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JRC Marine Modelling Framework in support of the Marine Strategy Framework Directive: Inventory of models, basin configurations and datasets

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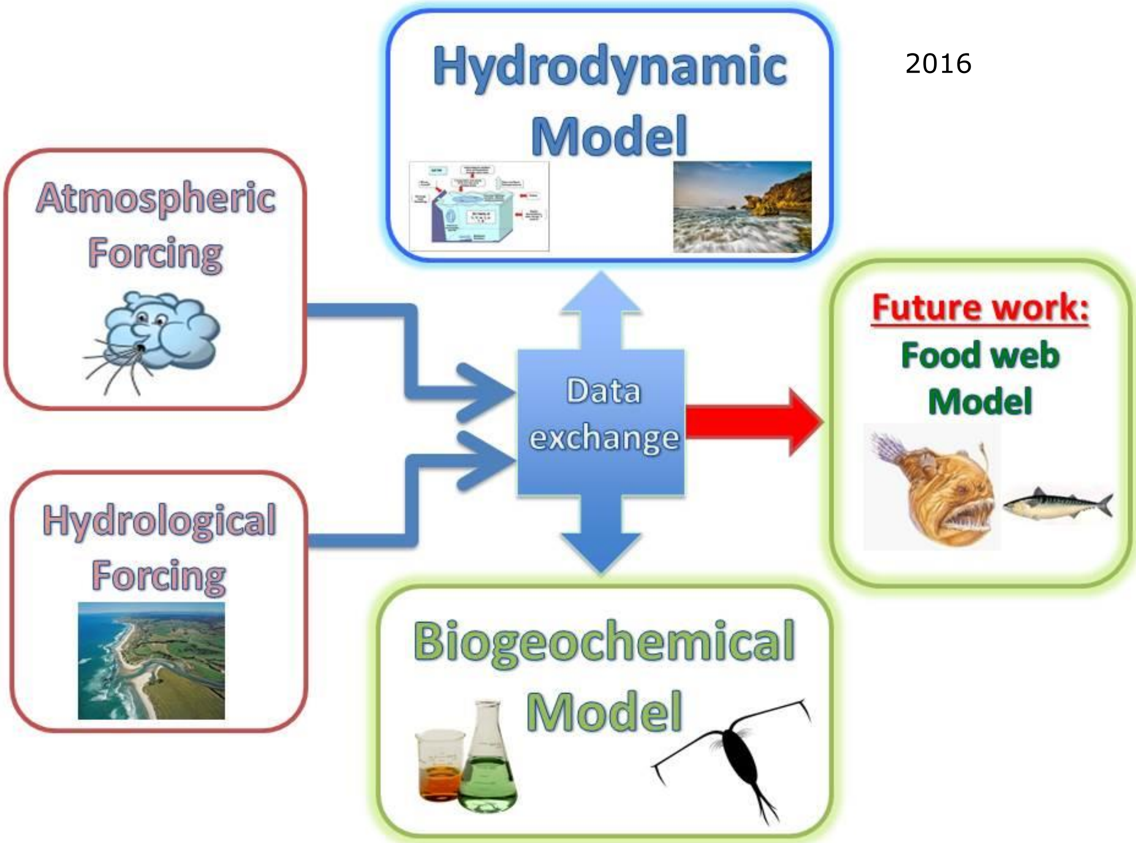

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Acknowledgements

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Abstract

The Marine Strategy Framework Directive (MSFD) foresees that all EU Member States take the necessary measures to maintain or progressively achieve Good Environmental Status (GES) in the marine environment by year 2020. In recent years, the JRC has delivered to the Commission scientific and technical support to the implementation of the Marine Strategy Framework Directive (MSFD). The Administrative Arrangement N° ENV.C.2/2015/070201/705766, signed between Directorate General for Environment (ENV) and Directorate General Joint Research Centre (JRC), Institute for Environment an Sustainability (IES, Unit H01), has a purpose the provision of support to further implementation of the MSFD.

In this context, the JRC IES Water Resources Unit has established a MSFD Competence Centre (MCC, http://mcc.jrc.ec.europa.eu/) to assist Member States (MSs) in the implementation of the MSFD. The MCC acts as a single entry point for policy-review activities, including the current review of the criteria and methodological standards for Good Environmental Status, which are the key to achieving the MSFD goals. The MCC also includes the marine Modelling Framework (or toolbox) for the assessment of MSFD descriptors, with the aim providing independent and evidence-based support in the assessment of the status of implementation throughout the whole policy cycle of the MSFD.

This report, which constitutes Deliverable 2.1 of the Administrative Arrangement No ENV C.2/2015/070201/ 705766 between DG Environment and DG JRC IES Water Resources Unit, includes an inventory of models, basin configurations and datasets within the Modelling Framework of the JRC Marine Competence Centre.

1. Introduction

The Marine Strategy Framework Directive (MSFD) foresees that all EU Member States take the necessary measures to maintain or progressively achieve Good Environmental Status (GES) in the marine environment by year 2020. In recent years, the JRC has delivered to the Commission scientific and technical support to the implementation of the Marine Strategy Framework Directive (MSFD). The Administrative Arrangement N° ENV.C.2/2015/070201/705766, signed between Directorate General for Environment (ENV) and Directorate General Joint Research Centre (JRC), Institute for Environment an Sustainability (IES, Unit H01), has a purpose the provision of support to further implementation of the MSFD.

In this context, the JRC IES Water Resources Unit has established a MSFD Competence Centre (MCC, http://mcc.jrc.ec.europa.eu/) to assist Member States (MSs) in the implementation of the MSFD. The MCC acts as a single entry point for policy-review activities, including the current review of the criteria and methodological standards for Good Environmental Status, which are the key to achieving the MSFD goals. The MCC also includes the marine Modelling Framework (or toolbox) for the assessment of MSFD descriptors, with the aim providing independent and evidence-based support in the assessment of the status of implementation throughout the whole policy cycle of the MSFD.

Within the MCC, the models in the marine Modelling Framework constitute a powerful tool for a number of purposes related with the implementation of the MSFD. MCC Marine models, both hydrodynamic and biogeochemical, can provide the numerical tools, for example, to determine baseline conditions from the past, to estimate the future impact of pressures on the marine environment, and complement spatially and temporally the scarcity in sampling of some marine-related datasets relevant for the assessment of the MSFD descriptors, as well as the effectiveness of the programs of measures put in place by MSs.

This report constitutes Deliverable 2.1 of the Administrative Arrangement N° ENV C.2/2015/070201/705766 between DG Environment and DG JRC IES Water Resources Unit. It includes an inventory of models, basin configurations, atmospheric and nutrient forcing scenarios and run results within the MCC Modelling Framework.

This report includes an inventory of models, basin configurations, atmospheric and nutrient forcing files and scenarios, and run results within the MCC Modelling Framework. Specifically, the list of codes used in the Modelling Framework is in Section 2. This inventory is structured in hindcast runs in Section 3 and scenario runs in Section 4. Within both hindcast and scenario runs, the results are grouped by basin. The basins included are the Atlantic North-West European Shelf, the Baltic Sea, the North Sea, the Black Sea and the Mediterranean Sea.

2. Inventory of model codes

Within the modelling group of the JRC IES Water Resources Unit, we use the 3-D General Estuarine Ocean Model (GETM) to simulate the hydrodynamics in the Atlantic North-West European Shelf, the Baltic Sea, the Black Sea, the Mediterranean Sea and the North Sea. A detailed description of the GETM equations can be found in Burchard and Bolding (2002), Stips et al. (2004) and in http://www.getm.eu. The hydrodynamic model GETM includes the General Ocean Turbulence Model (GOTM, http://www.gotm.net).

The biogeochemical models used are the following, in alphabetical order:

- The Black Sea Specific Ecosystem Model (BSSM) is used in the Black Sea and it is currently under development and validation at the JRC.

- The Ecological Regional Ocean Model (ERGOM) in the Baltic Sea and it is based on Neumann (2000) .

- The European Regional Seas Ecosystem Model-ERSEM (Baretta, 1995 and Butenschön, et al., 2015) is used in the North Sea runs. More specifically, we use the carbonate module of ERSEM (Artioli et al., 2012 and Blackford and Gilbert, 2007).

- Finally, the Mediterranean Sea biogeochemical Model (MEDEM) and the Mediterranean Sea Ecological Regional Ocean Model (MedERGOM) have been developed and validated at JRC. They are based on the ERGOM model but include higher complexity and specific features tailored for the Mediterranean Sea. MEDEM and MedERGOM have different trophic structures and coding strategies. For a more detailed description, see Macias et al., 2014a, 2014b and 2015b.

To couple the model GETM with any of the biogeochemical models mentioned above we use the Framework for Aquatic Biogeochemical Models (FABM, Bruggeman and Bolding, 2014), which is a general framework that provides the computing platform that allows the operational communication and exchange of data between the hydrodynamic and the biogeochemical models. Figure 1 illustrates the flow of data between the models, including the atmospheric and hydrological forcings. Future work, also indicated in Figure 1, will include the addition of coupling of food web models to the current framework.

Table 1 includes the list codes mentioned above, ordered by type, code name, where the codes are available from, specific basins where they are applied at JRC, as well as person responsible of the models at JRC. The models are physically stored and run at the JRC in the clusters ies-hpc.jrc.it and/or hpc-gw1.jrc.it

Figure 1: Schema of the JRC marine modelling framework

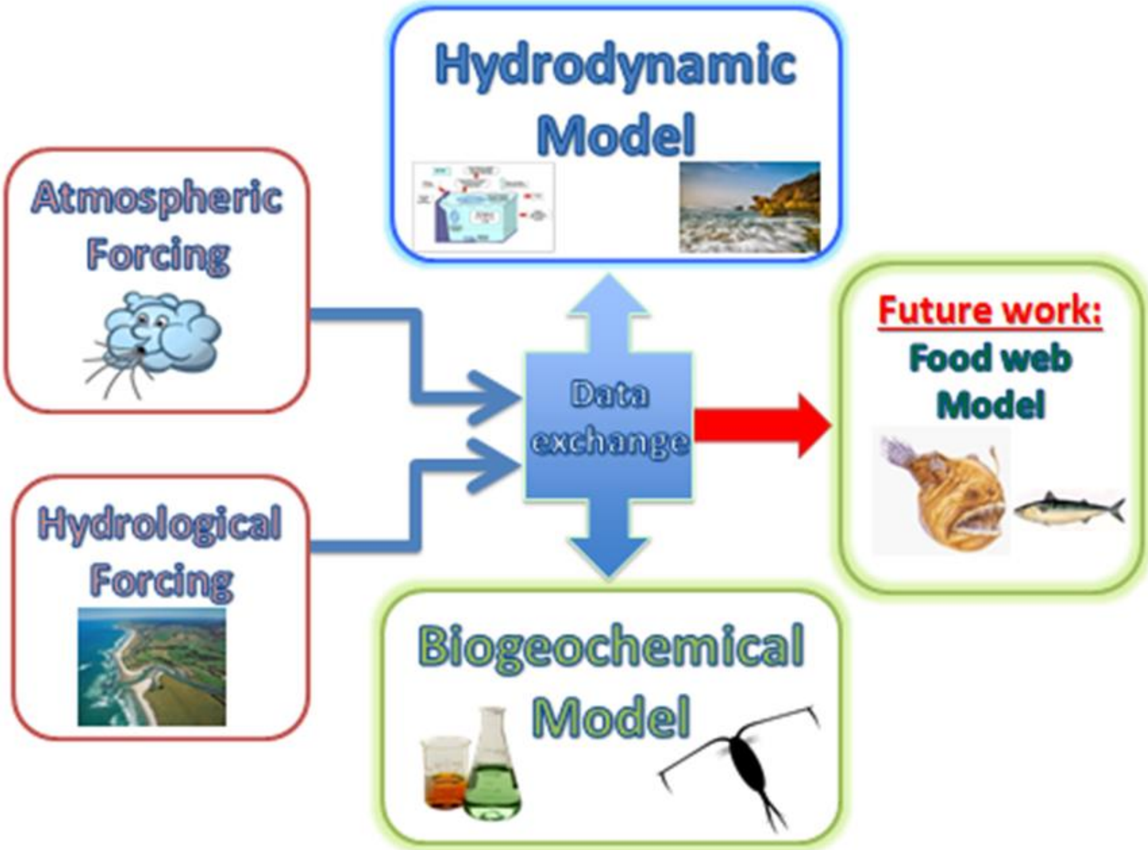

Table 1: List of codes used at JRC ordered by type, code name, where the codes are available from, specific basins where they are applied at JRC, as well as person responsible of the models at JRC. The models are physically stored and run at the JRC in the clusters ies-hpc.jrc.it and/or hpc-gw1.jrc.it.

Model Type	**Code name**	**Available from**	**Specific basin**	**JRC Responsible**
hydrodynamic	GETM GOTM (turbulence module)	git://git.code.sf.net/p/getm/ and http://www.getm.eu http://www.gotm.net	All basins in this Report	A. Stips E. Garcia-Gorriz D. Macias Moy S. Miladinova-Marinova
coupling framework hydrodynamic-biogeochemical	FABM	git://git.code.sf.net/p/fabm/ and http://www.fabm.net	All basins in this Report	A. Stips E. Garcia-Gorriz D. Macias Moy S. Miladinova-Marinova
biogeochemical	BSSM	ies-hpc.jrc.it cluster	Black Sea	S. Miladinova-Marinova D. Macias Moy
biogeochemical	ERGOM	git://git.code.sf.net/p/fabm/ and ies-hpc.jrc.it cluster	Baltic Sea	A. Stips D. Macias Moy
biogeochemical (carbonate module)	ERSEM	http://www.pml.ac.uk/Research/Projects/European-Regional-Seas-Ecosystem-Model-(ERSEM)	North Sea	A. Stips
biogeochemical	MedERGOM	ies-hpc.jrc.it cluster	Mediterranean Sea	D. Macias Moy
biogeochemical	MEDEM	ies-hpc.jrc.it cluster	Mediterranean Sea	D. Macias Moy

3. Hindcast runs: inventory of model configurations and run results per basin

To build the basin configurations and/or to force the model runs, we need a number of datasets that numerically describe the bathymetry of the basin, the atmospheric variables forcing the sea, the rivers discharges, the nutrient loads and the initial/boundary conditions of sea temperature and salinity.

For the hindcast runs, we use three sources of atmospheric forcing. First the European Centre for Medium Range Weather Forecast (ECMWF) atmospheric variables available from http://www.ecmwf.int. Secondly, the atmospheric forcing produced through the EuroCORDEX initiative (http://www.euro-cordex.net/) by the COSMO Climate Limited-area Modelling (CCLM) atmospheric regional climate model. In our hindcast runs we use three datasets of modelled atmospheric variables produced by the CCLM when it is forced by the ECMWF ERA-interim reanalysis (ERAin) and by two different global climate models, which are the Max Plank Institute MPI-ESM-LR (http://cmip-pcmdi.llnl.gov/cmpi5) and the Earth System Model of the EC- Earth Consortium (http://ecearth.knmi.nl/). For simplicity in this report, we will call these three datasets CORDEXerain, CORDEXmpi and CORDEXece. Finally, we also use the atmospheric forcing from the National Centers for Environmental Prediction (NCEP, http://www.esrl.noaa.gov).

The three sources of atmospheric forcing present different horizontal resolution and time coverage. The model time-frame of our runs is prescribed by the availability we have of the atmospheric datasets, which covers from 1958 to present for ECMWF, from 1979 to 2010 for NCEP, and from 1989 to 2005 for CORDEXerain, CORDEXmpi and CORDEXece.

Additionally, for the scenario runs in Section 4, CORDEXmpi and CORDEXece are also available, each one for the two emission scenarios rcp4.5 and rcp8.5 throughout the 21st century. They cover from the present to year 2100 (Table 2).

The river discharges are derived from the Global River Data Center database (http://www.bafg.de/GRDC/) while freshwater nutrient loads are computed from Ludwig et al. (2010) to have the most realistic nutrient dataset available. Some hindcast runs include nutrient scenarios. The type of nutrient forcing used is indicated throughout the basin runs in the following sections and Tables. The nutrient loads of atmospheric deposition are from the Atmospheric Chemistry and Climate Model Intercomparison Project (ACCMIP). In this report, only the Baltic Sea and the North Sea runs include atmospheric deposition as additional forcing. For the other basin, including atmospheric deposition in the runs is foreseen in the near future.

The bathymetric grid necessary for each basin configuration is built from the Earth topography ETOPO1 database (https://www.ngdc.noaa.gov/mgg/global/). The sea temperature and salinity 3D fields required at the start of the model integration are from the Mediterranean Data Archaeology and Rescue database (MEDAR/MEDATLAS, http://www.ifremer.fr/medar/), which uses in-situ historical hydrographic observations. The nitrate, phosphate and oxygen 3D fields necessary at the start of the coupled hydrodynamic-biogeochemical runs are climatologies produced by the World Ocean Atlas 2005 (WOA05, https://www.nodc.noaa.gov/OC5/WOA05/pr_woa05.html). The World Ocean Atlas 2013 version 2 (WOA13, https://www.nodc.noaa.gov/OC5/woa13/) also provides sea temperature, salinity, nitrate, phosphate and oxygen climatologies to build the initial and boundary conditions for the coupled model and is additionally used in some of the modelling experiments.

The location at JRC of the datasets mentioned in this report is included in Table 2. These datasets, the configurations and the runs are physically stored at the JRC ies-hpc.jrc.it cluster for the Atlantic North-West European Shelf, the Baltic Sea, the Black Sea and the Mediterranean Sea. That cluster contains the storage volumes COMMONDATA, vol05, vol06 and vol07, mentioned throughout the Tables. The North Sea configurations in Section 3.4 are stored in the JRC hpc-gw1.jrc.it cluster.

In each basin, several runs are included in the corresponding Tables. Each run corresponds to a specific modelling experiment which is relevant to the work in that basin. Different experiments in the same basin may differ, for example, in model time-frame, horizontal and/or vertical resolution, the atmospheric forcing, nutrient loads, initial/boundary sea conditions, scenarios of rivers, scenarios of nutrients, atmospheric scenarios, climatologic conditions, bathymetric smoothing, tidal formulation, albedo approximation, advection schema, turbulence formulation, etc. For some basins, a number of different modelling experiments have been necessary in the validation phase to obtain the optimal configurations which runs will be producing the most accurate results when compared with available observations. In general, the hydrodynamic runs are calibrated/validated first without biogeochemical coupling to obtain a configuration that provides the most realistic physical environment that will control and condition the biogeochemical variables in the sea. The coupled systems hydrodynamic-biogeochemical are run afterwards and the biogeochemical variables validated with available observations.

For specific details in each basin, the following subsections include the relevant scientific publications produced by the JRC marine modelling group that have used and/or have benefited from the results of the runs listed in the corresponding Tables.

Finally, the following subsections for the hindcast runs are structured by basin, in alphabetical order.

Table 2: Datasets necessary to build the basin configurations and/or to force the model runs.

Data type	Name of dataset	Stored at ies-hpc.jrc.it	JRC Responsible
Atmospheric hindcast	ECMWF CORDEXerain CORDEXmpi CORDEXece NCEP	/COMMONDATA/ECMWF/ /COMMONDATA/CORDEX/historical/erain/ /COMMONDATA/CORDEX/historical/mpiesm/ /COMMONDATA/CORDEX/historical/ecearth/ /COMMONDATA/NCEP/	A. Stips
Atmospheric scenarios	CORDEXmpi_rcp45 CORDEXmpi_rcp85 CORDEXece_rcp45 CORDEXece_rcp85	/COMMONDATA/CORDEX/rcp45/ /COMMONDATA/CORDEX/rcp85/ /COMMONDATA/CORDEX/rcp45/ /COMMONDATA/CORDEX/rcp85/	A. Stips
River discharges	GRDC	/COMMONDATA/RIVERS/	A. Stips
Nutrients from atmospheric deposition	DEPOSITION	/COMMONDATA/DEPOSITION/	A. Stips
Bathymetry	ETOPO1	/COMMONDATA/TOPO/	A. Stips
Sea temperature and salinity climatologies	MEDAR/MEDATLAS	/COMMONDATA/CLIMATOLOGY/MEDAR/	A. Stips
Sea nitrate, phosphate and oxygen climatologies	WOA05	/COMMONDATA/CLIMATOLOGY/WOA05nc/	A. Stips
Sea temperature, salinity, nitrate, phosphate and oxygen climatologies	WOA13	/COMMONDATA/CLIMATOLOGY/WOA13nc/	A. Stips

3.1 Atlantic North-West European Shelf

A description of the model runs and associated hydrodynamic results can be found in Coughlan and Stips (2015).

Table 3: Hindcast runs for the Atlantic North-West European Shelf. List of model configurations and run results including location of run results in the ies-hpc.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	**Run type (code)**	**Specific forcing: Atmospheric**	**Run results at ies-hpc.jrc.it**	**JRC Responsible**
Atlantic NW European Shelf	Hydrodynamic (GETM)	ECMWF	/vol05/coughcl/NWES_getm2_4_tidalanalysisruns_2003 /vol06/coughcl/swrNWES_getm2_4_66p /vol06/coughcl/emis_shelf_sea_1995_2012_monthlymean_3001 /vol06/coughcl/emis_shelf_sea_1997_2007_monthlymean_0513	A. Stips

3.2 Baltic Sea

A description of the model runs and associated hydrodynamic and biogeochemical results can be found in Lessin et al. (2014).

Table 4: Hindcast runs for the Baltic Sea. List of model configurations and run results including location of run results in the ies-hpc.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	**Run type (code)**	**Specific forcing: Atmospheric Nutrients**	**Run results at ies-hpc.jrc.it**	**JRC Responsible**
Baltic Sea	Hydrodynamic (GETM)	ECMWF	/vol04/stipsad/baltic_2x2_oxy_mean/	A. Stips
Baltic Sea	Hydrodynamic (GETM)	ECMWF	/vol05/stipsad/baltic_esto15_2012/	A. Stips
Baltic Sea	Coupled Hydrodynamic (GETM) – biogeochemical (ERGOM)	ECMWF Realistic nutrients	/vol05/stipsad/baltic_esto15/	A. Stips
Baltic Sea	Coupled Hydrodynamic (GETM) – biogeochemical (ERGOM)	ECMWF Realistic nutrients No salt-inflow	/vol06/stipsad/baltic_esto/	A. Stips

3.3 Black Sea

A description of the model runs and associated hydrodynamic and biogeochemical results can be found in Miladinova-Marinova et al. (2016).

Table 5: Hindcast runs for the Black Sea. List of model configurations and run results including location of run results in the ies-hpc.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	**Run type (code)**	**Specific forcing: atmospheric nutrients**	**Run results at ies-hpc.jrc.it**	**JRC Responsible**
Black Sea	Hydrodynamic (GETM)	ECMWF	/vol05/miladsv/ERAIN_MEDAR_RivDIS_a2_II_jo2 /vol07/miladsv/ERAIN_MEDAR_105_50_a1_at000 /vol07/miladsv/ERAIN_MHY_105_50_a1_at000	S. Miladinova-Marinova
Black Sea	Hydrodynamic (GETM)	CORDEXerain	/vol07/miladsv/CORDEX_MEDAR_GRDC_atten /vol05/miladsv/CORDEX_MEDAR_GRDC_200	S. Miladinova-Marinova
Black Sea	Hydrodynamic (GETM)	NCEP	/vol07/miladsv/NCEP_MEDAR_3x3_50_a1_at000	S. Miladinova-Marinova
Black Sea	Coupled Hydrodynamic (GETM) – biogeochemical (BSSM)	ECMWF Realistic nutrients	/vol05/miladsv/ERAIN_MEDAR_3x3_50_a1_at000 /vol05/miladsv/ERAIN_MEDAR_RivDIS_a2_II_jo2_79	S. Miladinova-Marinova
Black Sea	Coupled Hydrodynamic (GETM) – biogeochemical (BSSM)	CORDEXerain Realistic nutrients	/vol05/miladsv/CORDEX_MEDAR_GRDC_200 /vol07/miladsv/CORDEX_MEDAR_atten	S. Miladinova-Marinova

3.4 Mediterranean Sea

A description of the model runs and associated hydrodynamic and biogeochemical results can be found in Macias et al., 2014a, 2014b, 2015b, 2016a and 2016b

Table 6: Hindcast runs for the Mediterranean Sea. List of model configurations and run results including location of run results in the ies-hpc.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	**Run type (code)**	**Specific forcing: atmospheric nutrients**	**Run results at ies-hpc.jrc.it**	**JRC Responsible**
Mediterranean Sea	hydrodynamic (GETM)	ECMWF	/vol07/garciel/m5checksal_erain /vol07/garciel/m5checksal_erain1958 /vol07/garciel/m5checksal_erainwoa2013 /vol05/garciel/m5checksal_erainnewgetm /vol07/garciel/m5checksal_eraindoubleprecip /vol07/garciel/m5checksal_erainrightdarda /vol07/garciel/m5checksal_erainrightdarda1958 /vol07/garciel/m5checksal_erainrightdarda_vol05 /vol07/garciel/m5checksal_erainrightdarda_vol051958 /vol07/garciel/m5checksal_erainrightdardalesssal /vol05/garciel/m5checksal_erainrightdardalesssal1958 /vol07/garciel/m5checksal_erainrightdardalesssal_vol051958 /vol05/garciel/medsea_5x5_atlan2 /vol05/garciel/medsea_5x5_atlan2sm07 /vol05/garciel/medsea_5x5_atlan2sm09 /vol05/garciel/medsea_5x5_atlan2wind0	E. Garcia-Gorriz
Mediterranean Sea	hydrodynamic (GETM)	NCEP	/vol07/garciel/m5checksal_ncep	E. Garcia-Gorriz
Mediterranean Sea	hydrodynamic (GETM)	CORDEXerain	/vol06/garciel/medsea_5x5_fabm_CORDEXcor_meteooriginal /vol06/garciel/medsea_5x5_fabm_CORDEXcor_t2 /vol06/garciel/medsea_5x5_fabm_CORDEXcor_t2tcc /vol06/garciel/medsea_5x5_fabm_CORDEXcor_t2u10v10 /vol06/garciel/medsea_5x5_fabm_CORDEXcor_tcc /vol06/garciel/medsea_5x5_fabm_CORDEXcor_tccu10v10 /vol06/garciel/medsea_5x5_fabm_CORDEXcor_u10v10 /vol06/garciel/medsea_5x5_fabm_CORDEXcor	E. Garcia-Gorriz
Mediterranean Sea	hydrodynamic (GETM)	CORDEXmpi	/vol07/garciel/medsea_5x5_fabm_CORDEXmpi_t2tcc_baselineshift /vol06/garciel/medsea_5x5_fabm_CORDEXmpi_t2tcc /vol06/garciel/medsea_5x5_fabm_CORDEXmpi_u10v10 /vol06/garciel/medsea_5x5_fabm_CORDEXmpi	E. Garcia-Gorriz

Mediterranean Sea	hydrodynamic (GETM)	CORDEXece	/vol07/garciel/medsea_5x5_fabm_CORDEXece_t2tcc_baselineshift /vol06/garciel/medsea_5x5_fabm_CORDEXece_t2tcc /vol06/garciel/medsea_5x5_fabm_CORDEXece_u10v10 /vol06/garciel/medsea_5x5_fabm_CORDEXece	E. Garcia-Gorriz
Mediterranean Sea	Coupled hydrodynamic(GETM) – biogeochemical(MedERGOM)	Climatological meteo No nutrients from rivers	/vol07/maciadi/medsea_5x5_fabm_1958_self_clima_atmospheric_forcing_noNuts_rivers	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic(GETM) – biogeochemical(MedERGOM)	Climatological meteo Realistic nutrients	/vol07/maciadi/medsea_5x5_fabm_1958_self_clima_atmospheric_forcing_FullRivers	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical(Mediaroom)	ECMWF Realistic nutrients	/vol06/maciadi/medsea_5x5_fabm_new_1958_Exp4	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical(MEDEM)	ECMWF Realistic nutrients	/vol06/maciadi/medsea_5x5_fabm_new_medem_Exp1	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic(GETM) – biogeochemical (MedERGOM)	CORDEXerain Realistic nutrients	/vol06/maciadi/medsea_5x5_fabm_CORDEX_cordex_ERAIN_FABM_true	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic(GETM) – biogeochemical (MedERGOM)	CORDEXmpi Realistic nutrients	/vol06/maciadi/medsea_5x5_fabm_CORDEX_MPI_historic_1989_2005_shallowGib	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic(GETM) – biogeochemical (MedERGOM)	CORDEXece Realistic nutrients	/vol06/maciadi/medsea_5x5_fabm_CORDEX_EC_EARTH_historic_1989_2005_deepGib	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical (MedERGOM)	ECMWF Realistic nutrients	/vol06/garciel/medsea_5x5_fabm_twin_tides /vol06/garciel/medsea_5x5_fabm_twin_notides	E. Garcia-Gorriz
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical (MedERGOM)	ECMWF Nutrient Scenario	/vol05/garciel/medsea_5x5_fabm_climrivers_1960to70 /vol07/garciel/medsea_5x5_fabm_climrivers_1985to95	E. Garcia-Gorriz

3.5 North Sea

A description of the model runs and associated hydrodynamic and biogeochemical results can be found in Stips et al. (2016) .

Table 7: Hindcast runs for the North Sea. List of model configurations and run results including location of run results in the hpc-gw1.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	Run type (code)	Specific forcing: atmospheric nutrients	Run results at hpc-gw1.jrc.it	JRC Responsible
North Sea	Hydrodynamic (GETM)	ECMWF No SO2	/TEST/stipsad/NorthSea/river_TA_no_so2_co2_383	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF Realistic SO2	/TEST/stipsad/NorthSea/river_TA_so2_co2_383	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF Extreme SO2	/TEST/stipsad/NorthSea/river_TA_so2x5_co2_383	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF No SO2 High CO2	/TEST/stipsad/NorthSea/river_TA_no_so2_co2_400	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF SO2 High CO2	/TEST/stipsad/NorthSea/river_TA_so2_co2_400	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF SO2 No River Alkalinity	/TEST/stipsad/NorthSea/surface_so2_co2_383	A. Stips
North Sea	Coupled Hydrodynamic (GETM) – carbonate module (ERSEM)	ECMWF Extreme SO2 No River Alkalinity	/TEST/stipsad/NorthSea/surface_so2x5_co2_383	A. Stips

4. Scenario runs: Mediterranean Sea

For the Administrative Arrangement relevant for this report, the scenario runs are focused in the Mediterranean Sea. For these runs, we use the atmospheric forcing CORDEXmpi and CORDEXece produced through the EuroCORDEX initiative, mentioned in Section 3. Both datasets include two emission scenarios from the present to year 2100.

The first scenario is the worst-case or business-as-usual scenario rcp8.5, where emissions continue to grow throughout the 21st century. The second is the intermediate scenario rcp4.5 in which emissions peak around 2040 and decrease afterwards. For simplicity in this report, the corresponding atmospheric datasets are called CORDEXmpi_rcp4.5, CORDEXmpi_rcp8.5, CORDEXece_rcp4.5 and CORDEXece_rcp8.5. A complete description of the corresponding model runs and associated hydrodynamic and biogeochemical results can be found in Macias et al. (2015a), Macias et al. (2015b) and Macias et al. (2016b) .

Table 8: Scenario runs for the Mediterranean Sea. List of model configurations and run results including location of run results in the ies-hpc.jrc.it cluster, specific atmospheric and nutrient forcings, and person responsible at JRC.

Basin	**Run type (code)**	**Specific forcing: atmospheric nutrients**	**Run results at ies-hpc.jrc.it**	**JRC Responsible**
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical(MedERGOM)	CORDEXece_rcp4.5 Constant nutrients in rivers	/vol07/maciadi/medsea_5x5_fabm_CORDEX_2013_EC_rcp45_bias_corrected_riv_cte	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical()	CORDEXece_rcp8.5 Constant nutrients in rivers	/vol07/maciadi/medsea_5x5_fabm_CORDEX_2013_EC_rcp85_bias_corrected_riv_cte	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical()	CORDEXmpi_rcp4.5 Constant nutrients in rivers	/vol07/maciadi/medsea_5x5_fabm_CORDEX_2013_MPI_rcp45_bias_corrected_riv_cte	D. Macias Moy
Mediterranean Sea	Coupled hydrodynamic (GETM) – biogeochemical()	CORDEXmpi_rcp8.5 Constant nutrients in rivers	/vol07/maciadi/medsea_5x5_fabm_CORDEX_2013_MPI_rcp85_bias_corrected_riv_cte	D. Macias Moy

5. Conclusions

Within the Administrative Arrangement No ENV C.2/2015/070201/705766 between DG Environment and DG JRC IES Water Resources Unit, the JRC has established the MSFD Competence Centre to assist Member States in the implementation of the MSFD. The MCC includes the marine Modelling Framework (or toolbox) for the assessment of MSFD descriptors and provides independent and evidence-based scientific and technical support throughout the whole policy cycle of the MSFD. In this context, the models in the marine Modelling Framework of the MCC, both hydrodynamic and biogeochemical, can provide the numerical tools to determine baseline conditions from the past, to estimate the future impact of pressures on the marine environment, and complement spatially and temporally the scarcity in sampling of some marine-related datasets relevant for the assessment of the MSFD descriptors.

This report constitutes Deliverable 2.1 of the Administrative Arrangement and it includes an inventory of models, basin configurations, atmospheric and nutrient forcing datasets and scenarios, and run results within the MCC Modelling Framework. This inventory is structured in hindcast runs and scenario runs. Within both hindcast and scenario runs, the results are grouped by basin. The basins included are the Atlantic North-West European Shelf, the Baltic Sea, the Black Sea, the Mediterranean Sea and the North Sea.

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List of abbreviations and definitions

ACCMIP: Atmospheric Chemistry and Climate Model Intercomparison Project

BSSM: Black Sea Specific Ecosystem Model

CCLM: COSMO Climate Limited-area Modelling atmospheric regional climate model

CORDEXece: atmospheric dataset produced by CCLM with the Earth System Model of the EC- Earth Consortium

CORDEXece_rcp4.5: atmospheric dataset produced by CCLM with the Earth System Model of the EC- Earth Consortium for the intermediate emission scenario

CORDEXece_rcp8.5: atmospheric dataset produced by CCLM with the Earth System Model of the EC- Earth Consortium for the worst-case or business as usual emission scenario

CORDEXerain: atmospheric dataset produced by CCLM with ERA-interim reanalysis of the European Centre for Medium Range Weather Forecast

CORDEXmpi: atmospheric dataset produced by CCLM with the Max Plank Institute MPI-ESM-LR model

CORDEXmpi_rcp4.5: atmospheric dataset produced by CCLM with the Max Plank Institute MPI-ESM-LR model for the intermediate emission scenario

CORDEXmpi_rcp8.5: atmospheric dataset produced by CCLM with the Max Plank Institute MPI-ESM-LR model for the worst-case or business as usual emission scenario

DG ENV: Directorate General Environment

DG JRC: Directorate General Joint Research Centre

ECMWF: European Center for Medium Range Weather Forecast

ERAin: ECMWF ERA-interim reanalysis

ERGOM: Ecological Regional Ocean Model

ERSEM: European Regional Seas Ecosystem Model

ETOPO1: Earth topography database

FABM: Framework for Aquatic Biogeochemical Models

GRDC: Global River Data Center database

GES: Good Environmental Status

GETM: General Estuarine Ocean Model

GOTM: General Ocean Turbulence Model

IES: Institute for Environment and Sustainability

JRC: Joint Research Centre

MEDAR/MEDATLAS: Mediterranean Data Archaeology and Rescue database

MEDEM: Mediterranean Sea biogeochemical Model

MedERGOM: Mediterranean Sea Ecological Regional Ocean Model

MCC: MSFD Marine Competence Centre

MS: Member State

MSFD: Marine Strategy Framework Directive

NCEP: National Centers for Environmental Prediction

WOA05: World Ocean Atlas 2005 database

WOA13: World Ocean Atlas 2013 database version 2

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JRC Mission

As the Commission's in-house science service, the Joint Research Centre's mission is to provide EU policies with independent, evidence-based scientific and technical support throughout the whole policy cycle.

Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

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