Overview of observations available to evaluate Dynamic Green Ocean Models

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Abstract:

The links between climate and marine ecosystems are poorly known. On the one hand, recent studies have highlighted large changes in plankton and fish composition following well known climatic indexes. On the other hand, current ocean biogeochemistry models can hardly reproduce observed variations in surface plankton biomass over the last five years and predict small changes in marine productivity for the future. The gap between observations and models is possibly due to the over-simplification of marine ecosystem models. However this is hard to prove unless models are evaluated with an appropriate set of observations. The poster presents an overview of the observations available at this time to evaluate the PlankTOM-10 Dynamic Green Ocean Model.

Choice of Plankton Functional Types: A PFT should be distinguished when it has (a) an explicit biogeochemical role, (b) a quantitative importance in at least one region of the ocean; (c) a distinct set of environmental and nutrient requirements for productivity; and (d) a distinct impact on the rest of the community (e.g. composition). We identify ten PFTs that should be simulated explicitly in order to capture important biogeochemical processes in the ocean.

Pico-heterotrophs; remineralise dissolved and particulate organic matter

Pico-autotrophs; contribute to primary production but not to export

N2-fixers; control total ocean inventory of reactive N

Calcifiers; produce > half the marine carbonate flux, sensitive to pH

DMS-producers; influence atmospheric sulphur cycle

Mixed; the background biomass of phytoplankton

Silicifiers; contribute to export

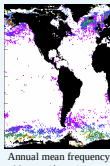
Proto; graze on small phytoplankton, control blooms

Meso; graze on all sizes plankton, produce fast-sinking faecal pellets

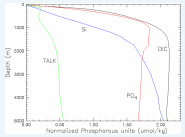
Macro; graze on all sizes of phyto-plankton and produce fast-sinking faecal pellets

Export and remineralization: The representation of PFTs is linked to biogeochemistry through the export of matter and its remineralization in the deep ocean. Here we focus on ecological factors affecting the spatial variability of organic carbon export and remineralization at depth and on the relationship between organic carbon export and minerals: $CaCO_3$ produced by coccolithophores and foraminiferans, Opal produced by diatoms and lithogenic material from dust inputs.

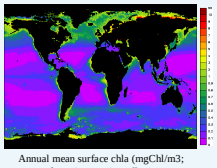
Evaluation strategy: The model evaluation is made using a wide range of observations, some of which are already available, some of which we synthesize ourselves.



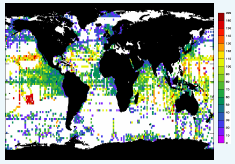
Annual mean frequency of coccolithophorid blooms (from SeaWiFS satellite based on analysis by C. Brown)



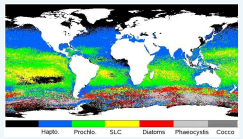
Global mean concentration of PO4, total alkalinity, Si, dissolved inorganic carbon (DIC). Tracers are normalized to surface values and to P units using a C/P ratio of 122 and a Si/P ratio of 55 (mol/L; from WDC)



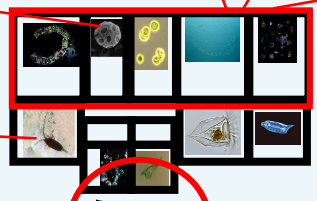
Annual mean surface chla (mgChl/m3; from SeaWiFS satellite)



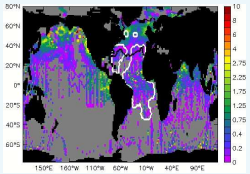
Depth of the maximum chla concentration (m; from NODC)



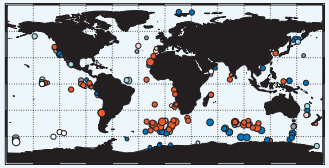
PHYSAT PFTs (January 98-05 synthesis map)



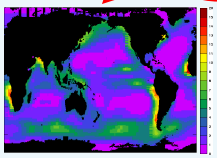
Current configuration of PLANKTOM-10



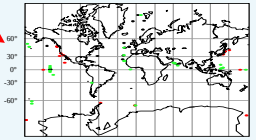
Annual mean surface mesozooplankton biomass (mol/L; from NODC)



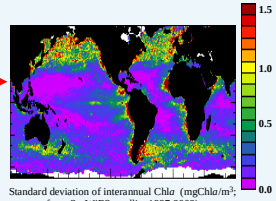
Change in export production recorded in marine sediments between the Last Glacial Maximum and today (red=higher export at the LGM; Bopp et al., paleoceanogr. 2003)



Export of C at 100 m (mol C/m2/y; Schlitzer 2000 AGU Monograph Series vol 114)



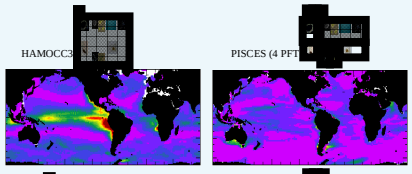
Location of sediment trap data analyzed by C. Klaas.
Shallow traps 100-900 m Cup data — **Deep traps 1000-5000 m Cup data** — **Deep traps 1000-5000 m Annual data**



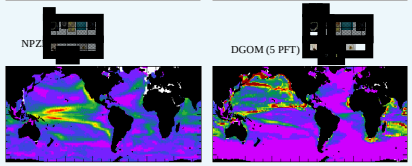
Standard deviation of interannual Chl*a* (mgChl*a*/m^3; from SeaWiFS satellite 1997-2002)

Results:

Modern (1997-2002): A suite of ecosystem models increasing by complexity were used to estimate the interannual variability in the export of carbon. The model results are very different. No models reproduce the observed patterns of variability. The most complex ecosystem model so far shows variability patterns that are comparable in amplitude to the observations, and that are not limited to the equatorial Pacific ocean.

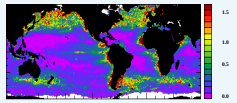


HAMOCC3 — PISCES (4 PFT)



NPZ — DGOM (5 PFT)

Standard deviation of export production variability 1997-2002 (mol C/m^2/yr)



SeaWiFS chl*a*, PP from Behrenfeld and Falkowski (1997), ef-ratio from Laws et al. (2000)

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