A numerical analysis of the effects of contemporary sea ice loss on Arctic primary production

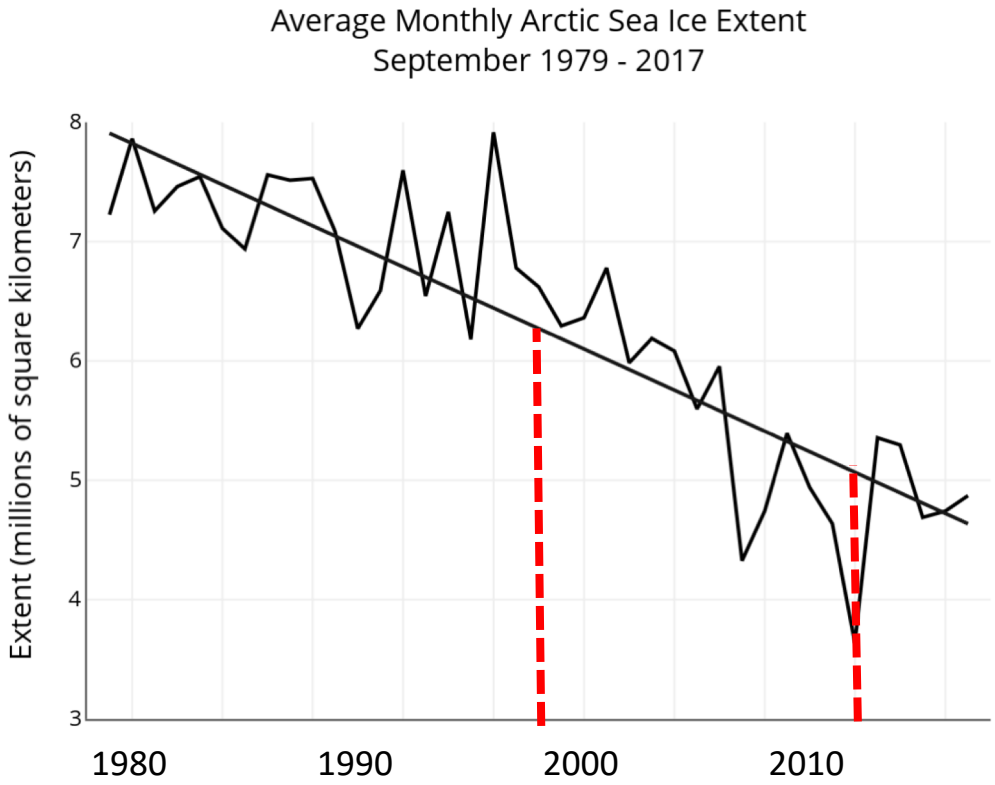
Timothée Bourgeois[1], Katja Fennel[1], Benjamin Richaud[1], Xiaofan Luo[2], Xianmin Hu[3] and Youyu Lu[3]

[1]Department of Oceanography, Dalhousie University, Halifax, Canada

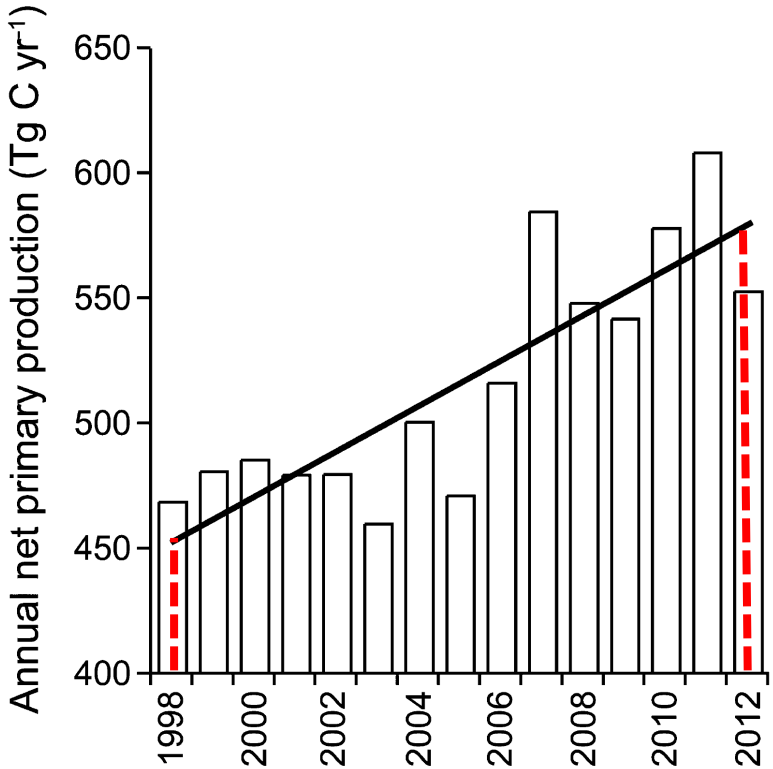
[2]School of Marine Science and Technology, Tianjin University, China

[3]Bedford Institute of Oceanography, Fisheries and Oceans Canada, Dartmouth, Canada

Introduction



National Snow and Ice Data Center



Arrigo and van Dijken (2015)

Hypothesis

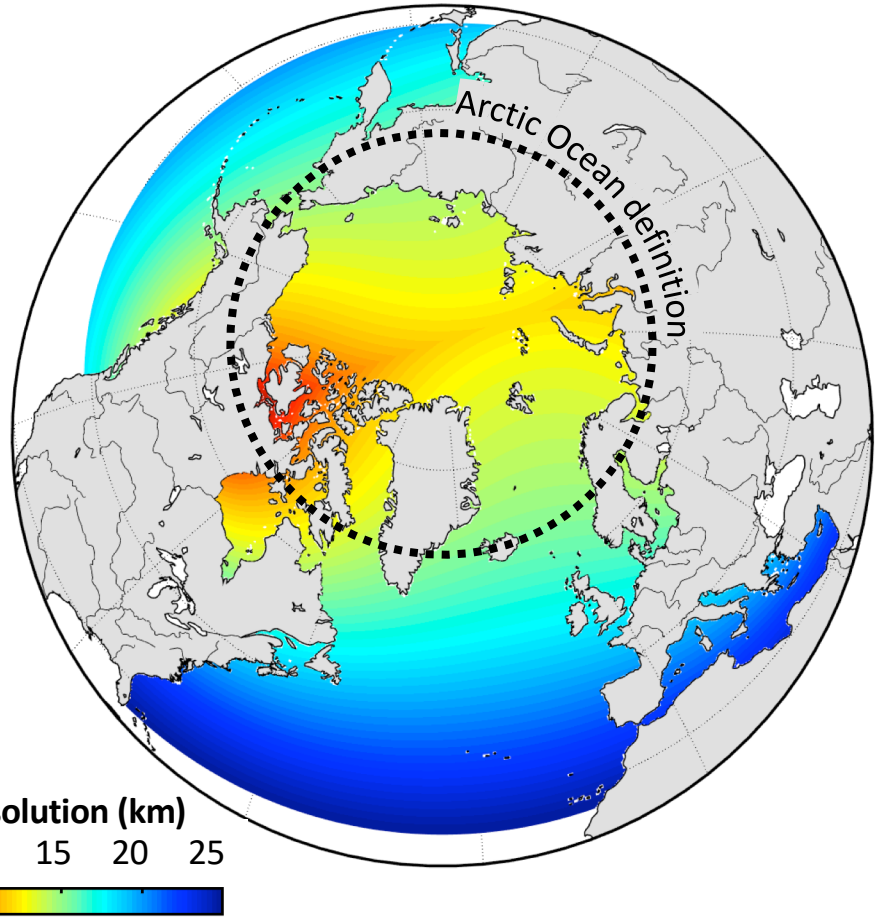
If Arctic sea ice cover drives primary production:

What about carbon export and burial efficiency?

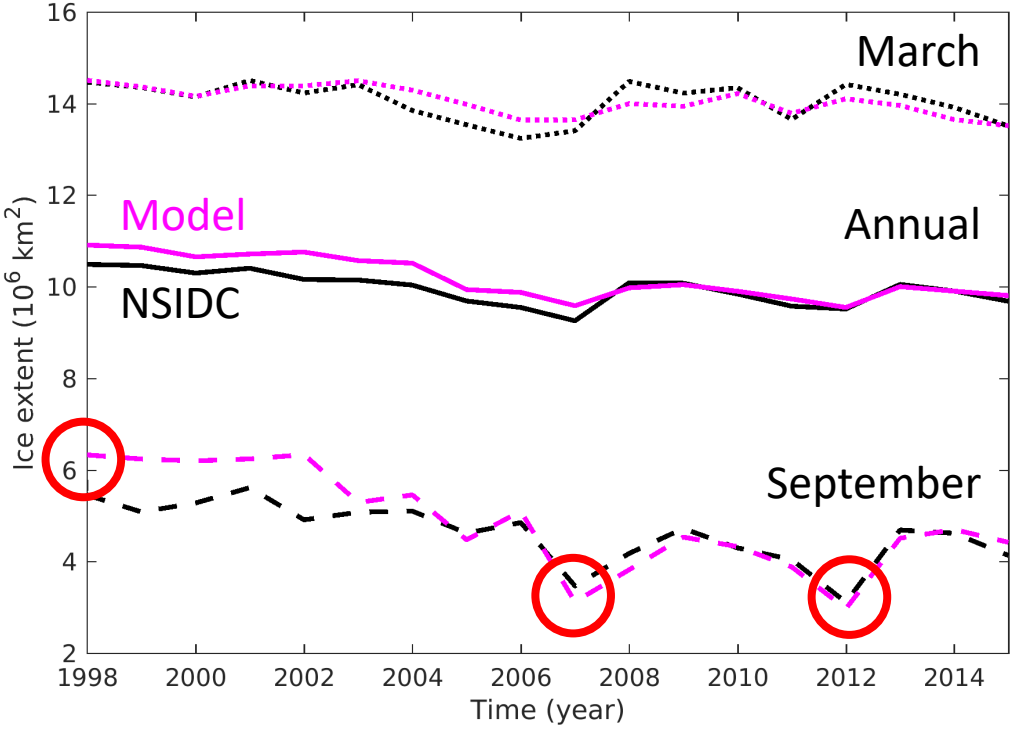
Carbon export or burial **/** primary production

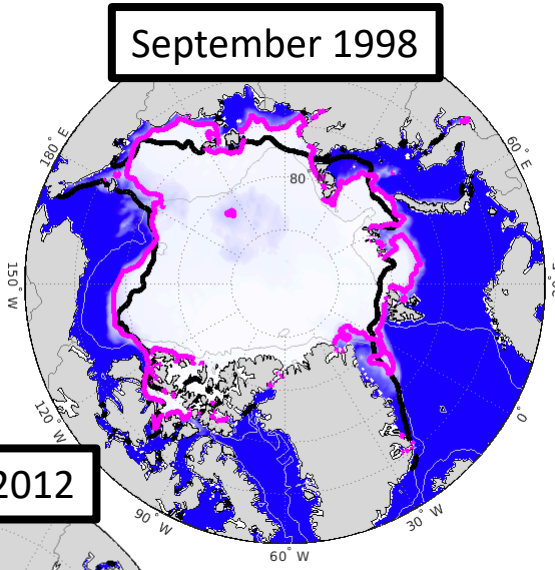
Model

- NEMO v3.6: OPA – LIM v3 – PISCES v2
- 75 vertical levels
- Surface forcing: Atmospheric reanalysis
- Biogeochemical conditions:
  - Initial: from observation (WOA, GLODAP)
  - Open boundary: same, constant
  - Rivers (C, N, P, Si): GEM, GlobalNEWS2
- 5 year spin-up
- Hindcast from 1998 to 2015

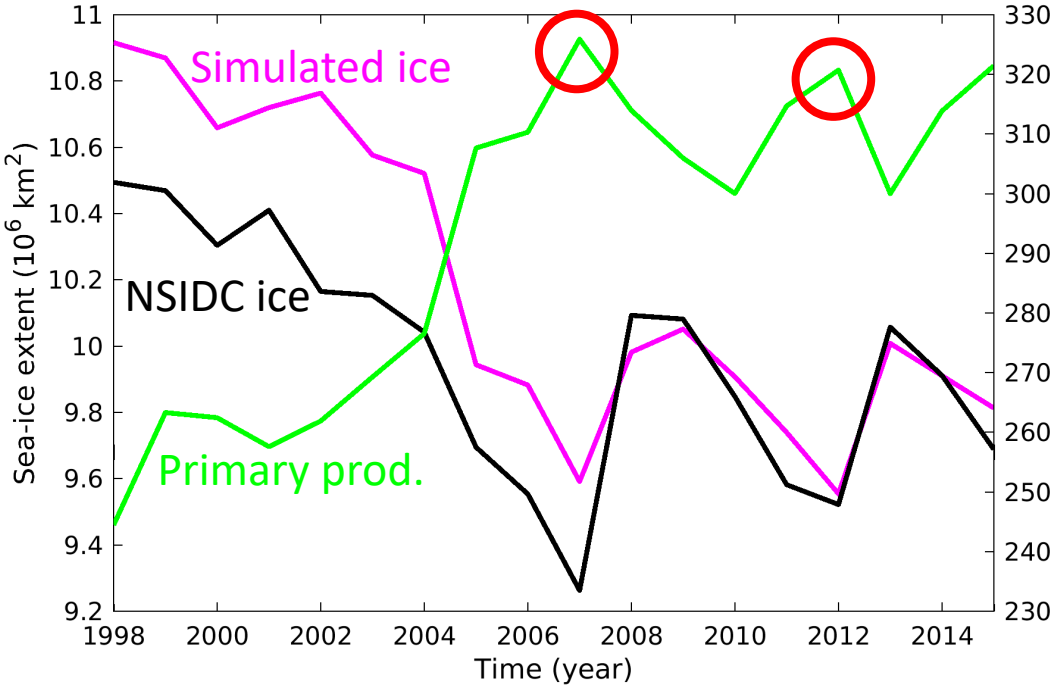


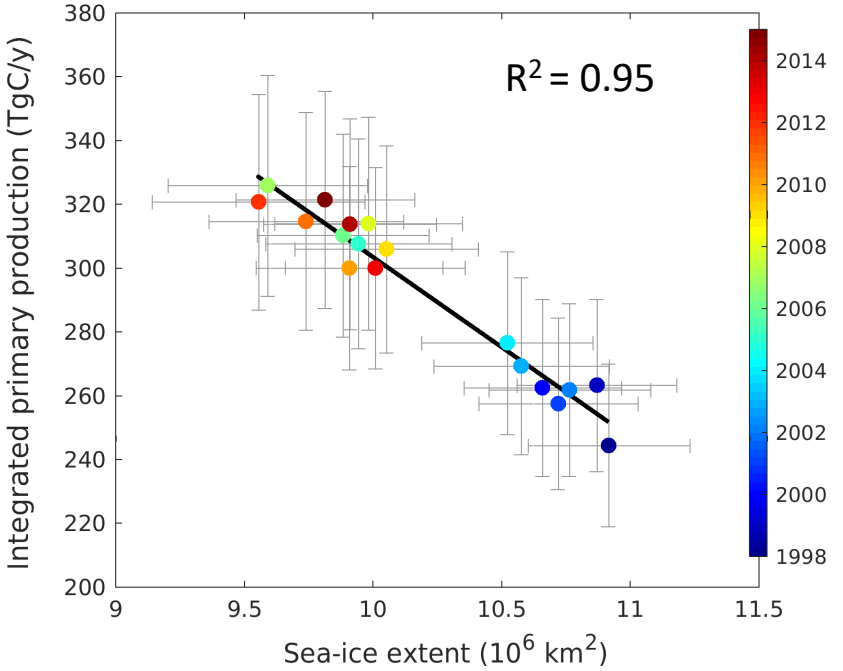
Sea ice extent



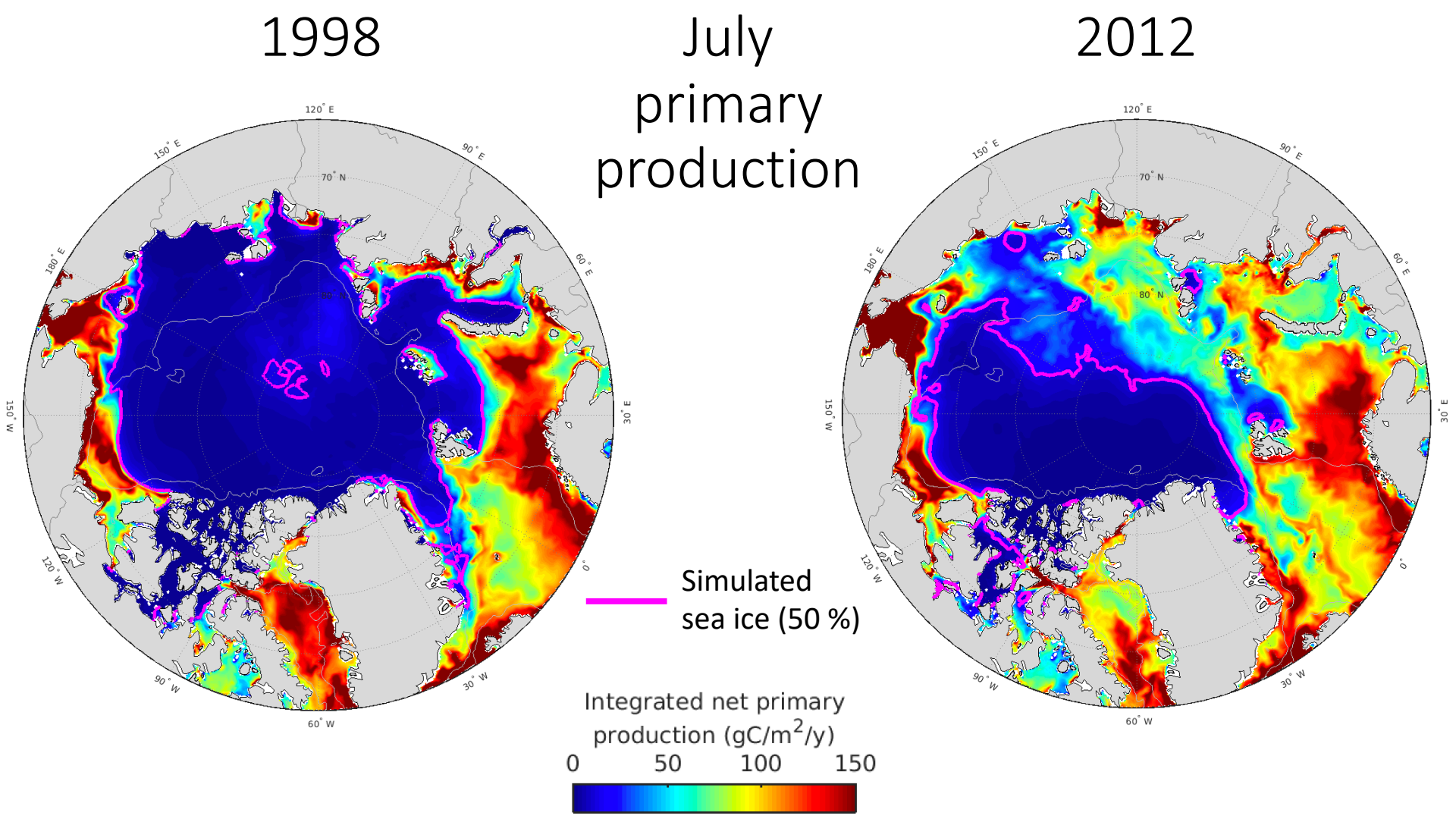


Sea ice drives primary production

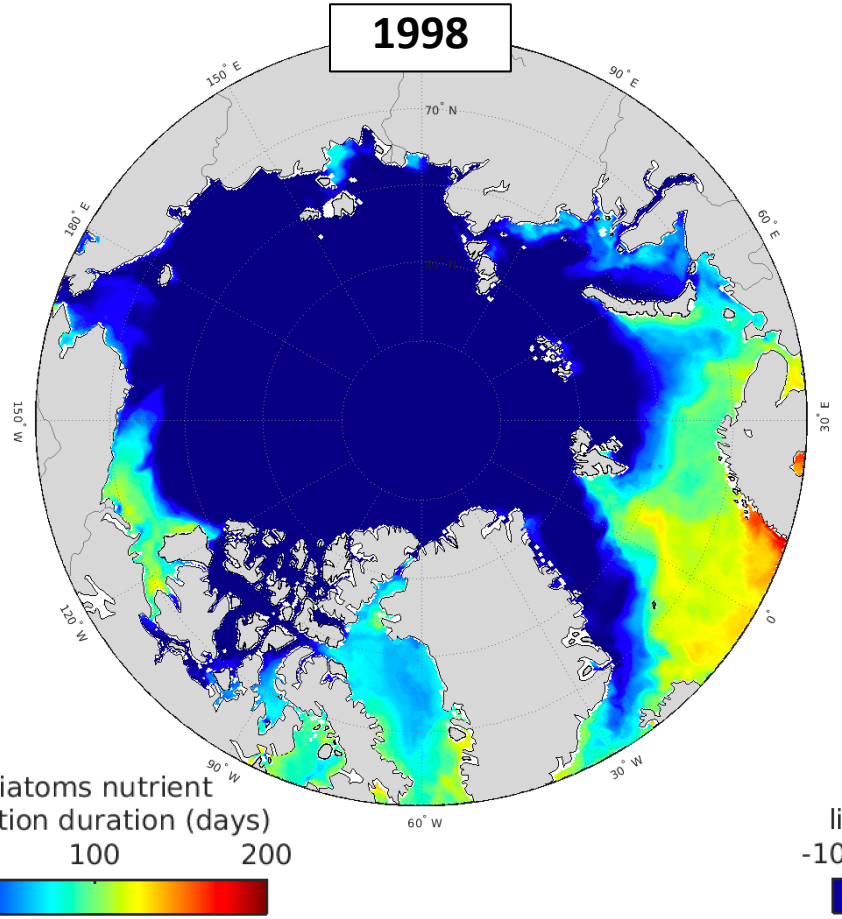


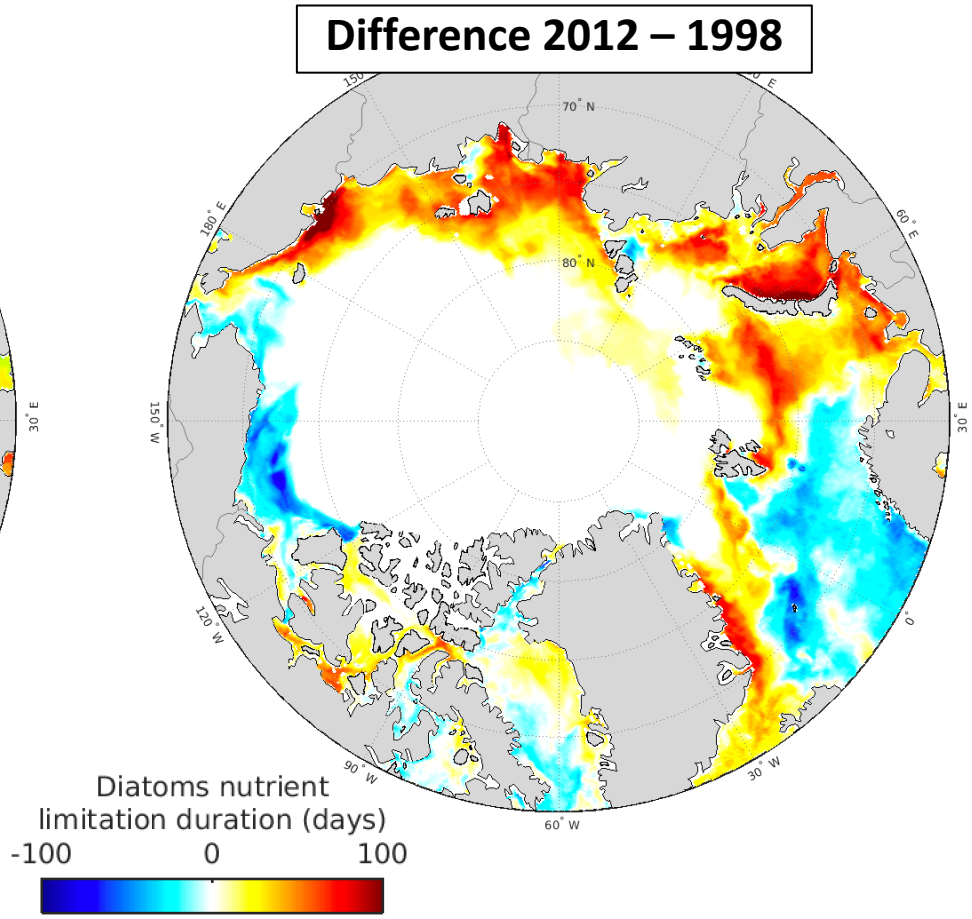


(annual means)


1998
July primary production
2012
Simulated sea ice (50 %)
Integrated net primary production (gC/m^2/y)
0
50
100
150

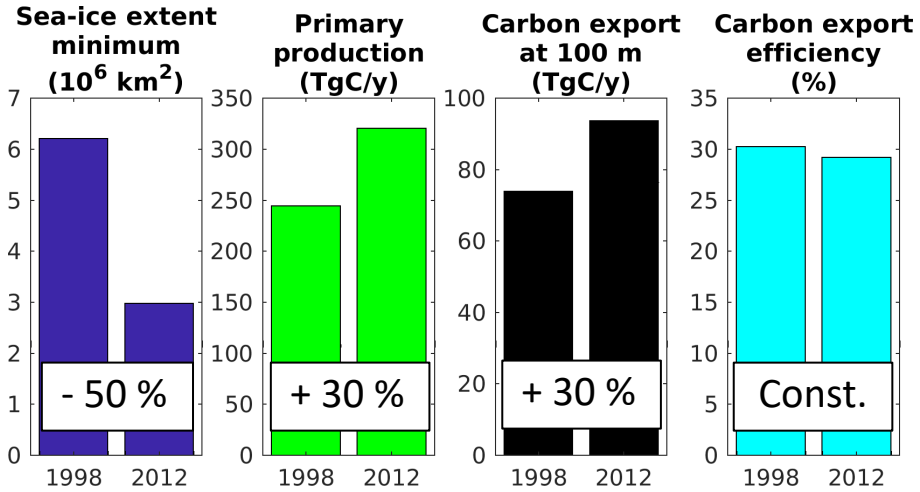
Emergence of nutrient limitation





Carbon export/burial efficiency

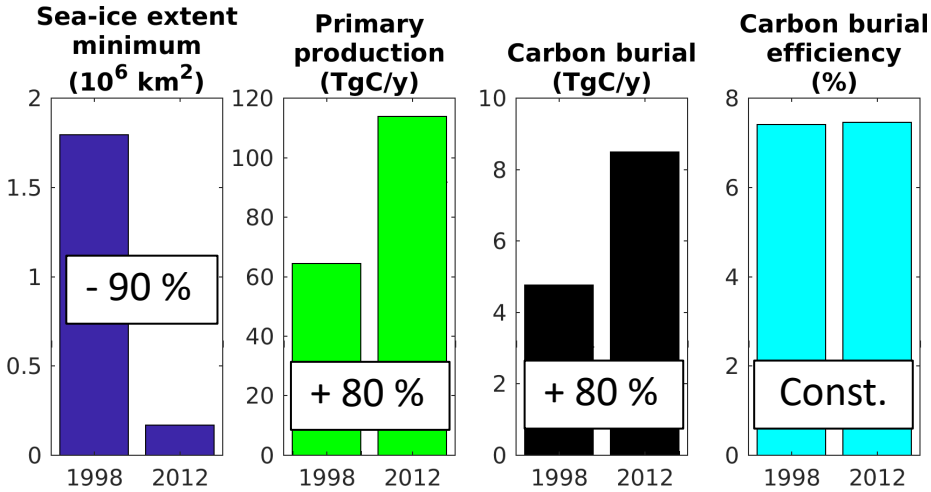
Arctic Ocean

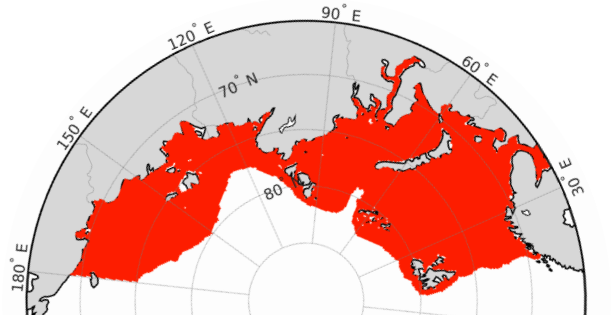


Arctic carbon export efficiency in literature:

- Chen et al. (2003): 26 %
- Gustafsson and Andersson (2012): 34 ± 8 %
- Roca-Martí et al. (2016): 50 ± 50 %

Eurasian shelves





Conclusion

- 2012 Arctic primary production of 320 TgC/y (+ 30 % vs. 1998)
  - Lower end of previous estimates (330-630 TgC/y)

- Carbon export and burial efficiency not sensitive to the change in sea ice cover conditions between 1998 and 2012

- Up to 3 months increase in nutrient limitation duration in Eurasian shelves

- Need to dig deeper into the characteristics of nutrient limitation

Model

NEMO-v3.6 (Madec et al., 2016)

- OPA
- LIM3 (Rousset et al., 2015)
- PISCES-v2 (Aumont et al., 2015)
  - 24 variables
  - 5N 2P 2Z 3D
  - Constant C:N:P:O_2 ratio
  - Carbonate chemistry included