BEeS

The LifeWatch ERIC Biodiversity & Ecosystem eScience Conference

Seville
22-24/05/23

Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

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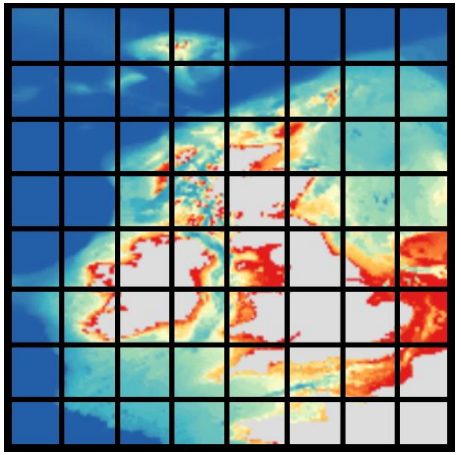
VLIZ pioneer in marine science

Bio-Oracle Version 3: Enhancing High-Resolution Marine Datasets for Ecological Modelling and Climate Change Predictions

Salvador Fernández Bejarano

What is Bio-Oracle?

Bio-ORACLE is a set of **GIS rasters** providing geophysical, biotic and environmental data for surface and benthic **marine** realms.



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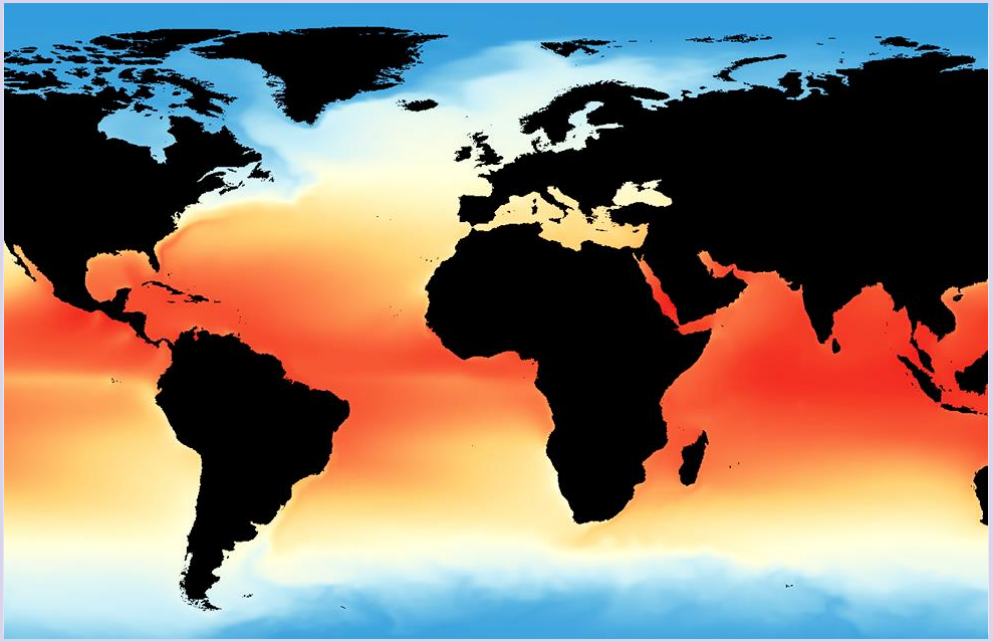
There are 18 environmental predictors

Temperature
Salinity
Sea Ice Cover
Sea Ice Thickness
Sea Water Velocity
Mixed Layer Depth
Diffuse Attenuation Coefficient
Photosynthetically Active Radiation
PAR at Bottom
…



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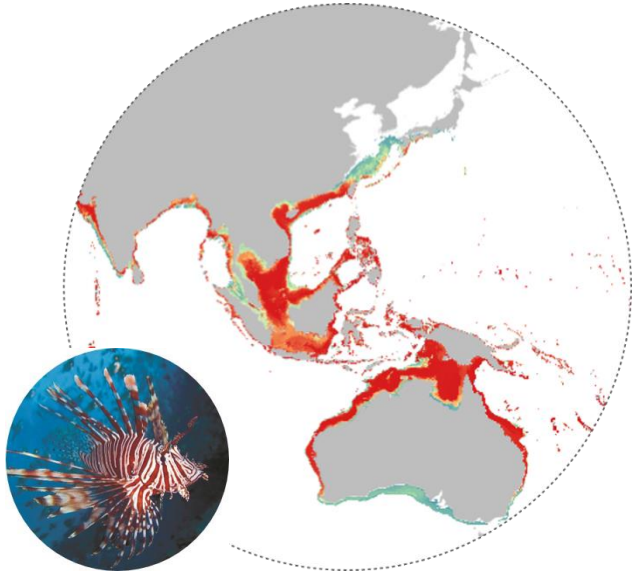
What is the potential of Bio-Oracle?

Bio-ORACLE is designed for
Species Distribution Modelling



E.g. predicted distribution of the lion fish *Pterois volitans*

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A bit of history

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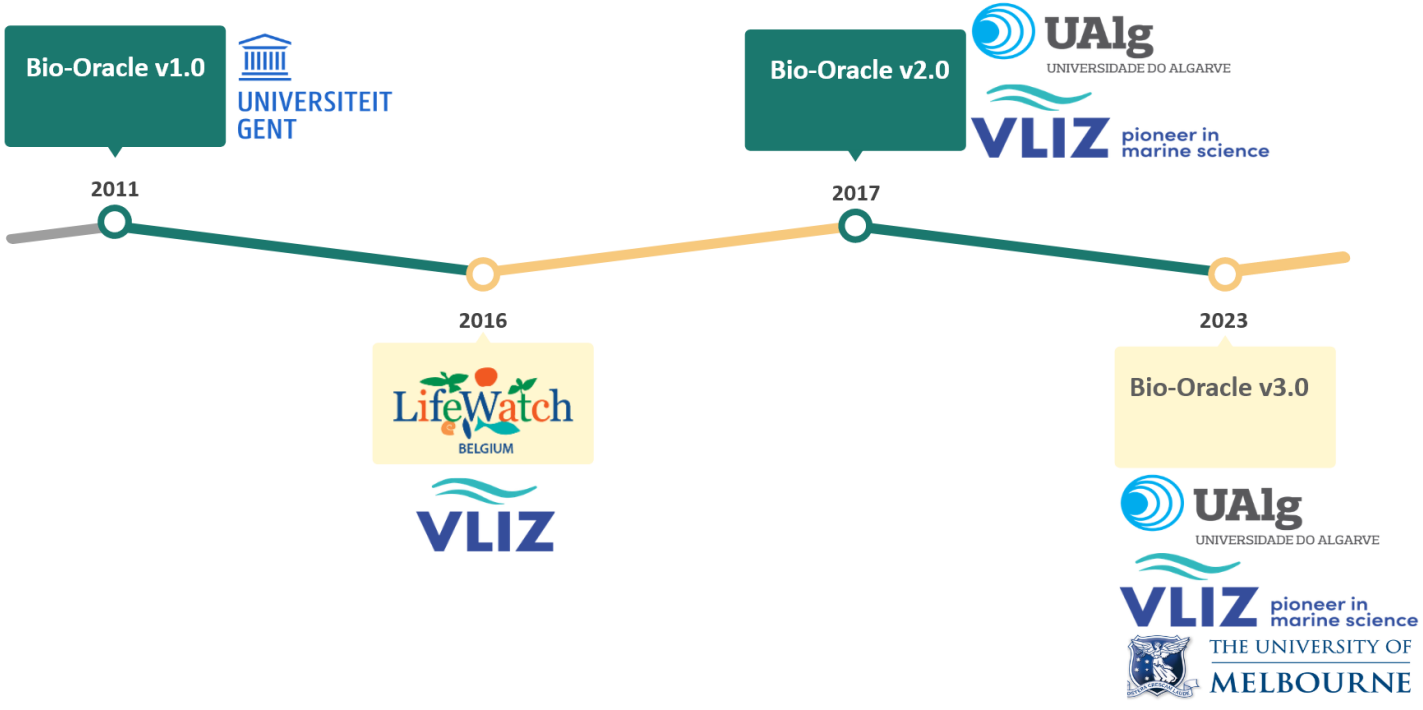

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Version 1

- 13 predictors
- Surface-Only
- Present-Only
- 4 calculated values:
  - min, mean, max
  - range
- 744 citations

doi: 10.1111/j.1466-8238.2011.00656.x

Global Ecology and Biogeography, (Global Ecol. Biogeogr.) (2012) **21**, 272–281

A Journal of Macroecology

Global Ecology and Biogeography

RESEARCH PAPER

Bio-ORACLE: a global environmental dataset for marine species distribution modelling

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ABSTRACT

Aim The oceans harbour a great diversity of organisms whose distribution and ecological preferences are often poorly understood. Species distribution modelling (SDM) could improve our knowledge and inform marine ecosystem management and conservation. Although marine environmental data are available from various sources, there are currently no user-friendly, high-resolution global datasets designed for SDM applications. This study aims to fill this gap by assembling a comprehensive, uniform, high-resolution and readily usable package of global environmental rasters.

Location Global, marine.

Methods We compiled global coverage data, e.g. satellite-based and *in situ* measured data, representing various aspects of the marine environment relevant for species distributions. Rasters were assembled at a resolution of 5 arcmin (*c.* 9.2 km) and a uniform landmask was applied. The utility of the dataset was evaluated by maximum entropy SDM of the invasive seaweed *Codium fragile* ssp. *fragile*.

Results We present Bio-ORACLE (ocean rasters for analysis of climate and environment), a global dataset consisting of 23 geophysical, biotic and climate rasters. This user-friendly data package for marine species distribution modelling is available for download at http://www.bio-oracle.ugent.be. The high predictive power of the distribution model of *C. fragile* ssp. *fragile* clearly illustrates the potential of the data package for SDM of shallow-water marine organisms.

Main conclusions The availability of this global environmental data package has the potential to stimulate marine SDM. The high predictive success of the presence-only model of a notorious invasive seaweed shows that the information contained in Bio-ORACLE can be informative about marine distributions and permits building highly accurate species distribution models.

Keywords
Bio-ORACLE, *Codium fragile*, ecological niche modelling, environmental data, global, macroecology, marine, oceanography, species distribution modelling.

Version 2

- 18 predictors
- Surface and Benthic realms
- Present and future predictions
- 7 calculated values:
  - min, mean, max
  - long-term min, mean, max
  - Range
- 459 citations

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DATA PAPER

WILEY Global Ecology and Biogeography

Bio-ORACLE v2.0: Extending marine data layers for bioclimatic modelling

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Abstract

Motivation: The availability of user-friendly, high-resolution global environmental datasets is crucial for bioclimatic modelling. For terrestrial environments, WorldClim has served this purpose since 2005, but equivalent marine data only became available in 2012, with pioneer initiatives like Bio-ORACLE providing data layers for several ecologically relevant variables. Currently, the available marine data packages have not yet been updated to the most recent Intergovernmental Panel on Climate Change (IPCC) predictions nor to present times, and are mostly restricted to the top surface layer of the oceans, precluding the modelling of a large fraction of the benthic diversity that inhabits deeper habitats. To address this gap, we present a significant update of Bio-ORACLE for new future climate scenarios, present-day conditions and benthic layers (near sea bottom). The reliability of data layers was assessed using a cross-validation framework against in situ quality-controlled data. This test showed a generally good agreement between our data layers and the global climatic patterns. We also provide a package of functions in the R software environment (*sdmpredictors*) to facilitate listing, extraction and management of data layers and allow easy integration with the available pipelines for bioclimatic modelling.

Main types of variable contained: Surface and benthic layers for water temperature, salinity, nutrients, chlorophyll, sea ice, current velocity, phytoplankton, primary productivity, iron and light at bottom.

Spatial location and grain: Global at 5 arcmin (c. 0.08° or 9.2 km at the equator).

Time period and grain: Present (2000–2014) and future (2040–2050 and 2090–2100) environmental conditions based on monthly averages.

Major taxa and level of measurement: Marine biodiversity associated with sea surface and epibenthic habitats.

Software format: ASCII and TIFF grid formats for geographical information systems and a package of functions developed for R software.

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What's new in Bio-Oracle?

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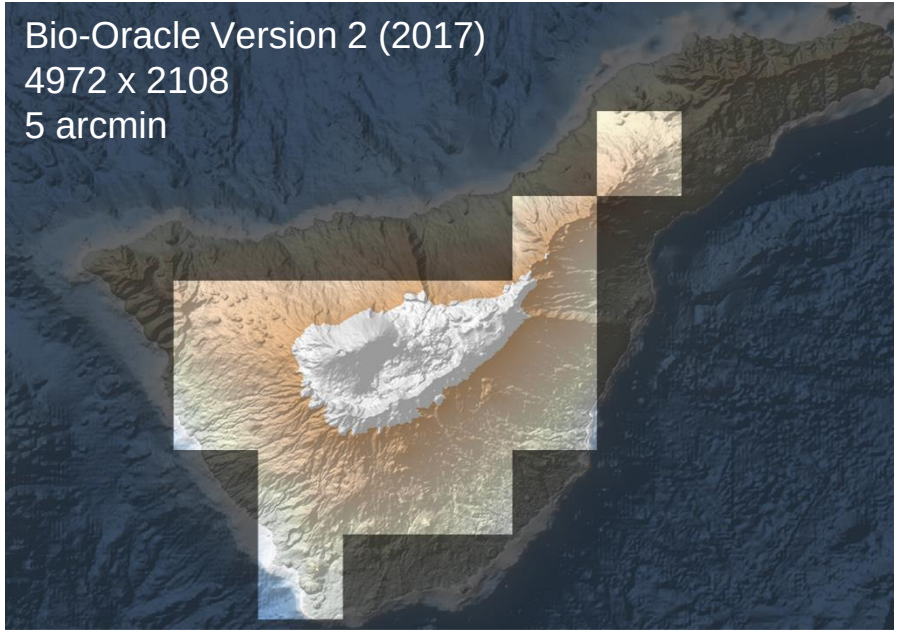
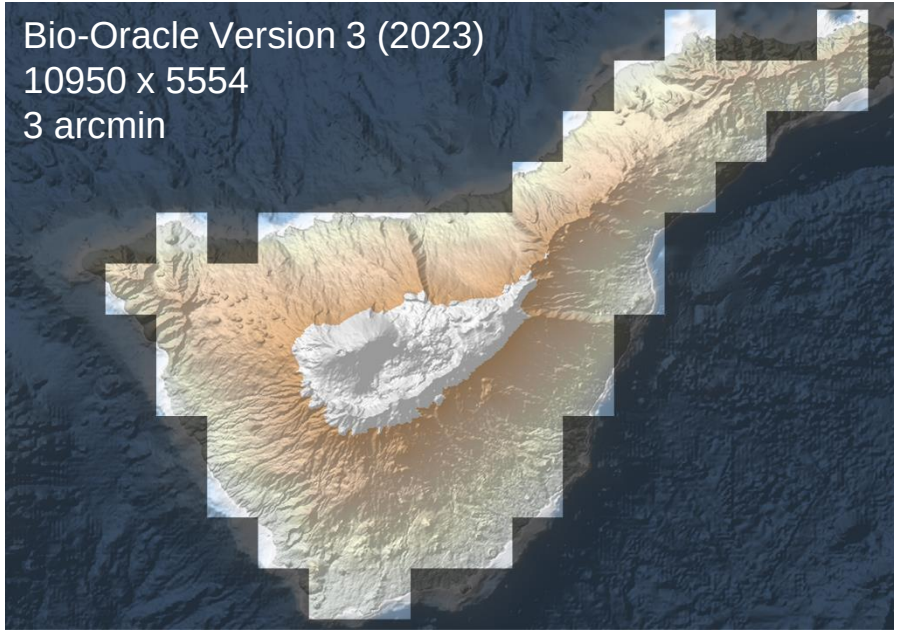
Some things stay the same

- 2023
- 18 predictors
- Surface and Benthic realms
- Present and future predictions
- 7 calculated values:
  - min, mean, max
  - long-term min, mean, max
  - range

But

Higher spatial resolution





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Temporal resolution: 10 decades

Bio-Oracle Version 2 (2017)

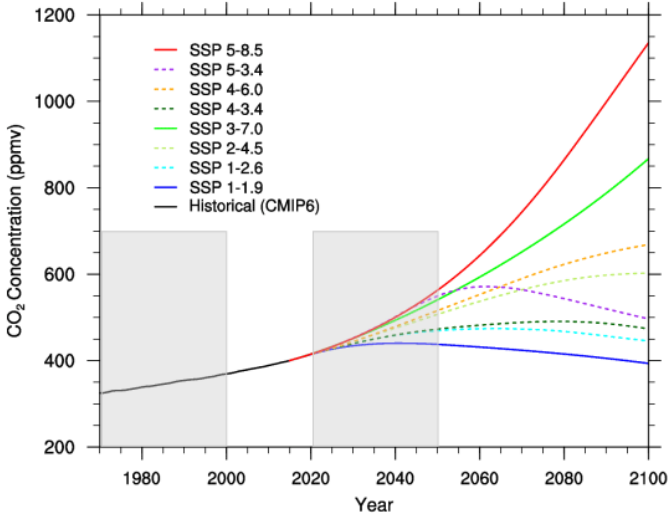
- 2000 - 2013
- 2014 - 2050
- 2050 - 2100

Bio-Oracle Version 3 (2023)

- 2000 - 2009
- 2010 - 2019
- 2020 - 2029
- 2030 - 2039
- 2040 - 2049
- 2050 - 2059
- 2060 - 2069
- 2070 - 2079
- 2080 - 2089
- 2090 - 2100

Shared Socioeconomic Pathways (SSP)

- Based on latest IPCC Report 6
- Six SSPs modelled:
  - SSP 1-1.9
  - SSP 1-2.6
  - SSP 2-4.5
  - SSP 3-7.0
  - SSP 4-6.0
  - SSP 5-8.5



Drugé et all, (2021). Future evolution of aerosols and implications for climate change in the Euro-Mediterranean region using the CNRM-ALADIN63 regional climate model. *Atmos. Chem. Phys*., 21, 7639–7669, https://doi.org/10.5194/acp-21-7639-2021

Accessing Bio-Oracle v3

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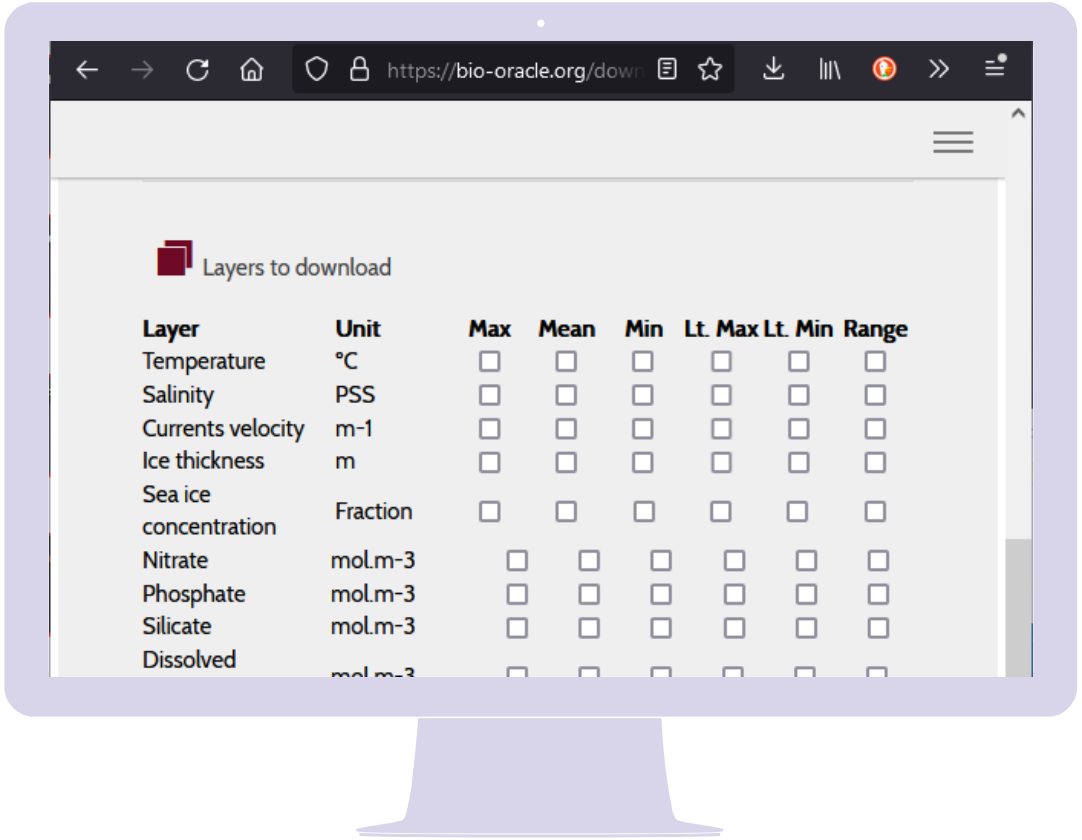
Direct Download

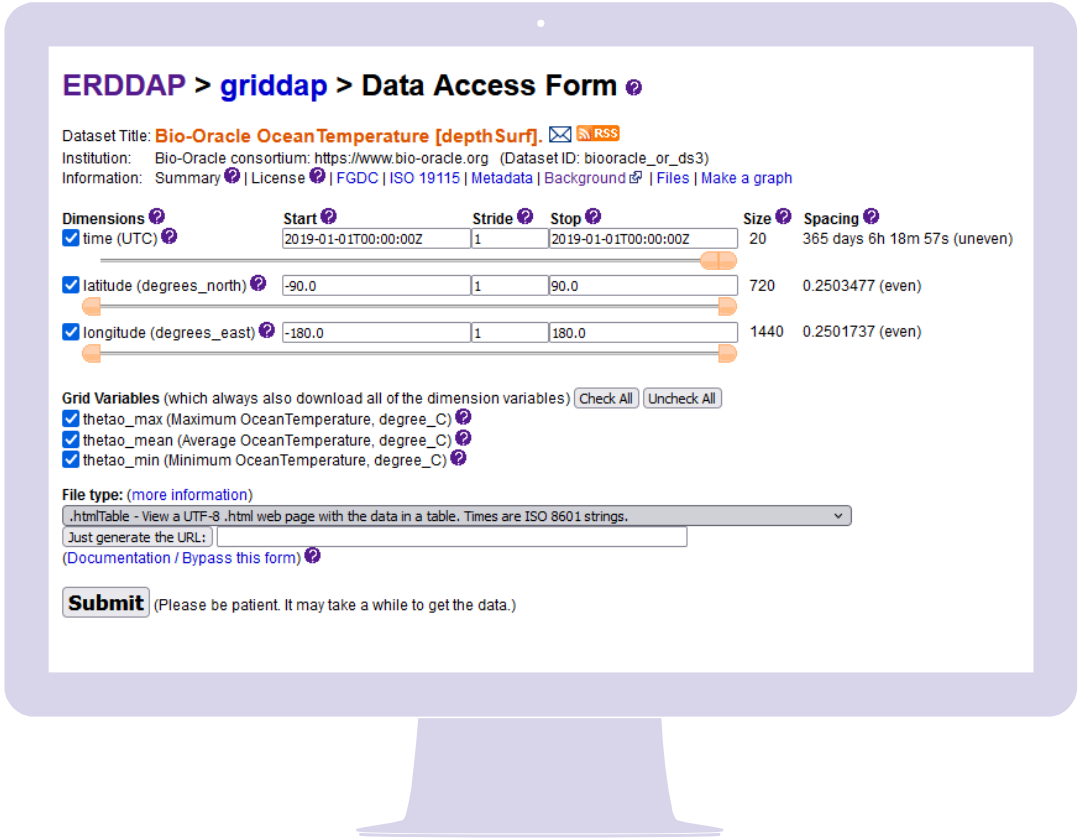
- bio-oracle.org
- User-Friendly
- GIS-Ready .geotif and .asc files
  - QGIS
  - ArcGIS
  - etc.



ERDDAP

A data server that downloads subsets of the Bio-Oracle dataset in many common file formats.

- Native format: NetCDF (.nc)
- Output formats: .nc, .csv, .tif, .asc
- Extra web services:
- REST API
- Web Map Service



Python and R clients

- pyo-oracle
- Install with pip/conda
- Based on erddapy

- bioracler
- Install with CRAN
- Based on rerrdap
- Cohabits sdmpredictors

Main purpose: download bio-oracle dataset with subsetting capacities

`github.com/bio-oracle`

Digital Twins

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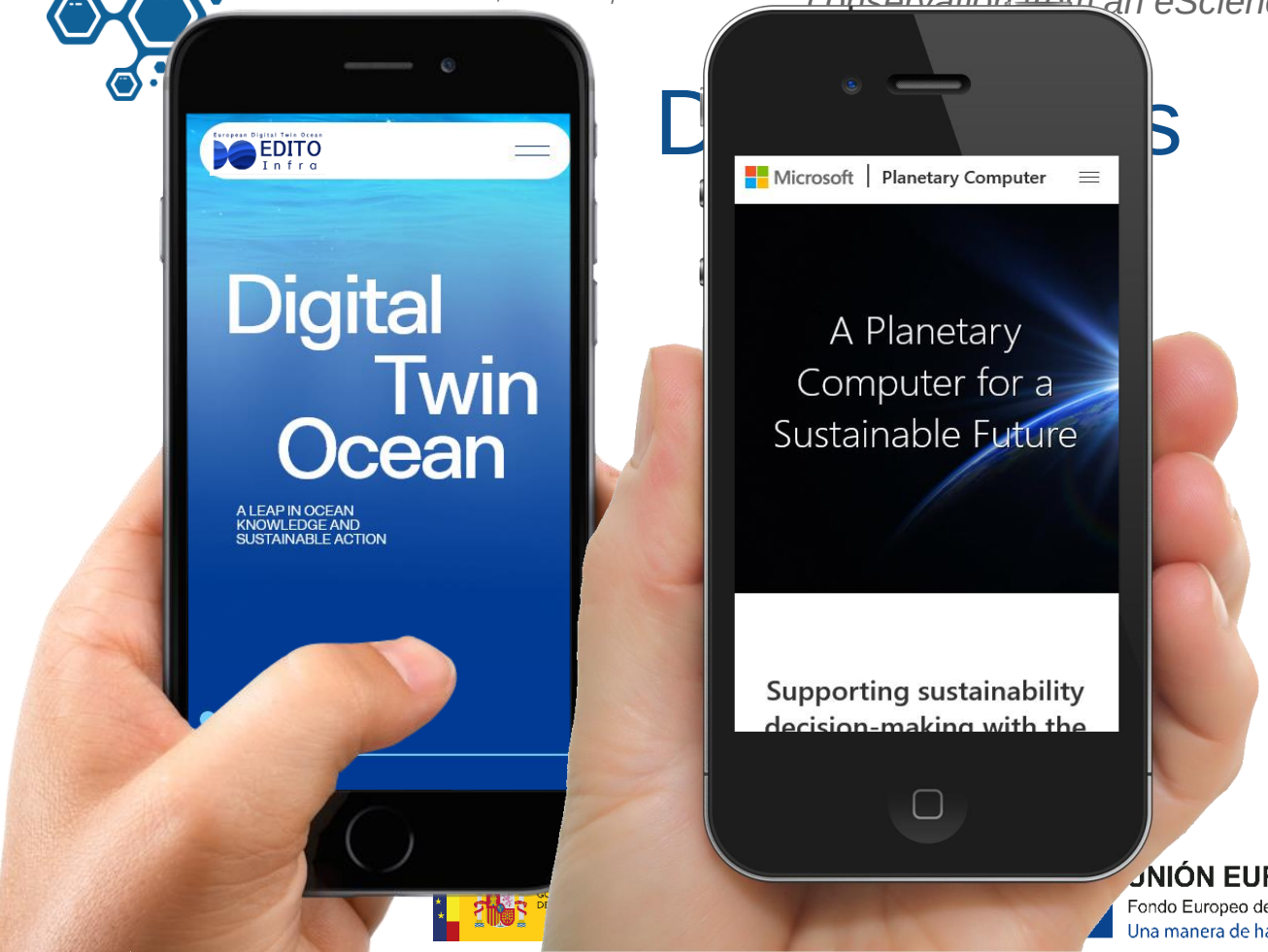
Digital Twins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Threats and challenges to biodiversity and ecosystem conservation from an eScience perspective

LifeWatch ERIC

Summer 2023

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VLIZ pioneer in marine science

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