FishMIP 2022 Model Evaluation Protocol

[ISIMIP 3a]

Global & Regional Models

Contents

1. Goal

The goal of the FishMIP Model Evaluation Protocol [3a] is to understand and reduce uncertainty associated with FishMIP models through model evaluation under historical climate and fishing effort forcings.

This information will allow FishMIP to better target policy initiatives such as IPCC and IPBES by providing more robust uncertainty assessment, as well as advancing the state of FishMIP models for informing vulnerability, impact, and adaptation plans of coastal sea ecosystems and fisheries (requested by the FAO).

The focus of papers produced from this simulation round will be a significant advance in at least two ways:

I. forcing models with higher spatial resolution of global climate models and reconstructed historical fishing effort and
II. assessment of models against reconstructed historical catches (as well as biomass and other fisheries and ecological metrics in regions where additional data are available).

Target date for uploading simulation outputs:

August 30th, 2022

Uploading simulations by this date is essential to ensure enough time for analysis and writing of manuscripts in time for presentation of preliminary results at the FishMIP workshop Oct 3-7th and for submission to the ISIMIP Special Issue by the end of 2022. If you are able to upload results sooner, that would be helpful. If you need more time, please let us know as soon as possible.

Progress towards this deadline will be supported and facilitated through online global and regional modeller workshops to:

- Ensure correct ESM model inputs and access
- Ensure fishing drivers work (separate global and regional breakaway groups)
- Tool sharing & troubleshooting
- Check model outputs/issues

We are also looking into upcoming in-person workshop options for the latter half of 2022 to brainstorm and discuss draft papers.

In this document we describe the general experimental and scenario set-up (Section 3). Further down in Section 4 we include the details of the specific **input** variables that modellers can use to implement scenarios. In Section 5 we describe the set of **outputs** to be created. Finally in Sections 6-7 we provide further **notes** and **instructions** on how to report and upload model results.

Further information on this protocol can be found here:

https://protocol.isimip.org/#ISIMIP3a/peat/marine-fishery_regional/marine-fishery_global

For this simulation round, we are asking you to run and upload 2 core runs, 2 optional (but preferred) detection and attribution runs, and 2 optional sensitivity test runs, described below.

2. Experiments & Scenarios

Each model experiment is a set of model simulations that has a particular goal (e.g. model evaluation). A scenario is a particular setting for forcing drivers that describes how each model run should be set up in the experiment, including both the type of climate forcing (CF) and the type of direct human forcing (DHF).

The model runs that we are requesting for this simulation round are listed below. Please prioritize the core runs below, and provide the 'optional' if possible.

Table 1: Experiment set-up. Each experiment is specified by the climate forcing (CF) and Direct Human Forcing (DHF).

Experiment	Scenario description	Scenario specifier Period: Historical (1961-2010)	Sensitivity specifier
	1.Climate, river inputs, fishing – high res		
Model evaluation 2 core runs	**CF:** Climate variability constrained by reanalysis atmospheric forcing (GFDL-COBALT2 forced by JRA-55 and river inputs) using 0.25 degree grid **DHF:** Varying direct human influences according to observed reconstructed fishing effort time series (histsoc).	**obsclim** **histsoc**	**15arcmin**
	2.Climate, river inputs, no fishing – high res		
	CF: same as above using 0.25 grid	**obsclim**	**15arcmin**

Experiment	Scenario description	Scenario specifier Period: Historical (1961-2010)	Sensitivity specifier
	DHF: without any fishing activity (nat)	**nat**	
Detection and attribution 2 optional (but preferred) runs	3.Climate, no river input forcing, fishing – high res		
	CF: Climate variability constrained by reanalysis atmospheric forcing (GFDL-COBALT2 "*control run*" only forced by JRA-55) using 0.25 degree grid **DHF:** Varying direct human influences according to observed reconstructed fishing effort time series (histsoc).	**ctrlclim** **histsoc**	**15arcmin**
	4.Climate, no river input forcing, no fishing – high res		
	CF: same as above using 0.25 grid **DHF:** without any fishing activity (nat)	**ctrlclim** **nat**	**15arcmin**
Resolution sensitivity test 2 optional runs	5.Climate, river input forcing, fishing – low res		
	CF: Climate variability constrained by reanalysis atmospheric forcing (GFDL-COBALT2 forced by JRA-55 and river inputs) using 1 degree grid **DHF:** Varying direct human influences according to observed reconstructed fishing effort time series (histsoc).	**obsclim** **histsoc**	**onedeg**
	6.Climate, river input forcing, no fishing – low res		
	CF: same as above using 1 degree grid	**obsclim** **nat**	**onedeg**

Experiment	Scenario description	Scenario specifier Period: Historical (1961-2010)	Sensitivity specifier
	DHF: without any fishing activity (nat)		

Note on spin-up and transition to 1961

The model evaluation experiment starts in 1961. To capture historical fishing effort prior to 1961, we also provide input for a pre-industrial transition period for the years 1841-1960 inclusive.

To set-up climate-forcing variables for 1841-1960, we ask modellers to use the "control run" (`ctrlclim`) monthly output **for the years 1961-1980 (inclusive) on repeat for six cycles.** These years have been selected because they correspond with an entire ENSO cycle and because no climate trend is detectable prior to 1980 from the GFDL model.

For fishing effort, we are providing reconstructed fishing effort annual time series for the pre-industrial transition (1841-1960 inclusive) period, which spans six ENSO cycles.

For models that require spin-up prior to 1841, please keep 1841 levels of fishing effort constant and, if needed, repeat the ENSO cycle (e.g. monthly values for 1961-1980 inclusive from `ctrlclim`) for as many times necessary.

For the 'no fishing' runs (`nat`), the spin-up and pre-industrial transition should not use any fishing effort.

We ask modellers to include all outputs from 1841 onwards for use in our analyses.

Scenario definitions

Throughout the protocol we use 'specifiers' that are shortened names used to denote a particular scenario, variables, or other parameter in the filenames of model inputs and outputs.

It is crucial that you also use the same specifiers in your output files.

Correct formatting and naming of output files are essential for model intercomparison and analysis.

Tables 2-4 describe the different scenarios for the model runs described in Table 1. These specifiers are used in the file names of the corresponding input files and should also be used for the names of the output files (see 7. Reporting model results).

Table 2: Climate scenario specifiers (climate-scenario).

Scenario specifier	Description
obsclim	Climate with observed atmospheric forcing and river input forcing used for model evaluation and the detection and attribution task.
ctrlclim	Climate with only observed atmospheric forcing being used as a control run for model evaluation and the detection and attribution task.

Table 3: Socio-economic scenario specifiers (soc-scenario).

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

Table 4: Sensitivity scenario specifiers (sens-scenario).

Scenario specifier	Description
15arcmin	0.25 degree resolution climate model inputs
onedeg	1 degree resolution climate model inputs

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

3. Input data

For modellers new to FishMIP: to access all input data you first need to set up an account with ISIMIP to access the DKRZ server. Please follow the instructions here: https://www.isimip.org/dashboard/accessing-isimip-data-dkrz-server/

a. Climate forcing

Table 5: Climate forcing

Title	Specifiers	Time period	Reanalysis	Bias adjustment target	Comments	Priority
GFDL-MOM6-COBALT2	**gfdl-mom6-cobalt2_obsclim_**<variable>**_15arcmin**	1961-2010	JRA55	none	River input and JRA-55 driven MOM6-COBALT2 reanalysis. Data on native grid was remapped to a regular **0.25° grid**. For further experiment design details see https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GL094367	1
GFDL-MOM6-COBALT2	**gfdl-mom6-cobalt2_ctrlclim_**<variable>**_15arcmin**	1961-2010	JRA55	none	JRA-55 only driven MOM6-COBALT2 reanalysis (control run). Data on native grid was remapped to a regular **0.25° grid**. For further experiment design details see https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GL094367	2
GFDL-MOM6-COBALT2	**gfdl-mom6-cobalt2_obsclim_**<variable>**_onedeg**	1961-2010	JRA55	none	River input and JRA-55 driven MOM6-COBALT2 reanalysis. Data on native grid was remapped to a regular **1° grid**. For further experiment design details see https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GL094367	3
GFDL-MOM6-COBALT2	**gfdl-mom6-cobalt2_ctrlclim_**<variable>**_15arcmin**	1961-2010	JRA55	none	JRA-55 only driven MOM6-COBALT2 reanalysis (control run). Data on native grid was remapped to a regular **1° grid**. For further experiment design details see https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2021GL094367	4

Table 6. Climate forcing variables and units for FishMIP 3a simulations. All variables are available on a 0.25 and 1 degree horizontal grid, monthly and annual resolutions. Note: Some variables are available as specific layers extracted from vertically resolved data. Their variable

names have been suffixed with -bot (ocean bottom, e.g. o2-bot), -surf (surface values, e.g. pH-surf) or -vint (vertically integrated, e.g. phyc-vint), respectively, or prefixed with int (vertically integrated, e.g. intpp). Temperature is suffixed with b or s for bottom (e.g. tob) or surface (e.g. tos) layers, respectively.

Variable	Variable specifier	Unit	Resolution	Datasets
Mass Concentration of Total Phytoplankton Expressed as Chlorophyll	**chl**	kg m-3	0.25° grid	GFDL-MOM6-COBALT2
Sea Floor Depth	**deptho**	m	0.25° grid	GFDL-MOM6-COBALT2
Downward Flux of Particulate Organic Carbon	**expc-bot**	mol m-2 s-1	0.25° grid	GFDL-MOM6-COBALT2
Particulate Organic Carbon Content	**intpoc**	kg m-2	0.25° grid	GFDL-MOM6-COBALT2
Primary Organic Carbon Production by All Types of Phytoplankton	**intpp**	mol m-2 s-1	0.25° grid	GFDL-MOM6-COBALT2
Net Primary Organic Carbon Production by Diatoms	**intppdiat**	mol m-2 s-1	0.25° grid	GFDL-MOM6-COBALT2
Net Primary Mole Productivity of Carbon by Diazotrophs	**intppdiaz**	mol m-2 s-1	0.25° grid	GFDL-MOM6-COBALT2
Net Primary Mole Productivity of Carbon by Picophytoplankton	**intpppico**	mol m-2 s-1	0.25° grid	GFDL-MOM6-COBALT2
Maximum Ocean Mixed Layer Thickness Defined by Sigma T	**mlotst-0125**	m m	0.25° grid	GFDL-MOM6-COBALT2
Dissolved Oxygen Concentration	**o2,** **o2-bot** **o2-surf**	mol m-3 mol m-2 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
pH	**ph** **ph-bot** **ph-surf**	1 1 1	0.25° grid	GFDL-MOM6-COBALT2
Phytoplankton Carbon Concentration	**phyc** **phyc-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Mole Concentration of Diatoms expressed as Carbon in sea water	**phydiat** **phydiat-vint**	mol m-3	0.25° grid	GFDL-MOM6-COBALT2

Variable	Variable specifier	Unit	Resolution	Datasets
		mol m-2		
Mole Concentration of Diazotrophs Expressed as Carbon in Sea Water	**phydiaz** **phydiaz-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Mole Concentration of Picophytoplankton Expressed as Carbon in Sea Water	**phypico** **phypico-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Sea Water Salinity	**so** **so-bot** **so-surf**	‰ ‰ ‰	0.25° grid	GFDL-MOM6-COBALT2
Sea Water Potential Temperature	**thetao**	°C	0.25° grid	GFDL-MOM6-COBALT2
Ocean Model Cell Thickness	**thkcello**	m	0.25° grid	GFDL-MOM6-COBALT2
Sea Water Potential Temperature at Sea Floor	**tob**	°C	0.25° grid	GFDL-MOM6-COBALT2
Sea Surface Temperature	**tos**	°C	0.25° grid	GFDL-MOM6-COBALT2
Sea Water X Velocity	**uo**	m s-1	0.25° grid	GFDL-MOM6-COBALT2
Sea Water Y Velocity	**vo**	m s-1	0.25° grid	GFDL-MOM6-COBALT2
Mole Concentration of Mesozooplankton expressed as Carbon in sea water	**zmeso** **zmeso-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Mole Concentration of Microzooplankton expressed as Carbon in sea water	**zmicro** **zmicro-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Zooplankton Carbon Concentration	**zooc** **zooc-vint**	mol m-3 mol m-2	0.25° grid	GFDL-MOM6-COBALT2
Net Downward Shortwave Radiation at Sea Water Surface	**rsntds**	W m-2	0.25° grid	GFDL-MOM6-COBALT2

Climate forcing file locations

The monthly climate forcing files for obsclim (onedeg and 15arcmin) of this simulation protocol can be found on DKRZ here:

levante:/work/bb0820/ISIMIP/ISIMIP3a/InputData/climate/ocean/obsclim/global/monthly/historical/GFDL-MOM6-COBALT2/

The monthly climate forcing files for climate forcing for spin-up and control runs (ctrlclim: onedeg and 15arcmin) of this simulation protocol can be found on DKRZ here:

levante:/work/bb0820/ISIMIP/ISIMIP3a/SecondaryInputData/climate/ocean/ctrlclim/global/

The variables **deptho** and **thkcello** are fixed through time and can be found in the "FixedInput/" folder (rather than monthly/).

Note on phytoplankton size structure inputs

Production and carbon data for large and small phytoplankton can be derived from the variables in Table 1 by the following:

large = diatoms + diazotrophs

small = picophytoplankton

The GFDL model treats diazotrophs as large phytoplankton as part of their food-web processes.

Note on Sea Ice Presence Absence within Ocean Grid Cells

The GFDL we are using does not have sea ice fraction saved as output directly. An alternative variable (sea ice presence or absence, 1 or 0) will be made available and will be derived from sea water temperature.

Note on regional model spatial extractions

For regional models, only specific grid cells will be needed from the above global outputs. Please let us know if you require assistance to extract results (e.g. using bounding boxes, masks or shapefiles). This functionality is now partially available (bounding box) through the ISIMIP web-based data portal.

A simple worked example on how to do this for specific regions in R is provided here: https://github.com/Fish-MIP/Extracting_NetCDF_to_Shapefile

b. Fishing effort forcing

Table 7: Fishing effort forcing files and variables for FishMIP 3a simulations. Please note that the data time series has been trimmed to 1961-2010 for this model experiment, which is the timeframe of the obsclim forcing.

Dataset	Included variables (short names)	Covered time period/Resolution	Reference/Source and Comments
Fishing			
Spatially aggregated fishing effort	socioeconomic/fishing/histsoc/effort_histsoc_1850_2010.csv		
	• eez_country_name = The exclusive economic zone/high seas name in which fishing effort is occurring • LME = A number code of the Large Marine ecosystem in which the Effort is occurring • SAUP = A number code for the fishing country, following Sea Around Us numbering • Gear = the fishing gear • FGroup = the targeted functional group • Sector = the fishing sector defined by the law of the country • NomActive = Nominal fishing effort of the active fleet • Phase = either “spin-up” or “experiment”	• 1850-2010 • Annual	Sources: Rousseau et al., 2019, PNAS 116 (25) 12238-12243 and Rousseau et al. 2022 in prep.
Gridded total industrial fishing effort	socioeconomic/fishing/histsoc/gridded_industrial_effort_histsoc_1961_2010.csv		
	• NomActive = Total nominal active fishing effort for the industrial sector summed across functional groups, gear, fishing country.	• 0.5 • 1850-2010 • Annual	Rousseau et al. 2022 in prep.
Gridded total artisanal fishing effort	socioeconomic/fishing/histsoc/gridded_artisanal_effort_histsoc_1961_2010.csv		
	• NomActive = Total nominal active fishing effort for the artisanal	• 0.5 • 1850-2010 • Annual	Rousseau et al. 2022 in prep.

Dataset	Included variables (short names)	Covered time period/Resolution	Reference/Source and Comments
	sector summed across functional groups, gear, fishing country.		

Table 8: Metadata for fishing effort variables.

Variable Name	Long name	Unit	Description/notes
Year	(End of the) year when the fishing effort is occurring	Number code	
Sector	The fishing sector defined by the law of the country	Name code	I = Industrial and A = artisanal, where artisanal include powered and unpowered artisanal fleets
LME	Large Marine Ecosystem Number	Number code	A number code of the Large Marine ecosystem in which the Effort is occurring
eez_country_name	Exclusive Economic Zone	Name code	The country-level exclusive economic zone (or high seas) name in which fishing effort is occurring
SAUP	A number code for the fishing country, following Sea Around Us numbering	Number code	Ex supranational entities (USSR, Yugoslavia) are disaggregated to their constituent countries. Serbian Fishing Effort included with Montenegro. Crimea included with Ukrainian.
Gear	The fishing gear	Name code	Gear names
FGroup	The targeted functional group	Name code	Functional groups are in accordance with those used by the Sea Around Us Project
NomActive	Nominal fishing effort (i.e., not including the technological creep) of the active fleet	Days at sea X kW	NomActive (of the active fleet; i.e., total) = P (engine power of active the fleet; i.e., total) x DAS (average days at sea of one vessel). Average DAS for one vessel ~ 200 DAS/year. NomActive corresponds to the total (reported, IUU, discards) catch. To find NomActive in DAS do (NomActive/P) X NV
Phase	Phase (year ranges) of simulation run	Text	Spin-up, transition, experiment, or validation

Fishing effort forcing file locations

The monthly fishing effort forcing files for the spin-up and experiments (Table 1) of this simulation protocol can be found on DKRZ here:

levante:/work/bb0820/ISIMIP/ISIMIP3a/InputData/socioeconomic/fishing/histsoc/

Note on global model fishing effort forcing

For **global models**, the above spatially aggregated fishing effort can be spatially allocated into 0.25 grid cells. This can be achieved using different approaches such as a simple gravity model – e.g. see Coll et al. 2020 but details will depend on model structure.

We are developing a simplified worked example for global modellers to explore and contribute to. This will be made available on github/FishMIP in due course.

While we recommend using the above spatially aggregated effort, for **global models** that cannot technically carry out spatial allocation of effort, gridded total industrial and artisanal nominal active effort have been provided in the same folder as the file above and are saved as netcdf files. These can be allocated to functional groups (e.g. according to relative biomass) depending on model structure.

Note on regional model fishing effort forcing

Downscaling of the above fishing effort to match regional model inputs is likely to be needed. We request that regional modellers work together in their specific regions to ensure we have clear and common methodologies.

We are developing a worked example for regional modellers to explore and contribute to for their region which will be made available on github/FishMIP in due course.

Note on model calibration using fishing catch data and model evaluation requirements

Modellers are permitted to calibrate or tune their models using historical fisheries catch data (that will also be used for model evaluation) on the condition that **only years up to and including 2004** are used in model calibration/tuning.

Modelling groups **must** keep **detailed documentation** on how their model was calibrated (e.g. input forcing, calibration data, time domain, spatial domain, fish grouping (size, functional types, total), optimization metric(s), weighting schemes, etc.) to be included in manuscript methods. Written description of sources of calibration data and methods used need to be provided with all simulation outputs. A template will be provided for this documentation in due course.

The fisheries catch data .csv file that can be used for model calibration is here: socioeconomic/fishing/histsoc/calibration_catch_histsoc_1850_2004.csv.

The fisheries catch data are already aggregated into the functional groups and spatial zones as the above effort forcing data. The original reference including links to full database is Watson & Tidd, 2018, Marine Policy, 93: 171-177.

Other static geographic information:

Large marine ecosystem (LME) masks in four different spatial resolutions. 0.1°, 0.25°, 0.5° and 1° are available here:

/work/bb0820/ISIMIP/ISIMIP3a/InputData/geo_conditions/fishmip_regions/

Each region has its own variable within each file.

We have also provided conversion tables that can be used to look up LME and SAUP names according to the numeric codes used in the catch and effort files (e.g. LME 22 – North Sea). These files (SAUPnames.csv and LMEnames.csv are also available here:

/work/bb0820/ISIMIP/ISIMIP3a/InputData/geo_conditions/fishmip_regions/

4. Output data

All spatially gridded outputs should be created as netcdf files. More information on how to prepare these files can be found here. Aspatial regional model results may be saved as .csv files.

In the output files, please label the time variable as months since January 1st, 1840.

Table 9: Mandatory output variables for Fisheries and Marine Ecosystem models (global and regional). See notes on additional optional model outputs below. Please use the value 1.e+20 for missing data within your output files.

Variable long name	Variable specifier	Unit	Resolution	Comments
Mandatory output from global and regional models (provide as many as possible). All biomasses are in wet weight, not g C.				
Total Consumer Biomass Density	**tcb**	g m-2	0.25° grid monthly	All consumers (trophic level >1, vertebrates and invertebrates)

Variable long name	Variable specifier	Unit	Resolution	Comments
Total Consumer Biomass Density in log10 Weight Bins	**tcblog10**	g m-2	0.25° grid monthly	**Level dimensions:** (time, bins, lat, lon). If the model is size-structured, please provide biomass in equal log 10 g weight bins (1-10g, 10-100g, 100g-1kg, 1-10kg, 10-100kg, >100kg)
Total Pelagic Biomass Density	**tpb**	g m-2	0.25° grid monthly	All pelagic consumers (trophic level >1, vertebrates and invertebrates)
Total Demersal Biomass Density	**tdb**	g m-2	0.25° grid monthly	All demersal consumers (trophic level >1, vertebrates and invertebrates)
Total Catch Density (all commercial functional groups / size classes)	**tc**	g m-2	0.25° grid monthly	Catch at sea (all catch as a result of all effort including reported and IUU) summed for both Industrial and Artisanal sector.
Total Industrial Catch Density (all commercial functional groups / size classes)	**tic**	g m-2	0.25° grid monthly	Catch at sea (all catch as a result of all effort including reported and IUU) for Industrial sector only.
Total Catch Density in log10 Weight Bins across both sectors	**tclog10**	g m-2	0.25° grid monthly	**Level dimensions:** (time, bins, lat, lon). If the model is size-structured, please provide biomass in equal log 10 g weight bins (1-10g, 10-100g, 100g-1kg, 1-10kg, 10-100kg, >100kg)
Total Pelagic Density Catch across Artisanal and Industrial sectors	**tpc**	g m-2	0.25° grid monthly	Catch at sea of all pelagic consumers (trophic level >1, vertebrates and invertebrates)
Total Demersal Catch Density across Artisanal and Industrial sectors	**tdc**	g m-2	0.25° grid monthly	Catch at sea of all demersal consumers (trophic level >1, vertebrates and invertebrates)
Optional output from global and regional models. All biomasses are in wet weight, not g C.				
Biomass Density of Small Pelagics <30cm	**bp30cm**	g m-2	0.25° 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	0.25° 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	0.25° grid monthly	If a pelagic species and L infinity is >=90cm, include in this variable
Biomass Density of Small Demersals <30cm	**bd30cm**	g m-2	0.25° 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	0.25° grid monthly	If a demersal species and L infinity is >=30 cm and <90cm, include in this variable

Variable long name	Variable specifier	Unit	Resolution	Comments
Biomass Density of Large Demersals >=90cm	**bd90cm**	g m-2	0.25° grid monthly	If a demersal species and L infinity is >=90cm, include in this variable
Catch Density of Small Pelagics <30cm	**cp30cm**	g m-2	0.25° 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	0.25° grid monthly	Catch at sea of pelagic species with L infinity >=30 cm and <90 cm
Catch Density of Large Pelagics >=90cm	**cp90cm**	g m-2	0.25° grid monthly	Catch at sea of pelagic species with L infinity >=90 cm
Catch Density of Small Demersals <30cm	**cd30cm**	g m-2	0.25° 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	0.25° 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	0.25° grid monthly	Catch at sea of demersal species with L infinity >=90 cm

5. Additional notes for Regional FishMIP Models

More specific protocols for each regional model type will be circulated and made available on the website.

Regional modellers may additionally wish to make their raw unaggregated output available for more detailed analyses, including for example, a wider range of functional groups/size classes/species and ecosystem indicators Please discuss this with FishMIP regional coordinators before uploading files.

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, to facilitate the analysis of your simulation results in the ISIMIP framework. Incorrect formatting can seriously delay analyses. 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 variable 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.
- Data model is NETCDF4_CLASSIC with minimum compression level of 5.
- NetCDF file extension is .nc.
- For models using spin-up, include the final 10 years of spin-up in your results.
- The relative time axis' reference year and month to include in model output is months since January 1st 1840.

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>_<time-step>_<start-
year>_<end-year>.nc
```

Regional models

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

and replace the identifiers with the specifiers given in the tables of this document.

Examples:

Global

```
boats_gfdl-mom6_cobalt2_none_
obsclim_histsoc_15arcmin_tcb_global_monthly_1840_2010.nc
```

Regional

```
osmose_gfdl-mom6_cobalt2_none_ obsclim_histsoc_15arcmin
_tcb_benguela_monthly_1840_2010.nc
```

Please if you have any questions or clarifications, contact FishMIP coordinators or ISIMIP data managers directly (isimip-data@pik-potsdam.de) before submitting files.

Finally, please email FishMIP coordinators:

If you would like to participate in this simulation round but have encountered issues with any aspect of the protocol.

(For fishing): please provide all assumptions about catchability, technological creep, and model calibration.

Please provide any conversion factors that you have used to convert units.

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