EURO-BASIN
BASIN SCALE ANALYSIS, SYNTHESIS AND INTEGRATION

SEVENTH FRAMEWORK PROGRAMME THEME 7 Environment

Collaborative project (Large-scale Integrating Project)

Project no: 246 933

Project Acronym: EURO-BASIN

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

Deliverable 6.2 CMIP5 climate forcing 2000-2040

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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. 2 CMIP5 climate forcing 2000-2040, is a contribution to

Task T6.3.1: Definition of the climate forcing (AR5 climate scenarios) for the EURO-BASIN community. Suitable climate forcing for the basin region will be selected and obtained from the French and UK climate modelling centres.

Responsible: CNRS;
Start month: 12, End month: 18

Executive Summary:
EURO-BASIN focuses on the near future (+30 years), hence it is important to clarify what are the expected emissions during this time window that will affect the ocean climate conditions.

Relevance to the project & potential policy impact:
This climate forced simulations allow the extension of the ensemble of biogeochemical models to the policy relevant future. EURO-BASIN focuses on the near future (+30 years), it is important to clarify what are the expected emissions during this time window that will affect the ocean climate conditions. These future projections will be analysed for changes in biogeography fish habitat and population dynamics and the results applied in WorkPackages 5 and 7.

Report:
The second class of model simulations are forced by global climate simulations, which are unconstrained by observations and represent 'typical' conditions both in the past and under various atmospheric composition scenarios (defined in IPCC-AR5). The scenarios of GreenHouse Gas (GHG) emissions and land-use changes that will be used for these simulations are the Reference Concentration Pathways (RCP). RCP are divided according to the radiative forcing level achieved at the end of this century, therefore RCP8.5 is constructed to have an additional GHG-driven 8.5 W m^{-2} radiative forcing from the atmosphere. Three major levels have been selected in the RCP database (Fig. 1): RCP8.5 (Riahi and Nakicenovic, 2007), RCP4.5 (Clarke et al., 2007) and RCP3 (van Vuuren et al., 2007) that was developed in the framework of the EC FP6 ENSEMBLES project.

Since EURO-BASIN focuses on the near future (+30 years), it is important to clarify what are the expected emissions during this time window that will affect the ocean climate conditions. The optimal choice would be to carry out simulations using two extreme conditions, although the focus up to year 2030 limits the GHG differences to a few ppm (CO_2 range is about 435 to 455 ppm).

This task aims to understand how bio geographic regions are maintained in the North Atlantic and how will they change with climate change. It will build on the methodologies developed in **Task 6.1**. Once again using the medium resolution basin model (1/4) degree models, we will make an ensemble of targeted future climate states simulations, this time driven by IPCC climate scenarios from AR5 rather than the reanalysis forcing form DRAKKAR. The simulations will be analysed with a focus on the understanding of the processes controlling the historical evolution of the bio-geography and fish habitat of the North Atlantic basin and providing error quantified estimates of future states. The focus will be on the next 30 years to address the time frame of most concern to policy requirements.

A full list of proposed simulations along with the responsible partner can be found in Table 6.4

This output is drawn from an IPCC AR5 simulation (UKMO reference: KAAEF) following the RCP8.5 scenario, which reaches a climate warming equivalent to 8.5 W m^{-2} by 2100. The model output used to force NEMO almost exactly parallels the reanalysis forcing routinely used in conventional ocean-only simulations. Fields of atmospheric T, Q, U and V are used together with short-wave, long-wave, rain, snow and runoff, all at the same temporal frequency (ranging 6-hourly to monthly) as reanalysis forcing. The only differences with the latter lie in the precise atmospheric height of some fields (due to the configuration of the HadGEM2-ES atmosphere) and the use of time-varying surface salinity from HadGEM2-ES instead of a fixed climatology.

HadGEM3 stands for the Hadley Centre Global Environment Model version 3. The HadGEM3 family of models comprises a range of specific model configurations incorporating different levels of complexity but with a common physical framework. The HadGEM3 family includes a coupled atmosphere-ocean configuration, with or without a vertical extension in the atmosphere to include a well-resolved stratosphere, and an Earth-System configuration which includes dynamic vegetation, ocean biology and atmospheric chemistry.

One of the main changes in the HadGEM3 family of models compared with previous versions is the inclusion of the NEMO ocean modelling framework, which is also used in the Met Office's ocean forecasting system, and CICE, the Los Alamos sea ice model. These are coupled to the atmospheric model through the OASIS coupler developed at CERFACS in France.

The HadGEM3 family of climate configurations is currently under development. The GloSea4 seasonal forecasting system uses the first release of a member of this model family.

A range of atmospheric resolutions is available. There is a choice of vertical resolutions between 38 levels extending to ~40km height (of which 29 are below 18km), 63 levels extending to ~40km height (of which 50 are below 18km), and 85 levels extending to 85km in height (of which 50 are below 18km), the latter allowing improved representation of stratospheric processes. Horizontal resolutions vary between 2.5 degrees of latitude by 3.75 degrees of longitude and 0.556 degrees of latitude by 0.833 degrees of longitude, depending on the application.

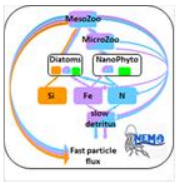
The ocean component uses the ORCA tripolar grid (Madec and Imbard, 1996) which is available at 2.0 degree, 1.0 degree and 0.25 degree horizontal resolutions, and vertical resolutions of 42 levels (a resolution of 5m near the surface), and 75 levels (a resolution of 1m near the surface).

In order to assess the suitability of the chosen climate forcing a high-resolution (1/4-degree) simulation will be undertaken for BASIN using V3.2 NEMO forced using output from the UK Met. Office (UKMO) HadGEM2-ES coupled climate model.

The MEDUSA model of ocean biogeochemistry is additionally forced using the corresponding atmospheric pCO2 concentration from the HadGEM2-ES model.

This configuration of NEMO and MEDUSA will be simulated under the described forcing from 1990 to 2040. Ocean physics and biogeochemistry will be initialised at 1990 using output from a lower resolution (1-degree) instance of NEMO-MEDUSA which is otherwise identical. Though this approach avoids using observationally-derived initial fields, it aims to decrease the errors that would be introduced by initialising NEMO-MEDUSA with fields that are “out-of-tune” with modelled biogeochemistry.

Figure 1 shows examples of the a potential future state of the N Atlantic ecosystem under climate change. The simulations are characterised by a general warming trend and a reduction in total primary production (TPP), which at least in part appears to be a consequence of an expansion of the sub-tropical gyre. A consequence of this is a reduction in the export of C to the deep ocean particularly in the N North Atlantic.



NOC,S: NEMO-MEDUSA (1º)

1860-2099, IPCC scenario RCP8.5

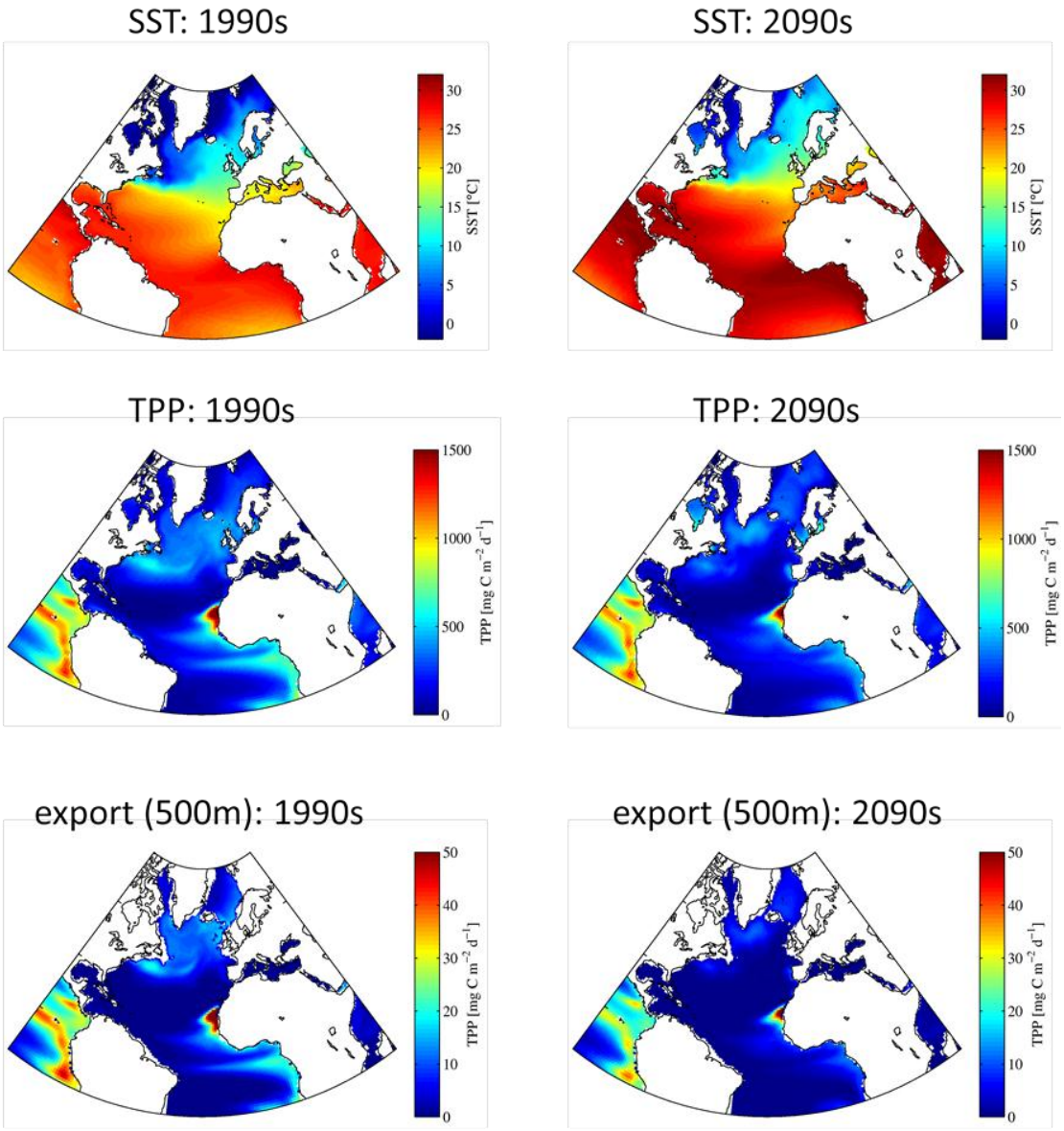


Figure 1: Comparison of climate forced model outputs 1990's vs 2090os. For sea surface temperature, total primary production and export at 500m.