Jellyfish Forecasting from Earth Observation Data Using Computational Intelligence Techniques

Laia Romero\(^1\), Laura Moreno-Patricio, Aureli Soria-Frisch, Iván Cester
[1] laia.romero@starlab.es, Starlab Barcelona S.L., Camí de l’Observatori s/n 08830 Barcelona Spain

Introduction

Unexpected blooms of jellyfish are increasingly taking place along the coast of the Mediterranean Sea. Jellyfish populations tend to drift towards the shoreline with repercussions on coastal related activities. Potential causes to this rising number of blooms at a global scale can range from overfishing of top-predators to climate change.

Physical-biological interactions support the development and persistence of plankton blooms (Decker et al. 2007) among which we find the gelatinous planktonic aggregations. Specific environmental conditions associated with the occurrence of jellyfish can be determined with the use of Earth Observation data with predicting purposes.

Most jellyfish exhibit sexual reproduction in the dominant medusa stage, and the resulting larva forms a polyp which reproduces asexually by budding ephyra (strobilation) which then develop into adult medusa. Experiments and studies carried out in the past years show a series of effects that temperature, salinity, and food availability have on the asexual reproduction of jellyfish (for example: H-hour pattern, 2005; Gruppo di lavoro per l’Obiettivo di Pesci, 2005). In addition, physical conditions can facilitate jellyfish movement, create discontinuities that promote their accumulation, and set optimal conditions for sexual reproduction.

The objective of this work is to create a processing chain that will transform physical and biological Earth Observation ocean data (chlorophyll-a, salinity, temperature, winds and currents) over the NW Mediterranean coasts into the probability of jellyfish occurrence. The feature extraction and classification methodology will be developed using ground truth from in-situ measurements by means of machine learning techniques.

Available data

The system counts on the following historical data:

Earth Observation and Model-driven data:
- Chl-a concentration
- Salinity
- Temperature
- Surface winds and currents

Ground truth:
- Jellyfish occurrence observations

Validation of the data

EO and model-driven water conditions (chl-a, salinity, temperature, winds, and currents) will be validated with those of the in-situ measurements provided by ACA (Catalan Water Agency). This validation will be done by means of a regression analysis.

Feature extraction

Interesting features to be extracted from our data are proposed based on a scientific literature review of potential factors that trigger jellyfish occurrence. The temporal and spatial evolution of each measurement will be of key importance when studying a potential forecasting model.

Classification Algorithm and training

Support Vector Machine (SVM) classifiers are used to determine the probability of occurrence of a bloom based on features extracted from EO data as well as in-situ measurements. Jellyfish occurrence is used as ground truth.

Training of the classifier
The SVM module is trained with the features extracted from historical data and the ground truth to automatically detect patterns that lead to a jellyfish bloom.

Prediction
The SVM classifier will give an estimate of the probability of occurrence of a bloom based on real time data introduced

Systematic analysis of classification performance

Determination of optimal classification threshold is conducted through Equal Error Rate analysis:
- Plotting the histograms of each class
- Finding the optimal threshold (the intersection between the histograms)
- Create a confusion matrix where we determine the false alarm rate

Hit: true positive; miss: false negative; internal response: classification output; correct reject: true negative; false alarm: false positive.

Conclusions

The methodology of work presented corresponds to an on-going project which will start giving the first results for jellyfish prediction indicators by 2009.

Acknowledgements

The present research work is carried out by Starlab in the framework of DASO, project funded by the Catalan Government that counts with the collaboration of ACA (Catalan Water Agency) and CMIMA (Mediterranean Center for Marine and Environmental Research).

References