FishMIP Phase 1 2020 Protocol [ISIMIP3b]

Global & Regional Models

V1.0 July 23rd 2020

1. Goal

The goal of FishMIP Phase 1 2020 is to provide input to the IPCC WGII AR6 report. This necessitates submitting a manuscript by **November 1st 2020**.

The focus of this simulation round will be on (a) new FishMIP outputs using three climate scenarios from the CMIP6 earth-system model forcings; (b) exploring fishing impacts in addition to those of climate; (c) comparison to a no-climate change pre-industrial control baseline (which was not available for the last round of simulations), and (d) if possible, validation against observed catches.

Note that this FishMIP Phase 1 protocol represents only a subset of the full ISIMIP3b protocol with a smaller set of scenarios considered. The FishMIP Phase 2 2021 protocol will build upon these simulations.

2. Target date for all simulations to be uploaded to ISI-MIP servers

31st August 2020

Uploading simulations by this date is essential since it only leaves 2 months for analysis and writing of a manuscript(!) If you are able to upload results sooner, that would be helpful. If you are unable to make the deadline but still wish to contribute simulations, please go ahead as we may be able to incorporate them later on.

Throughout the protocol we use specifiers that denote a particular scenario, experiment, variable or other parameter.

We use these specifiers in the tables below, in the filenames of the input data sets, and **ask you to use the same specifiers in your output files. Correct formatting and naming of output files is essential for model inter-comparison.** More on reporting data outputs can be found at the end of this document.

3. Scenarios & Experiments

Scenario definitions

Table 1: Climate scenario specifiers

Scenario specifier	Description
picontrol	Pre-industrial climate as simulated by the Earth System Models (ESMs)
historical	Historical climate as simulated by the ESMs, starting in 1950.
ssp126	SSP1-RCP2.6 climate as simulated by the ESMs.
ssp585	SSP5-RCP8.5 climate as simulated by the ESMs.

Table 2: Fishing scenario specifiers

Scenario specifier	Description
histsoc	Varying direct human influences in the historical period (1950-2014) (i.e. historical estimates of fishing effort).
2015soc	Fixed year-2015 direct human influences (i.e. fishing effort).
nat	No fishing (naturalized run).

Please remember to **use these same specifiers in your output files.** More on reporting data can be found at the end of this document.

Table 3: Experiments

	Experiment	Short description	Historical 1950-2014	Future 2015-2100	Explanation
1	**pre-industrial control** histsoc	**Climate:** no climate change, pre-industrial CO_2 fixed at 1850 levels	**picontrol**	**picontrol**	**No climate-change but with fishing**
		Fishing: historical effort until 2015, then fixed at 2015 levels thereafter	**histsoc**	**2015soc**	
2	**pre-industrial control** nat	**Climate:** no climate change, pre-industrial CO_2 fixed at 1850 levels	**picontrol**	**picontrol**	**No climate-change without fishing**
		Fishing: No fishing	**nat**	**nat**	
3	**RCP2.6** histsoc	**Climate:** Simulated historical climate in historical period, then SSP1-RCP2.6 climate	**historical**	**ssp126**	**RCP2.6 with fishing**
		Fishing: historical effort until 2015, then fixed at 2015 levels thereafter	**histsoc**	**2015soc**	
4	**RCP2.6** nat	**Climate:** Simulated historical climate in historical period, then SSP1-RCP2.6 climate	**historical**	**ssp126**	**RCP2.6 without fishing**
		Fishing: No fishing	**nat**	**nat**	
5	**RCP8.5** histsoc	**Climate:** Simulated historical climate in historical period, then SSP5-RCP8.5 climate	**historical**	**ssp585**	**RCP8.5 with fishing**
		Fishing: historical effort until 2015, then fixed at 2015 levels thereafter	**histsoc**	**2015soc**	
6	**RCP8.5** nat	**Climate:** SSP5-RCP8.5 climate & CO_2	**historical**	**ssp585**	**RCP8.5 without fishing**
		Fishing: No fishing	**nat**	**nat**	

Please note that all experiments start in 1950 but that ESM forcing files on the ISI-MIP servers start in 1850. This is for models which require spin-up

For models requiring spin-up, **please use the pre-industrial control data and CO_2 concentration from 1850-1949.** Please also **use either (a) no fishing during this period, or (b) 1950 fishing held constant during this period**, depending on whether it is a no fishing or a fishing run. If you do not require any spin-up, please start with 1950.

Each experiment should be run with each of the ESM models (GFDL and IPSL below), for a total of 6 x 2 = 12 runs. If there are any challenges with doing all twelve, please contact us and we will help to prioritize. Note that runs (3) and (5), and (40 and (6) share identical forcings from 1950 to 2014, so it may be possible to minimize simulation time there.

4. Input data

The base directory for accessing ocean input data at DKRZ is:

`/work/bb0820/ISIMIP/ISIMIP3b/InputData/climate/ocean/uncorrected/`

Further information on accessing ISIMIP data can be found at ISIMIP - getting started under the 'ISI-MIP participants' section

Table 4: Climate and climate-related forcing data (climate-forcing).

Title	Specifier	Institution	Original resolution	Ensemble member
GFDL-ESM4	**gfdl-esm4**	National Oceanic and Atmospheric Administration, Geophysical Fluid Dynamics Laboratory, Princeton, NJ 08540, USA	288x180	r1i1p1f1
IPSL-CM6A-LR	**ipsl-cm6a-lr**	Institut Pierre Simon Laplace, Paris 75252, France	144x143	r1i1p1f1

Table 5: Climate forcing variables and units. A green box means the variable is available for the Earth System Model, a red box means not available. All variables are 1-degree, monthly resolution.

Variable	Units	GFDL-ESM4	IPSL-CM6A-LR
chl (3D Phytoplankton Chlorophyll Concentration)	kg m-3		
expc-bot (Export Carbon to Bottom)	mol m-2 s-1		
intpoc (Integrated Particulate Organic Carbon)	kg m-2		
intpp (Integrated Total Primary Production)	mol m-2 s-1		
intppdiat (Integrated Diatom/Large Phytoplankton Production)	mol m-2 s-1		
intppdiaz (Integrated Diazotroph Production)	mol m-2 s-1		
intppsmall (Integrated Small Phytoplankton Production)	mol m-2 s-1	*	*
mlotstmax (Maximum Mixed Layer Thickness Defined by Sigma T)	m		
o2 (3D Dissolved Oxygen Concentration)	mol m-3		
o2-bot (Dissolved Oxygen Concentration on Bottom)	mol m-3		
o2-surf (Dissolved Oxygen Concentration on Top)	mol m-3		
pH	1		
pH-bot	1		
pH-surf	1		
phyc (3D Phytoplankton Carbon Concentration)	mol m-3		
phyc-vint (Integrated Total Phytoplankton Carbon Concentration)	mol m-2		
phydiat (3D Diatom Carbon Concentration)	mol m-3		
phydiat-vint (Integrated Diatom/Large Phytoplankton Carbon Concentration)	mol m-2		
phydiaz (3D Diazotroph Carbon Concentration)	mol m-3		

phydiaz-vint (Integrated Diazotroph Carbon Concentration)	mol m-2		
physmall (3D Small Phytoplankton Carbon Concentration)	mol m-3	*	*
physmall-vint (Integrated Small Phytoplankton Carbon Concentration)	mol m-2	*	*
rsntds (Net Downward Shortwave Flux at Sea Water Surface)	W m-2		
siconc (Sea Ice Fraction of Ocean Grid)	%		
so (Sea Water Salinity)	0.001		
so-bot (Sea Water Salinity)	0.001		
so-surf (Sea Water Salinity)	0.001		
thetao (3D Sea Water Potential Temperature)	deg C		
thetao-bot (Sea Water Potential Temperature on Bottom)	deg C		
tos (Sea Surface Temperature)	deg C		
uo (Sea Water x Velocity)	m s-1		
vo (Sea Water y Velocity)	m s-1		
wo (Sea Water z Velocity)	m s-1		
zmicro (3D Microzooplankton/Small Zoo Carbon Concentration)	mol m-3		
zmicro (Integrated Microzooplankton/Small Zoo Carbon Concentration)	mol m-2		
zmeso (3D Mesozooplankton/Large Zoo Carbon Concentration)	mol m-3		
zmeso (Integrated Mesozooplankton/Large Zoo Carbon Concentration)	mol m-2		
zooc (Integrated Total Zooplankton Carbon Concentration)	mol m-2		

* **Small phytoplankton carbon/production data** are not available on the server, but can be made by modellers by subtracting diatom carbon/production from total phytoplankton carbon/production.

The climate forcing input files can be found using the following pattern:

```
/work/bb0820/ISIMIP/ISIMIP3b/InputData/climate/ocean/uncorrected/<glob
al or regional>/monthly/<climate-scenario>/<climate-forcing>/<climate-
forcing>_<ensemble-member>_<climate-scenario>_<climate-
variable>_global_monthly_<start-year>_<end-year>.nc
```

Please note that if you can only run one set of Earth System Model forcings due to missing data (red in the table above), that is fine: please just let the FishMIP coordinators know.

Please note that all experiments start in 1950 but that ESM forcing files on the ISI-MIP servers start in 1850.

Table 6: Fisheries forcings

These forcings can be found on the ISI-MIP servers as .CSV files at:

/mnt/lustre01/work/bb0820/ISIMIP/ISIMIP3b/InputData/socioeconomic/fishing

Dataset	Included variables (specifier)	Covered time period	Resolution	Reference/Source and Comments
Fishing effort	For global modellers, **effort forcing by functional group is available at aggregated spatial scales listed below**. We suggest that regional modelers use the effort currently used in your model at present. All assumptions about fishing process, catchability, and technological creep need to be provided by each modeller.			
	fishing effort	1950-2014	Aggregated spatial units (FAO regions, Large marine ecosystems, EEZs). Annual.	These data comprise the nominal effort of industrial and artisanal fleets aggregated into 6 functional groups: Small Pelagics (<30 cm) Medium Pelagics (30 - 90 cm) Large Pelagics (>=90 cm) Small Demersals (<30 cm) Medium Demersals (30 - 90 cm) Large Demersals (>=90 cm) Source: Rousseau et al., 2019, PNAS 116 (25) 12238-1224
Fish catch	**These data will be available on the ISIMIP servers** for use with the effort data (e.g. calibration or catchability estimation).			
	fish catch	1950-2014	Aggregated spatial units (FAO regions, Large marine ecosystems, EEZs). Annual.	Data will be made available in ISMIP servers. These data comprise the catches of industrial and artisanal fleets aggregated into 6 functional groups: Small Pelagics (<30 cm) Medium Pelagics (30 - 90 cm) Large Pelagics (>=90 cm)

Dataset	Included variables (specifier)	Covered time period	Resolution	Reference/Source and Comments	
				Small Demersals (<30 cm) Medium Demersals (30 - 90 cm) Large Demersals (>=90 cm) Reference for data source: Watson & Tidd, 2018, Marine Policy, 93: 171-177	

Table 7: Geographic data and information (if needed)

Dataset	Included variables (specifier)	Resolution	Reference/Source and Comments
Land/Sea masks			
landseamask	`geo_conditions/landseamask/landseamask.nc`		
	• land-sea mask (mask)	0.5° grid	GSWP3-W5E5 (with Antarctica)
landseamask_no-ant	`geo_conditions/landseamask/landseamask_no-ant.nc`		
	• land-sea mask (mask)	0.5° grid	GSWP3-W5E5 (without Antarctica)

5. Output data

Output variables requested. DARK GREY indicates summary variables. **LIGHT GREY** indicates sub-categorized variables – **please provide these if at all possible**.

Please **use the value 1.e+20f for missing data** within your output files.

*Annual output is also acceptable if monthly output is not feasible with your model.

Please note that all biomasses are in wet weight, not g C. If you do not already have a conversion factor from carbon to wet weight, please contact the FishMIP coordinators for assistance.

Variable	Variable specifier	Unit	Resolution*	Comments
Mandatory output (provide as many as possible)				
TOTAL consumer biomass density	**tcb**	g m-2	• 1° grid • monthly	all consumers (trophic level >1, vertebrates and invertebrates)
TOTAL consumer biomass density in log10 weight bins	**tcblog10**	g m-2	• 1° grid • monthly • 6 size bins	If the model is size-structured, please provide biomass in equal log 10 g C weight bins (1g, 10g, 100g, 1kg, 10kg, 100kg)
TOTAL pelagic biomass density	**tpb**	g m-2	• 1° grid • monthly	all pelagic consumers (trophic level >1, vertebrates and invertebrates)
Biomass density of small pelagics <30cm	**bp30cm**	g m-2	• 1° grid • monthly	if a pelagic species and L infinity is <30 cm, include in this variable
Biomass density of medium pelagics >=30cm and <90cm	**bp30to90cm**	g m-2	• 1° grid • monthly	if a pelagic species and L infinity is >=30 cm and <90cm, include in this variable
Biomass density of large pelagics >=90cm	**bp90cm**	g m-2	• 1° grid • monthly	if a pelagic species and L infinity is >=90cm, include in this variable

Variable	Variable specifier	Unit	Resolution*	Comments
TOTAL demersal biomass density	**tdb**	g m-2	• 1° grid • monthly	all demersal consumers (trophic level >1, vertebrates and invertebrates)
Biomass density of small demersals <30cm	**bd30cm**	g m-2	• 1° grid • monthly	if a demersal species and L infinity is <30 cm, include in this variable
Biomass density of medium demersals >=30cm and <90cm	**bd30to90cm**	g m-2	• 1° grid • monthly	if a demersal species and L infinity is >=30 cm and <90cm, include in this variable
Biomass density of large demersals >90cm	**bd90cm**	g m-2	• 1° grid • monthly	if a demersal species and L infinity is >=90cm, include in this variable
TOTAL Catch (all commercial functional groups / size classes)	**tc**	g m-2	• 1° grid • monthly	catch at sea (commercial landings plus discards, fish and invertebrates)
TOTAL Catch in log10 weight bins	**tclog10**	g m-2	• 1° grid • monthly • 6 size bins	If the model is size-structured, please provide catch in equal log 10 g C weight bins (1g, 10g, 100g, 1kg, 10kg, 100kg)
TOTAL pelagic catch	**tpc**	g m-2	• 1° grid • monthly	catch at sea of all pelagic consumers (trophic level >1, vertebrates and invertebrates)
Catch density of small pelagics <30cm	**cp30cm**	g m-2	• 1° grid • monthly	catch at sea of pelagic species with L infinity <30 cm
Catch density of medium pelagics >=30cm and <90cm	**cp30to90cm**	g m-2	• 1° grid • monthly	catch at sea of pelagic species with L infinity >=30 cm and <90 cm

Variable	Variable specifier	Unit	Resolution*	Comments
Catch density of large pelagics >=90cm	**cp90cm**	g m-2	• 1° grid • monthly	catch at sea of pelagic species with L infinity >=90 cm
TOTAL demersal catch	**tdc**	g m-2	• 1° grid • monthly	catch at sea of all demersal consumers (trophic level >1, vertebrates and invertebrates)
Catch density of small demersals <30cm	**cd30cm**	g m-2	• 1° grid • monthly	catch at sea of demersal species with L infinity <30 cm
Catch density of medium demersals >=30cm and <90cm	**cd30to90cm**	g m-2	• 1° grid • monthly	catch at sea of demersal species with L infinity >=30 cm and <90 cm
Catch density of large demersals >=90cm	**cd90cm**	g m-2	• 1° grid • monthly	catch at sea of demersal species with L infinity >=90 cm

6. Reporting model results

The specification on how to submit the data, as well as further information and instructions are given on the ISIMIP website at:

https://www.isimip.org/protocol/preparing-simulation-files

It is important that you comply precisely with the formatting specified there, in order to facilitate the analysis of your simulation results in the ISIMIP framework. **Incorrect formatting can seriously delay the analysis**. **The ISIMIP Team will be glad to assist with the preparation of these files if necessary.**

File names consist of a series of identifier, separated by underscores. Things to note:

- Report one output ouvariable per file
- In filenames, use lowercase letters only
- Use underscore (_) to separate identifiers
- Variable names consist of a single word without hyphens or underscores
- Use hyphens (-) to separate strings within an identifier, e.g. in a model name
- If no specific `sens-scenario` is given in the experiments table (as here), use `default`.
- NetCDF file extension is `.nc`

Please name the files in the Fisheries and Marine Ecosystems sector **according to the following pattern**:

Global models

```
<model>_<climate-forcing>_<bias-adjustment>_<climate-
scenario>_<soc-scenario>_<sens-
scenario>_<variable>_<global>_<timestep>_<start-year>_<end-
year>.nc
```

Regional models

```
<model>_<climate-forcing>_<bias-adjustment>_<climate-
scenario>_<soc-scenario>_<sens-
scenario>_<variable>_<region>_<timestep>_<start-year>_<end-
year>.nc
```

and replace the identifiers with the specifiers given in the tables of this document. No bias adjustment has been done for these forcings, so bias-adjustment should be marked as 'nobc' (no bias-correction). An example would be:

```
apecosm_gfdl-
esm4_nobc_picontrol_histsoc_default_tcb_global_monthly_2001_
2010.nc
```

The following regular expression can be used to validate and parse the file name for the fisheries and marine ecosystems sector:

```
(?P<model>[a-z0-9-+.]+)_(?P<climate_forcing>[a-z0-9-
]+)_(?P<bias_adjustment>[a-z0-9-]+)_(?P<climate_scenario>[a-
z0-9-]+)_(?P<soc_scenario>[a-z0-9-]+)_(?P<sens_scenario>[a-
z0-9-]+)_(?P<variable>[a-z0-
9]+)_(?P<region>(global))_(?P<timestep>[a-z0-9-
]+)_(?P<start_year>\d{4})_(?P<end_year>\d{4}).nc
```

Finally, please also provide (by email to FishMIP coordinators):

- (For fishing): all assumptions about catchability and technological creep
- Any conversion factors that you used to convert from wet weight to carbon (if relevant)

For questions or clarifications, please contact info@isimip.org or the data managers directly (isimip-data@pik-potsdam.de) before submitting files.

Thank you for your contributions to FishMIP, ISI-MIP, and (hopefully) the AR6! FishMIP is entirely community-driven, and we appreciate the effort of all involved.