Putting the Atlantic Ocean under the microscope

Exploration of the hidden world beneath the ocean’s surface unveils the complexities of marine life, helping to understand the balance of oceanic ecosystems.

Beneath the Earth’s oceans lies a complex web of life, characterised by extensive biodiversity ranging from microorganisms – classically known as plankton – to marine mammals. Oceanic ecosystems play a vital role in the Earth’s balance – regulating climate and sequestering heat and carbon dioxide. They also produce oxygen, nurture life and provide invaluable resources.

However, environmental and climate stressors, including changes in water temperature, ocean circulation, overfishing and the amount of chemicals in the water threaten the resilience of oceanic ecosystems. Understanding the precise implications of these challenges demands a deeper comprehension of the intricate mechanisms governing ecosystem responses.

Insight into the oceanic microbiome
With a focus on the Atlantic Ocean, the EU-funded AtlantECO project sought to unravel the mysteries and dynamics of oceanic ecosystems, using cutting-edge techniques.

“We combined molecular biology with ecology and oceanography to investigate the interactions of marine organisms and their interplay with their environments,” explains project coordinator Daniele Iudicone.

Through metagenomic data analysis, the project unveiled the geographic spread of the microbiome, shedding light on diverse responses to climate change that impact carbon production and export. Another study exposed increased species interactions toward the poles, unveiling biome-specific vulnerabilities.

Ocean currents emerge as a pivotal player in microbiome distribution. In principle, the microbiome can reach any surface location but it is constrained by the water temperature and resources availability. Therefore, rising oceanic temperatures may modulate microbiome movement, directly impacting the ecosystem. Using mathematical modelling, researchers charted the routes and timing of microbiome movement across the ocean in correlation with temperature.

Evolving ocean behaviour

“The oceans contribute and respond to climate change through intricate mechanisms. Analysing singular factors, such as temperature, is insufficient to untangle the underlying processes,” states Iudicone.

By studying 25 years of oceanic and atmospheric data, AtlantECO yielded invaluable insights into long-term trends. Researchers discovered significant alterations in ocean circulation, water temperature and salinity levels. AtlantECO’s findings indicate that these changes have deeply altered the distribution of the abundance of the microbiome across the Atlantic.

Changes in atmospheric air patterns over the ocean are disrupting the normal interaction between the ocean and the atmosphere, which typically aids in stabilising Earth’s temperature. These disruptions have an immediate impact on the ocean response to global warming. Analysis of these new ocean dynamic patterns and their contributing environmental factors led to a more comprehensive framework for assessing the accuracy of climate models and predicting these changes.

“This advancement will refine climate predictions and deepen our understanding of environmental shifts,” highlights Iudicone.

Safeguarding oceanic ecosystems
Various pollutants including heavy metals and pesticides, excess nutrients from agriculture and sewage as well as pharmaceuticals and plastics affect oceanic microbiomes. Climate-induced temperature shifts reduce nutrient supply, escalate toxicity and create oxygen-depleted zones. These stressors combine nonlinearly, affecting aquatic life, particularly through amplified pollution via riverine inputs and altered precipitation patterns.

The AtlantECO-BASE database encapsulates ocean-related information, bridging comprehension gaps and serving as a unified resource for studying ocean dynamics and ecosystems within the Atlantic region. The predictive AtlantECO-MAPS provides a detailed view of ocean dynamics and connectivity, microbiomes and microplastics. Together, these resources aim to inform more effective ocean policies and initiatives, ensuring better management of Atlantic Ocean ecosystems.

Keywords

AtlantECO, ecosystem, temperature, microbiome, Atlantic Ocean plankton, circulation, climate change, salinity, mathematical modelling, database

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