SEVENTH FRAMEWORK PROGRAMME THEME 7 Environment

Collaborative project (Large-scale Integrating Project)

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Project Acronym: EURO-BASIN

Project title: European Basin-scale Analysis, Synthesis and Integration

Deliverable 6.1 Initial conditions, boundary conditions and forcing functions

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Dissemination Level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Deliverable 6.1 Initial conditions, boundary conditions and forcing functions, is a contribution to

Task T6.1.1: Definition of the forcing (different atmospheric models and different scenarios) and boundary conditions for hindcast simulations. Tests on NEMO/DRAKKAR will be performed.

Responsible: CNRS;
Start month: 1, End month: 6 (July 2011)

Executive Summary:

The goal of T6.1 is to simulate how historic changes over the last 50 years in the climate induced changes in the hydrodynamics of the North Atlantic have impacted on ecosystem productivity, structure and function. The simulations strategy for the integrated modelling in Euro-Basin involves the comparison of different biogeochemical models in the same physical model in an range of configurations is order to explore the impacts of model structural and parameter uncertainty, horizontal resolution and boundary conditions. It is therefore necessary to use consistent high quality boundary conditions and forcing which describe the conditions from 1960. The deliverable outlines the simulations to be made and defines the initial conditions, describes of boundary conditions and atmospheric forcing to be used.

Relevance to the project & potential policy impact:

The outputs of the simulations will be used as forcing or input data for the MTL simulations in WP6 and the higher tropic levels, and economic impact) work in WP5 and WP7.

Report:

The purpose of the deliverable is to document the common forcings and boundary conditions which used to drive the hindcast simulations of the N Atlantic in Tasks 6.1 and 6.2.

- T6.1 aims to investigate how climate induced changes in the hydrodynamic of the North Atlantic have impacted on ecosystem productivity and function by delivering an ensemble of past ecosystem states (phytoplankton, zooplankton and micronekton). This information will be used to generate a weighted basin-scale ensemble of ecosystem states, which take account of structural and parameter uncertainty. The ensemble of ecosystem states will be analysis focusing on the question what is the role of phytoplankton, zooplankton and micro nekton distributions in driving carbon either towards higher tropic levels (marine resources) or towards the deep waters (carbon pump, export flux, vertical migration of zooplankton).
- T6.2. aims to investigate the sensitivity of ecosystem response to key physical processes hindcast scenarios though developing model domains and parameterisations to quantify the impact of physical processes (cross shelf exchanges and fluxes, eddies and winter convection) and their relative importance to the overall primary and secondary production and sequestration of carbon at the basin-scale) using a high resolution (1/12 degree) NEMO-shelf model of the Northern North Atlantic.

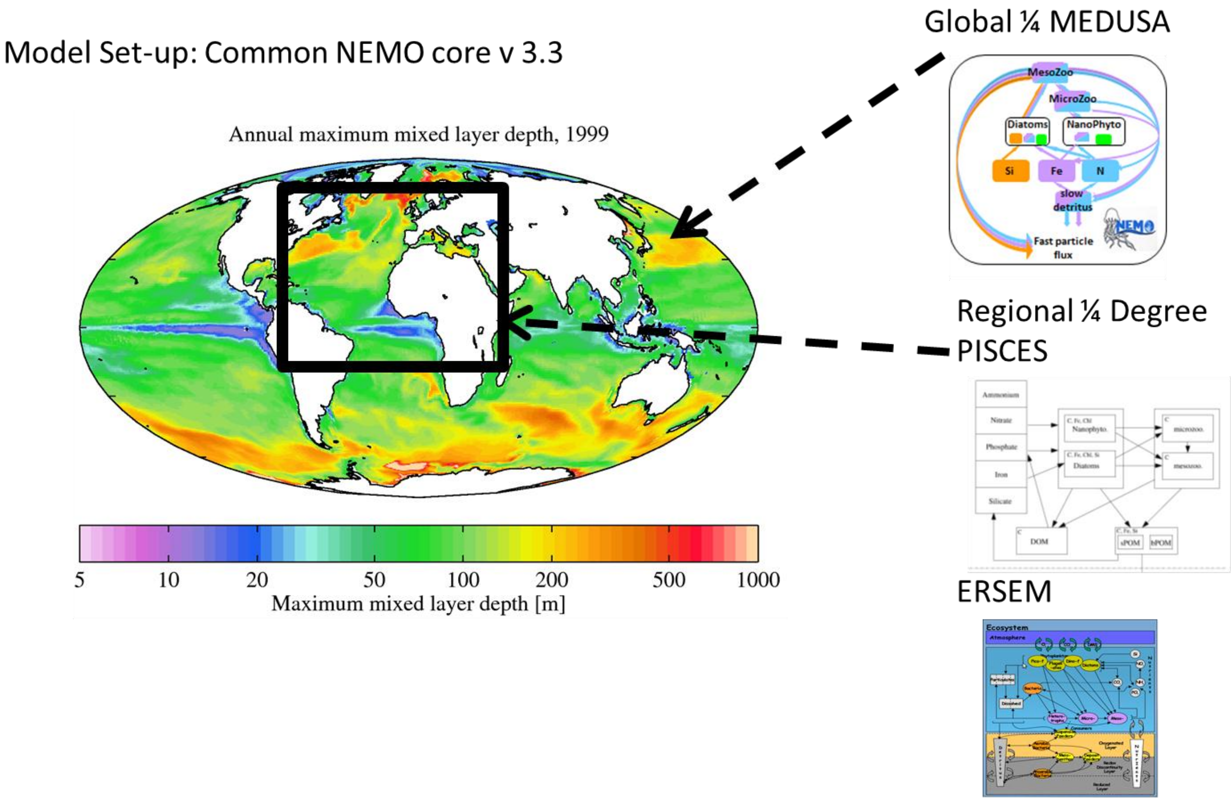

Figure 1 – Spatial extend of domains A and B along with schematics of the biogeochemical models.

The simulation strategy of Euro-Basin integrated modelling is based up using a common physical model setups and forcing to drive a suite of plankton ecosystem models of differing complexity (PISCES, MEDUSA, ERSEM) into a common physical framework for the North Atlantic basin and shelf seas (NEMO), to quantify the inherent structural uncertainty ecosystem models. The physical framework used is NEMO (version 3.4) and is applied in 3 different domains.

A. Global ¼ degree horizontal resolution and 64 vertical levels. It is used to drive the MEDUSA model. (figure 1)
B. North Atlantic regional domain simulated covers the Atlantic Basin from 20°S to 80°N at a ¼ degree horizontal resolution and 64 vertical levels. It is used to drive the ERSEM and PISCES models (figure 1).
C. Northern N Atlantic 1/12 degree horizontal resolution (figure 2)and 74 vertical levels (40N to 70N) and coupled with ERSEM

All the forcing fields (either initial or boundary or surface) have been interpolated on the grid model, using relevant NEMO tools. The simulations (Table 1)will be for the period 1980-2005 and all be forced with the identical external forcing taken from DRAKKAR to obtain commonality in the physics and assist the ensemble interpretation.

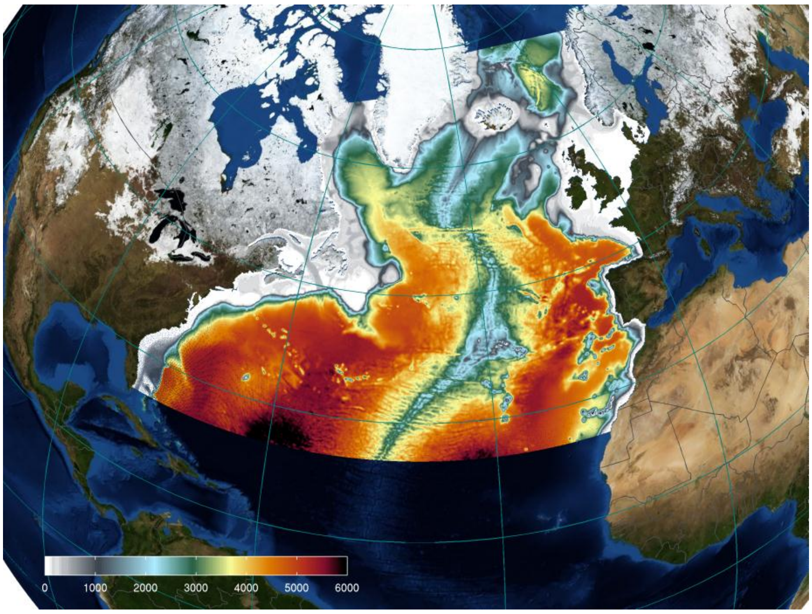

Figure 2 – Spatial extent and bathymetry for Domain C

Table 1 Biogeochemical Hindcast Simulations in Task 6.1 & 6.2

Sub task	Region	Responsible Partner	Participants	Ecosystem Model	Simulation Period
6.1.2	B 1/4 North Atlantic NEMO	CNRS	-	PISCES	1960-2005
6.1.2	A 1/4 N Global NEMO	NERC	-	MEDUSA	1960-2005
6.1.2	B 1/4 North Atlantic NEMO	PML	CNRS	ERSEM	1960-2005
6.2.2	C 1/12 NN Atlantic NEMO-shelf	NERC	IMS	ERSEM	1980-2005

1. Initial conditions.

For domains A and B the simulation is started with an ocean at rest: the temperature and salinity distributions come from the NODC data.

The initial conditions for the ecosystem model are important for the dissolved tracers associated with long time scales. The tracers associated with organic matter have a very short memory and the initial conditions are lost within less than a year. The inorganic tracers e.g. nutrients and oxygen have a longer memory of the initial conditions. In this case the initial conditions come from the observed climatology's (Conkright *et al*., 2002).

2. Boundary conditions.

Domain A is a global model so by definition has no open boundary conditions. Domain B is closed at the northern, southern and eastern (Gibraltar) boundaries, with a "sponge" region of six points characterized by a nudging towards climatological data (same as the initial fields) of increasing intensity towards the outer limit. Domain C will use a similar approach.

3. Forcing

3.1. Atmospheric forcing

The atmospheric forcing are defined by the DFS4 data set, used in the DRAKKAR consortium (http://www.drakkar-ocean.eu/). DFS4 has been constructed by assembling the corrected fields of the ERA40 surface atmospheric variables and the satellite radiation and precipitation. When computing net heat and freshwater fluxes for the 1958-2004 period with the prescribed SST fields of Hurrell et al. (2008), DFS4 presents an almost-zero global imbalance of heat (+0.3 W/m^2), and freshwater (-0.2mm/year). The corrections applied are such that their impact on fluxes lies within the range of usual flux uncertainties (i.e. less than10 W/m^2 on the net heat flux). Therefore, the major effect of these corrections is not to change the intrinsic realism of the ERA40 forcing, but to significantly improve its consistency (better continuity, correction of unrealistically high trends, nearly equilibrate budget). This dataset starts in 1958 and ends in 2007.
Some sensitivity studies have been undertaken with another forcing field set, based on the CORE/NCEP formulation, as it was used in previous global biogeochemical simulations using NEMO/PISCES (Aumont and Bopp, 2006). These sensitivity studies were based on 20 year NEMO simulations, of which 10 coupled with the ecosystem model PISCES: although differences do exist between the two simulations, they are not large, are geographically very variable and none of them showed a consistent improvement compared to the other one. As the DFS4 is the basic forcing used in the DRAKKAR community and as its drawbacks are well known, the final choice for EURO BASIN was to use the DFS4 dataset. A new version (DFS5), which will extend to the present years, and which will be updated with time, will be available in September : it will give a better spatial resolution of the forcing (0.7° vs. 1.125°), as well as a better time resolution (3h vs. 6h). Moreover, it is issued from ERA_interim, which is of higher quality than ERA40.

Figure 3 illustrates the difference between the monthly mean of the Mixed Layer Depth (MLD) coming from an average of the simulated years 1992-1998 using the DF4 forcing, and the climatological observations of de Boyer - Montégut et *al*. (2004) in domain B. Although the impact of the horizontal circulation can be locally strong, this MLD distribution is mostly linked to the atmospheric forcing. Although the averages have not been made for the same periods, which could bias the comparison, the simulation seems to overestimate the MLD in the sub polar gyre in winter, mostly in the Labrador Sea: this drawback is quite common in the simulations of the North Atlantic, and is partly linked to the horizontal resolution, which is too low to represent the small scale dynamics.

3.2. Biogeochemical forcing

Besides the sediments (which have their own representation in each biogeochemical model used in EURO BASIN), the two major sources of nutrients to the ocean are the atmospheric dust deposition and the rivers. Atmospheric inputs are estimated from the climatological monthly maps of dust deposition simulated by the model of Tegen and Fung (1995), with constant ratios between the elements (Fe/P/N/Si/C).

The river inputs have been updated compared to the standard fluxes used in NEMO/PISCES until now, presented in Aumont and Bopp (2006). River discharge of carbon was taken from the Global Erosion Model of Ludwig et al. (1996), considering constant ratios for the different elements (Fe/P/N/Si/C). The updated runoff forcing is based on the latest data sets (COSCAT coast segmentation : Meybeck *et al*., 2006) and hydrological models (NEW2 model : Mayorga *et al*., 2010), the new version takes into account in a consistent way the water fluxes and the nutrient fluxes : it was not the case in the previous NEMO versions. Comparative global simulations (with a 2° resolution) have shown that his new method decreases greatly the nutrient content (and therefore the surface chlorophyll and primary production) of the ocean surface in several productive regions, mostly in the Arctic Ocean, but also in the North Atlantic Ocean, near the Grand Banks (as well in the Indian Ocean, in the Bengal bay) : it is interesting to realize that these new results are closer to observations. A precise analysis explaining these results has not been undertaken yet for the global simulation, but it is believed that the non Redfieldian constant ratio of the runoff inputs play a major role, in association with co-limitation of primary production.

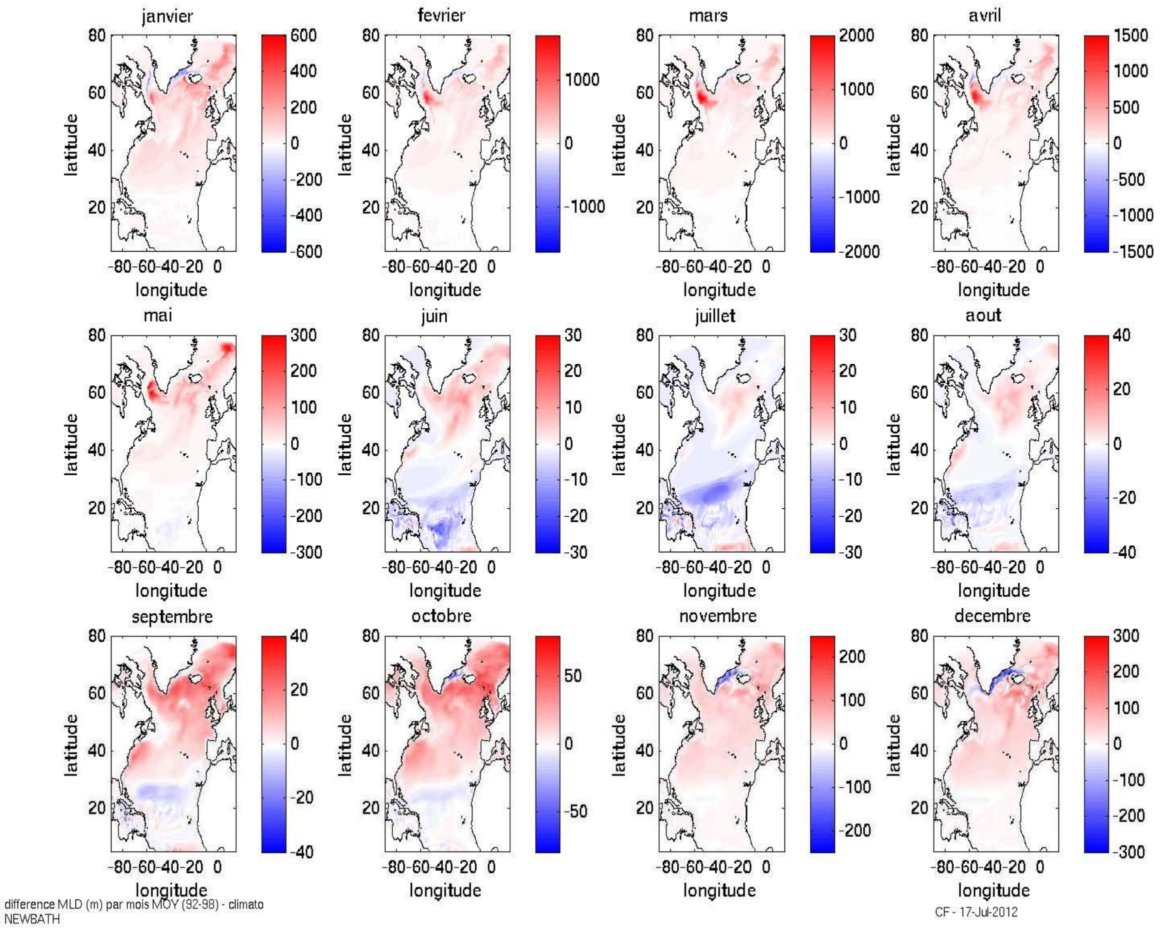

Figure 3 : monthly differences of the MLD between the average of the simulation for the years 1992-1998 and the climatology data set of de Boyer Montégut et al. (2004)

Data access

The data used for the forcing and initialization for the basin scale simulation of EURO BASIN is available via ftp on ***nauplius.univ-brest.fr*** in the directories ***/eurobasin/FORCING***; there are 8 directories with all the files needed to make the simulation.

The data is password projected. Contact Laurent Memery Laurent.Memery@univ-brest.fr if you wish to access the data.

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