

An update on the IOTC oceanographic atlas project

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Abstract

The development of the IOTC oceanographic atlas project was among the priorities of the WPDCS 20 that were endorsed by the SC27 (2024). Administrative arrangements are underway for an implementation of the project in January 2026. This technical note presents an update of the preparatory phase of the project.

Introduction

The project of an interactive ocean atlas covering the area of competence of the IOTC was presented at various working parties in 2024 (WPEB, WPTT and WPDCS), to assess the interest of the Scientific Committee in a product that would support studies on the impacts of climate change in tuna fisheries. The SC 27 endorsed the ocean atlas project among the priorities of the WPDCS. This atlas, named IODA (Indian Ocean Digital Atlas), will be accessible online.

We remind that the IODA benefits from the experience gained in an atlas project developed in the Seychelles (SDOA) from 2021 to 2023. This paper is a short technical note reporting on minor changes made in the design of the atlas since the version presented at the WPDCS20 (Marsac et al, 2024¹), with the objective of optimizing the operations of the IODA.

Changes to the original design of the atlas

1- Source of the data products

The original version proposed to incorporate four Copernicus model products, at a monthly basis:

- for the Blue Ocean component (physics): Global Ocean Reanalysis and Global Ocean Physics Analysis and Forecast;
- for the Green Ocean component (Biogeochemistry): Global Ocean Biogeochemistry Hindcast and Global Ocean Biogeochemistry Analysis and Forecast.

In the final version, only the reanalysis and Hindcast products will be used as they are adequately updated with reasonable delay (3 months) and ensure a coherence of the simulations over time. The Forecast models and the Reanalysis/Hindcast models use different configurations of atmospheric forcing, so they may produce slightly different outputs. The use of the Forecast products could be considered if we were using daily products in the atlas.

The source of satellite products to estimate the sea surface chlorophyll remains unchanged (product OCEANCOLOUR_GLO_BGC_L4_MY_009_104)

2- Spatial coverage of the atlas

The eastern boundary was slightly changed to avoid that calculations done inside user-defined spatial polygons (average and general statistics) include some fractions of the adjacent Pacific Ocean waters in the Indonesian part of the atlas, in particular north of Java. Consequently, the 100°E boundary was shifted to 105.75°E and the 0° latitudinal boundary was shifted to 5°S. The rest of the boundaries, north, south and west remain unchanged. The original and revised boundaries can be compared in Fig. 1.

¹ Marsac, F., Gunawardane, N., Noel, E. (2024). An online digital atlas for the Indian Ocean to study the impacts of climate change and variability on tuna fisheries. 20th session of the WPDCS IOTC, IOTC-2024-WPDCS20-27.

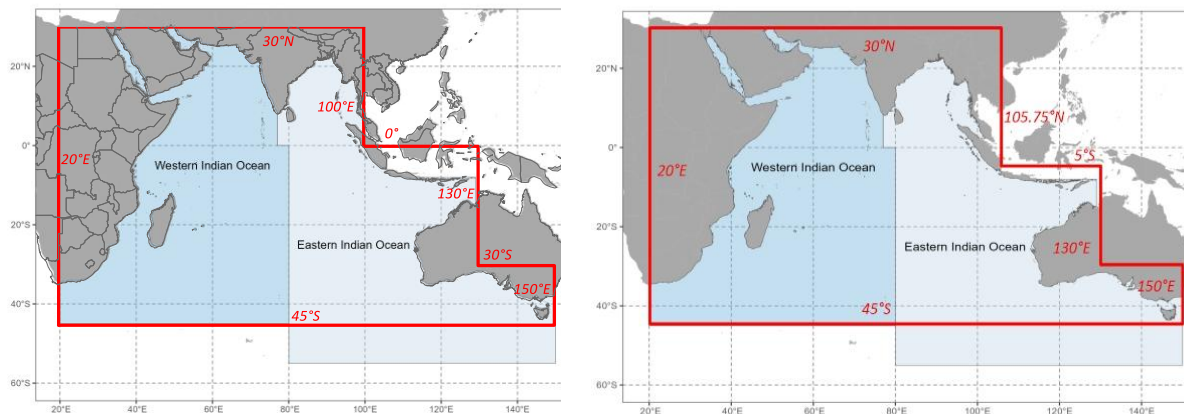


Figure 1 – Original (2024) and revised (2025) boundaries for the IODA

3- Ocean and climate variables

The original version of the IODA comprised 7 biogeochemical variables (6 from ocean models, 1 from satellite observations) directly sourced from the Copernicus system. One of these variables, the surface partial pressure of carbon dioxide, has been removed as it did not show contrasted values at the Indian Ocean scale. In addition, the relevance to the tuna fisheries was quite unclear.

To summarize, the ocean variables to be included in the atlas are:

- Physical variables (8-km spatial resolution):
 - Along 20 depth levels (0-900m): temperature, salinity, eastward and westward current velocity, and their anomalies;
 - Unilayer variables: sea surface height, mixed layer depth, 20°C isothermal depth, vertical current shear in the upper 130 and 450m, and their anomalies;
- Biogeochemical variables (25-km spatial resolution)
 - Along 20 depth levels (0-900m): Mass concentration of Chlorophyll-a, net primary production of biomass, dissolved oxygen content, sea water pH
 - Unilayer variables: depth of the 2.5 ml/l dissolved oxygen content, depth of the maximum fluorescence, integrated chlorophyll concentration in the upper 300 m, and sea surface chlorophyll (satellite measurements at a 4-km resolution).

The climatological fields for each variable will be extracted from the Copernicus system. The long-term monthly climatology is used to calculate monthly anomalies.

Climate indices were not included in the former IODA design. Considering the highly integrative value of these indices (depicting processes that ultimately drive the ocean variability), we have added the ENSO index (tracing the El Niño/La Niña events) and the DMI (tracing the Indian Ocean Dipole). These indices will be displayed as time series.

4- Size of the database

The size of the whole physical and biogeochemical datasets to be uploaded to the data server has been re-estimated. Some optimization in data formatting has allowed to reduce the size of the dataset. In 2024, we estimated the overall database size to 434 Gb (for the period 1993-2024), with a yearly growth rate of 26 Gb. In the revised version, with one variable removed and for a period one year longer (1993-2025, 33 years), the overall database size is estimated to 365 Gb, with a growth rate of 11 Gb per year, representing a 58% reduction compared to the original design. More compact datasets are recommended to improve the performance of the users' queries through the IODA app. The details by variable are shown in Table 1.

Table 1 – Estimated size (in Kb) of the different variables of the IODA, by year and for the whole period archived (1993-2025).

3dim files	Standard	Anomalies	Climatology	Total IOTC area
t	659 299	659 299	659 299	1 977 897
s	659 299	659 299	659 299	1 977 897
u	659 299	659 299	659 299	1 977 897
v	659 299	659 299	659 299	1 977 897
do	147 028	147 028	147 028	441 084
npp	147 028	147 028	147 028	441 084
ph	147 028	147 028	147 028	441 084
chl (0-300m)	147 028	147 028	147 028	441 084
<i>One-layer files by year</i>				
mld	32 985	32 985	32 985	98 955
z20	32 985	32 985	32 985	98 955
sh130	32 985	32 985	32 985	98 955
sh450	32 985	32 985	32 985	98 955
ssh	32 985	32 985	32 985	98 955
chlsat	263 302	263 302	263 302	789 906
intChl	7 375	7 375	7 375	22 125
fmax	7 375	7 375	7 375	22 125
ox25	7 375	7 375	7 375	22 125
Total by year	3 675 660	3 675 660	3 675 660	11 026 980
Total 1993-2025	121 296 780	121 296 780	121 296 780	363 890 340
GEBCO	1 097 264			1 097 264
Total incl. GEBCO	122 394 044	121 296 780	121 296 780	364 987 604
Shiny server app	100 000			
Total space requested	365 087 604			

Overlay of external data

We have tested the overlay of a tuna catch layer on a map. The catch data was extracted from the reported geo-referenced dataset of the IOTC. To be included as a new layer within the IODA, the user will have to prepare a csv file including the following variables in the first three columns: longitude, latitude, value to be plotted. The data will be represented by empty circles proportional to the value, overlaid on the IODA map. Examples are given in Fig.2 and 3, with tuna catch overlaid on a temperature and a current map, respectively.

This may appear as a basic representation of overlaid information. Other types of representation might be devised in a second stage.

Stages of the development phase

The work should start in 2026, once the administrative process is completed. Over the four months of the project, the following activities should be rolled out:

- Assembling datasets of oceanic products covering the Indian Ocean (started);
- Setting up a data server hosting the atlas (Sri Lanka);
- Developing scripts and a web application
- Install the app on the server in Sri Lanka

- Training a technical team in the server hosting site to ensure the maintenance of the atlas and to update of the datasets.

Once the IODA in place and operational, users' training sessions will be proposed to the interested CPCs.

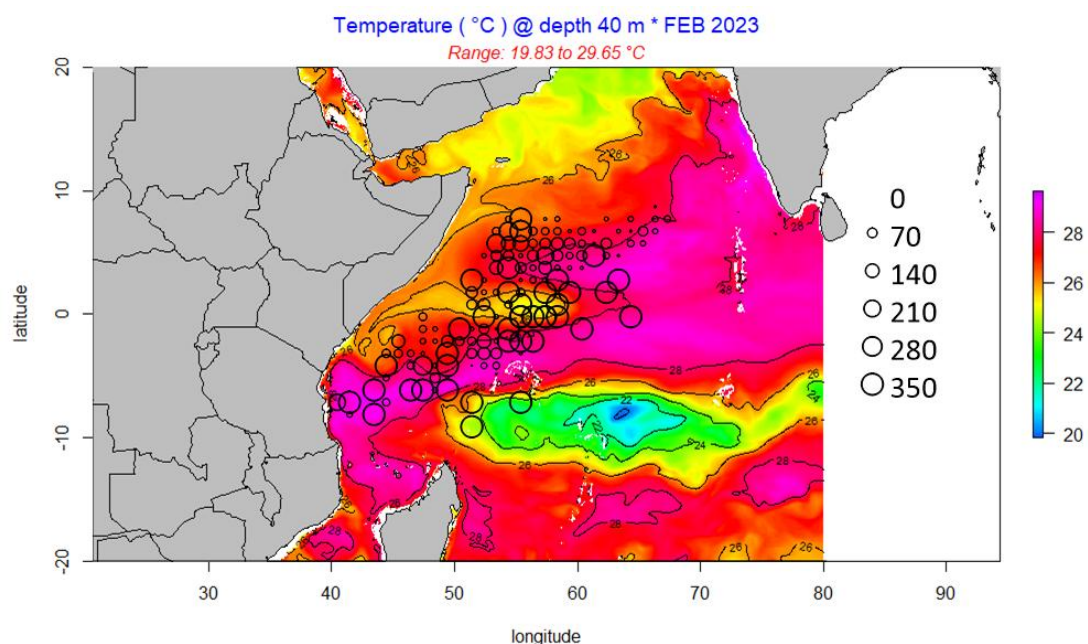


Figure 2 – Overlay of associated skipjack catches (in tons) by the purse seine gear on a temperature map (40 m depth) in February 2023

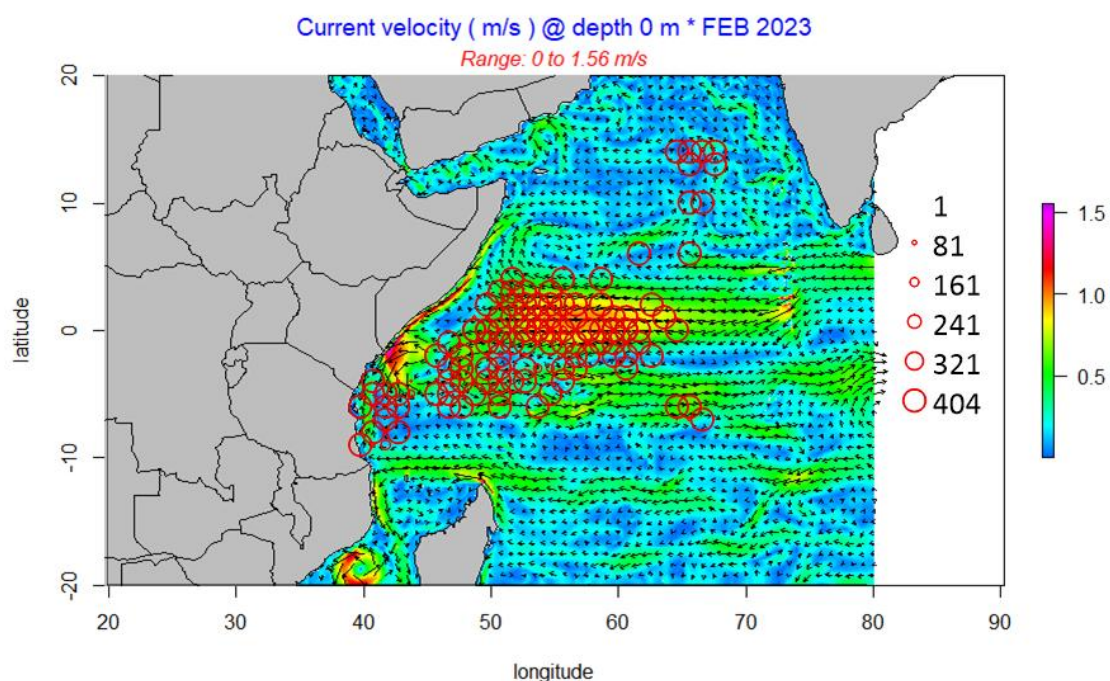


Figure 3 – Overlay of associated skipjack catches (in tons) by the purse seine gear on a surface current map, in February 2023