Biogéochimie marine, écosystèmes et ressources

Olivier Aumont

Journées IPSL-CMC

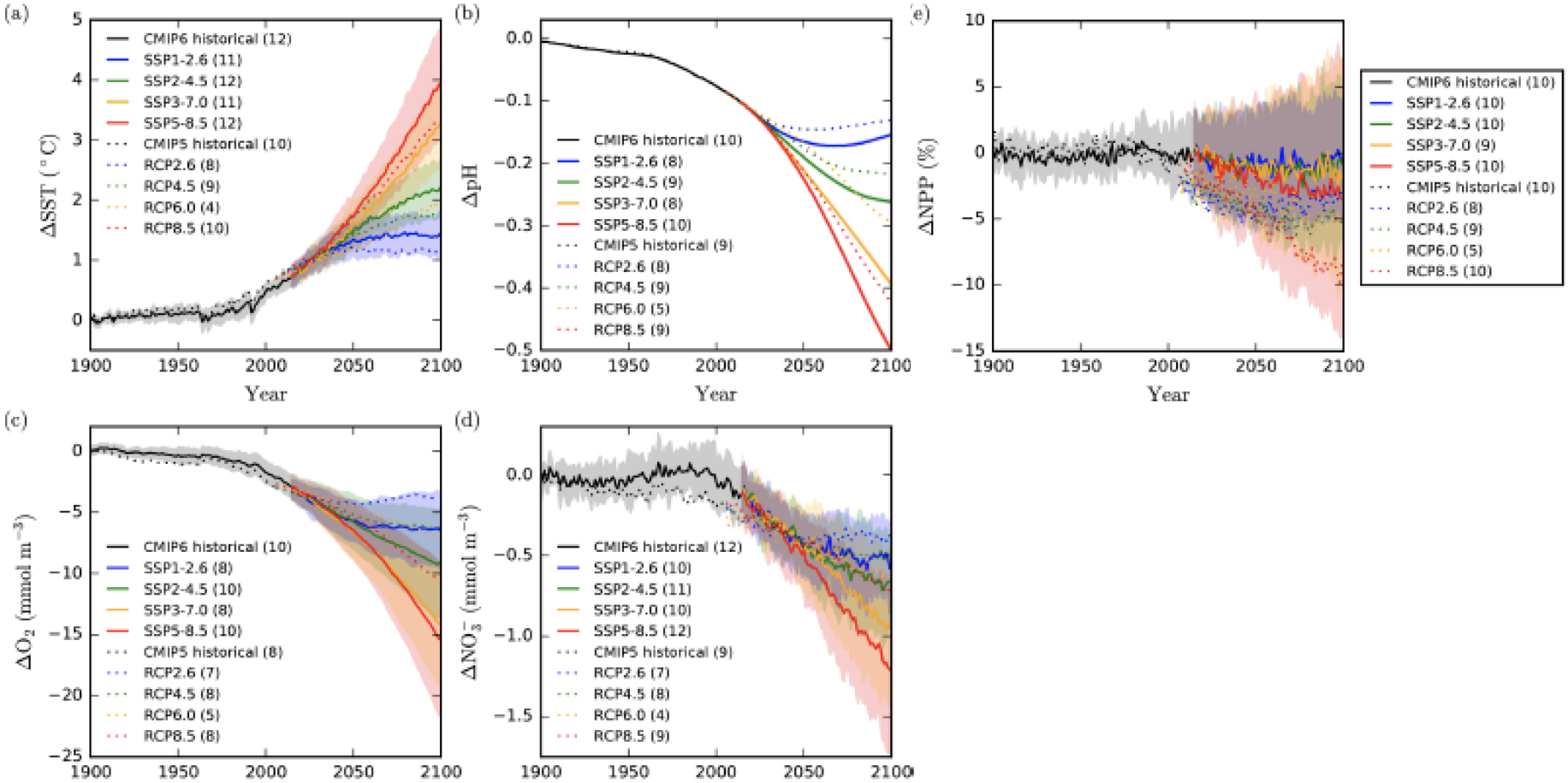
8-9 Décembre 2020

CMIP6 PROJECTIONS

Twenty-first century ocean warming, acidification, deoxygenation, and upper-ocean nutrient and primary production decline from CMIP6 model projections

Biogeosciences Open Access EGU

Lester Kwiatkowski[1], Olivier Torres[2], Laurent Bopp[2], Olivier Aumont[1], Matthew Chamberlain[3], James R. Christian[5], John P. Dunne[6], Marion Gehlen[7], Tatiana Ilyina[8], Jasmin G. John[6], Andrew Lenton[3,4], Hongmei Li[8], Nicole S. Lovenduski[9], James C. Orr[7], Julien Palmieri[10], Yeray Santana-Falcón[11], Jörg Schwinger[12], Roland Séférian[11], Charles A. Stock[6], Alessandro Tagliabue[13], Yohei Takano[8,14], Jerry Tjiputra[12], Katsuya Toyama[15], Hiroyuki Tsujino[15], Michio Watanabe[16], Akitomo Yamamoto[16], Andrew Yool[10], and Tilo Ziehn[3]

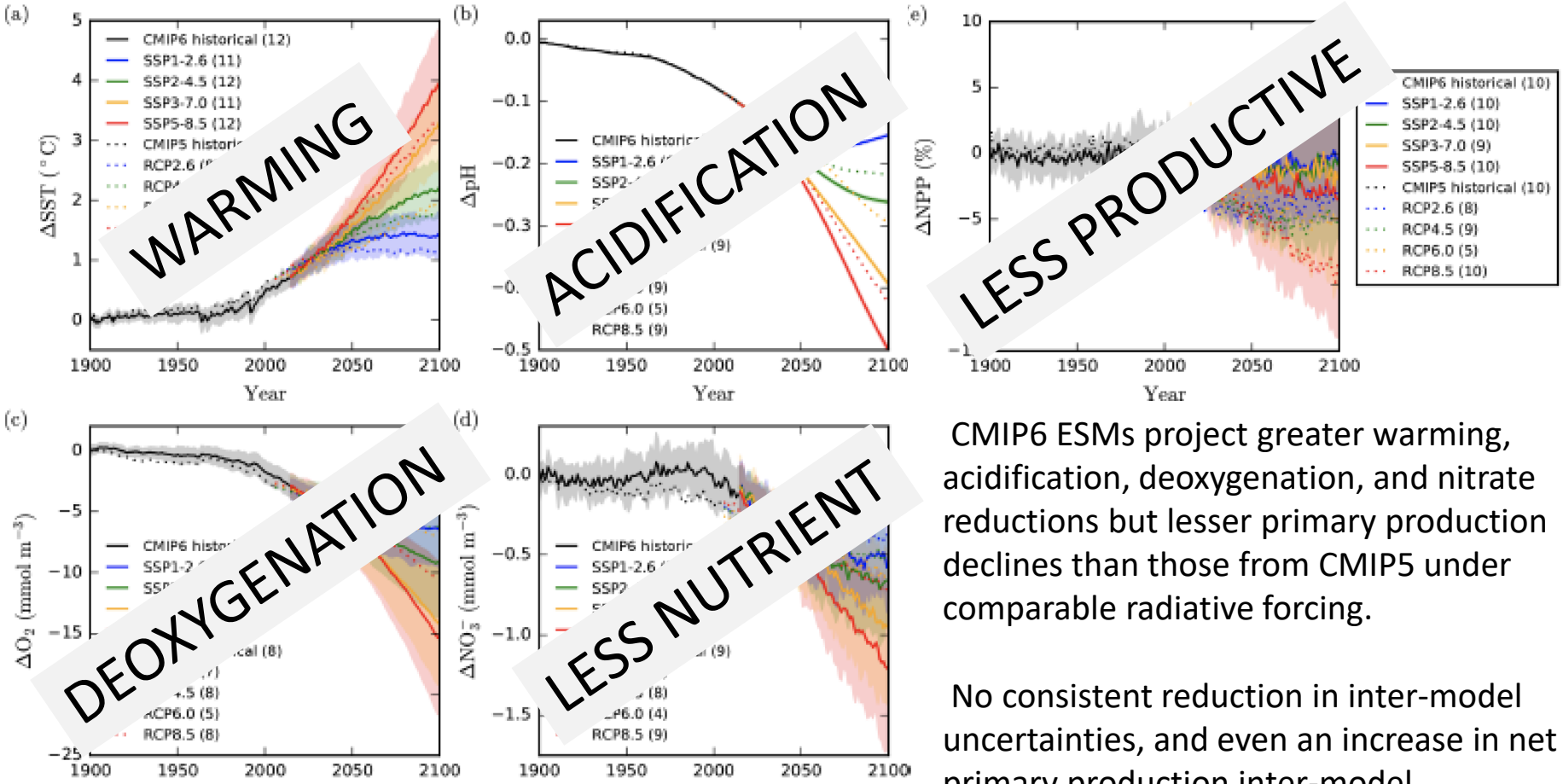


CMIP6 PROJECTIONS

Twenty-first century ocean warming, acidification, deoxygenation, and upper-ocean nutrient and primary production decline from CMIP6 model projections

Lester Kwiatkowski[1], Olivier Torres[2], Laurent Bopp[2], Olivier Aumont[1], Matthew Chamberlain[3], James R. Christian[5], John P. Dunne[6], Marion Gehlen[7], Tatiana Ilyina[8], Jasmin G. John[6], Andrew Lenton[3,4], Hongmei Li[8], Nicole S. Lovenduski[9], James C. Orr[7], Julien Palmieri[10], Yeray Santana-Falcón[11], Jörg Schwinger[12], Roland Séférian[11], Charles A. Stock[6], Alessandro Tagliabue[13], Yohei Takano[8,14], Jerry Tjiputra[12], Katsuya Toyama[15], Hiroyuki Tsujino[15], Michio Watanabe[16], Akitomo Yamamoto[16], Andrew Yool[10], and Tilo Ziehn[3]

Biogeosciences Open Access EGU



CMIP6 ESMs project greater warming, acidification, deoxygenation, and nitrate reductions but lesser primary production declines than those from CMIP5 under comparable radiative forcing.

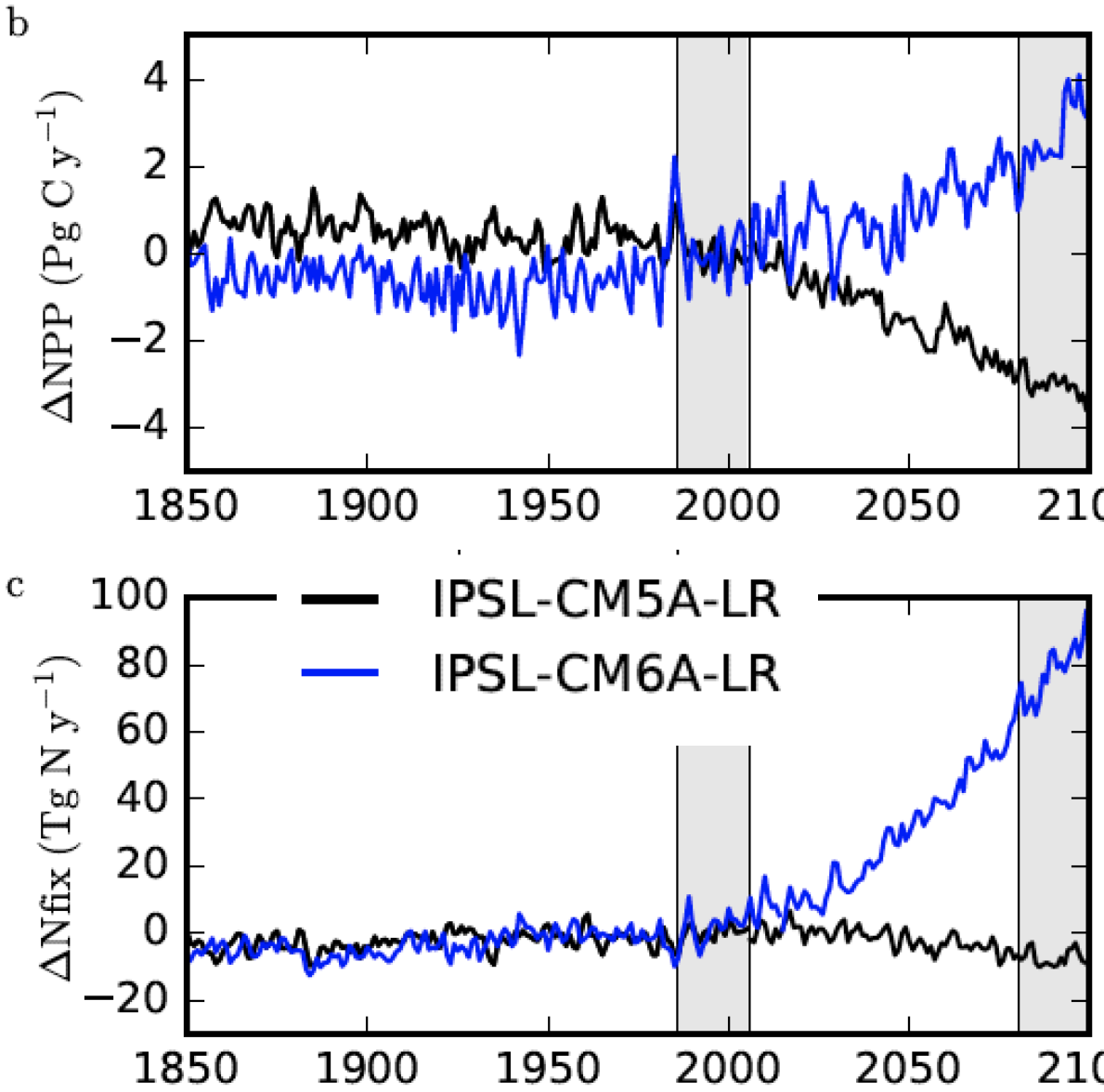
No consistent reduction in inter-model uncertainties, and even an increase in net primary production inter-model uncertainties in CMIP6, as compared to CMIP5.

IPSL-CM6 PROJECTIONS: un-expected increase in NPP

Similar Warming for :
IPSL-CM5A-LR under RCP8.5
& IPSL-CM6A-LR under SSP585

But very different NPP !
IPSL-CM5A-LR : -10%
IPSL-CM6A-LR : +10%

N-fixation almost doubles in
IPSL-IPS-CM6A
but decreases in IPSL-CM5A



Bopp et al. in prep

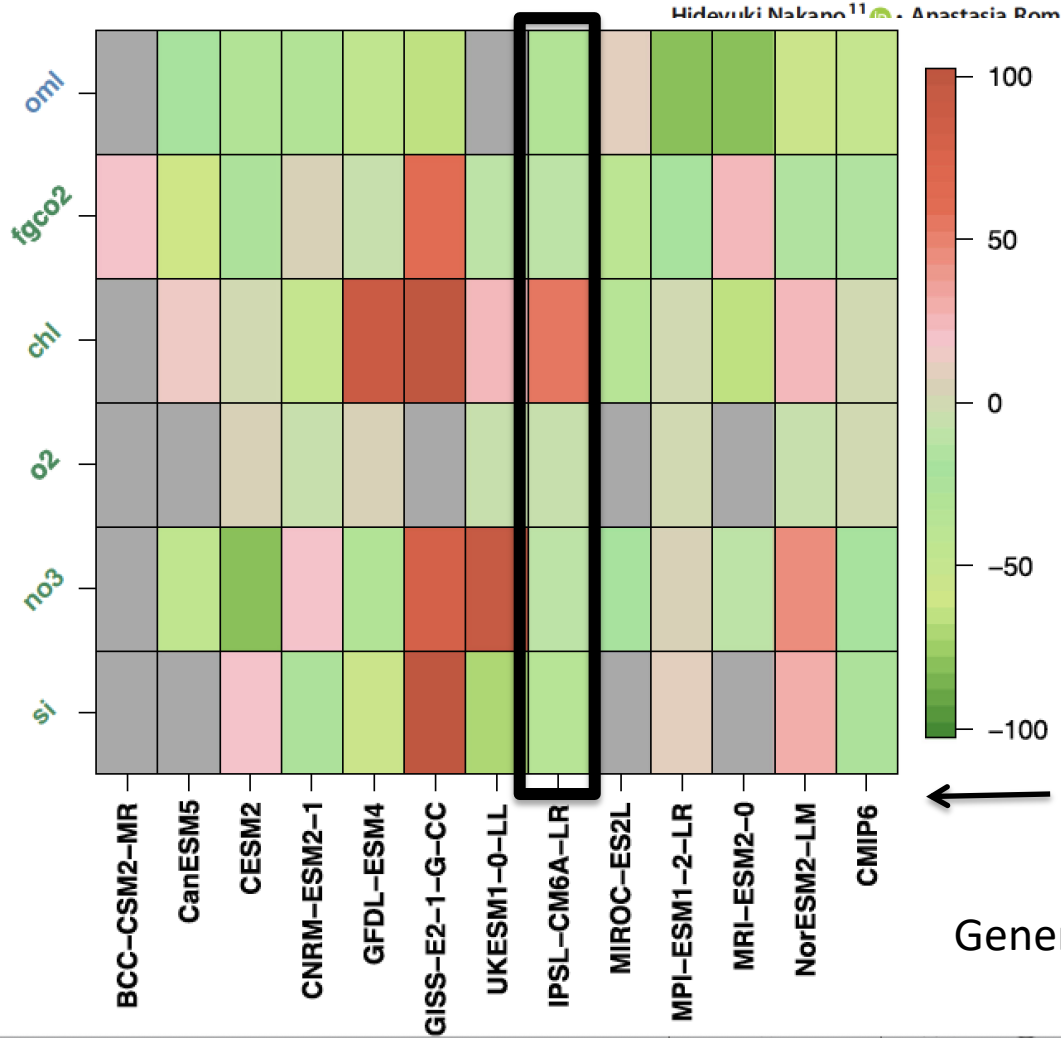
EVALUATION

CARBON CYCLE AND CLIMATE (K ZICKFELD, JR MELTON AND N LOVENDUSKI, SECTION EDITORS)

Check for updates

Tracking Improvement in Simulated Marine Biogeochemistry Between CMIP5 and CMIP6

Roland Séférian[1] · Sarah Berthet[1] · Andrew Yool[2] · Julien Palmiéri[2] · Laurent Bopp[3] · Alessandro Tagliabue[4] · Lester Kwiatkowski[5] · Olivier Aumont[5] · James Christian[6] · John Dunne[7] · Marion Gehlen[8] · Tatiana Ilyina[9] · Jasmin G. John[7] · Hongmei Li[9] · Matthew C. Long[10] · Jessica Y. Luo[7] · Hideyuki Nakano[11] · Anastasia Romanou[12] · Jörg Schwinger[13] · Charles Stock[7] · Yeray Santana-Falcón[1] · Hiroyuki Tsujino[11] · Michio Watanabe[15] · Tongwen Wu[16] ·



The representation of marine biogeochemistry has progressed within the current generation of Earth system models. However, it remains difficult to identify which model updates are responsible for a given improvement.

Portrait diagram highlighting the performance of CMIP6 models with respect to their CMIP5 predecessors.

General Improvment for IPSL-CM6 (except Chl)

Developments in PISCES
→ to be included (or not) in next configurations

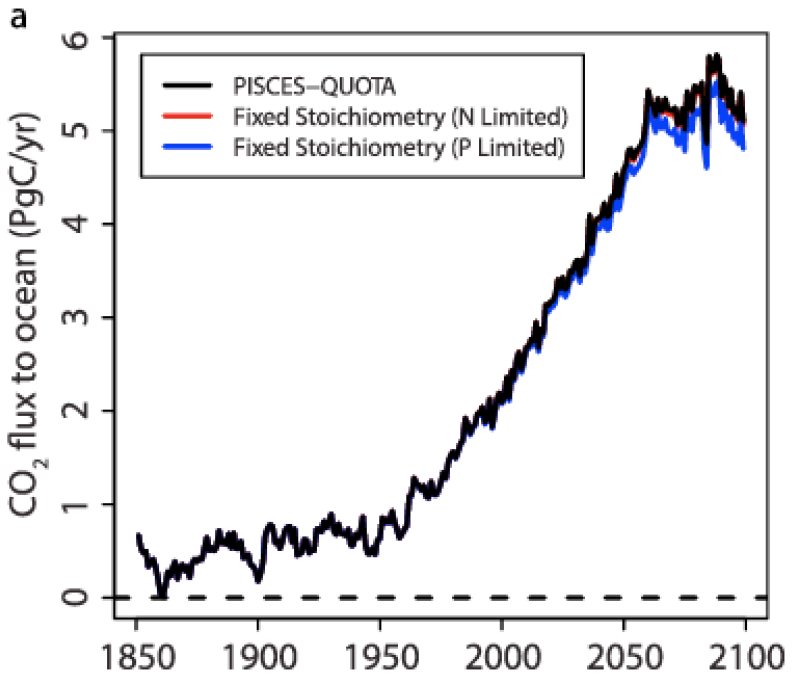
1). PISCES-quota version
(decoupling between Carbon / Nitrogen / Phosphorus cycles)

Not a big effect on Carbon Uptake and NPP changes for the next decades… but important for food quality.

Much closer to actual processes

May be important for longer time scales

(Kwiatkowski et al. 2018)



✓ Tested, ✓ Useful but ✗ Expensive

Developments in PISCES

→ to be included (or not) in next configurations

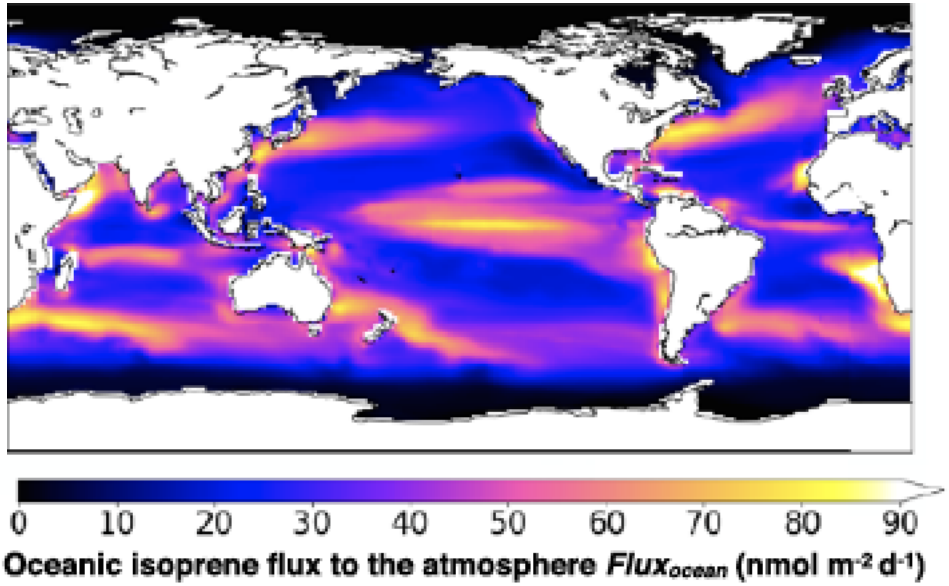
1). PISCES-quota version

2). PISCES-gaz version

(including additional trace gases – N_2O, DMS, CO, isoprene, …)

Tested in offline versions – useful if atmospheric chemists need it !

(Conte et al. 2019 for CO)
(Conte et al. 2020 for isoprene)
(Martinez-Rey et al. 2015 for N2O)



✓ Tested, ✓ not expensive, but ? Useful

Developments in PISCES

→ to be included (or not) in next configurations

1). PISCES-quota version

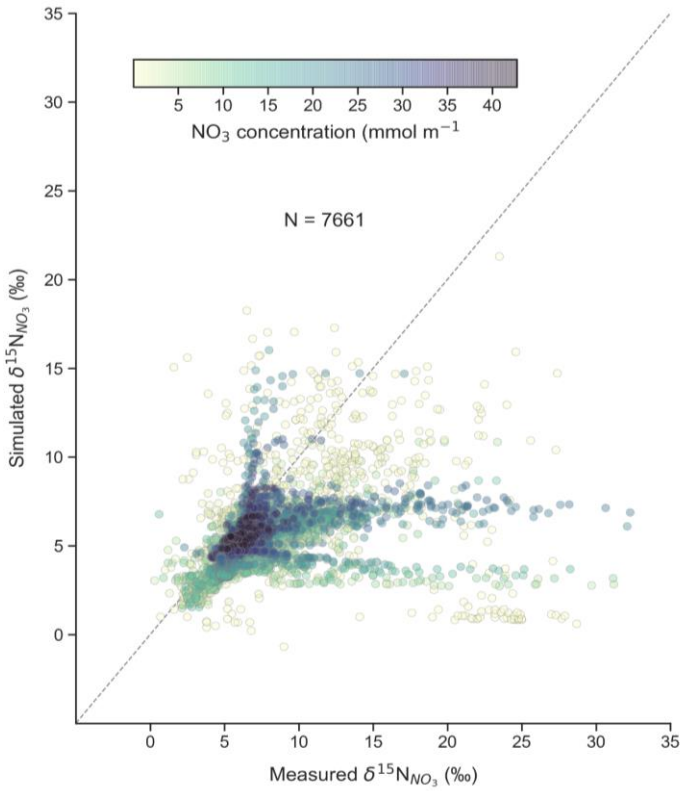
2). PISCES-gaz version

3). PISCES-iso version

(including stable isotopes : ^{13}C and ^{15}N)

^{15}N : Developped and in the process of being published (15N, Buchanan et al. in prep)

^{13}C : Re-coded in PISCES-v2. To be checked (13C, updated from Tagliabue et al. 2008)



✓ Tested, ✓ Useful for paleo configs, ✗ very very expensive

Developments in PISCES

→ to be included (or not) in next configurations

1). PISCES-quota version

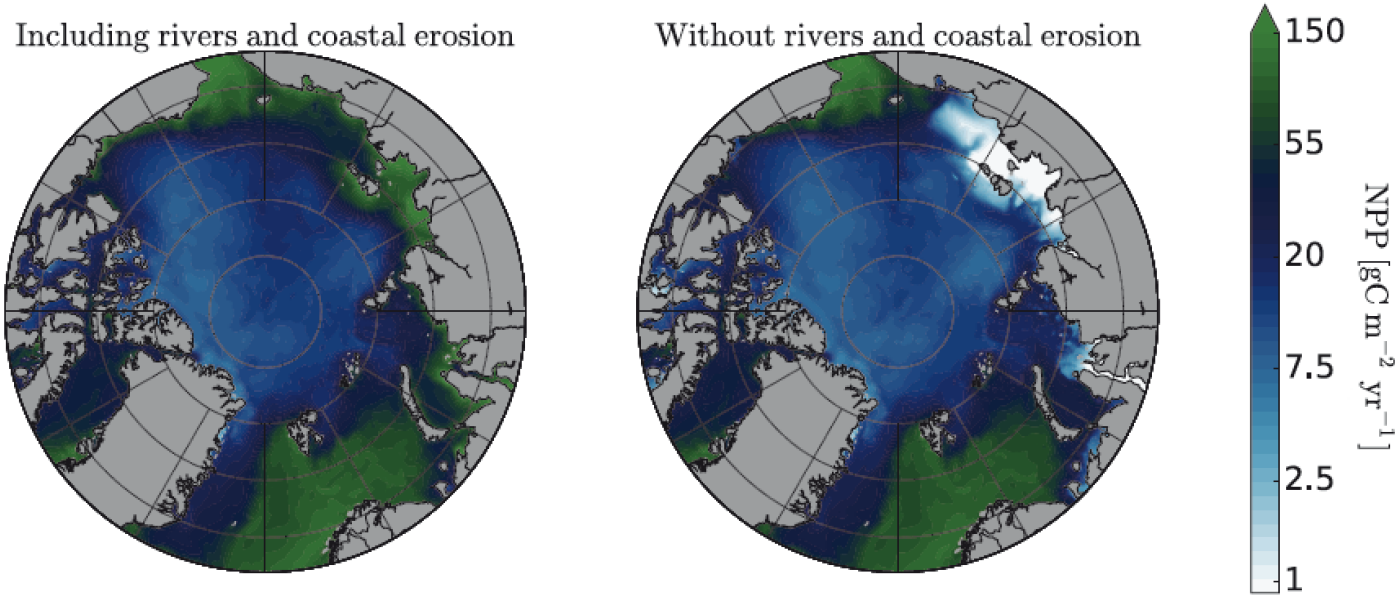
2). PISCES-gaz version

3). PISCES-iso version

4). PISCES with variable input sources

(atm. deposition, river input)

e.g. 1/3 of Arctic NPP sustained by river and coastal erosiion (Terhaar et al. in press)



✓ Tested, ✓ Useful, ✓ Not expensive

Developments in PISCES
→ to be included (or not) in next configurations

1). PISCES-quota version
2). PISCES-gaz version
3). PISCES-iso version
4). PISCES with variable input sources
5). Other PISCES devlpmts

- New sediment model
- Coupling with upper trophic model
- Other paleo proxies (Pa/Th, …)

No top-down effect on global carbon uptake (Dupont et al. in prep)