Century scale CO_2 pulses could substantially alter marine primary production, $CaCO_3$ export, oxygen concentrations and DMS emissions

by Ralf Liebermann and Matthias Hofmann

Presentation for OS3.1 – Response of ocean biogeochemical cycles to climate change

May, 26th 2022

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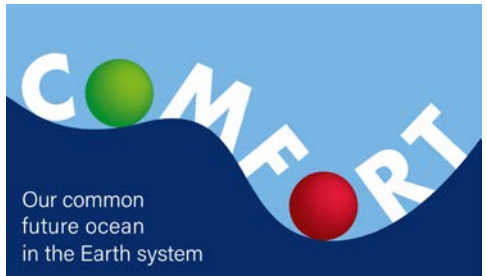


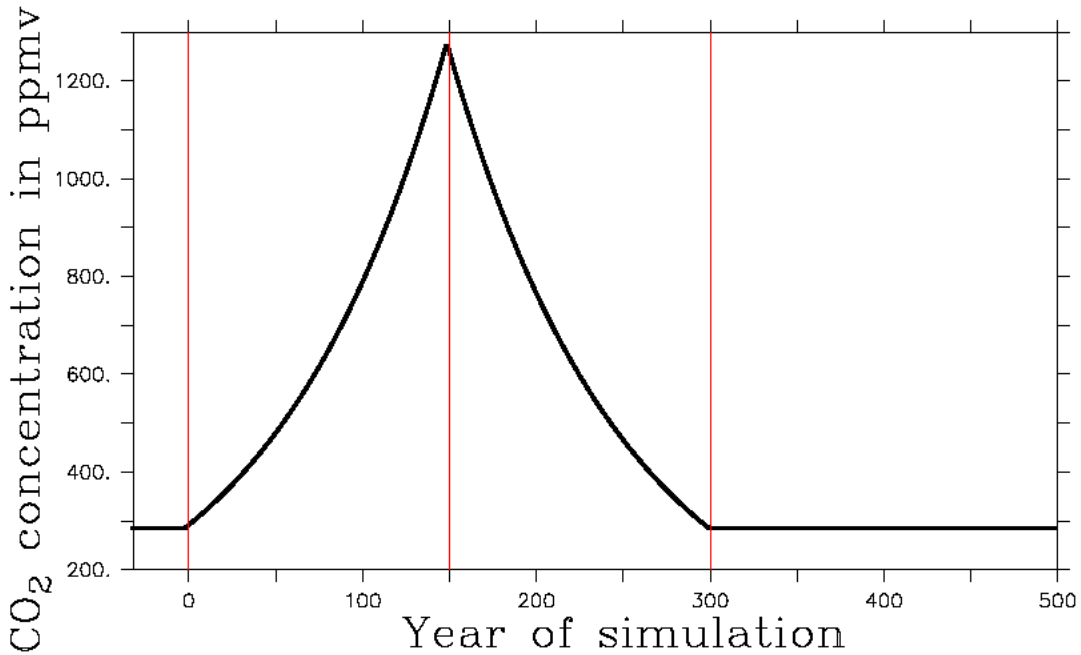
Overview

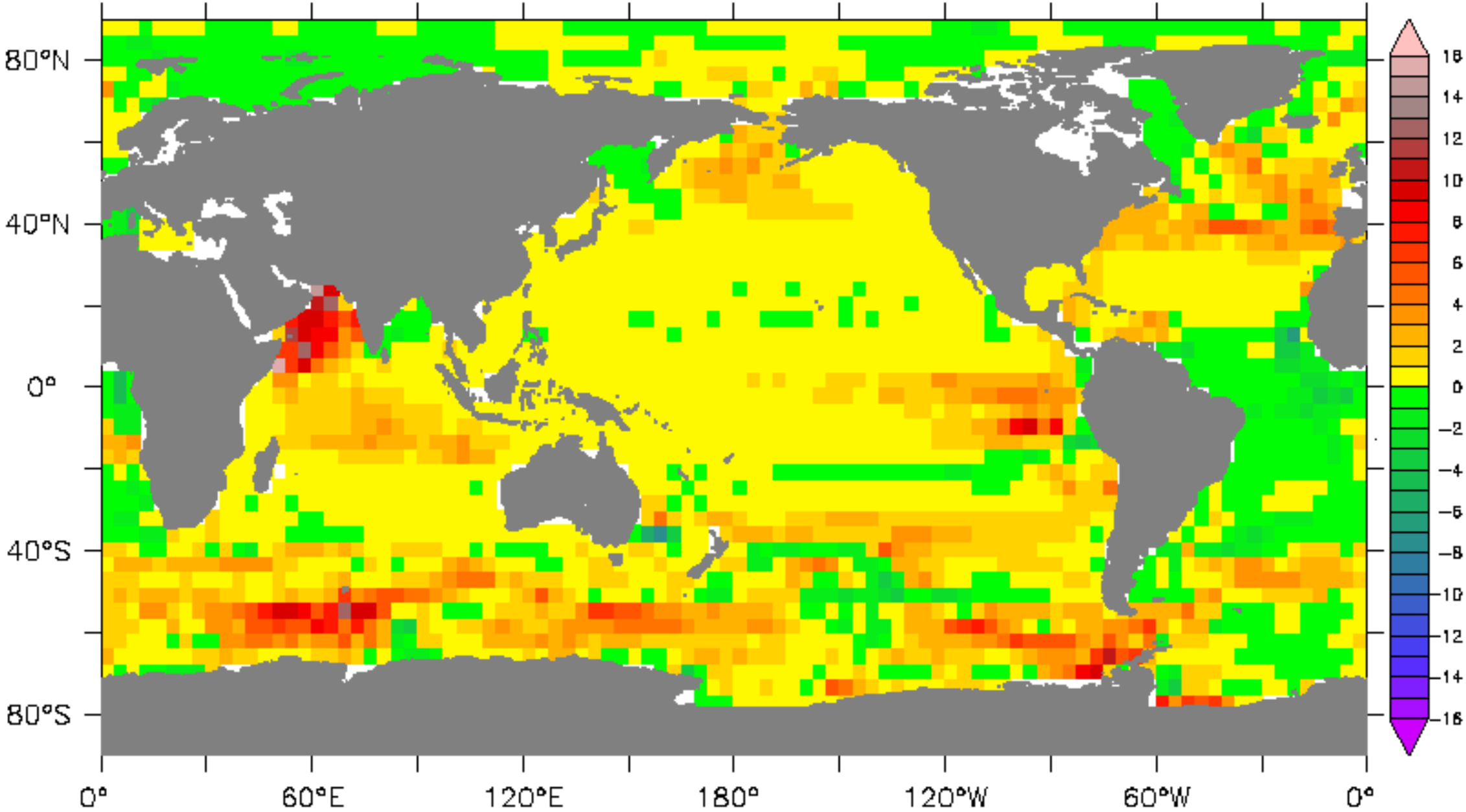
- Work in progress within the COMFORT project, work package 2.1 (https://comfort.w.uib.no/)
- **Topic: Identification of possible tipping points in the oceanic biogeochemistry**
- simulation data based on a preset transient fourfold increase of atmospheric CO_2 concentrations ($4xCO_2$)
- using the EMIC Climber3α+C

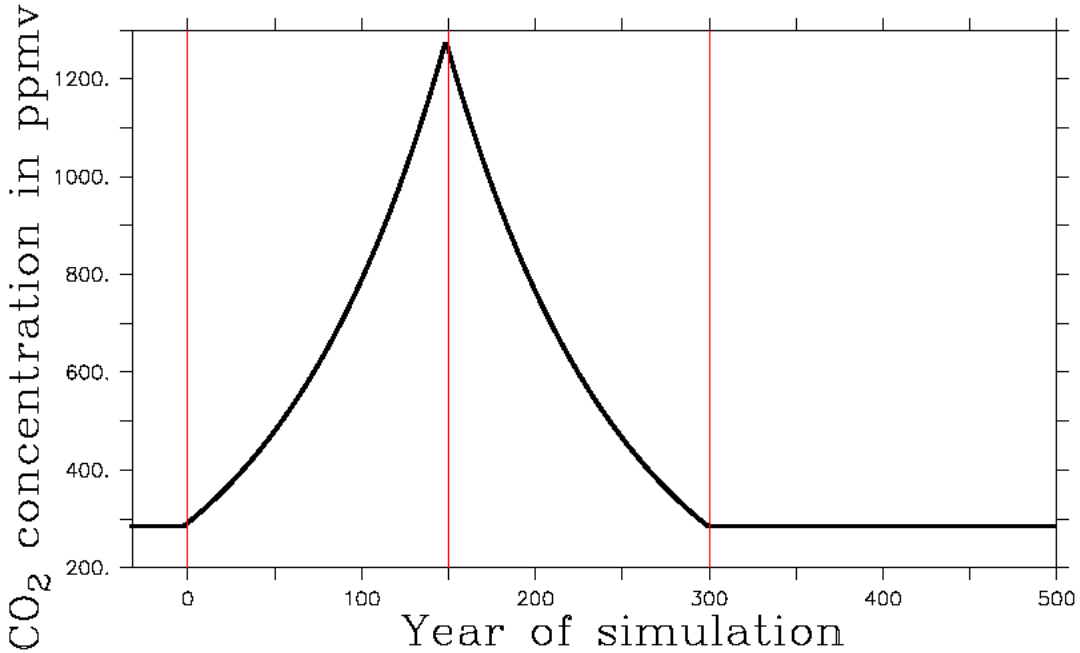
  (for Climber3, see [1])
- evaluating possible memory effects

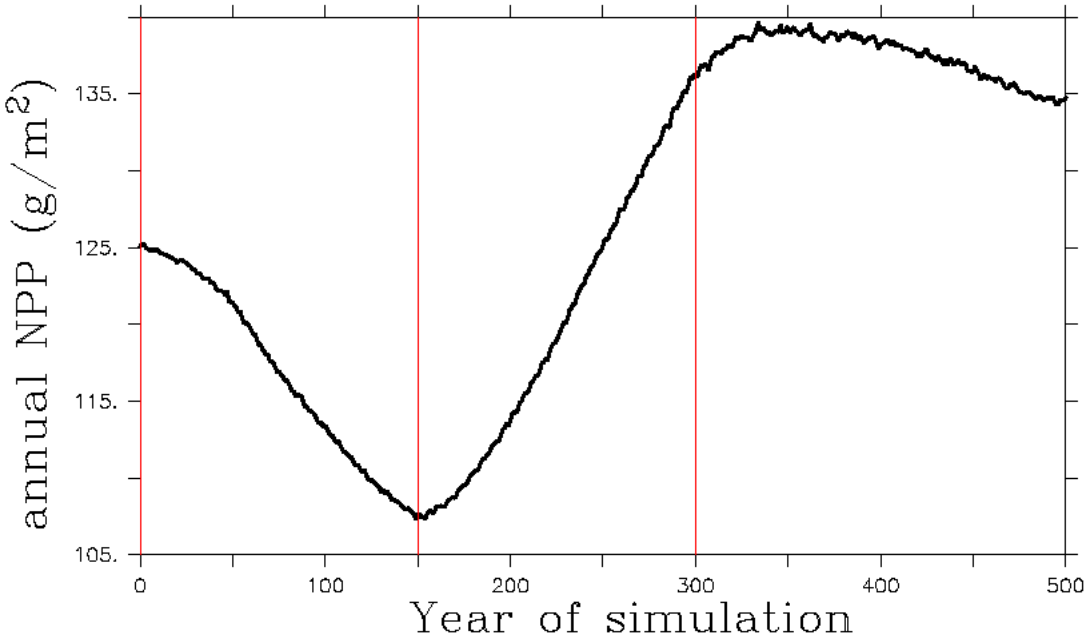
  of NPP, DMS, O_2 (Appendix, see [2])

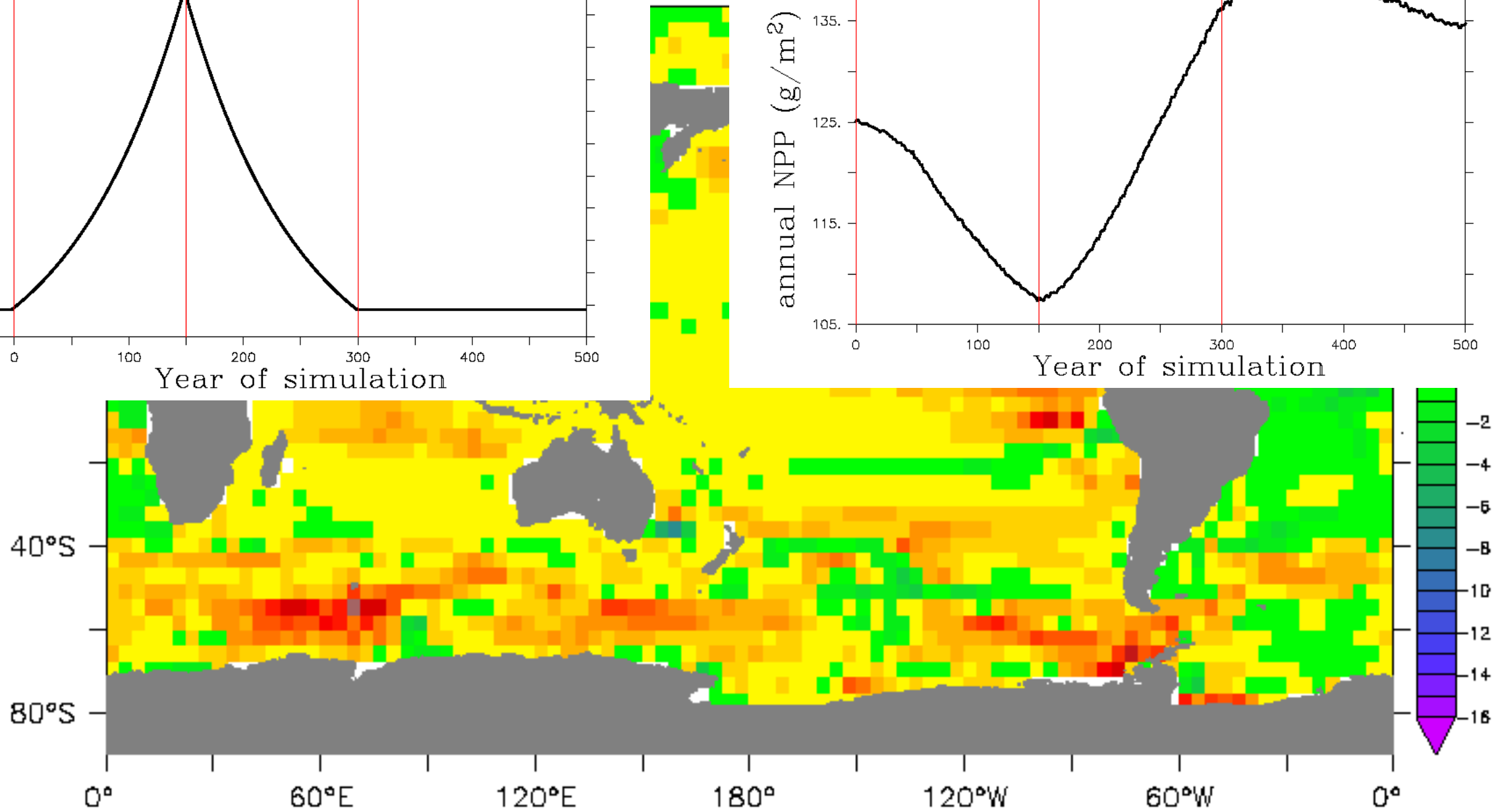
  and $CaCO_3$




80°N
40°N
0°
40°S
80°S
0°
60°E
120°E
180°
120°W
60°W
0°
16
14
12
10
8
6
4
2
0
−2
−4
−6
−8
−10
−12
−14
−16
Change of primary production (NPP difference in g/m²)


CO_2 concentration in ppmv
1200.
1000.
800.
600.
400.
200.
0
100
200
300
400
500
Year of simulation


annual NPP (g/m^2)
135.
125.
115.
105.
0
100
200
300
400
500
Year of simulation


40°S
80°S
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120°E
180°
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−2
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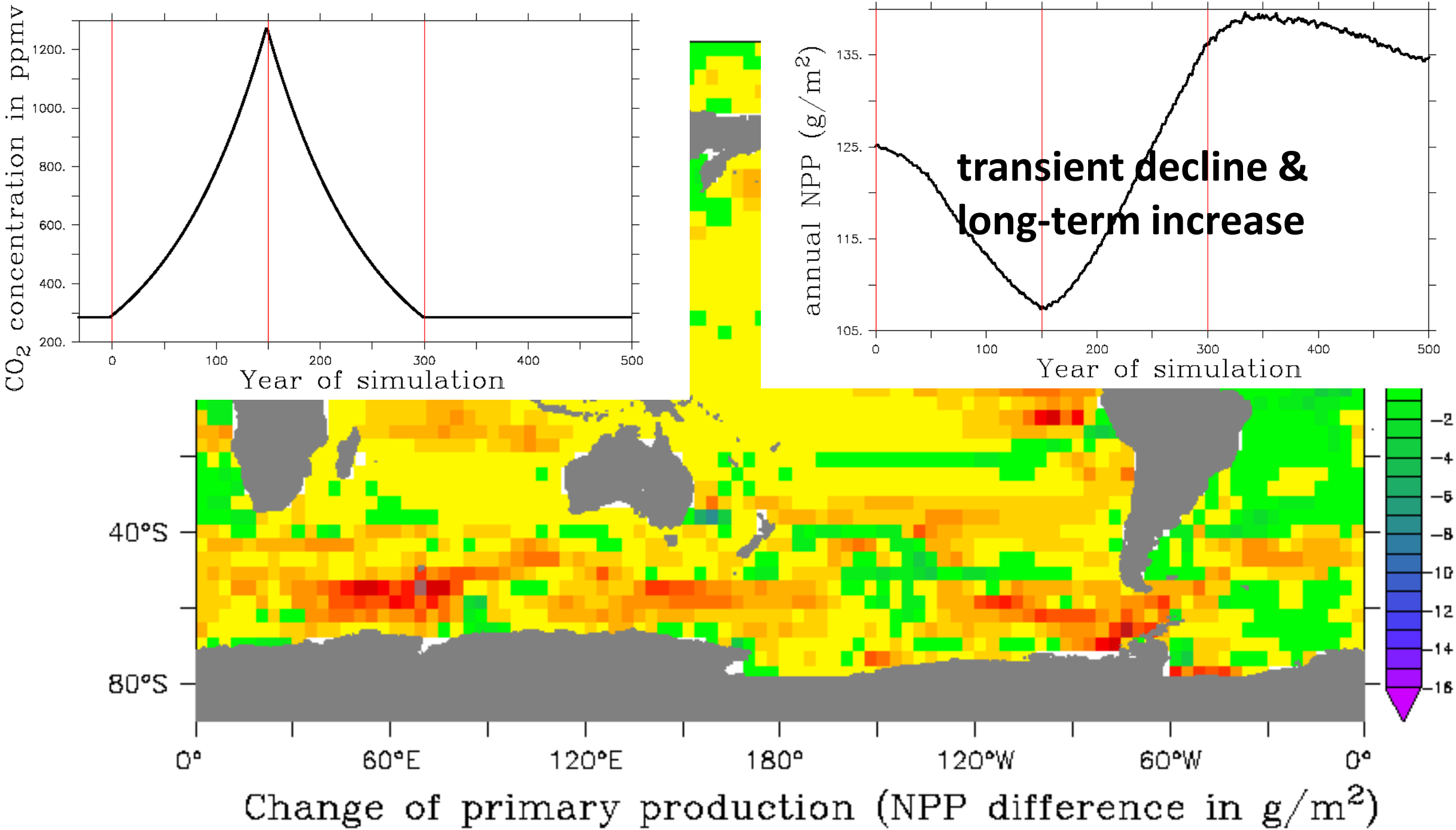
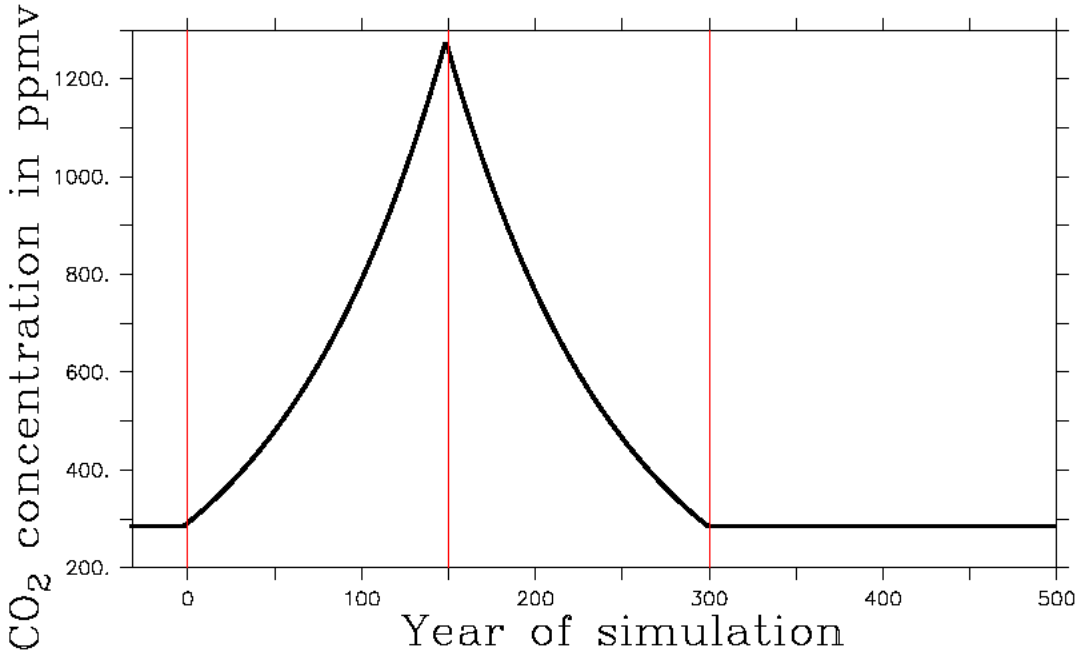
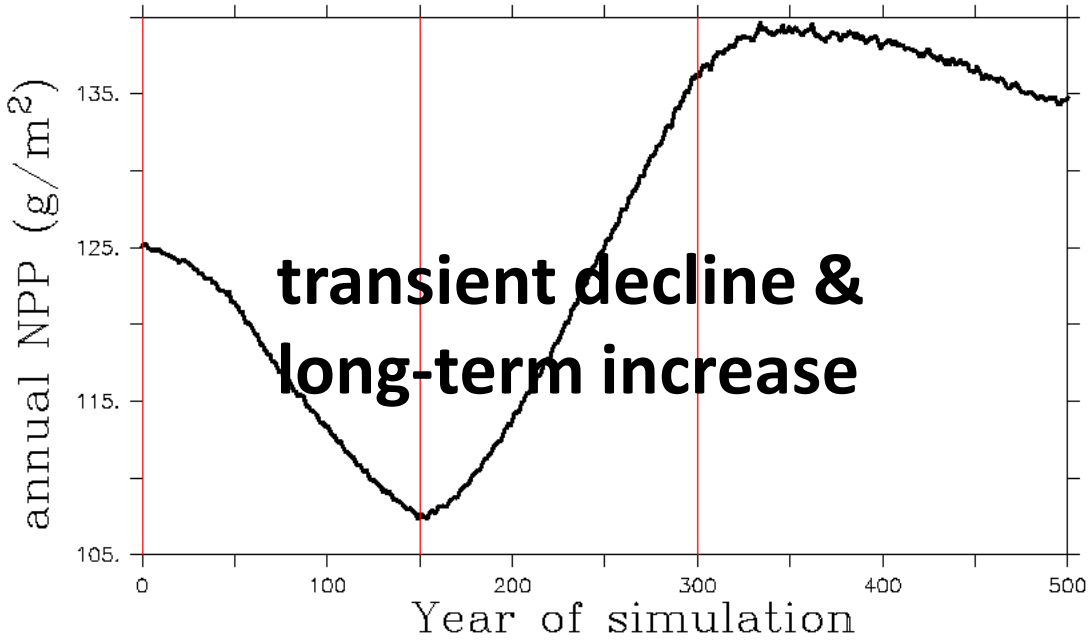
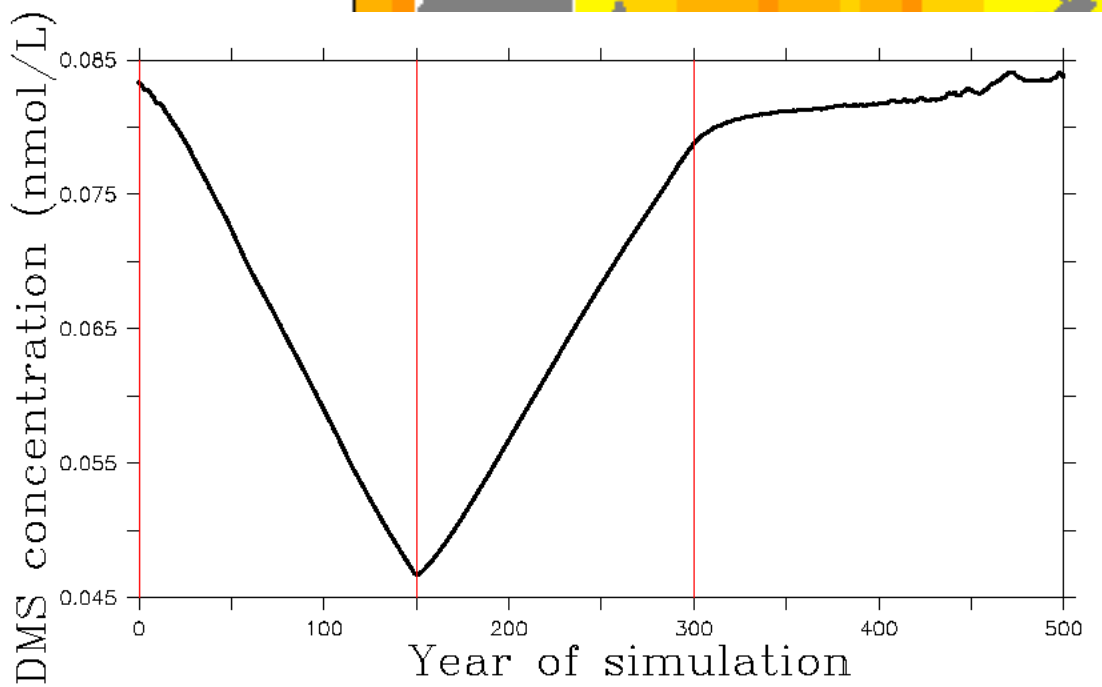
−12
−14
−16
Change of primary production (NPP difference in g/m^2)

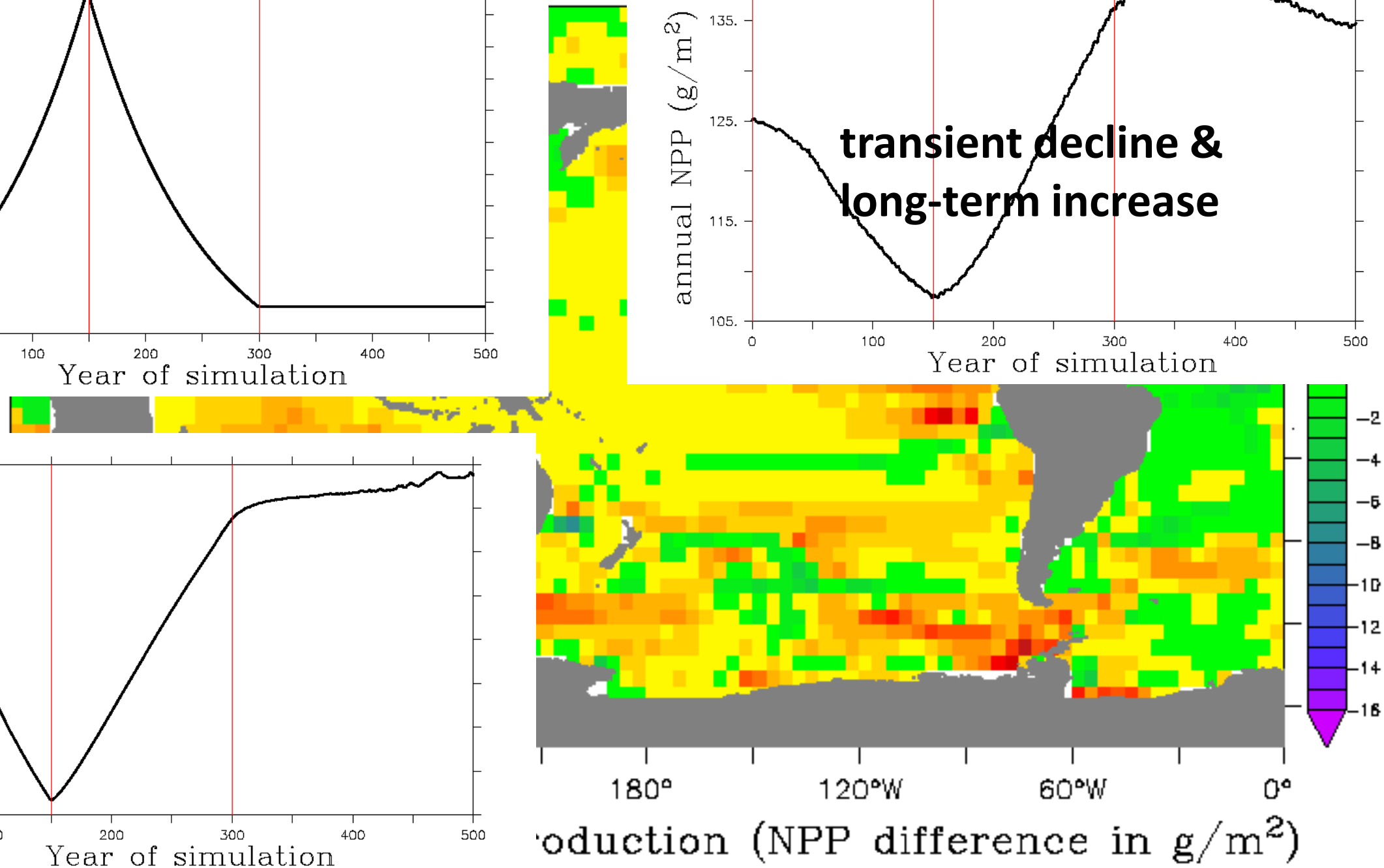

CO_2 concentration in ppmv
1200.
1000.
800.
600.
400.
200.
0
100
200
300
400
500
Year of simulation
annual NPP (g/m^2)
135.
125.
115.
105.
0
100
200
300
400
500
Year of simulation
transient decline &
long-term increase
40°S
80°S
0°
60°E
120°E
180°
120°W
60°W
0°
−2
−4
−6
−8
−10
−12
−14
−16
Change of primary production (NPP difference in g/m^2)

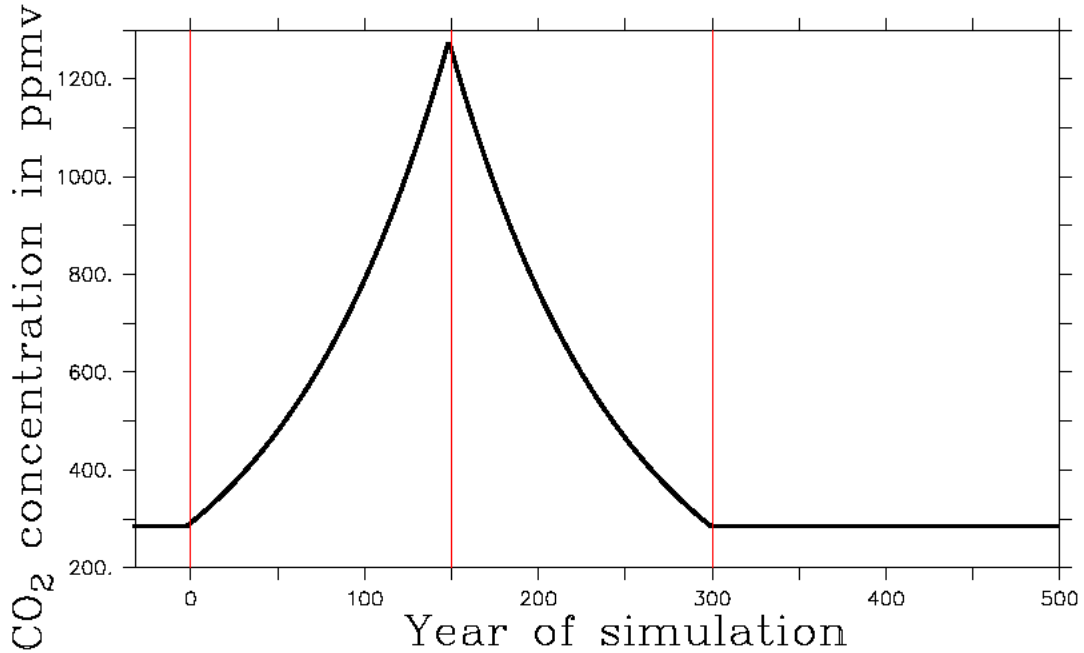


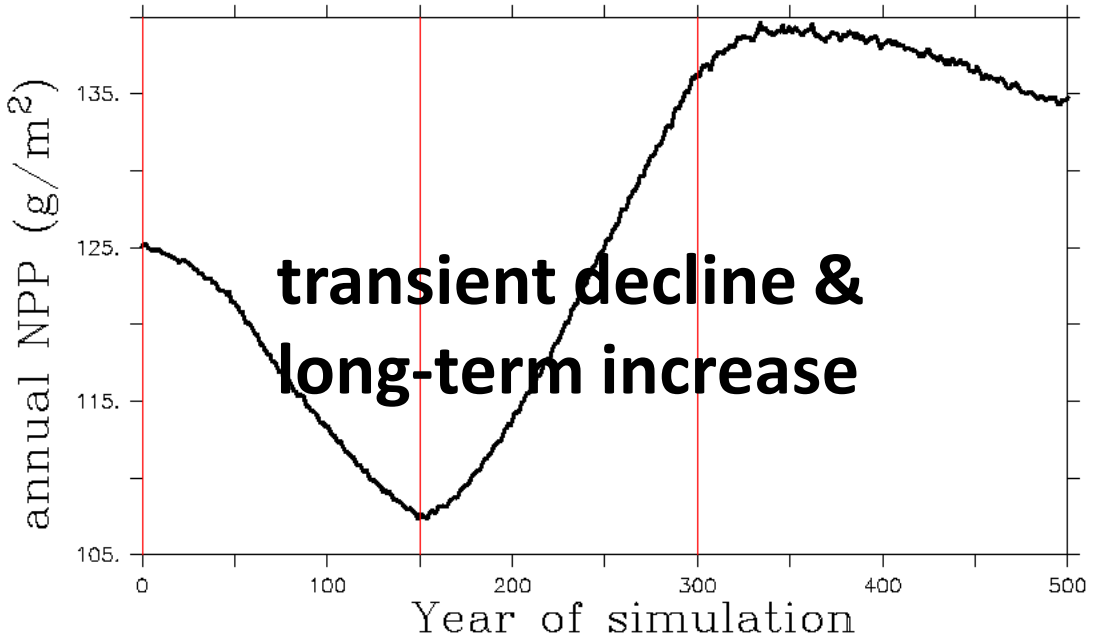


transient decline & long-term increase

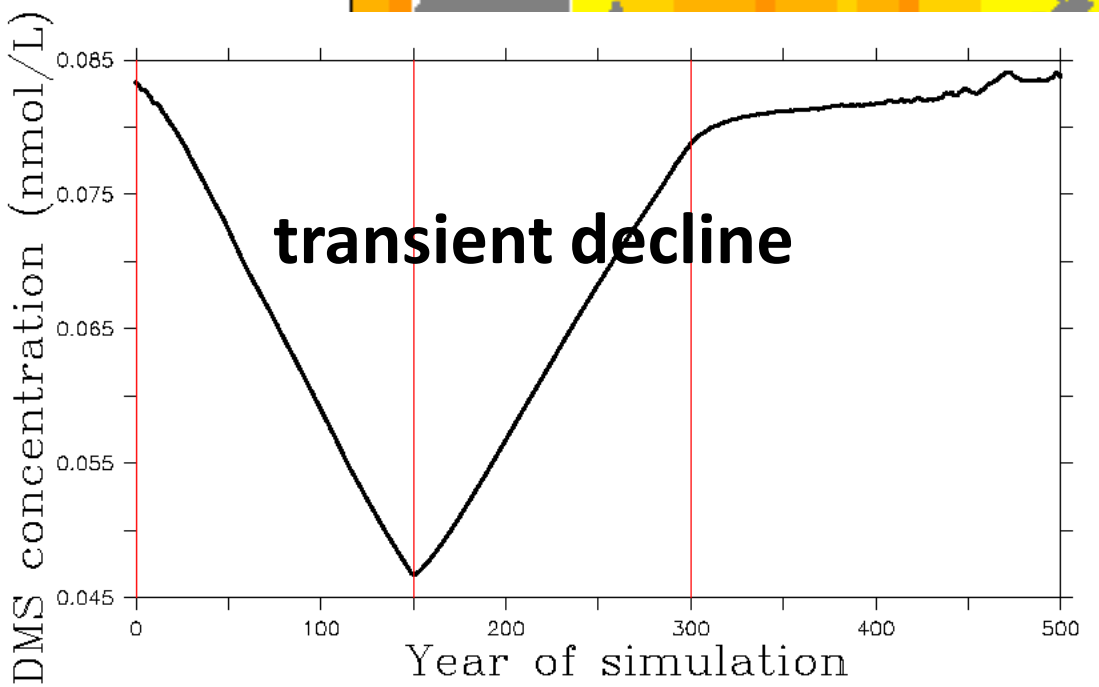




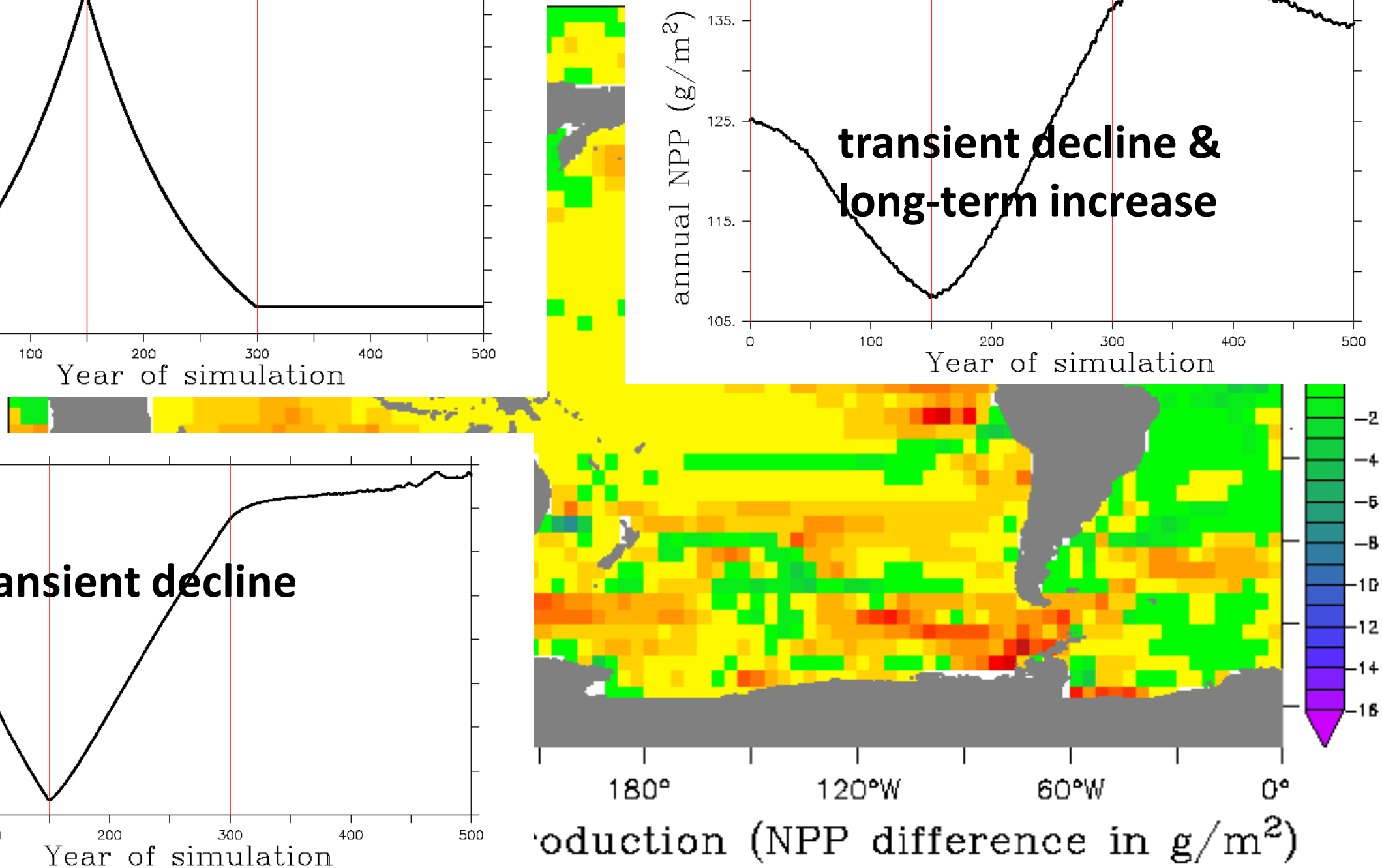




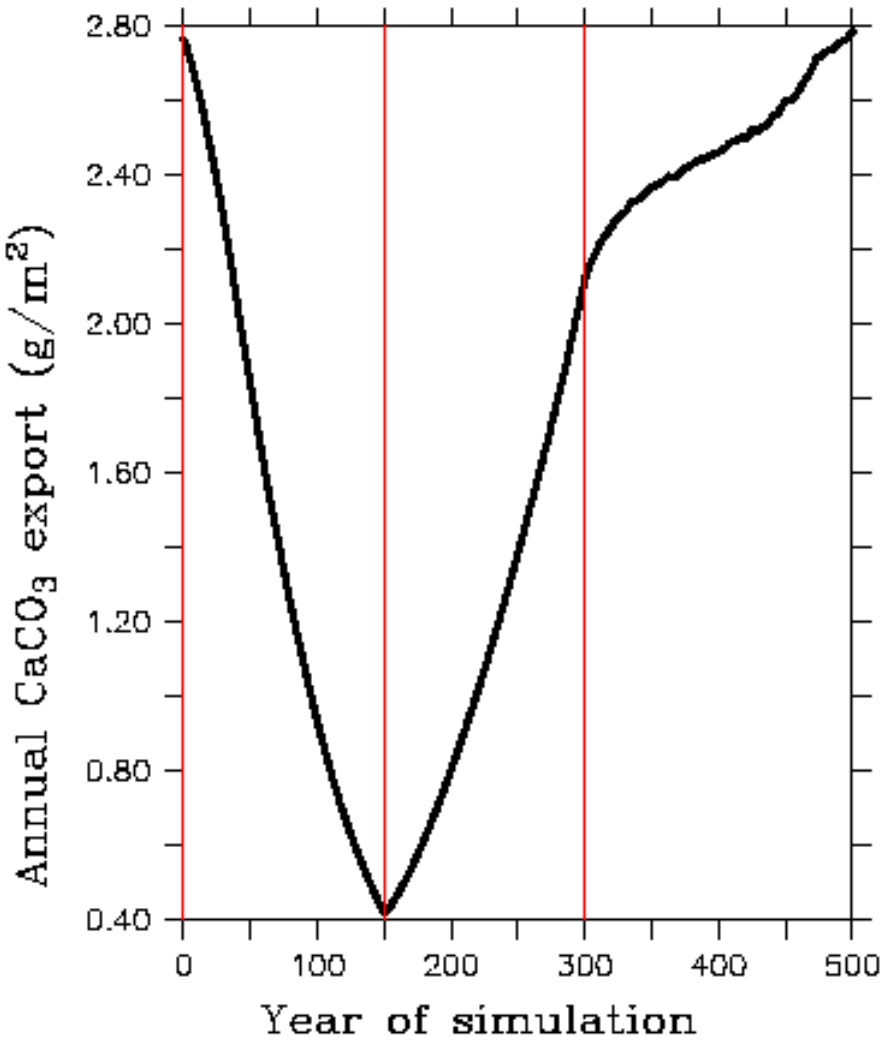
transient decline & long-term increase

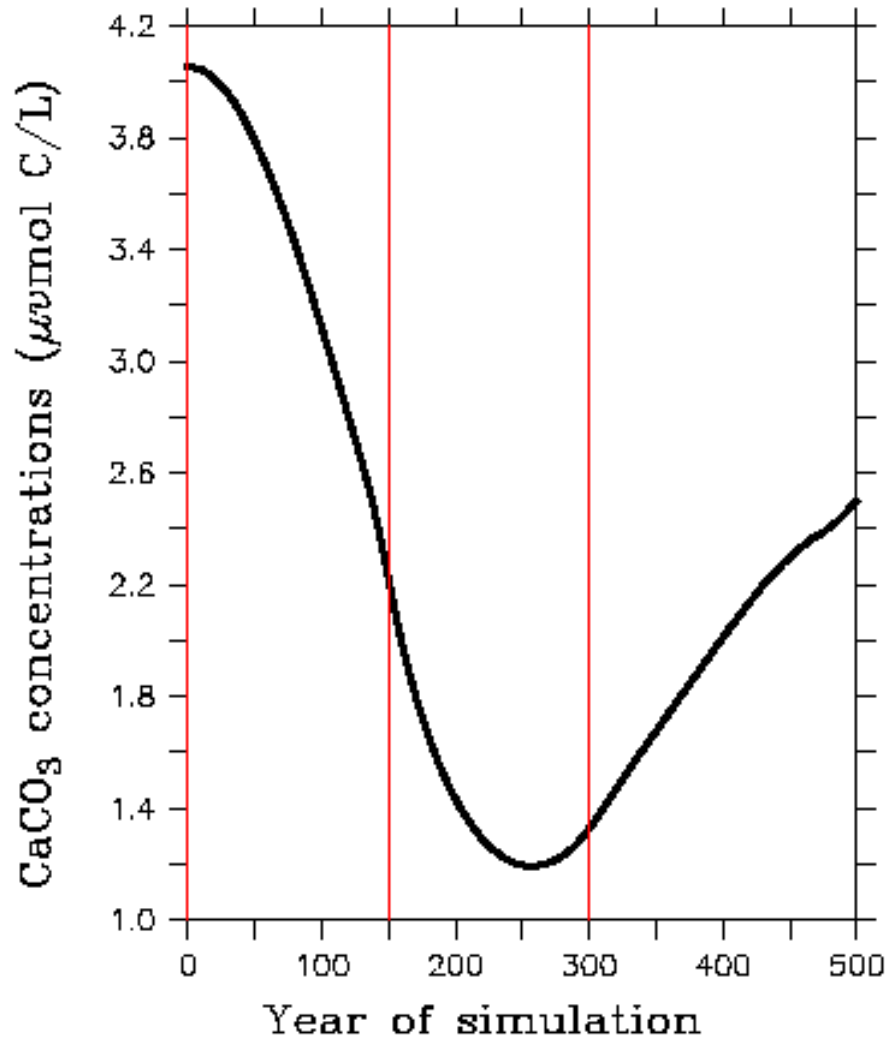


transient decline

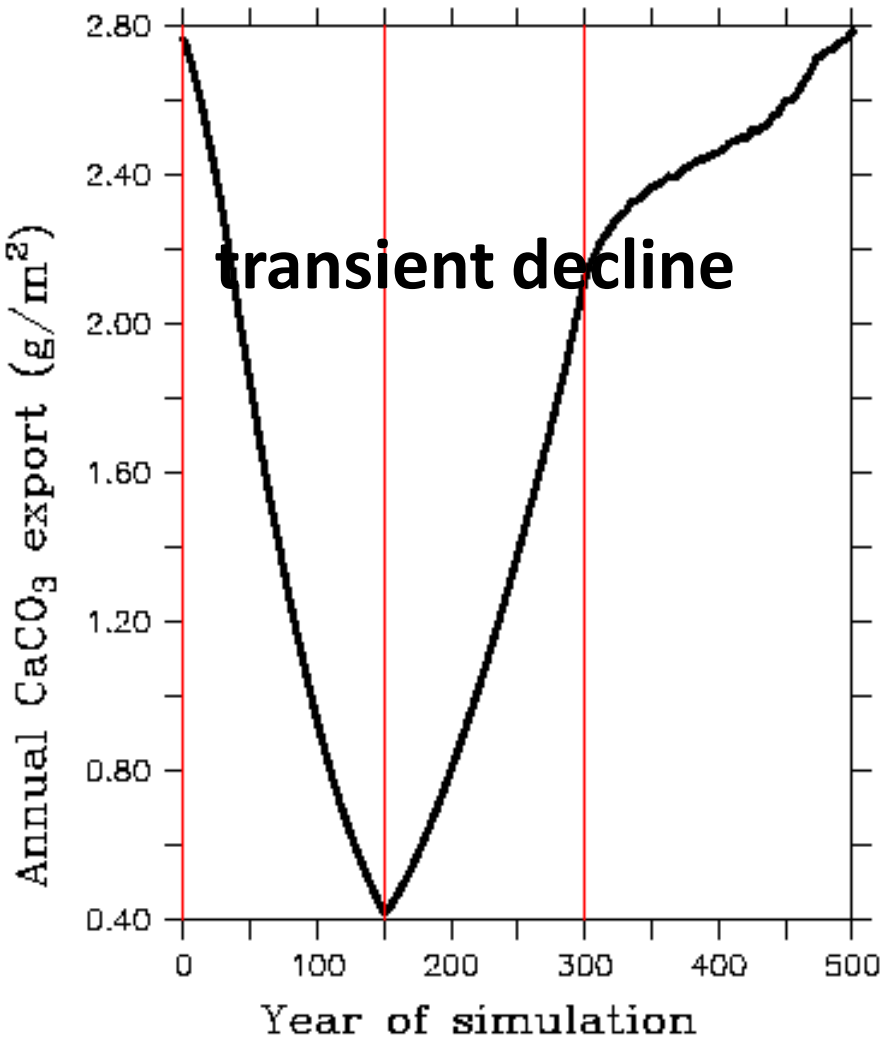


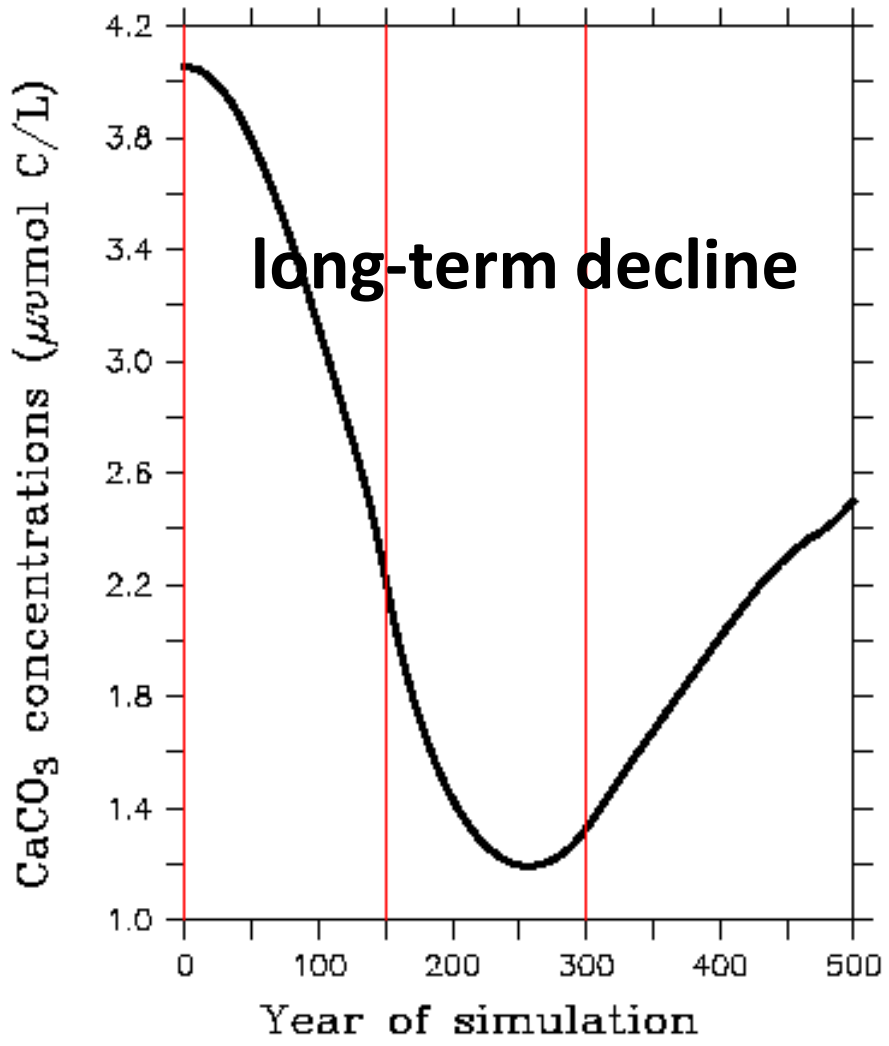
Change in $CaCO_3$



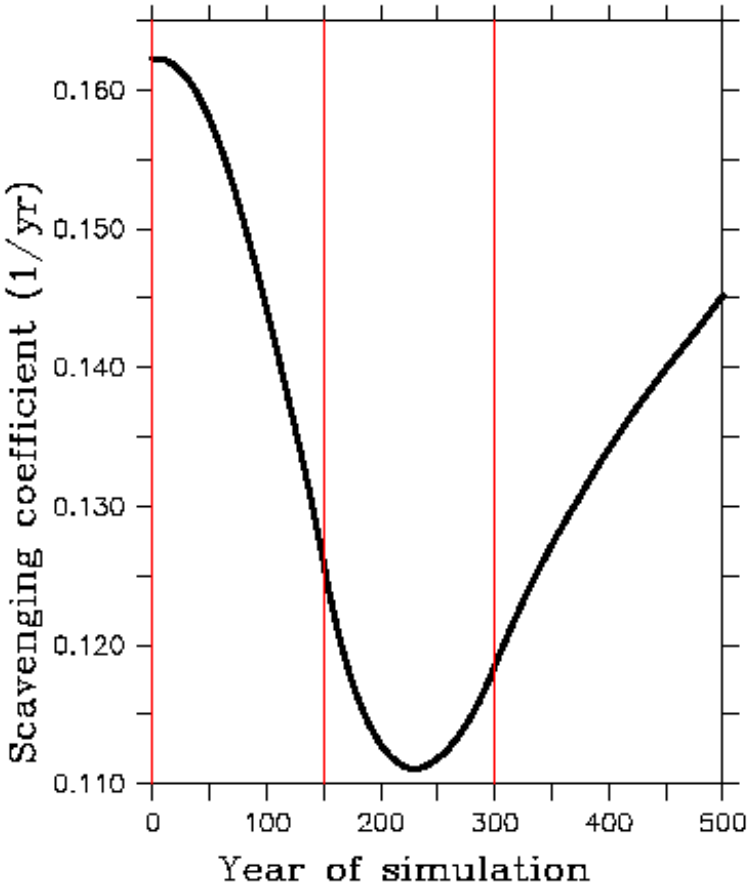


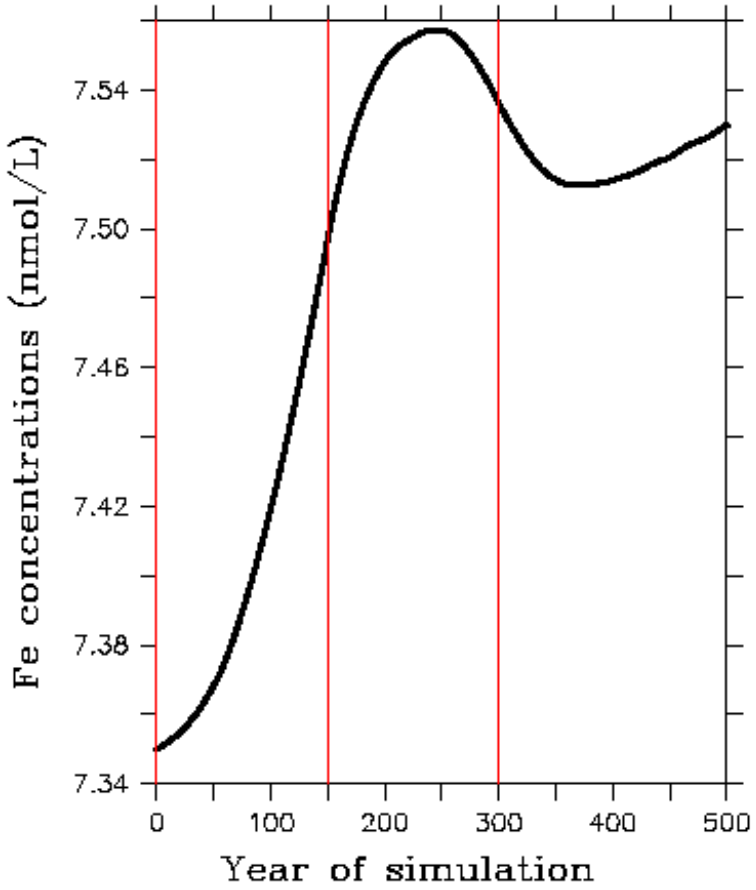
Change in $CaCO_3$





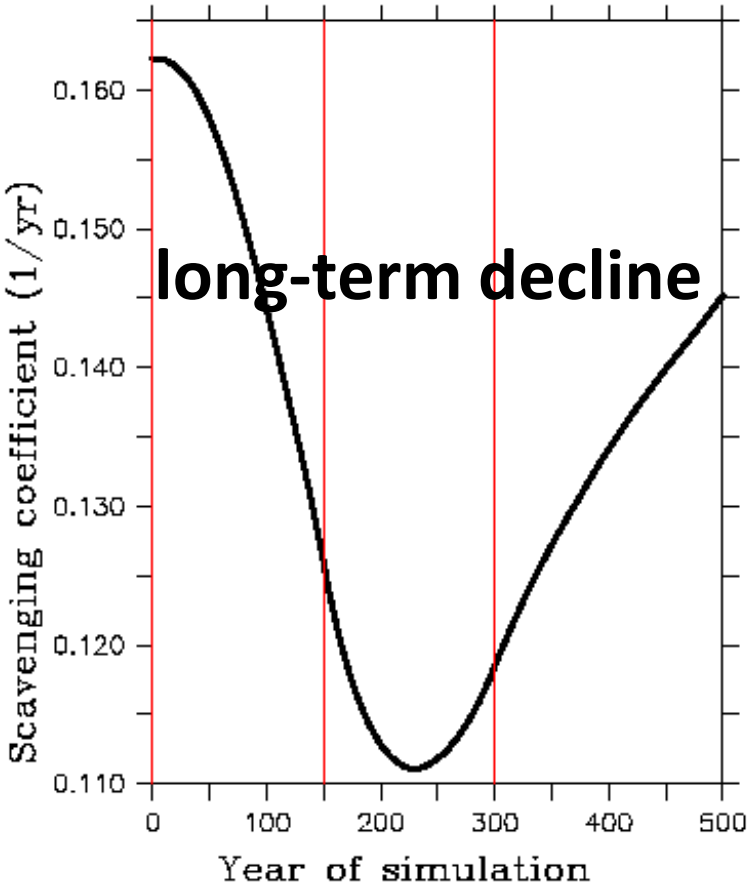
Fe scavenging

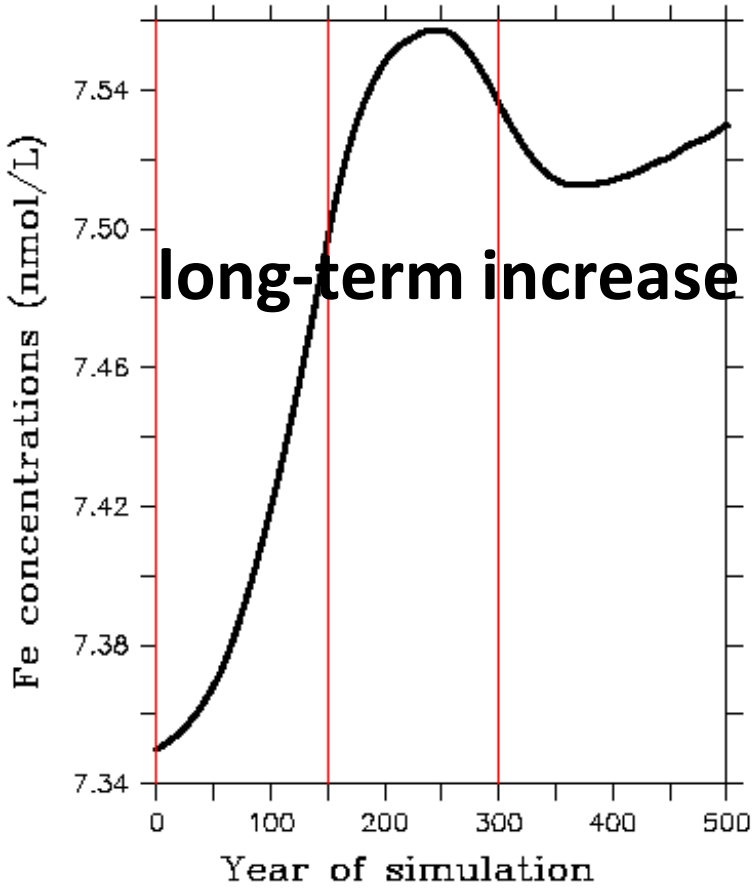




Scavenging $=$
$0.01([CaCO_3] + [POC])^{0.58}$

Fe scavenging





Scavenging $=$
$0.01([CaCO_3] + [POC])^{0.58}$

Summary

- only transient impacts of the CO_2 pulse on DMS and $CaCO_3$ export
- memory effects visible for NPP and $CaCO_3$ concentrations
- next step: investigate the long-term fertilizer effect of $CaCO_3$ decline due to reduced Fe scavenging

References

[1] M. Montoya, A. Griesel, A. Levermann et al., Climate Dynamics 25: 237-263 (2005). DOI 10.1007/s00382-005-0044-1

[2] D. Breitburg, L. A. Levin, A. Oschlies et al., Science 359, eaam7240 (2018). DOI: 10.1126/science.aam7240

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Thank you for your attention!

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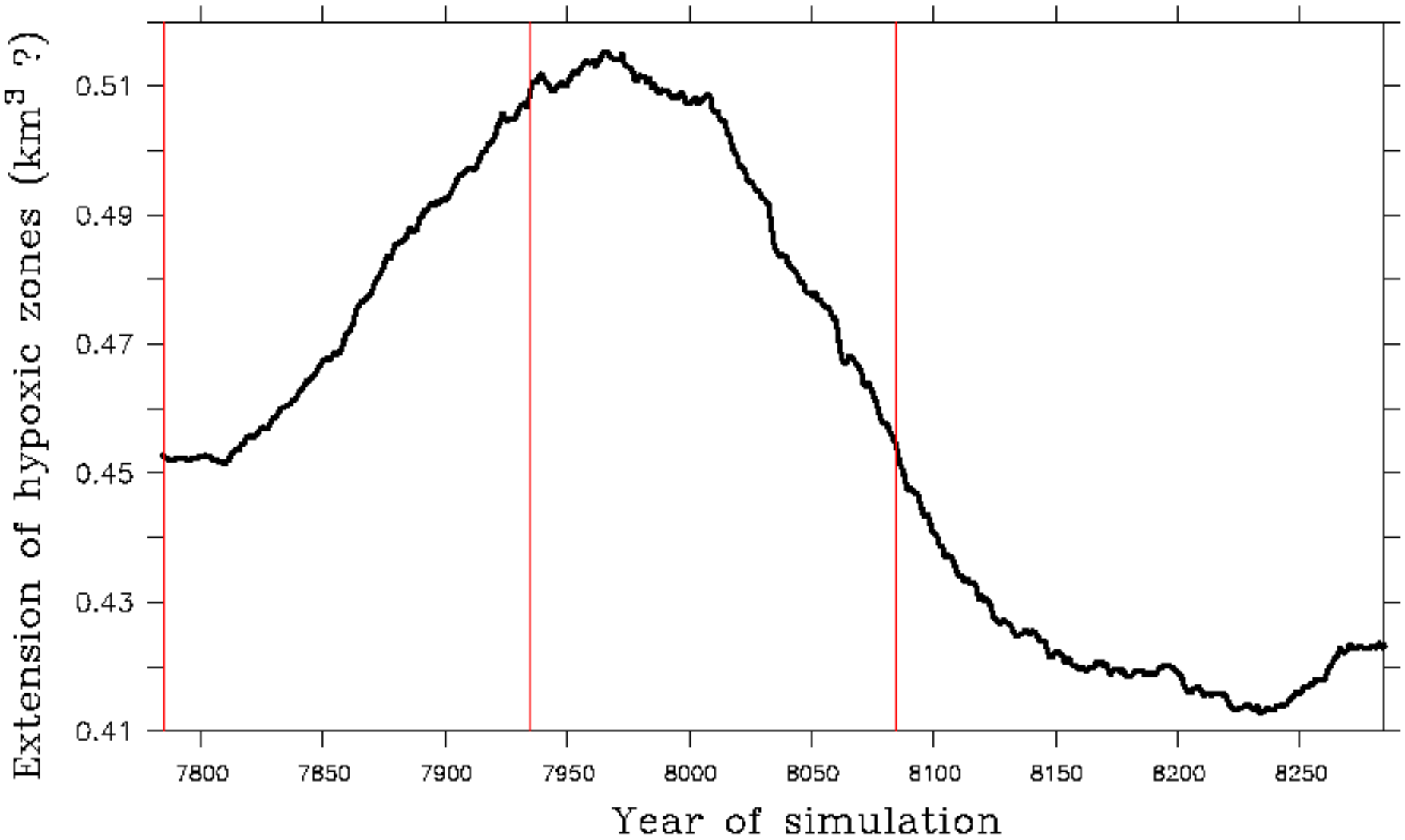
Appendix: Change in hypoxic zones



Appendix: Fe concentrations (depths 100m - 5000m)