

The Ocean Patterns Indicator

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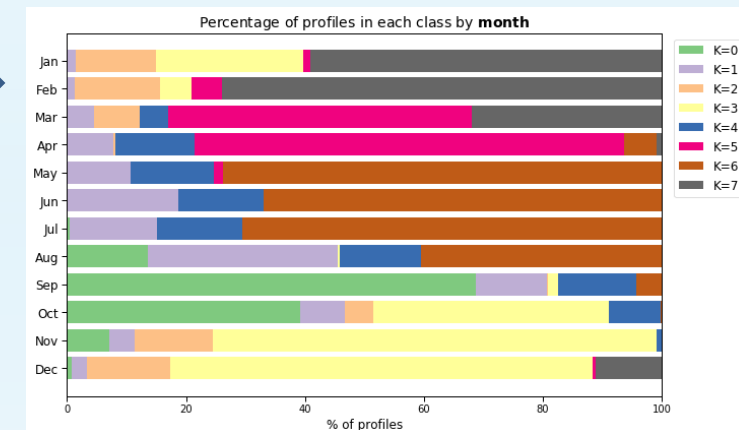
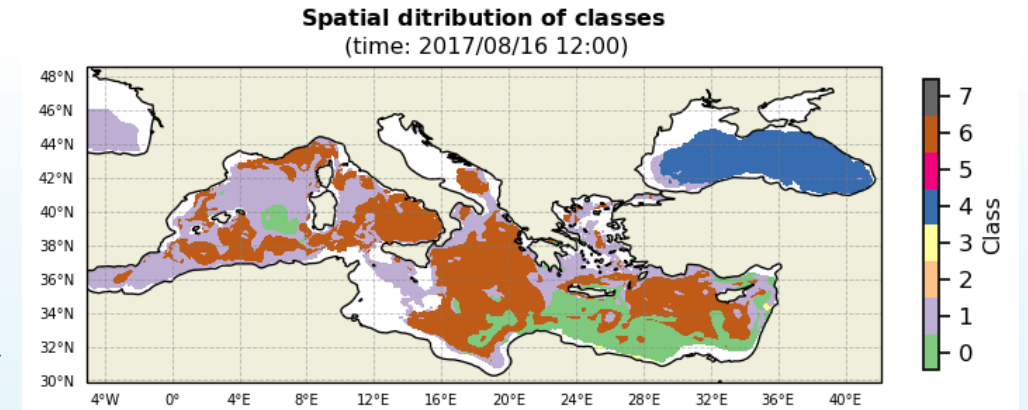
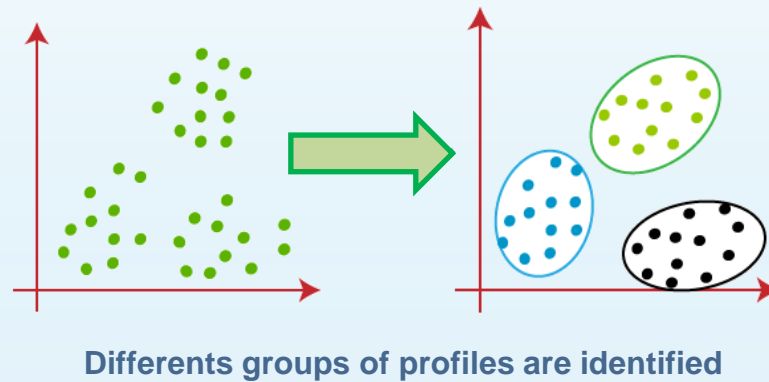
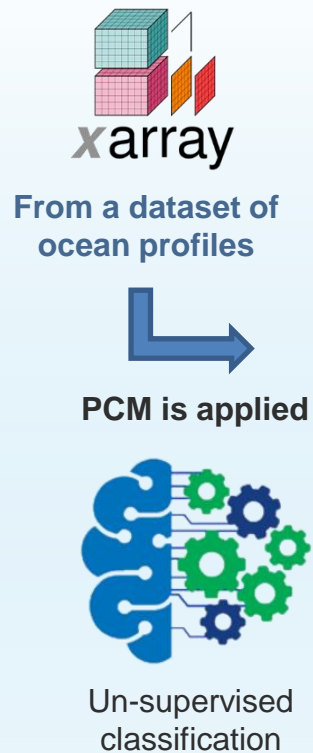


Presentation plan

- What is the Ocean Patterns Indicator?
- How a Profile Classification Model (PCM) works?
- Jupyter notebooks
 - Development notebook
 - Prediction notebook
- What are we doing next?

What is the Ocean Patterns Indicator?

- PCM (Profile Classification Model): allows to automatically gather ocean profiles in clusters according to their vertical structure similarities. Depending on the dataset, such clusters can show space/time coherence: **the ocean patterns indicators**.

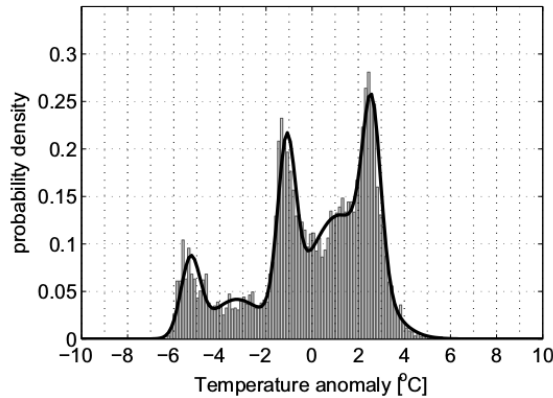


Plot analysis can reveal space/time coherences: the Ocean Patterns indicator

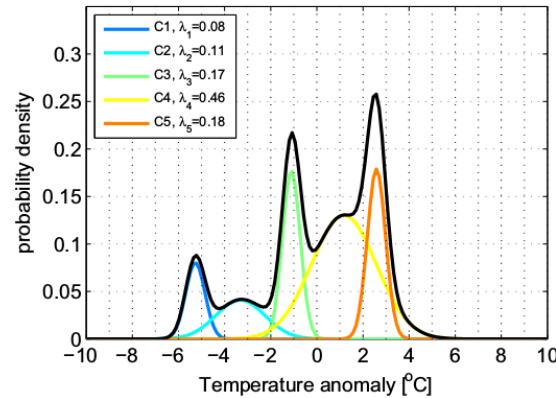
How a Profile Classification Model (PCM) works?

- Gaussian Mixture Models method (GMM): decompose the probability density functions (PDF) of the dataset in to a sum of gaussian PDF.

C: Observed (bars) and Model (plain line) PDFs for K=5

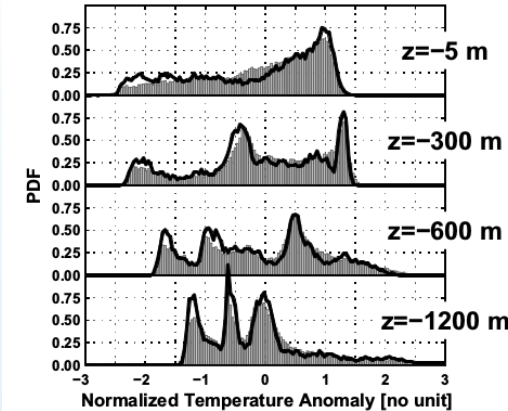


D: Model PDF details for K=5



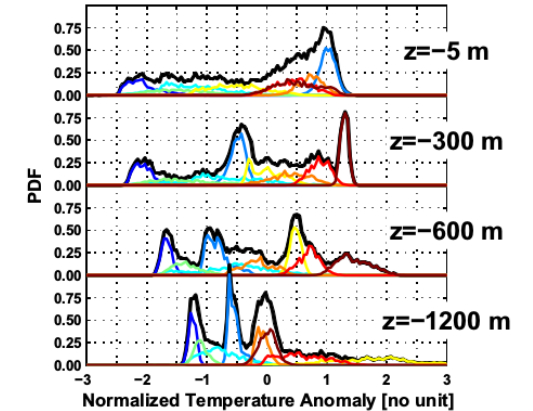
Decomposing PDF in 5 gaussian PDF

C: Model vs Observed PDFz



Representation in nz dimensions

D: Detailed Model PDFz



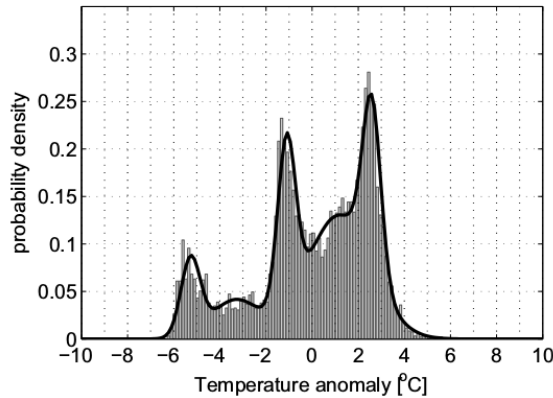
Maze et al, Prg.Oc, 2017

- The user should only chose the number of classes
- In the input there is no spatial or temporal information
- Probability of a profile to be in a class

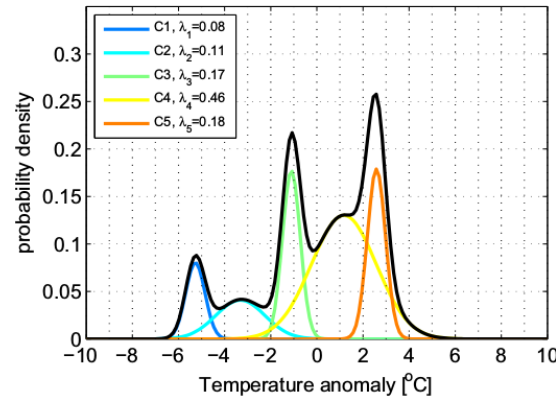
How a Profile Classification Model (PCM) works?

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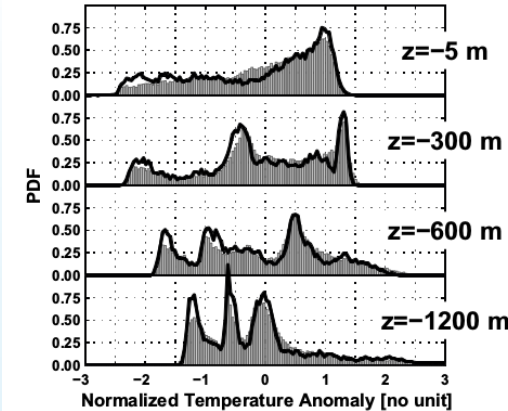


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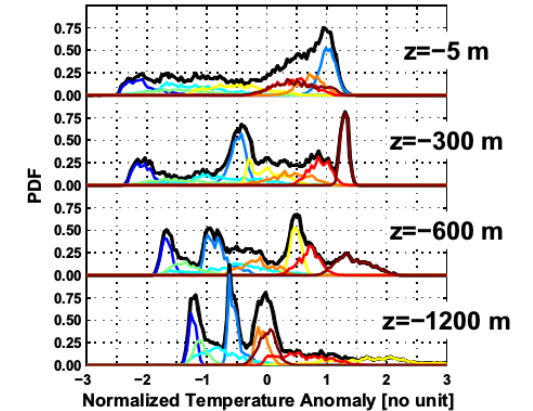
Decomposing PDF in 5 gaussian PDF

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Representation in nz dimensions

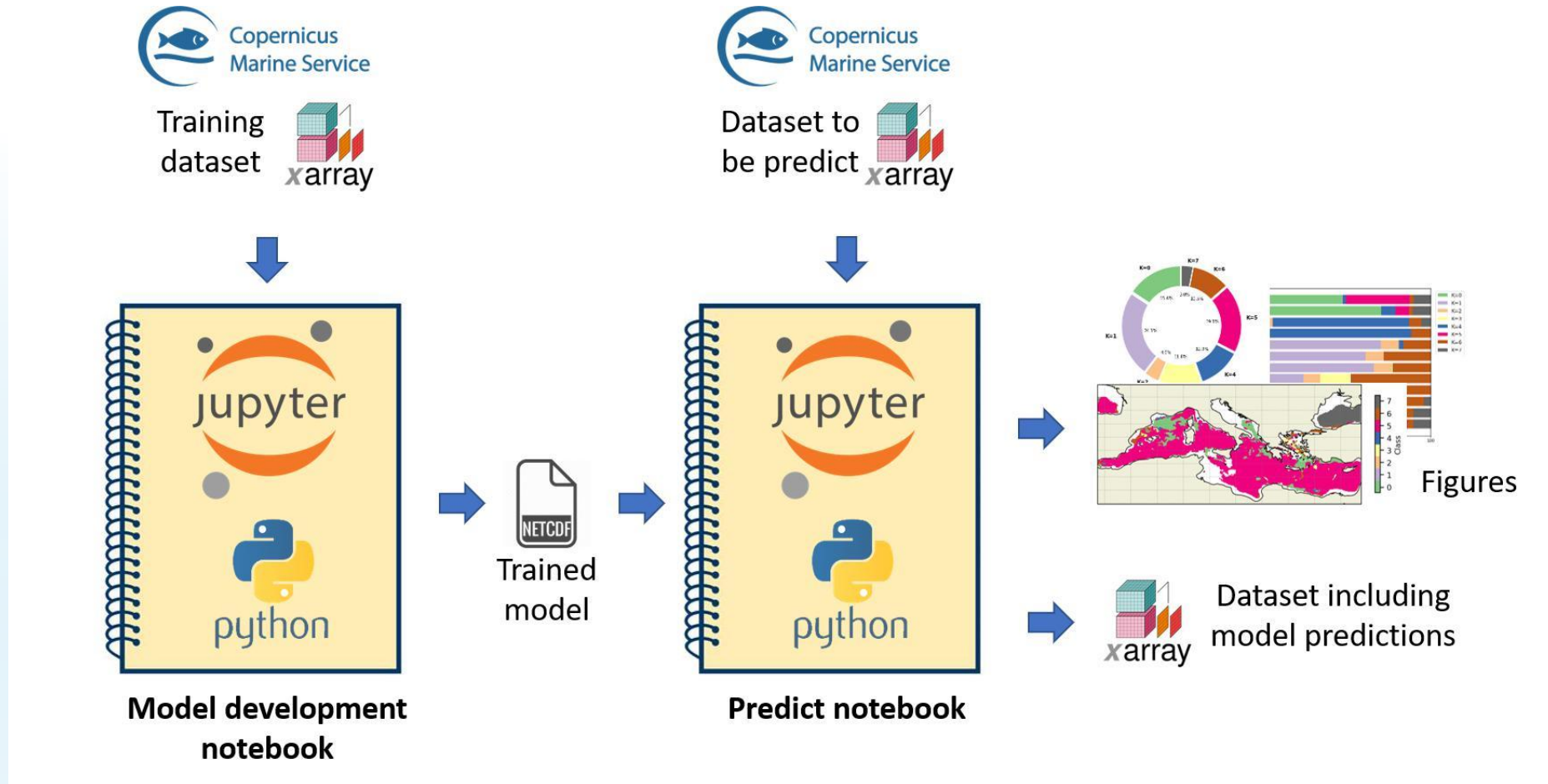
D: Detailed Model PDFz



Maze et al, Prg.Oc, 2017

- Ocean Patterns Indicators are computed using the **pyXpcm** python software (see documentation at <https://pyxpcm.readthedocs.io>)
- For more information about the method see Maze et al, Prg.Oc, 2017.

Jupyter notebooks



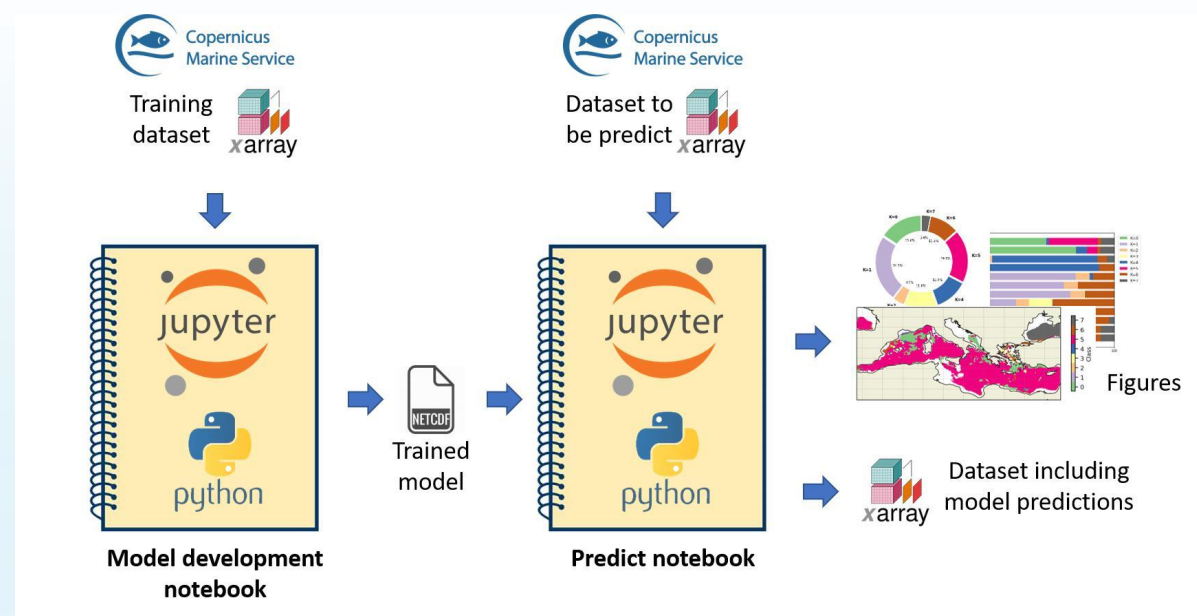
Jupyter notebooks

Folder icon /

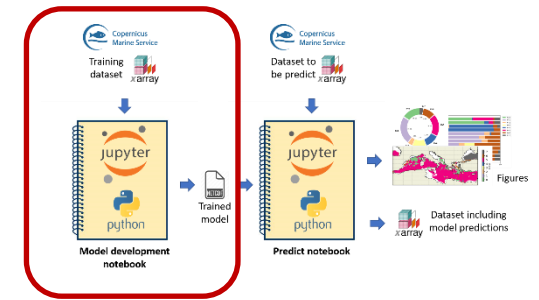
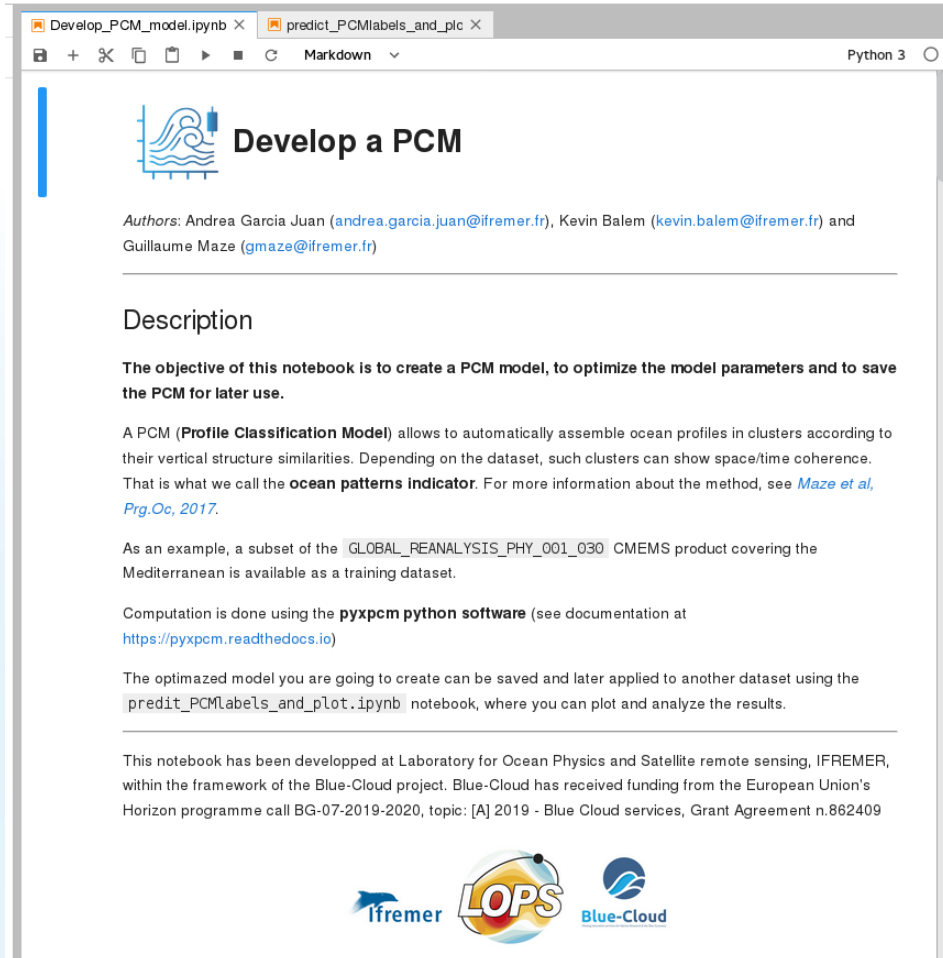
Name
logos
models
datasets
figures
workspace
Plotter.py
BIC_calculation.py
Develop_PCM_model.ipynb
predict_PCMLabels_and_plot.ipynb

4 pretrained models ready to use:

- **Reanalysis models**
 - temperature (Mediterranean Sea)
 - chlorophyll (Mediterranean Sea)
- **Argo floats models**
 - temperature (Mediterranean sea)
 - temperature and salinity (North Atlantic, Maze et al, Prg.Oc,2017)



Development notebook

Develop a PCM

Authors: Andrea Garcia Juan (andrea.garcia.juan@ifremer.fr), Kevin Balem (kevin.balem@ifremer.fr) and Guillaume Maze (gmaze@ifremer.fr)

Description

The objective of this notebook is to create a PCM model, to optimize the model parameters and to save the PCM for later use.




A PCM (**Profile Classification Model**) allows to automatically assemble ocean profiles in clusters according to their vertical structure similarities. Depending on the dataset, such clusters can show space/time coherence. That is what we call the **ocean patterns indicator**. For more information about the method, see [Maze et al, Prg.Oc, 2017](#).


As an example, a subset of the GLOBAL_REANALYSIS_PHY_001_030 CMEMS product covering the Mediterranean is available as a training dataset.

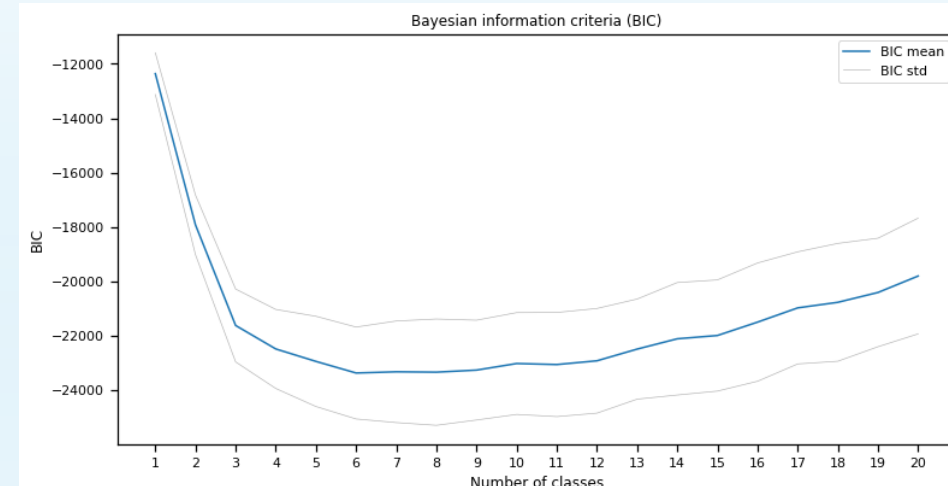
Computation is done using the **pyxpcm python software** (see documentation at <https://pyxpcm.readthedocs.io>)

The optimized model you are going to create can be saved and later applied to another dataset using the `predict_PCMLabels_and_plot.ipynb` notebook, where you can plot and analyze the results.

This notebook has been developed at Laboratory for Ocean Physics and Satellite remote sensing, IFREMER, within the framework of the Blue-Cloud project. Blue-Cloud has received funding from the European Union's Horizon programme call BG-07-2019-2020, topic: [A] 2019 - Blue Cloud services, Grant Agreement n.862409

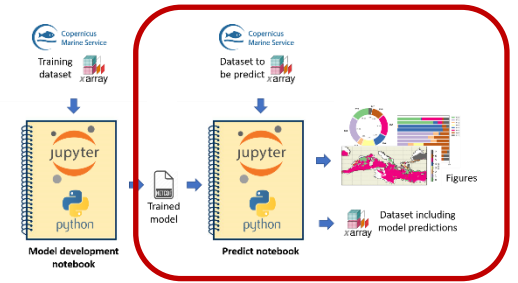
  

- Model parameters: number of classes and variable
- Load training dataset: Data are loaded from Copernicus Marine Service (the user will need a CMEMS account) 
- Create model
- Plot and metrics to optimize model




- Save model

Prediction notebook



Develop_PCM_model.ipynb
predict_PCLabels_and_plc
Python 3



Predict labels with a PCM and plot results

Authors: Andrea Garcia Juan (andrea.garcia.juan@ifremer.fr), Kevin Balem (kevin.balem@ifremer.fr) and Guillaume Maze (gmaze@ifremer.fr)

Description

The objective of this notebook is to load a PCM model, to classify a dataset (make predictions) and to visualise the results with a collection of plots.




A PCM (**Profile Classification Model**) allows to automatically, without supervision, assemble ocean profiles into clusters according to their vertical structure similarities. Depending on the dataset, such clusters can show space/time coherence. That is what we call the *ocean patterns indicator*. Clusters will be presented through different plots. For more information about the method, see [Maze et al, Prg.Oc, 2017](#).




As an example, a selection of the GLOBAL_REANALYSIS_PHY_001_030 CMEMS product covering the Mediterranean is used as an input dataset to be classified.

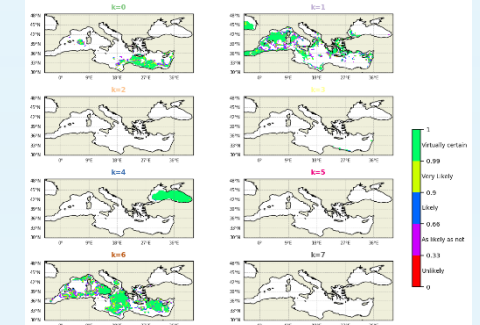
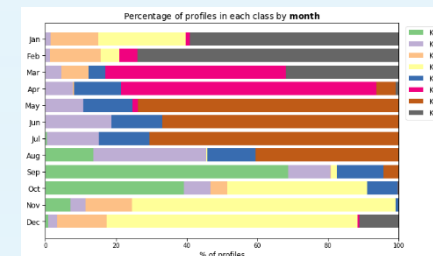
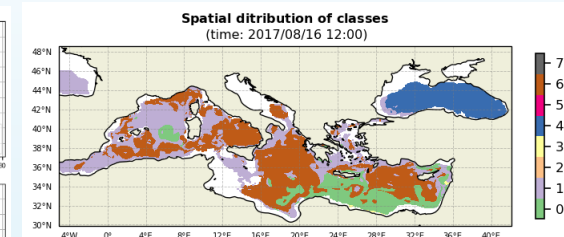
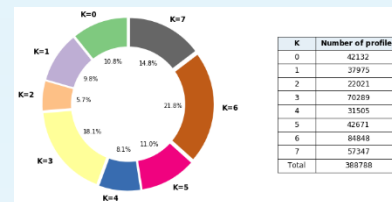
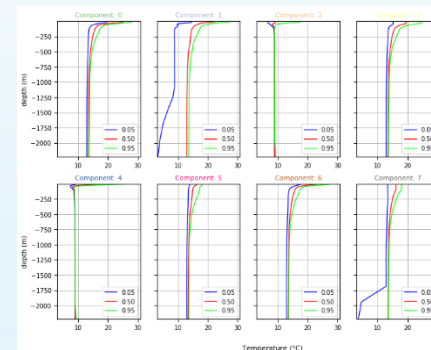
In this notebook we're going to load an existing classification model (PCM). Note that you can develop, train and optimize a PCM of your own using the notebook `Develop_PCM_model.ipynb`.

All PCM operations (load, predict) are done using the **pyxpcm python software** (see documentation at <https://pyxpcm.readthedocs.io>)

This notebook has been developed at Laboratory for Ocean Physics and Satellite remote sensing, IFREMER, within the framework of the Blue-Cloud project. Blue-Cloud has received funding from the European Union's Horizon programme call BG-07-2019-2020, topic: [A] 2019 - Blue Cloud services, Grant Agreement n.862409

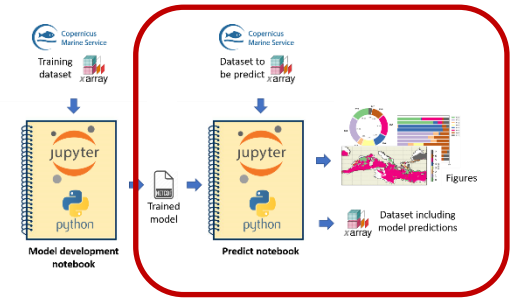




-  **Load model and dataset:** The user can use the pretrained models or the one developed in the 1st notebook
-  **Predict labels:** sort each profile of the dataset into a specific class
-  **Plot results**

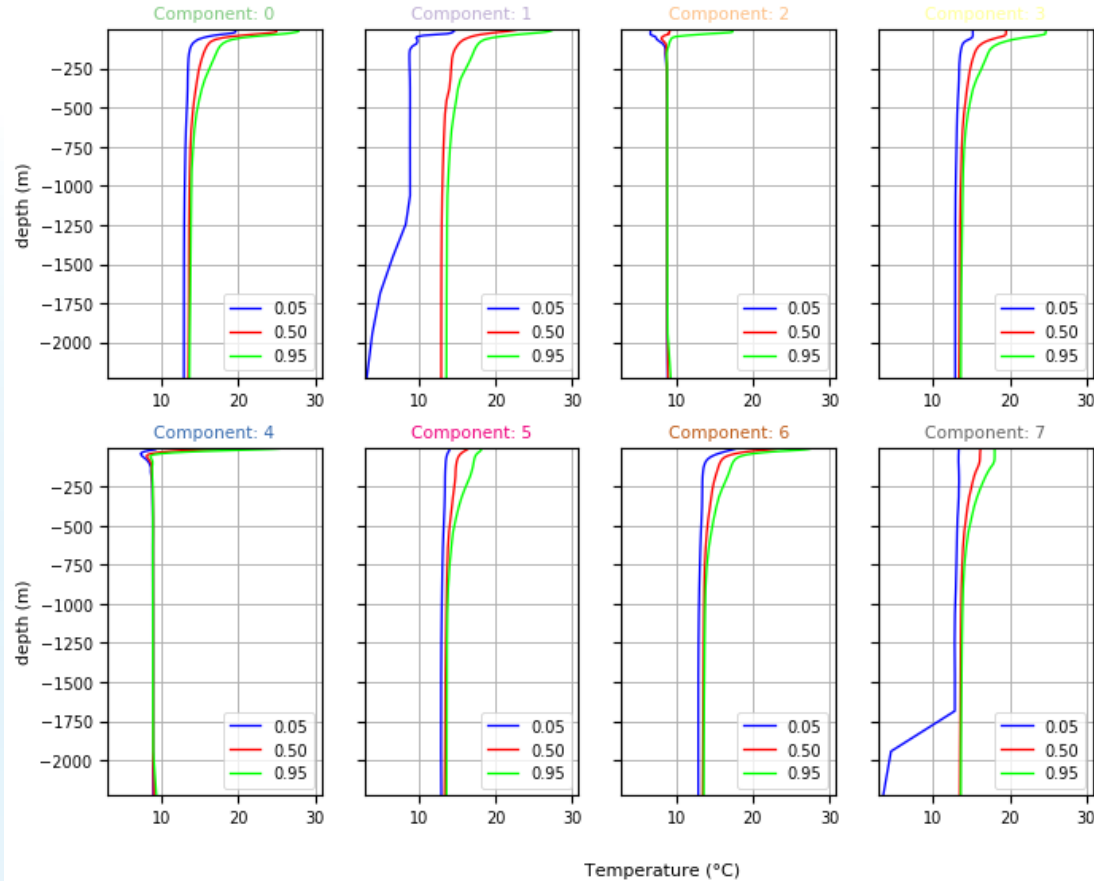


-  **Save data**

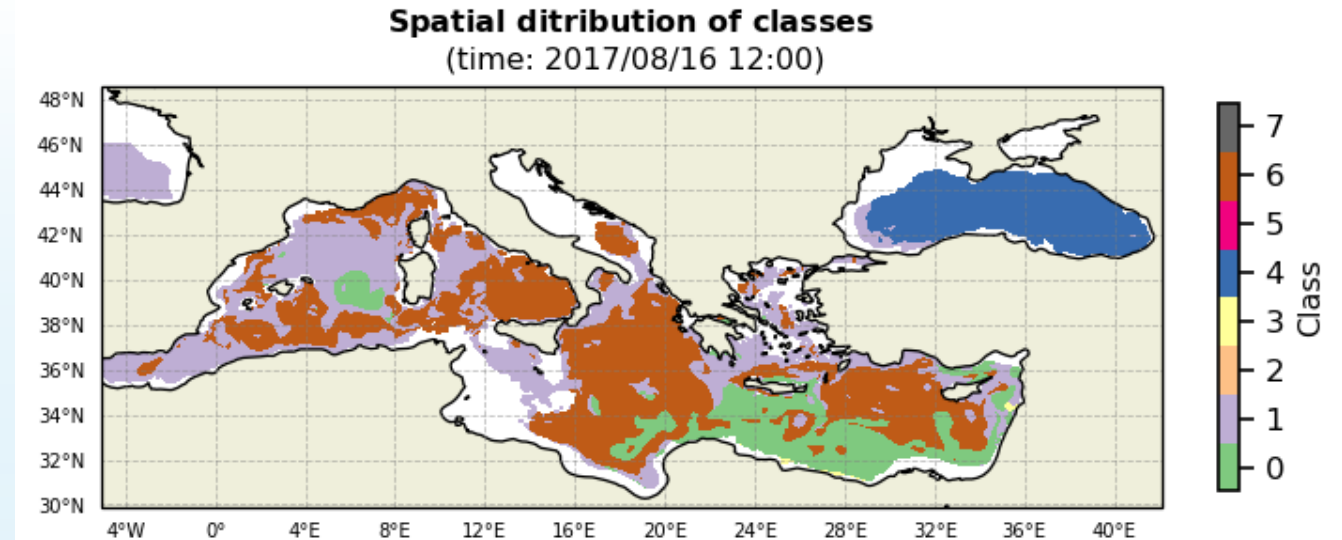
Prediction notebook



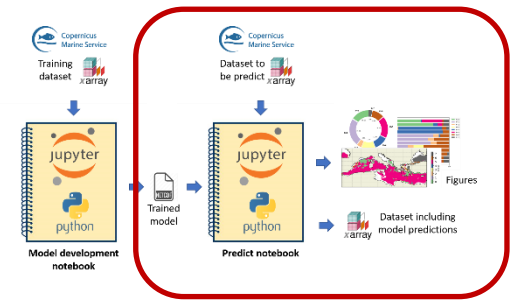
Vertical structure (quantiles)



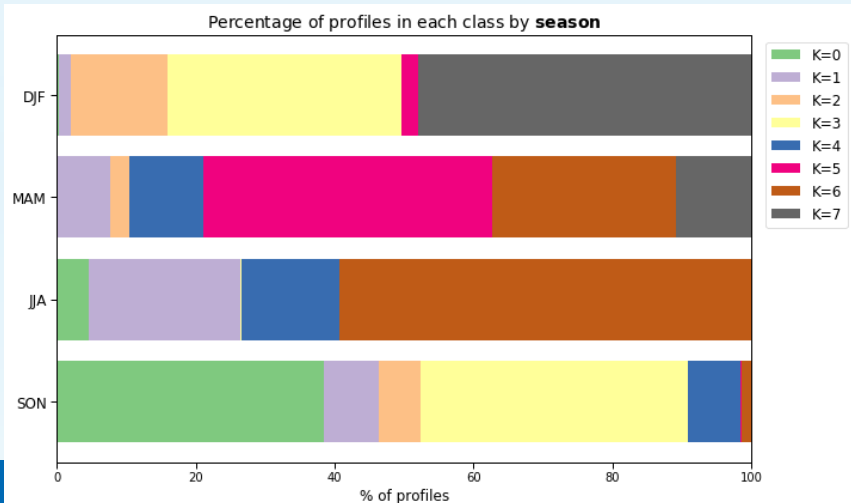
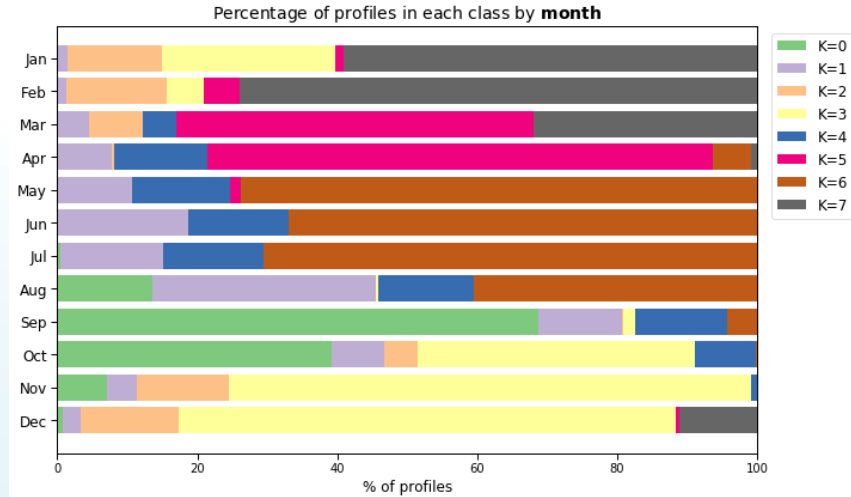
Spatial distribution



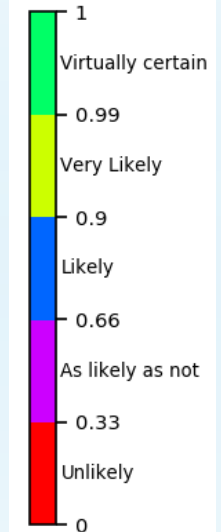
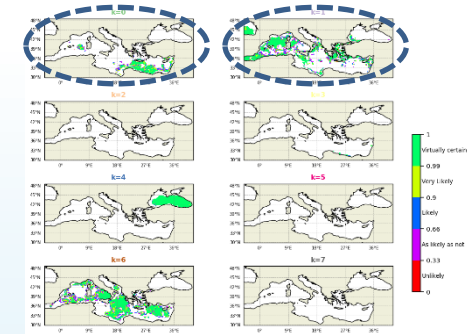
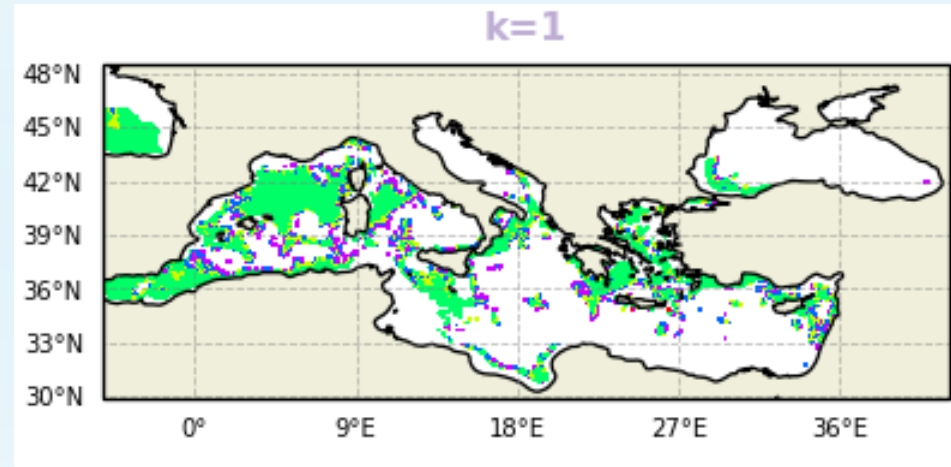
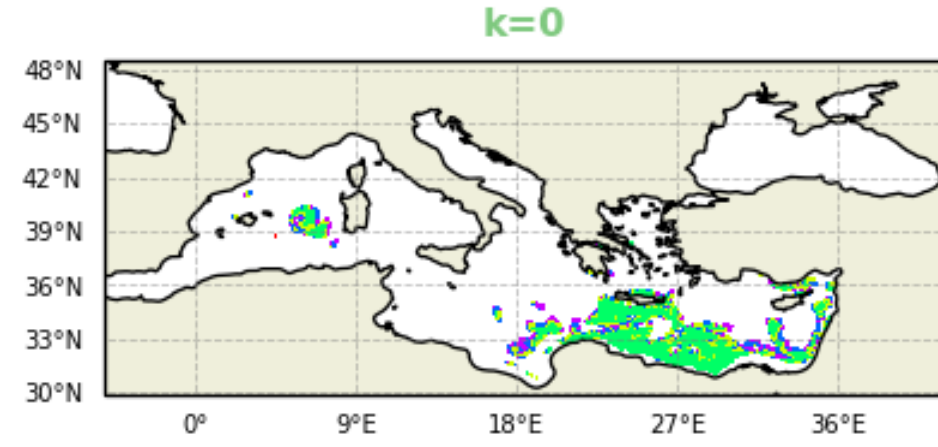
Prediction notebook



Temporal distribution



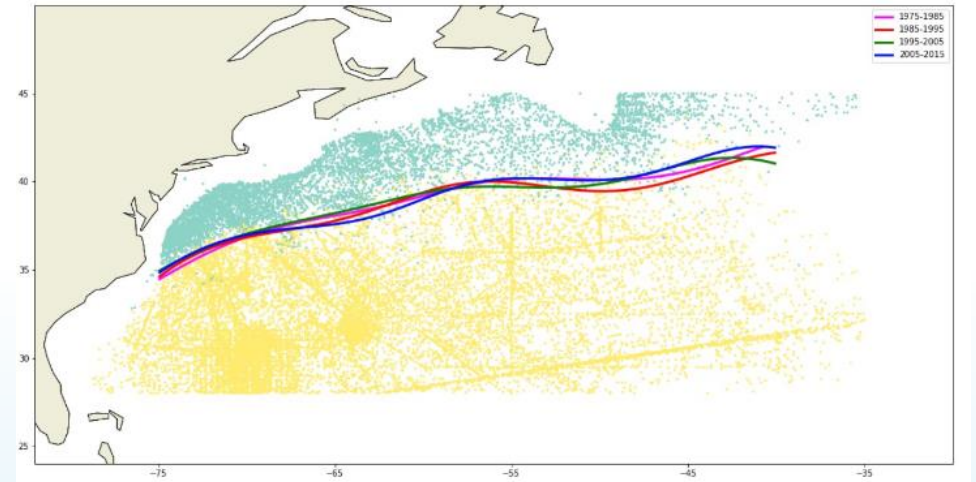
Robustness



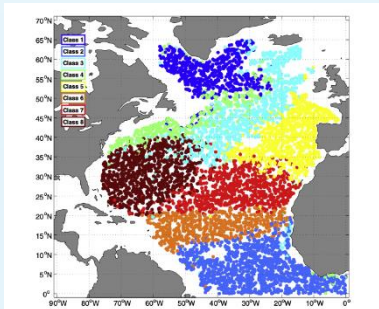
Examples of applications

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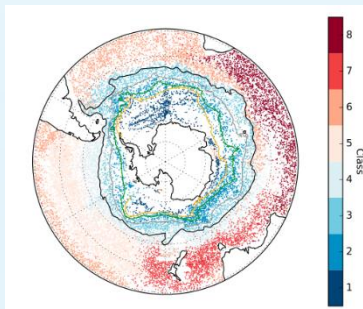
- Study of a region with natural boundaries
- Structure of frontal regions
- Model evaluation
-



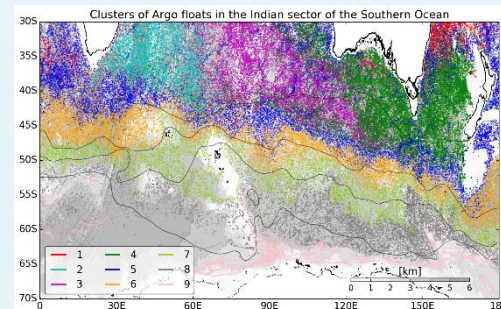
Balem and Maze, 2019



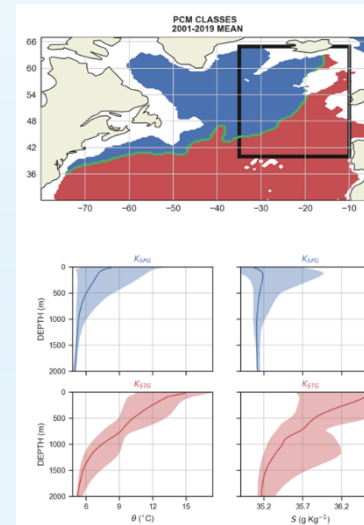
Maze et al, Prg.Oc, 2017



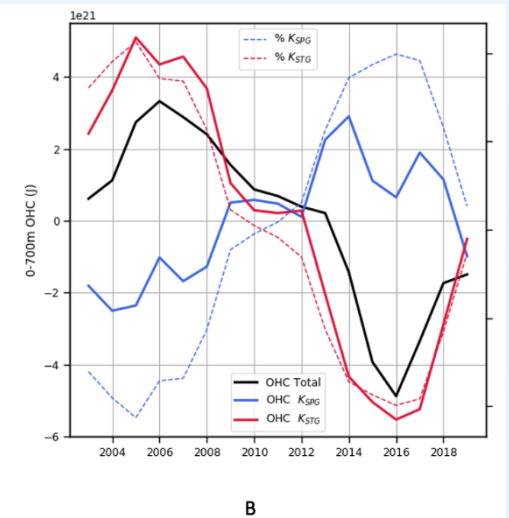
Jones et al, J. Geophys. Res, 2019



Rosso et al, J. Geophys. Res, 2019



A



B

Desbruyeres et al, Nature (rev.), 2020

To summarize

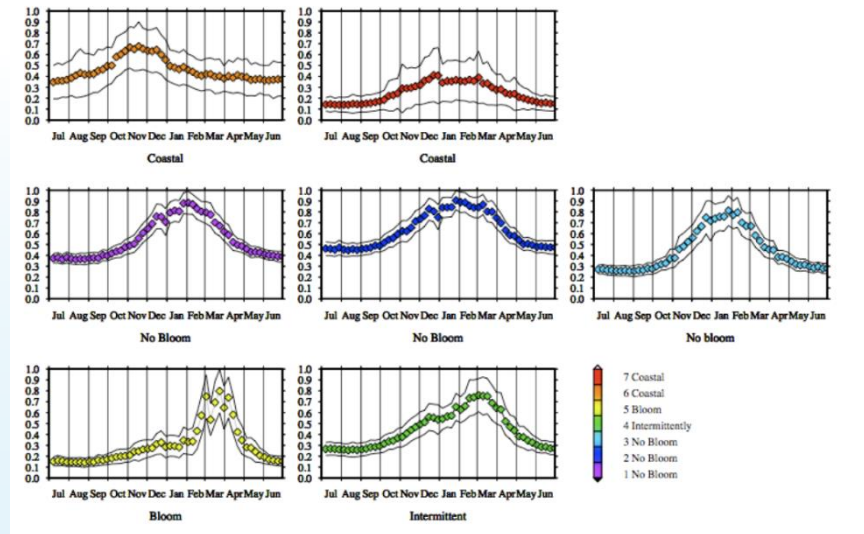
- The ocean patterns indicator is an easy way to analyse and explore an ocean region using Machine Learning
- PCM can be applied to all types of oceanographic profiles:
 - From 3D numerical simulations or in-situ observations
 - With one or more physical or biogeochemical variables

Feel free to play!

What are we doing next?

Ocean regimes indicator

Classification of time series



D'Ortenzio et al,
Biogeosciences 2009