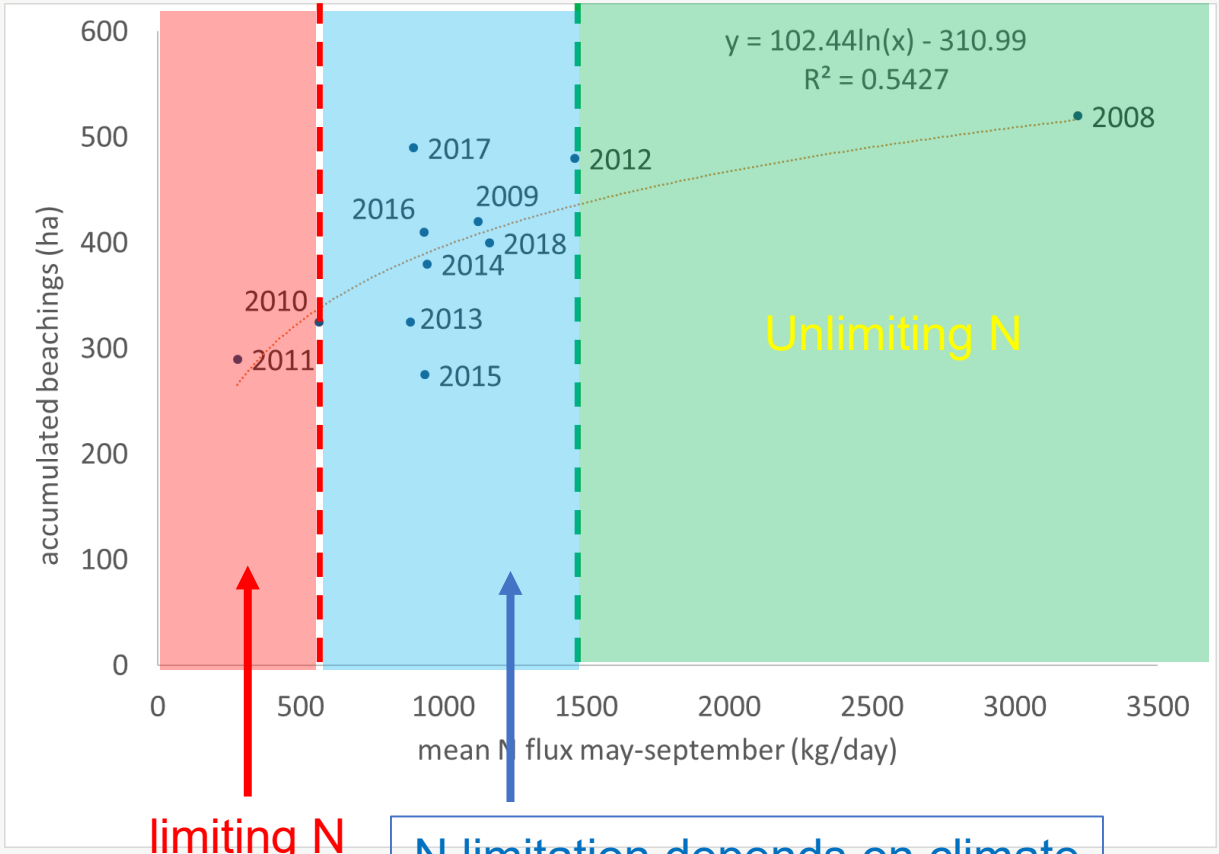


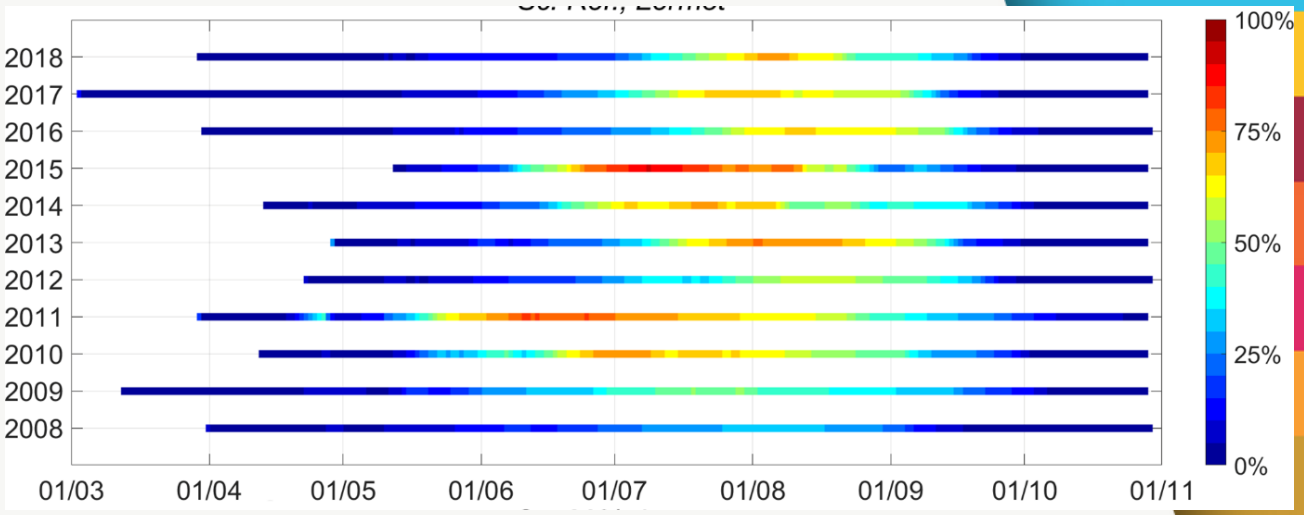


% of growth limitation by N

Results

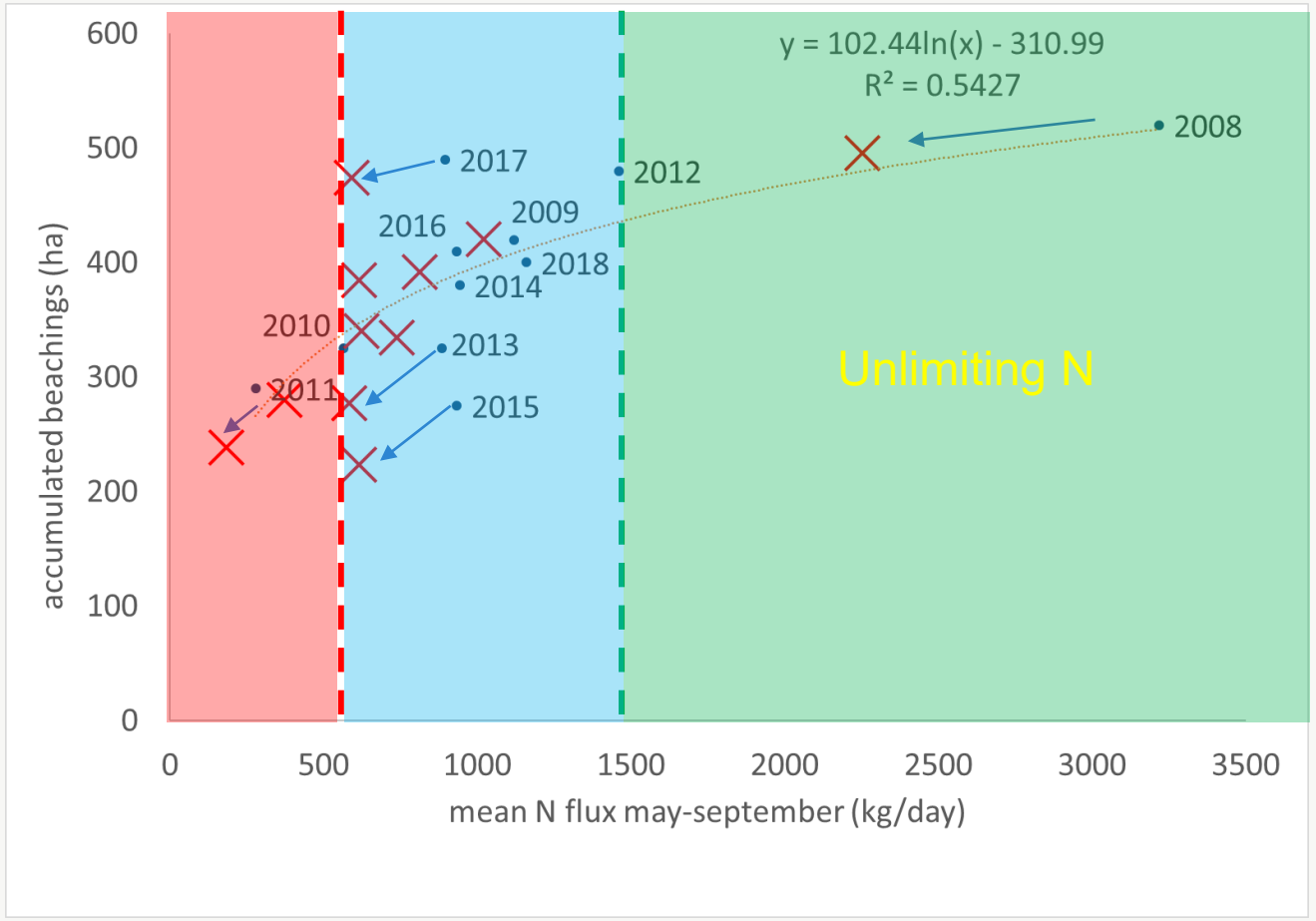
N fluxes vs. area of beach covered by algae





% of growth limitation by N

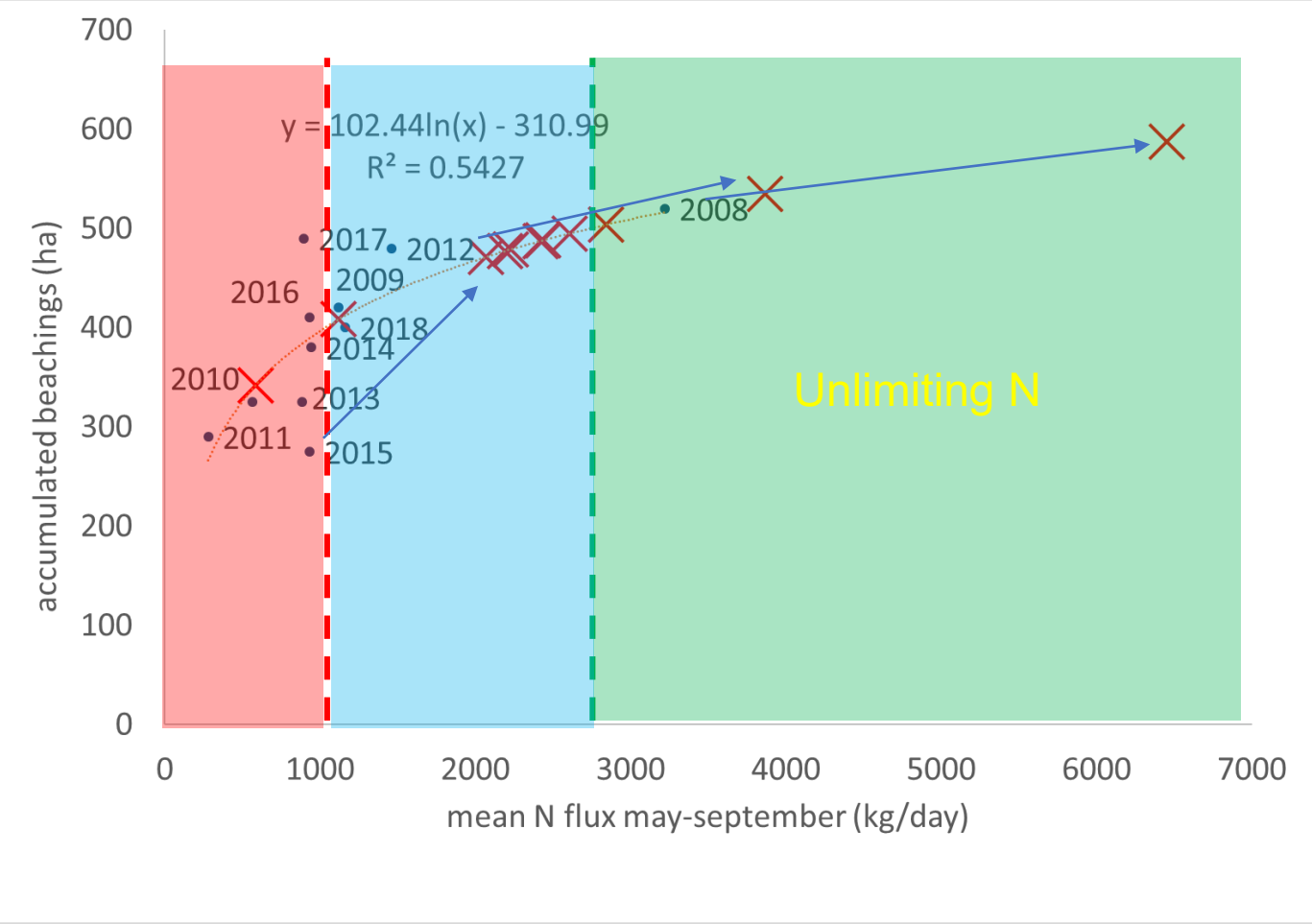
Impact of 30% N flux reduction



Only 10% biomass reduction :

Bad years would remain bad years…

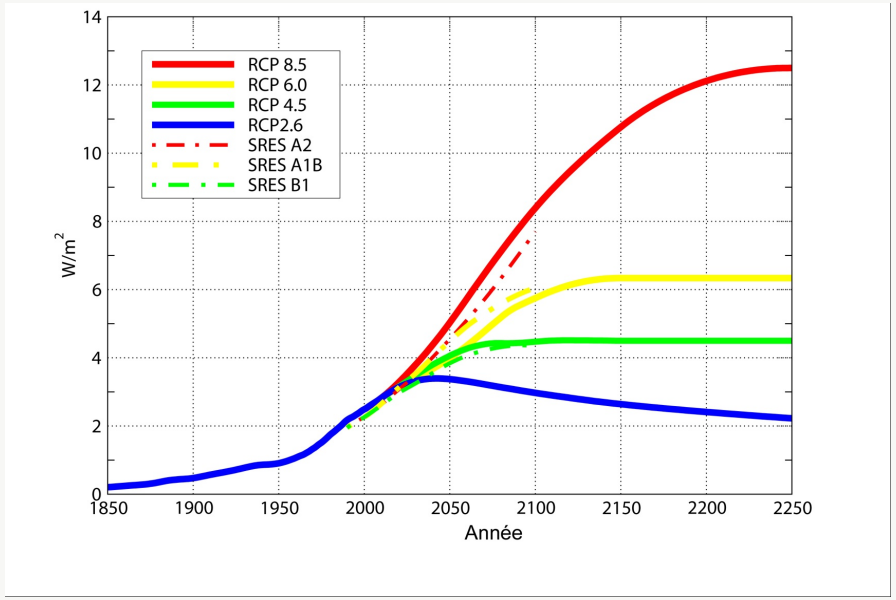
What if N03 directive and national regulations had not existed?

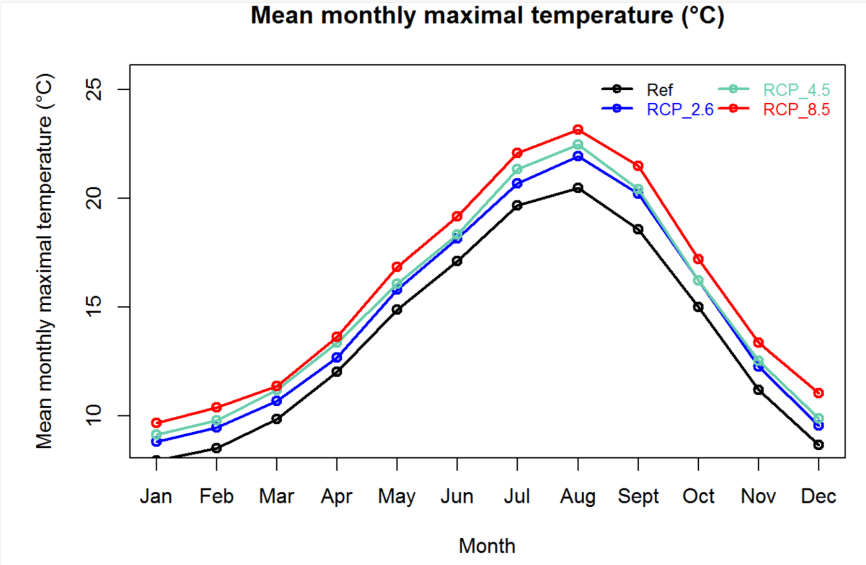


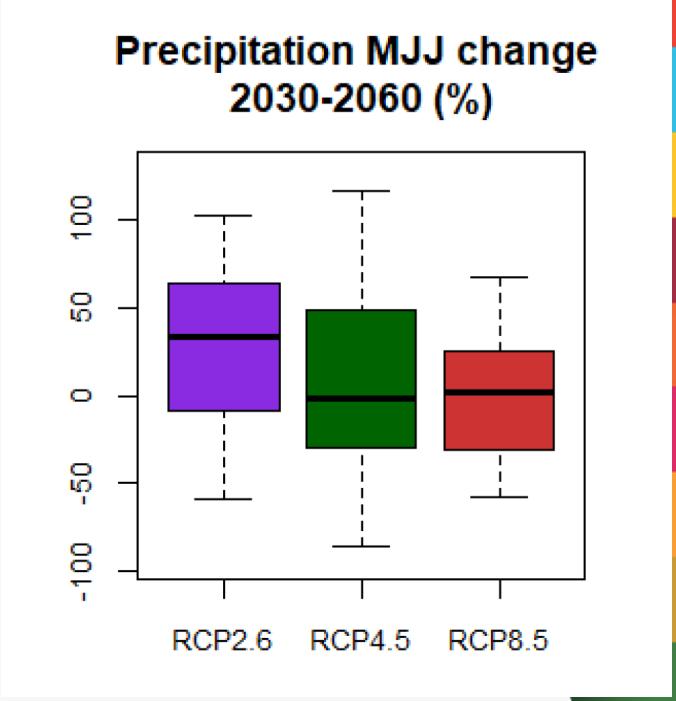
Probably only one « good » year in the decade

most « good » years would have been bad years…

Climate scenarios



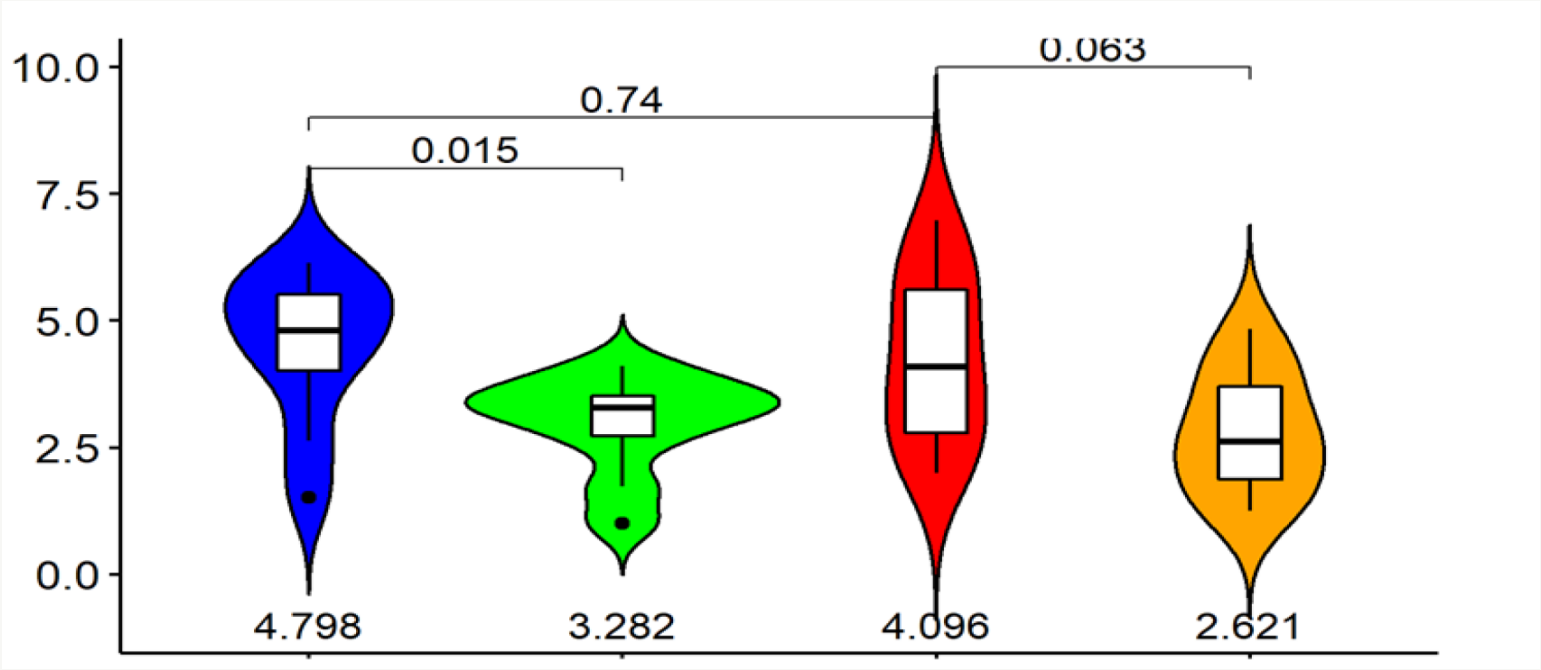




Selected scenario: RCP 8.5 for 2030-2060

Impact of climate scenarios

Summer N flux (kg/ha



Eco-MARS : very limited >0 impact of increased water temperature

Conclusions

Results need consolidation :

- ✓ The simulation of (uncertain) low flow/concentration data by hydrological model is difficult
- ✓ Ecological model overestimated biomass in late summer-automn -> *underestimation of impact of reduced N scenario?*
- ✓ Simulation of 7 other bays in progress.

Main messages :

- ✓ Limited N reduction will not improve « bad » years green tides *other solutions to reduce initial pools and spring growth?*
- ✓ No significant impact of climate change in the next decades (probably more impact of other anthropogenic changes)