National Oceanography Centre

Global Marine Partnerships

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The ocean is the dominant feature of the Earth and its largest ecosystem, covering 70% of its surface, making the planet habitable, regulating climate and producing half the oxygen we breathe.

The human population will grow to 9 billion people by 2050, with low-lying coastal areas and coastal megacities the fastest growing regions. The NOC recognises that through strong international partnerships we will be better equipped to solve the marine environmental challenges these changes bring from the coast to the deep ocean. Enhanced collaborations will enable us to deliver new knowledge about the current and projected future state of the ocean, will increase resilience and security for developing coastal economies, and will build global capability and capacity for marine science.

Global Marine Partnerships for Global Challenges

The health of the global ocean is vital to life on this planet. It is the world's largest ecosystem, generating goods and services with an estimated value of $2.5 trillion per annum – equivalent to the world's seventh largest economy.

The ocean regulates regional weather and climate, provides food and energy resources but also generates hazards that threaten life, infrastructure and prosperity. More than one billion people depend directly on the ocean for their main source of food.

For coastal nations the marine environment is an opportunity for economic growth resulting from food production, maritime security, resource exploitation, tourism, and sustainable energy. However, marine and maritime economies need to ensure they are resilient to both economic and environmental shocks. For example, sea level rise poses a significant threat to low lying coastal communities, increasing the risk of flooding and causing saltwater intrusion and loss of habitat.

Strong international collaboration will allow us to tackle the most pressing global scientific issues, providing an evidence base for marine environmental management at the local level.

The new knowledge and new capabilities will directly support the United Nations Sustainable Development Goal 14, to

"Conserve and sustainably use the oceans, seas and marine resources for sustainable development"

Our partnerships will promote:

- increased resilience to climate change
- food and energy security
- accelerated Blue Economies
- innovation in marine technology

Innovative Marine Science

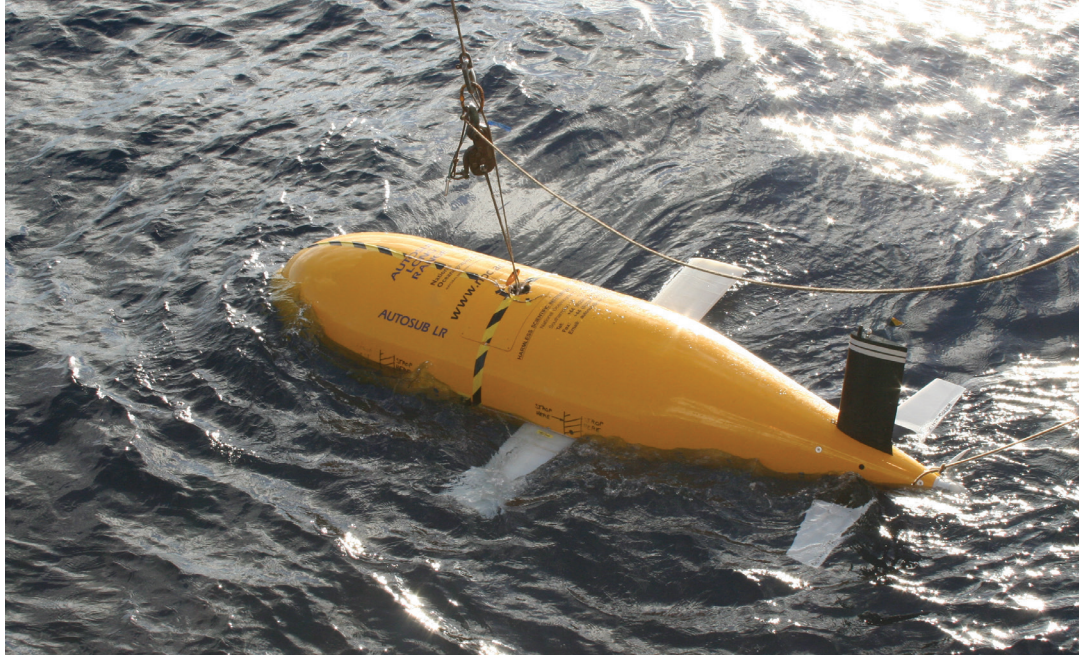
Marine robotics

The NOC is a world-leader in the development and deployment of unmanned marine autonomous systems with an increasing focus on portable, low-cost, long-endurance platforms that carry multiple miniaturised sensors.

These technologies provide new opportunities for marine data collection in hostile environments or by regions with reduced access to research vessel infrastructure. They can be integrated with satellite remote sensing and ocean modelling to provide a real-time three-dimensional picture of the ocean.

Potential applications include:

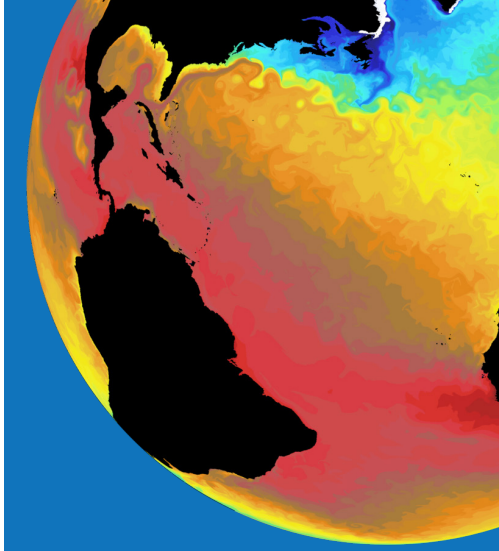
- environmental monitoring of pollution and harmful algal blooms
- seabed mapping of marine protected areas
- acoustic monitoring for marine mammals, anthropogenic noise and maritime security



Remote sensing

Satellite observations give a global view of the ocean, making them a powerful, low-cost tool for understanding and monitoring the marine environment and for validating ocean models that underpin policy and management decisions.

The NOC uses satellite oceanography in both the coastal zone and deep ocean to measure ocean temperature, currents, waves, and productivity (which controls the removal of carbon dioxide from the atmosphere). We also have particular expertise in coastal radar altimetry, an innovative technology that is revolutionising our ability to understand sea level changes close to the coast.



Ocean modelling

Numerical models are powerful and essential tools that allow us to understand the interaction of processes from the local to the global scale, make predictions of how the ocean will respond to climate change, and simultaneously test the possible impact of management measures.

The NOC has a unique capability in interdisciplinary high resolution ocean modelling that spans from the global ocean to coastal regions. These models underpin the development of Blue Economies and sustainable resource management around the world by addressing issues such as the adverse impacts of climate change and marine pollution.

Understanding the Changing Ocean

Climate change is one of the greatest challenges of our time. The NOC works with international partners around the world to understand and monitor its impacts and to assess the vulnerability of the marine environment to climate change.

Global consequences of local land use changes

Changes in land use patterns such as intensification of agriculture and the replacement of one land ecosystem by another can lead to altered fluxes of material (pollutants, nutrients, sediments, carbon) to coastal waters.

These can affect marine ecosystems by changing light fields, disrupting food chains, and have direct impacts on marine species and the habitats that sustain them.

The NOC has world-class expertise in linking changes in terrestrial processes to coastal carbon cycling and other effects on aquatic systems. Application of this expertise provides the information required to manage terrestrial and marine systems in a holistic manner.

Coral bleaching

Unusually high sea surface temperatures over extended periods during local summer months can lead to coral bleaching, and potentially coral death. The NOC uses cutting-edge, high resolution models to forecast the current and future occurrence of bleaching events, and predict their frequency and duration.

We are also able to monitor the effects of bleaching on coral growth and mortality and any related effects on the rich communities of fish, which frequently associated with coral.

Ocean acidification

Some of the carbon dioxide we release to the atmosphere in fossil fuel burning enters the ocean, causing it to become more acidic.

This causes a significant risk to marine ecosystems, as many organisms including commercially important shellfish species and corals form their body parts and skeletons from minerals that may dissolve at low pH.

The NOC has unique expertise in monitoring and predicting changes in ocean acidity and any associated effects on marine ecosystems, generating knowledge that promotes sustainable management plans.

Understanding extreme weather

Unusually warm or cold ocean temperatures affect the large-scale atmospheric circulation and contribute to the development of heat and cold waves, droughts, flooding and tropical storms.

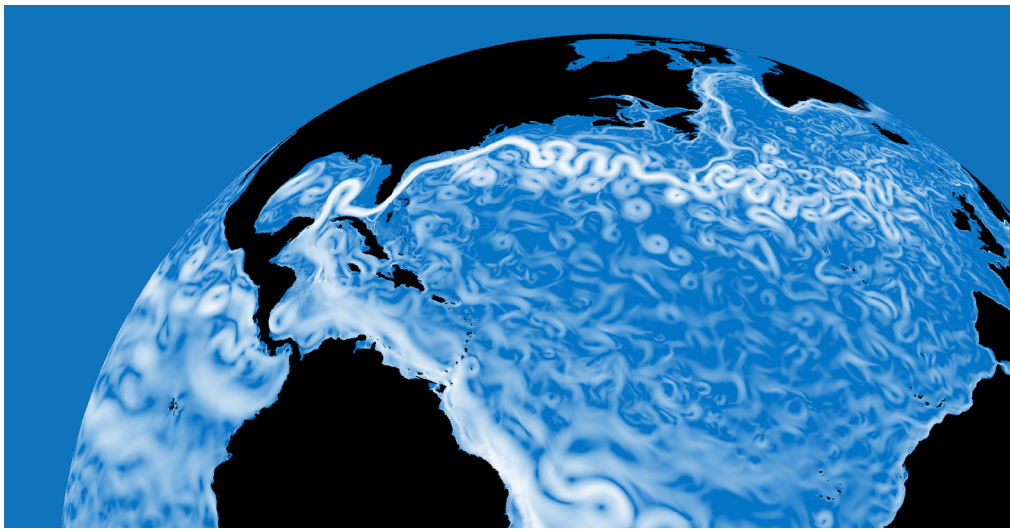
In partnership with the UK Met Office, the NOC develops state-of-the-art computer models of the ocean, sea-ice, atmosphere and land surface, which help to identify causes, precursors and likely impacts of such events.

Managing Environmental Change

Impact of climate change on living marine resources

Climate change is a global phenomenon. However, its impacts on living marine resource and dependent communities are local and often unique. The NOC is a world leader in developing global models to assess marine system response to changing climate in any location on the globe.

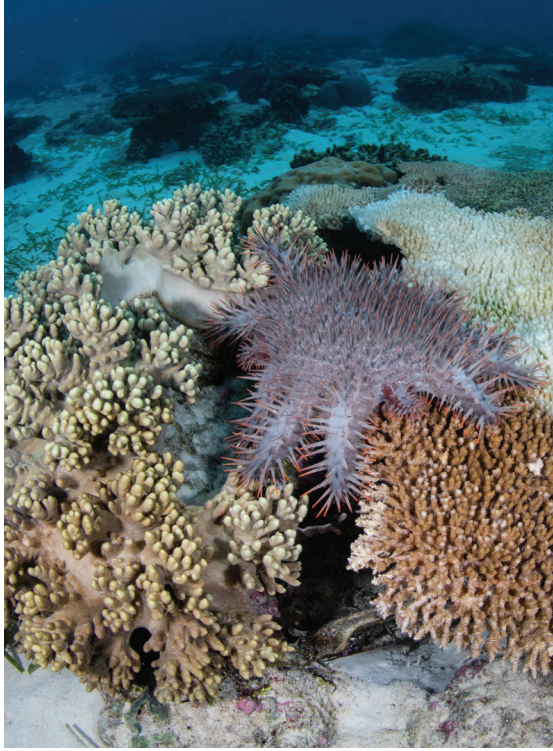
These models have high regional realism which meets the local needs and is designed to inform decisions regarding long-term climate change adaptation and food security management.



Mega-deltas – environmental sensitive hotspots of global change

River deltas are unique environments, home to over 500 million people, these coupled human – riverine – coastal systems are uniquely vulnerable to a wide range of environmental and ecological stresses. Many are especially vulnerable to sea level rise and coastal flooding.

The NOC has unique expertise in developing models of the hydrodynamics of mega-deltas to understand historic water levels, river salinity, and degradation of farmland as well as making projections under future climate, rising sea levels and river management scenarios.



Invasive species

Invasive and alien marine species transported by ballast water, aquaculture or changes in ocean properties or circulation can undermine efforts to protect biodiversity and can affect the functioning and resilience of ecosystems. This can lead to secondary effects on aquaculture and coastal fisheries, affecting food security and damaging marine economies.

The NOC uses unique taxonomic and modelling expertise to survey and predict local patterns of biological diversity in order to determine how invasive species can impact stability of marine ecosystems.

Sustainable Living Marine Resources

Marine Protected Areas

Marine Protected Areas (MPAs) are being established around the world to improve the sustainability of living marine resources.

It is critically important to establish baseline knowledge about marine conditions before and after their introduction in order to determine whether they are effective. The NOC can conduct such surveys from a variety of vessels or using recent advances in marine robotics and autonomous systems, acoustic and photographic imaging.

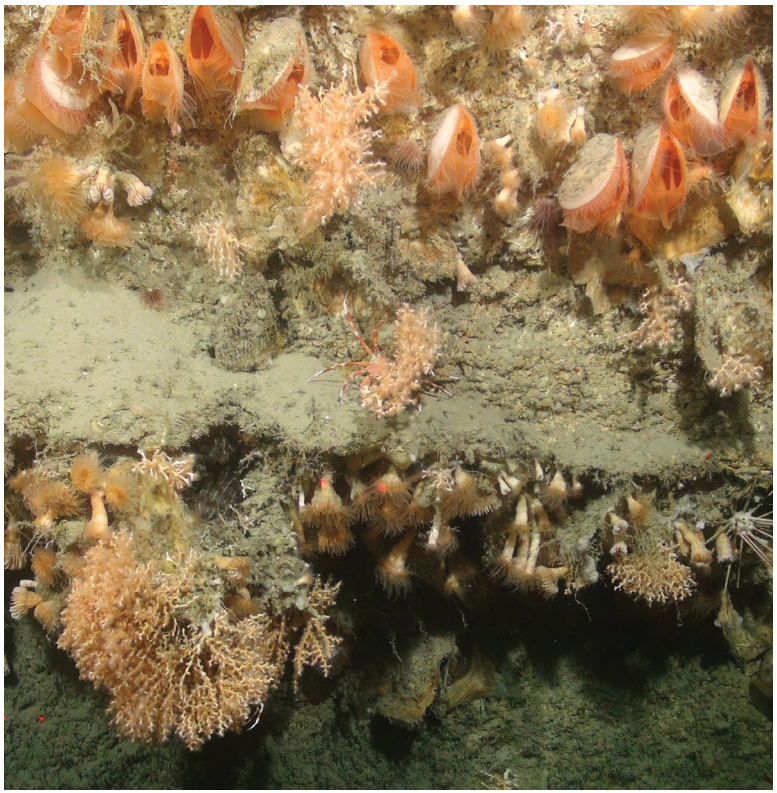
MPAs are influenced not only by what is happening immediately within them, but also by processes in areas connected to them by energetic ocean currents. To guide the selection and subsequent governance of these key marine areas, the NOC uses unique modelling techniques to improve understanding of how MPAs are affected by and connected to the surrounding ocean.

Biodiversity and habitat mapping

Good quality maps of the local marine environment are vital resources needed to underpin marine spatial planning and the management of ecosystems. The NOC has pioneered a unique multidisciplinary approach to providing such resources in a highly cost effective and timely manner.

This combines geophysical, sedimentological, biological and ecological information to chart and present seafloor features including biomass and community composition in a format highly accessible to the non-specialist.

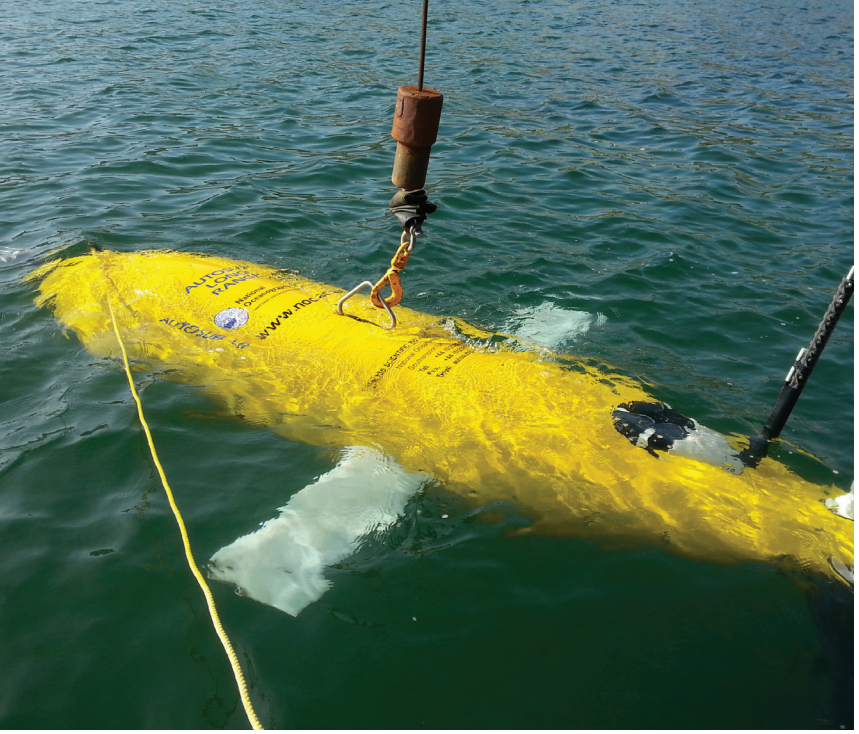
We use recent developments in marine and robotic technology, and our own, easy-to-use software solutions to transform raw data into powerful added-value products.



Aquaculture

As the global population increases, countries are turning to aquaculture in their coastal environments to satisfy the need for high quality protein-based food supplies. This intensification of aquaculture brings with it a whole series of key scientific questions regarding the environmental impact of this new industry.

The NOC offers advanced expertise and an extensive network of collaborators in molecular biology, plankton ecology, ecotoxicology, numerical modelling and benthic system functioning to address challenges of sustainable aquaculture around the world.



Mineral Resources

Seafloor mineral resources for a low-carbon future

Humankind is increasingly turning to the ocean for the new valuable rare minerals required to support our e-tech lifestyle. Identifying and sustainably exploiting these resources is a considerable challenge.

The NOC has expertise in discovering marine resources and also understanding the impacts of mining a wide range of novel e-tech elements such as tellurium, cobalt and rare earth elements from the deep-sea mineral deposits which constitute the largest resource of e-tech elements on the planet. We deliver key research through engagement with the off-shore survey and mining engineering industries, policy makers, and academic researchers internationally.

Carbon capture and storage

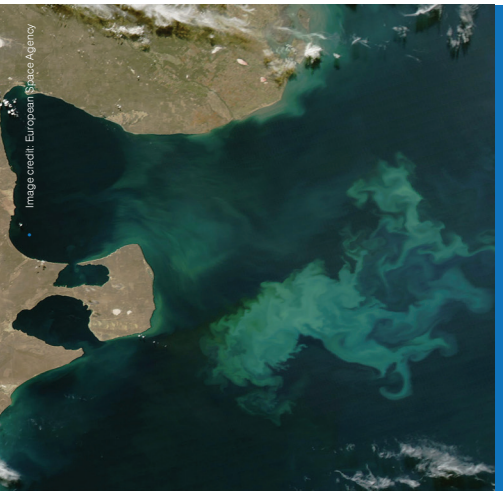
The storage beneath the seafloor of carbon dioxide captured from power stations is increasingly being explored as a cost effective method of mitigating climate change. The NOC has expertise in both establishing the likely size (and hence value) of any storage site and the potential environmental consequences of storage, including the possible leakage of acidic CO2 rich fluid into the seafloor. We conduct research on all aspects of this complex process including geophysical assessments of potential storage sites, and techniques for monitoring environmental impacts using photographic footage from autonomous underwater vehicles.

Resilience to Marine Hazards

Geohazards: threats posed by a dynamic seafloor

Submarine infrastructure networks underpin our daily lives, providing critical global communication links and supporting our demand for energy supplies. More than 95% of all global data communication traffic (including the internet) runs via a network of seafloor cables. Oil and gas pipelines traverse from deep to shallow seas.

Such seafloor structures are vulnerable to a range of natural hazards including tropical cyclones, earthquakes, submarine landslides and sediment avalanches ('turbidity currents'). Technological advances made by the NOC, such as repeat seafloor mapping using autonomous vehicles and acoustic sensing from instrumented seafloor observatories, now allow direct monitoring of deep-sea hazards. We aim to quantify the impacts of seafloor hazards and therefore reduce future economic and environmental consequences.



Harmful Algal Blooms (HABs)

'Each year, $49 million dollars are lost through the impacts from Harmful Algal Blooms, with significant costs to Public Health ($22 million), Fisheries ($18 million) and Tourism ($7 million).'

Anderson et al. (2000), WHOI Report

The global distribution and reporting of HABs is expanding, with the causes of bloom formation linked to recognisable physical, chemical and biological factors, including climate change and anthropogenic impacts such as nutrient pollution.

The NOC has advanced expertise in plankton ecology, nutrient chemistry, ecotoxicology, numerical modelling, autonomous detection and sensor development, to assist in the identification and monitoring of HAB occurrences, where early detection and mitigation strategies are essential to moderate impacts on human health and local economies.

Sea level science

Sea level rise is one of the most costly and damaging effects of climate change, leading to increased coastal flooding and erosion, saltwater intrusion into aquifers and the loss of wetland habitats. Global sea level is projected to rise by between 0.3m and 1.0m by the end of the century and coastal flooding is a threat to life as well as to economic and environmental assets.

The NOC has an international reputation for the research of global and regional sea level rise, variability, and extremes, and a track record of delivering capability in sea level measurement and coastal flood warning systems for coastal developing states.

Impact of industrial processes on coastal waters.

Humankind is increasingly turning to coastal waters for key resources needed to support economic development. Key industries include aquaculture, mining, oil and gas extraction, port development and marine renewable energy solutions.

Each of these can have unforeseen effects on the marine environment, with possible consequences including pollution, escape of farmed species, changes in sediment transport, altered food-webs and coastal circulation patterns. The NOC has pioneered a wide range of techniques to monitor, predict, understand and control such effects. These include shore mounted radar systems, autonomous vehicles equipped with seabed photography systems, numerical models and state of the art surveying techniques.

Consultancy

The NOC is able to offer advice on the following:

- Ocean governance
- Research vessels, autonomous vehicles and instrumentation operations
- Numerical modelling of coastal waters
- Bespoke offshore tidal products
- Managing marine data
- Coordinating collaborative projects
- Technology transfer

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