BOULAALAM El-Mehdi, GAUVIN Florian, VAN GENNIP Simon, CAILLEAU Sylvain, COLONNETTE Laurent, GAUDEL Quentin, LI Long, SOUCHARD Julien, EL AOUNI Anas

Mercator Ocean International

Evaluation of machine learning-based ocean forecasting systems for extreme marine events: the IBI-Mediterranean marine heatwave of spring 2

The recent emergence of machine learning models represents a significant development in the field of ocean forecasting, particularly due to their ability to simulate the ocean at a lower computational cost. These models learn ocean dynamics from historical and reanalysis datasets. Because extreme events are, by definition, under-represented in the training data, forecasting them remains a major challenge for data-driven systems. Among these events, marine heatwaves (MHWs), characterized by prolonged and anomalously high ocean temperatures, can have major ecological and socioeconomic impacts.

In this study, we investigate the ability of several data-driven ocean forecasting systems to predict the marine heatwave that affected the Iberia–Biscay–Ireland (IBI) and Mediterranean Sea regions in late spring 2026. The event is first characterized using the observational sea-surface-temperature product OSTIA and analyses from the Global Ocean Physics Analysis and Forecasting System at 1/12° resolution (GLO12), in order to describe its spatial and temporal evolution at high resolution. Marine heatwaves are detected consistently across all products following the Hobday et al. (2016) method, while preserving the native spatial resolution of each product.

Forecasts from data-driven systems and from the physics-based GLO12 forecasting system are then evaluated against GLO12 analyses and OSTIA product. The evaluation first relies on qualitative comparisons of the detected events and is subsequently complemented by quantitative diagnostics as a function of forecast lead time. This case study aims to assess whether current ocean forecasting systems can reproduce not only the background ocean state, but also the onset, spatial extent, intensity and evolution of major marine extreme events.