Estimating primary production in the North Atlantic

S. Losa[1], J. Schröter[1], D. Wright[2], A. Vézina[2]

[1]AWI, Bremerhaven, Germany; [2]BIO, Bedford, Canada;
Svetlana.Loza@AWI.de

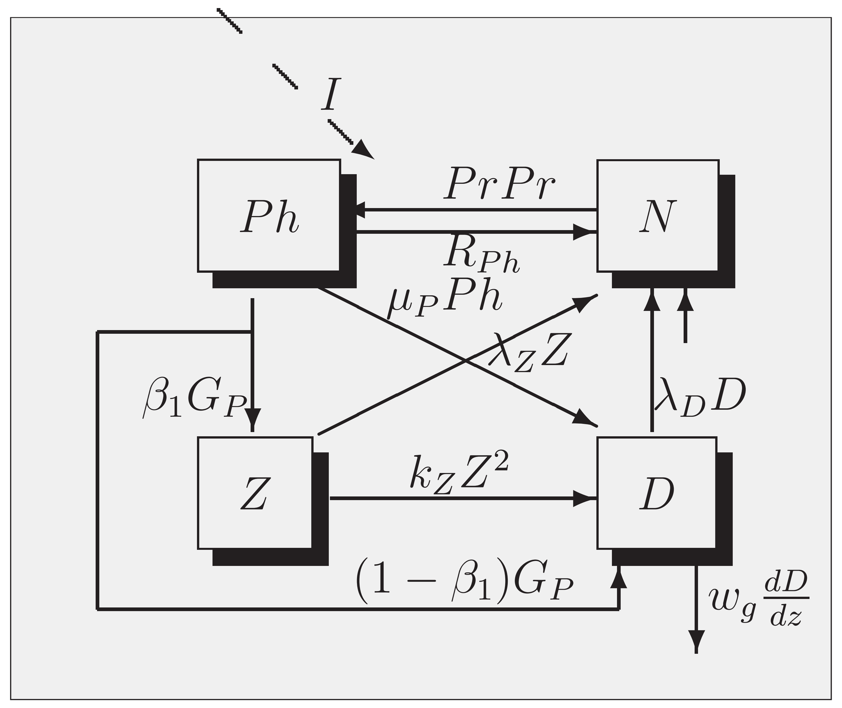
AWI
Alfred Wegener Institute
for Polar and Marine Research

Abstract

A number of coupled physical/biological studies dealing with ocean primary production estimates have already emphasized the impact of correct mathematical formulation of physical mechanisms controlling the ocean ecosystem dynamics. We would like however investigate how much the modelled ocean primary production is sensitive to parameterizations of biogeochemical processes. We consider 3 different versions of the ecosystem model (2 of them are developed within EU MERSEA project). The models have been coupled to a North Atlantic general circulation model based on the Parallel Ocean Program.

1 Models

Model of Kriest and Oschlies (2006)



In the model, phytolpankton is presented by a spectrum of different sizes. Thus, some of the parameterized biogeochemical process- in particular, phytoplankton growth and exudation,- are size-dependent. (We will refer to the model as SD NPZD).

Figure 1. NPZD model schematic diagram.

LOBSTER Ecosystem Model

(Lévy et al, 2006)

In the model, photosynthetic available radiance is presenting by green and blue regions of the spectrum.

Chl:N ratio is explicitly counted, since Chl is an additional model variable.

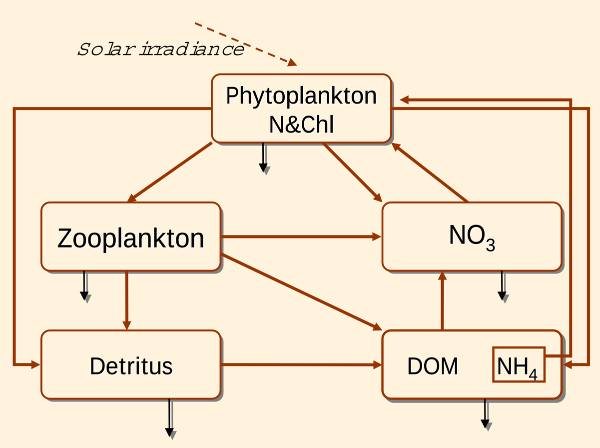
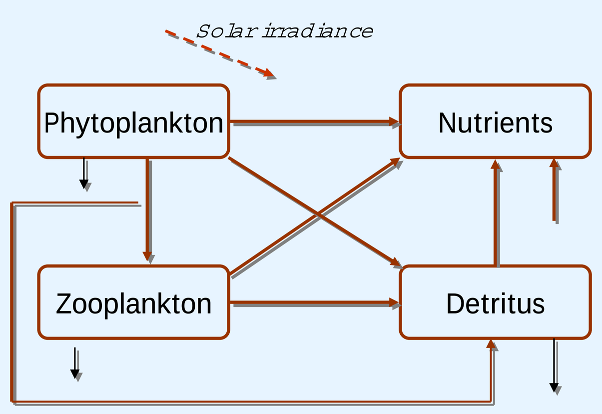


Figure 2 (right). Schematic diagram of the LOBSTER model.

The flow network between 7 biogeochemical components possesses ~ 19 biological parameters.

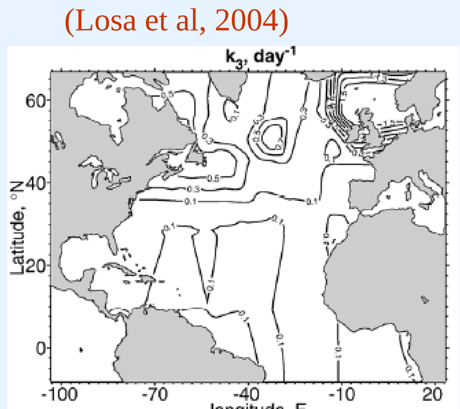
Popova's Ecosystem Model

(1995)



Assimilated data:
Monthly mean satellite CZCS surface chlorophyll averaged over 1979 – 1985.

Method : a weak constraint variational technique (Losa et al, 2004)



The flow network between 4 biogeochemical components possesses 19 biological parameters.

6 of them have been adjusted for each cell of 5^0x5^0 grid covering the North Atlantic

Physical model

A North Atlantic circulation model, based on the Los Alamos Parallel Ocean Program (POP) (Smith et al. 1992) with an implicit treatment of the Coriolis term and vertical diffusion.

The K-profile parameterization (Large et al., 1994) is used for vertical mixing.

1^0 horizontal resolution ($10^0S - 80^0N$, $99^0W - 20^0E$)

23 vertical levels (10, 20, 35, 55, 75, 100, 135, 185, 260, 360, 510, 710, 985,1335, 1750, 2200, 2700, 3200, 3700, 4200, 4700, 5200, 5700).

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2 Forcing, Initial and Boundary conditions (*similar to Losa et al., 2006*)

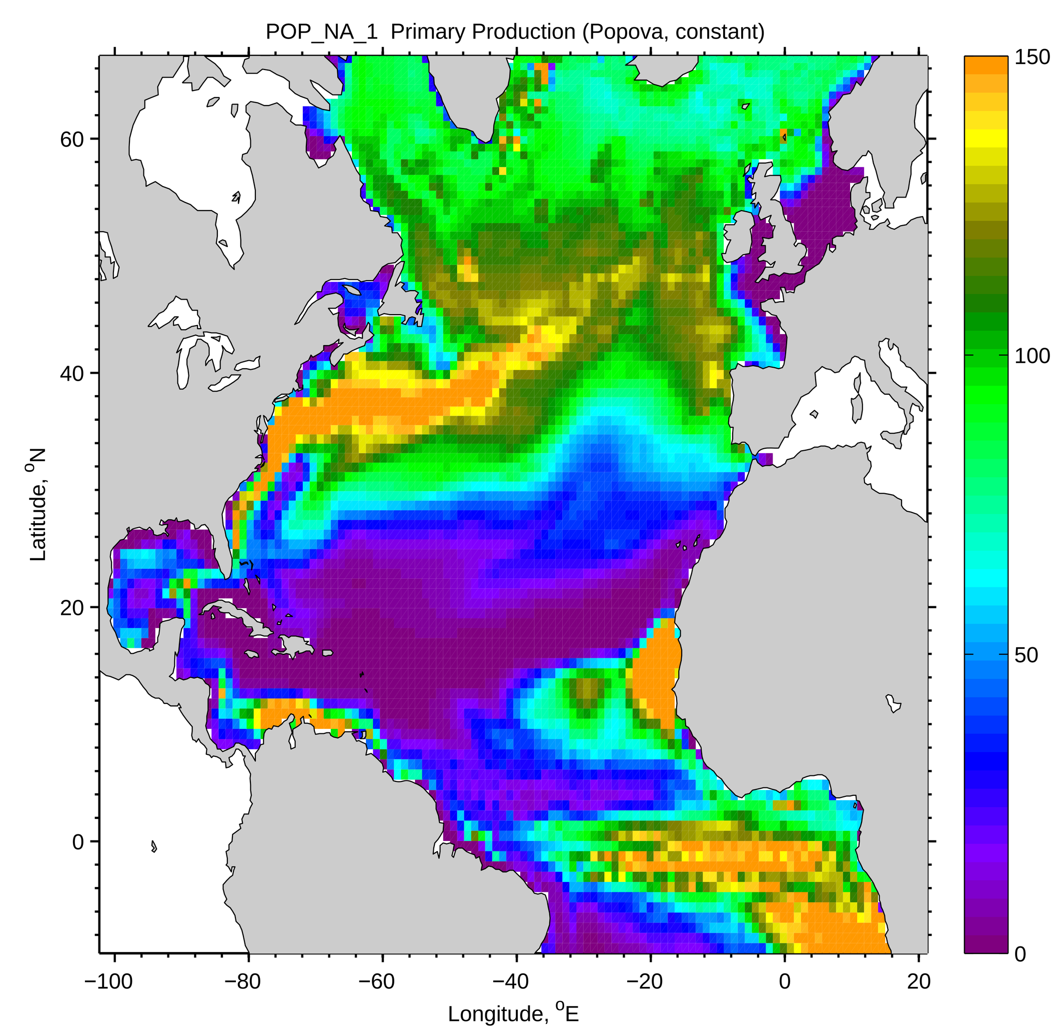
Phisical

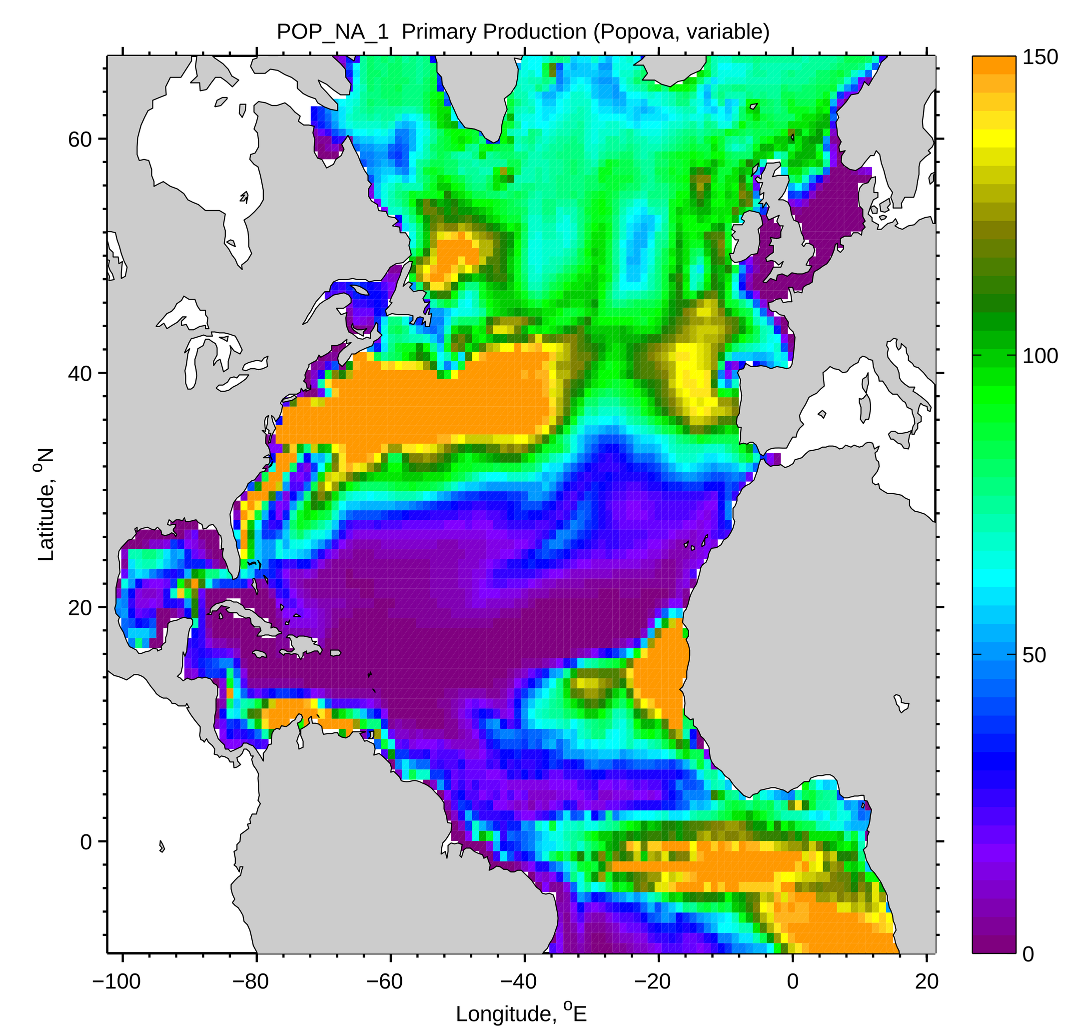
- Climatological monthly mean surface fluxes and wind stress (da Silva et al., 1994).
- Climatological monthly mean temperature and salinity (**I. Yashayaev, Bedford Institute of Oceanography**).
- Northern and Southern boundaries are closed with sponge layers at which the water temperature and salinity are relaxed to climatological values.

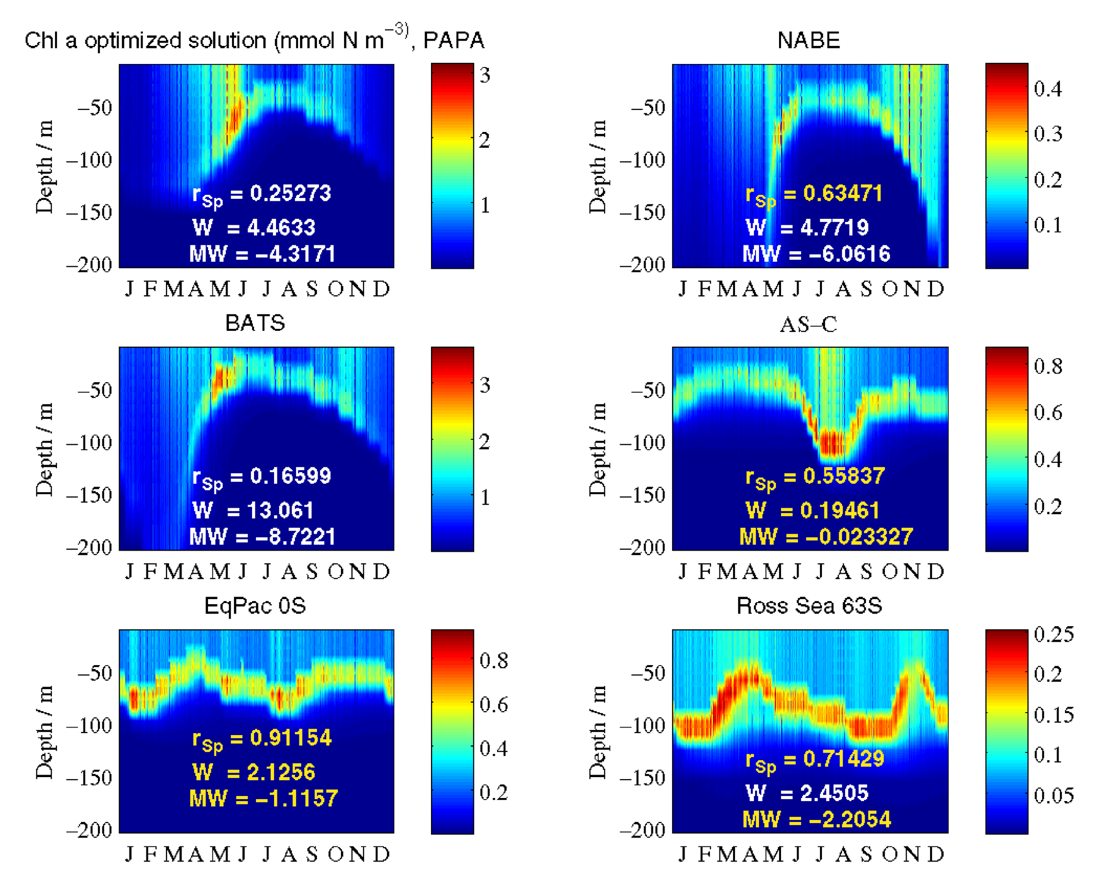
Biogeochemical

- Climatological seasonal mean nutrients, derived from the World Ocean Database (1998).
- Climatological monthly mean surface chlorophyll estimates, obtained by averaging SeaWiFS data over the period 1997-2003.We assume phytoplankton concentration to decrease exponentially with depth.
- Other model variables in the sponge layer is chosen to be some contants at the surface and then, similar to P, the concentrations change exponentially with depth over the characteristic scale depth of 100m.

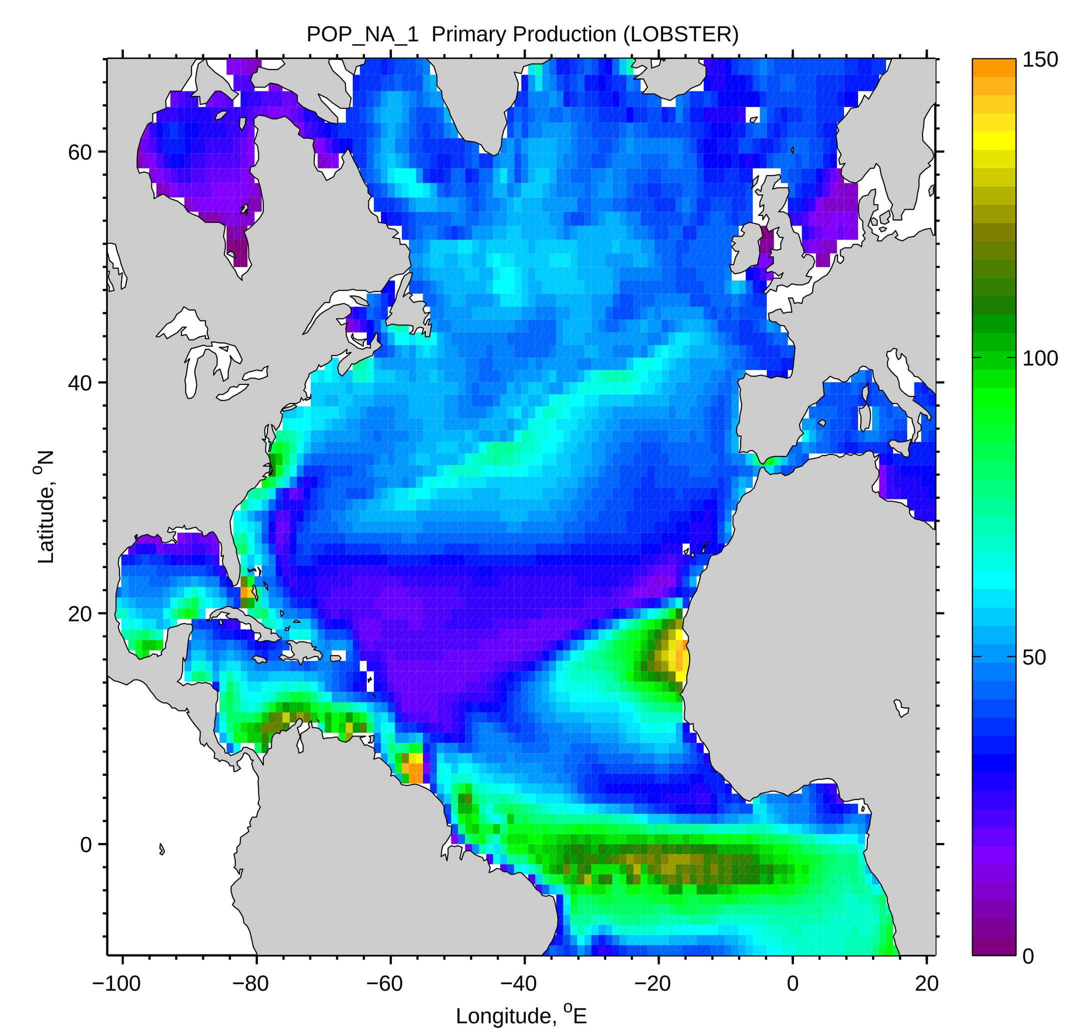
3 Primary production estimates ($gC\ m^{-2}\ y^{-1}$)







LOBSTER chlorophyll concentrations at different sites in the global ocean.(Numbers of yellow colours indicate good agreement with the data).



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