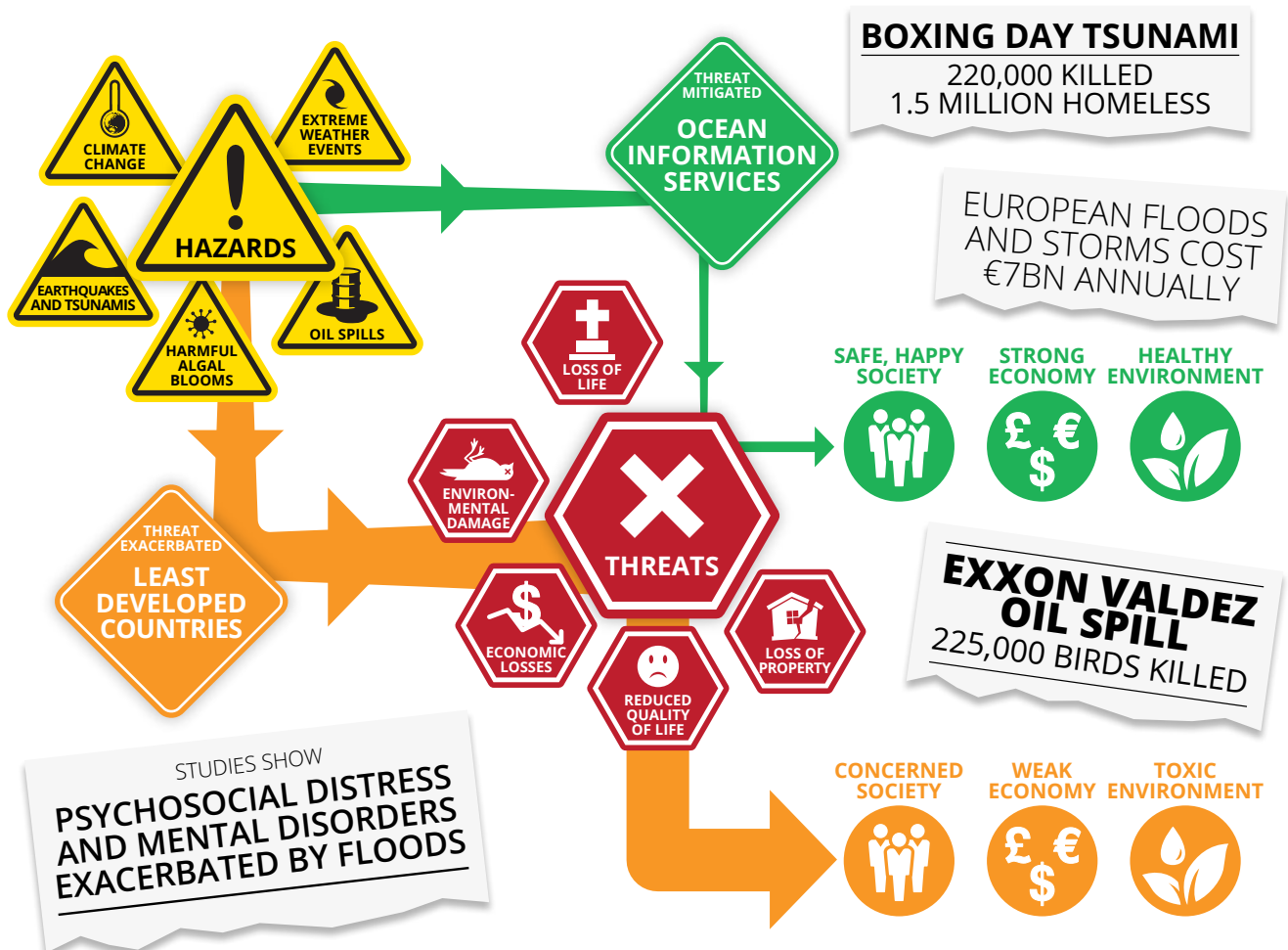


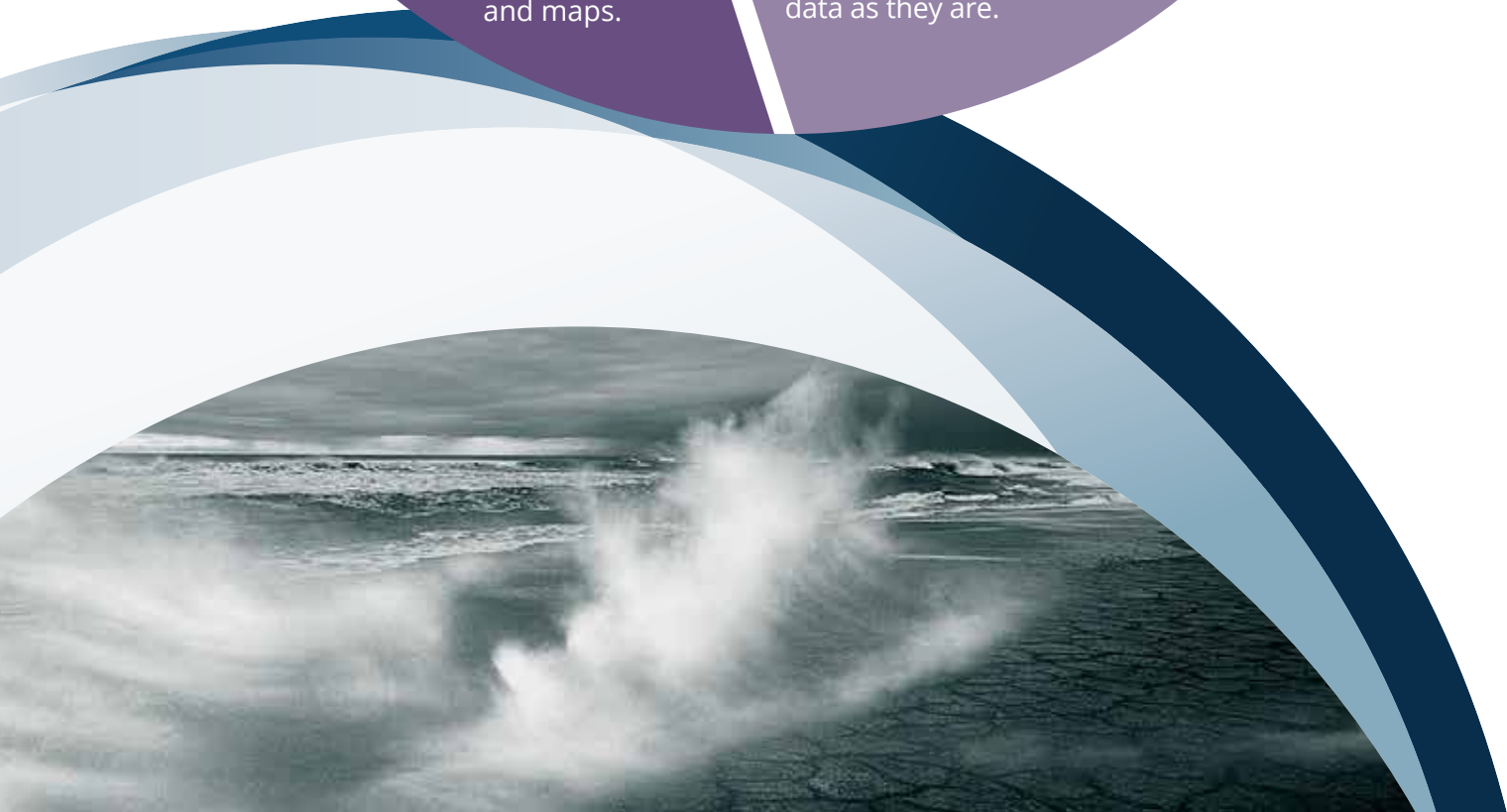
What can the ocean tell us?

Why ocean observation products and services are vital for us and our planet

The ocean impacts almost every aspect of our lives, regardless of how far from the coast we live. The ocean influences our weather, climate, economy and health. Likewise, information derived from ocean observations (such as forecasts and early warnings) can reduce the risks from disasters, improve public health and ecosystem health, and support the global economy. All of these benefits are particularly critical for developing countries, islands and coastal communities.



How ocean observations improve our knowledge and enable action

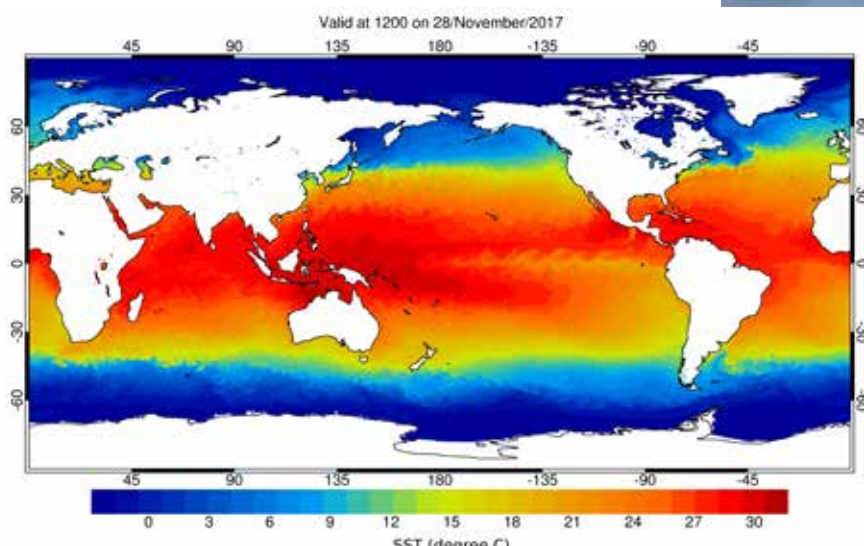


Weather forecasts

Day to day weather forecasts are produced using Numerical Weather Prediction (NWP) systems, which combine environmental observations and computer models of the atmosphere to forecast future weather. In addition to atmospheric observations, information on the ocean Sea Surface Temperature (SST) is required by NWP. SST products are available that meet this need, including the Met Office Operational Sea surface Temperature and Sea Ice Analysis (OSTIA). This uses data assimilation methods to combine in situ and satellite SST data to provide daily global high resolution gridded products in near real time.

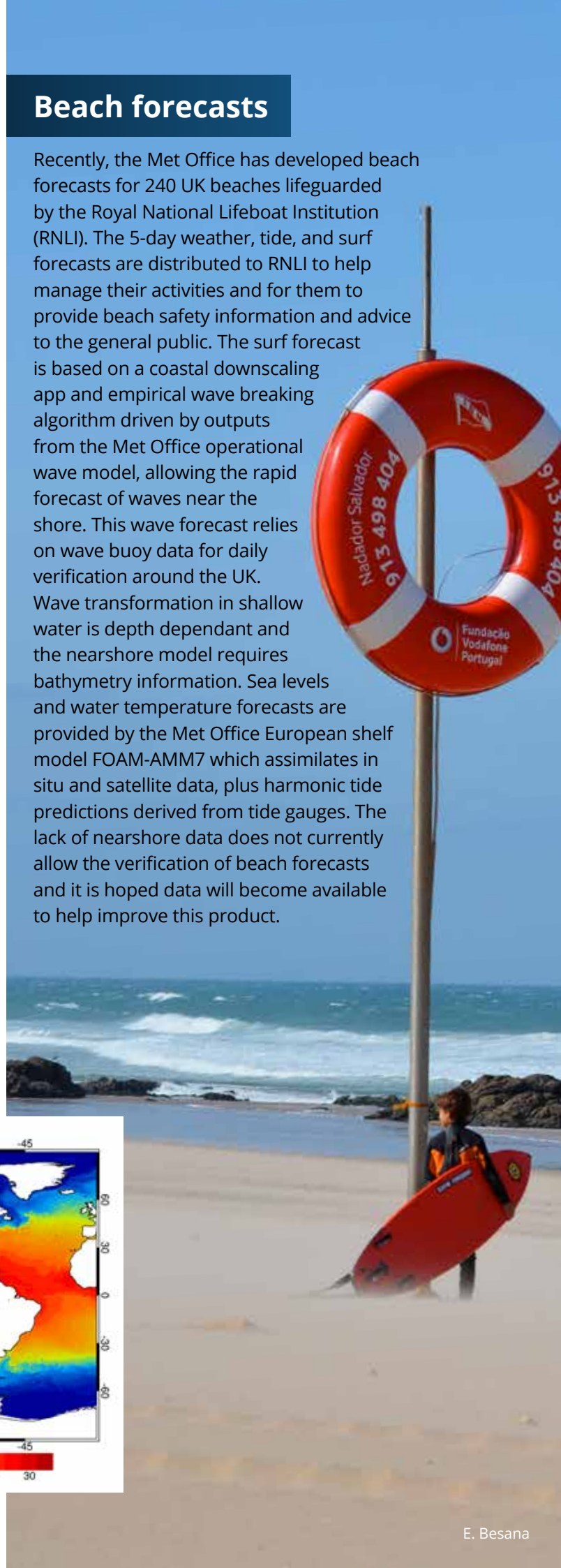
Weather forecasting has a variety of uses, from knowing whether to take an umbrella to work to being able to prepare for storms, floods and hurricanes. Weather forecasting also supports the global economy. A broad range of industry sectors use weather forecasts to optimise and safeguard their operations.

In addition, ocean observations can be assimilated directly into coupled ocean-atmosphere models. The use of observations is crucial to seasonal forecasts, for which accurate initial conditions of both the atmosphere and the ocean are required. The development of coordinated observing efforts, such as the Argo profiling floats program, have greatly improved ocean models and in turn coupled ocean-atmosphere prediction. Such models are particularly important to forecast processes for which heat fluxes between ocean and atmosphere are critical such as cyclones and monsoons.



























Beach forecasts

Recently, the Met Office has developed beach forecasts for 240 UK beaches lifeguarded by the Royal National Lifeboat Institution (RNLI). The 5-day weather, tide, and surf forecasts are distributed to RNLI to help manage their activities and for them to provide beach safety information and advice to the general public. The surf forecast is based on a coastal downscaling app and empirical wave breaking algorithm driven by outputs from the Met Office operational wave model, allowing the rapid forecast of waves near the shore. This wave forecast relies on wave buoy data for daily verification around the UK. Wave transformation in shallow water is depth dependant and the nearshore model requires bathymetry information. Sea levels and water temperature forecasts are provided by the Met Office European shelf model FOAM-AMM7 which assimilates in situ and satellite data, plus harmonic tide predictions derived from tide gauges. The lack of nearshore data does not currently allow the verification of beach forecasts and it is hoped data will become available to help improve this product.



Societal benefits achieved with observations and services

	Issues	Example products and services	Data and observation platforms
Human Health 	Pathogens	Hydrodynamic models are used to forecast abundance of <i>Vibrio</i> bacteria, which can cause illnesses from gastroenteritis to cholera via seafood consumption	Temperature, Salinity, Currents 
	Human Safety 	Safety at sea	Weather and sea state forecasts are transmitted to fishers (see "Fishing bulletins for artisanal fisheries")
Food Security 	Harmful algal blooms	HAB forecasts/risk maps are sent directly to fish/shellfish farmers (see "HAB alerts for aquaculture managers")	Ocean colour, Chlorophyll, Phytoplankton species 
Disaster risk reduction 	Tsunami	Tsunami warning systems provide inundation and evacuation maps to issue tsunami watches and warnings to local authorities and governments	Seismic activity, Sea floor bathymetry, Topography, Sea level 
	Extreme weather events	Weather forecasts are used to provide alerts and evacuation notices for storms, tornadoes, hurricanes, typhoons, etc	Temperature, Humidity, Wind 
	Flooding	Weather forecasts combined with tide data are used to produce flood maps and alerts	Precipitation, Sea Level, Topography 
Climate resilience 	Sea-level rise	Models of long-term changes in sea level, atmospheric/ ocean temperature and ocean pH are produced for the Intergovernmental Panel on Climate Change (IPCC) Assessment Reports to inform policy	Sea level 
	Warming ocean		Temperature 
	Ocean acidification		pH, pCO ₂ , aragonite and CaCO ₃ saturation 
Recreation/ well-being 	Need to know if conditions are optimal and/or safe for recreation	Beach and surf forecasts are made available to the general public via websites (see "Beach forecasts")	Wind speed, Wave height, Current speed/direction 
Water quality and healthy ecosystems 	Pollution	Oil spill detection, tracking and prediction services are used for environmental management	Currents, Bathymetry, Fauna/flora 
Transport 	Facilitating supply chain logistics	Weather forecasts provide information to companies to support decisions on how best to transport their products	Temperature, Wind, Humidity 
	Maritime navigation	Weather, wave and currents maps provide information on optimal (quickest/safest) routes for navigation	Sea level, Temperature, Salinity, Wind, Waves, Currents 
Supporting livelihoods 	Need to increase efficiency of small scale fishing efforts	Potential Fishing Zone maps and advisories are sent via e-mail, SMS and available on-line to artisanal fishers (see "Fishing bulletins for artisanal fisheries")	Ocean colour 
Sustainable economic development 	Supporting sustainable fisheries through monitoring of illegal, unreported and unregulated (IUU) fishing	Information on vessel locations is provided via radio and/or satellite communications and correlated with fishing fleet register to alert national authorities of IUU fishing.	Vessel position information 

HAB alerts for aquaculture managers

*"[This service] allowed us to put the farms on 'alert' a few days before a bloom came... We are convinced that this prevented us from suffering losses."
"I would not feel secure enough to go blind in future; we need this information"*

Harmful Algal Blooms (HABs) pose severe threats to human health, through the contamination of seafood with toxins. They can also cause considerable economic losses to the aquaculture industry. To prevent shellfish poisoning and reduce economic losses, ocean observations are increasingly being used to provide HAB alerts to fish and shellfish farmers. Plymouth Marine Laboratory (PML) in the UK has developed a service in the framework of the EC-funded AQUA-USERS project that provides bulletins to the Scottish aquaculture industry. The service processes ocean colour data from the National Aeronautics and Space Administration (NASA) and European Space Agency (ESA) in near-real time, combined with in situ measurements for validation, and applies novel techniques for discriminating between harmful and harmless algae, to produce risk maps. Within the project they are extending this capability to further HAB species within several European countries. The service, now funded by the aquaculture industry, has been running successfully for several years. The end users include the Scottish Salmon Producers' Organisation and individual fish farming companies in Scotland. Other potential end users include the marine insurance industry, the UK's Crown Estate, and fish farming and aquaculture companies in other countries.

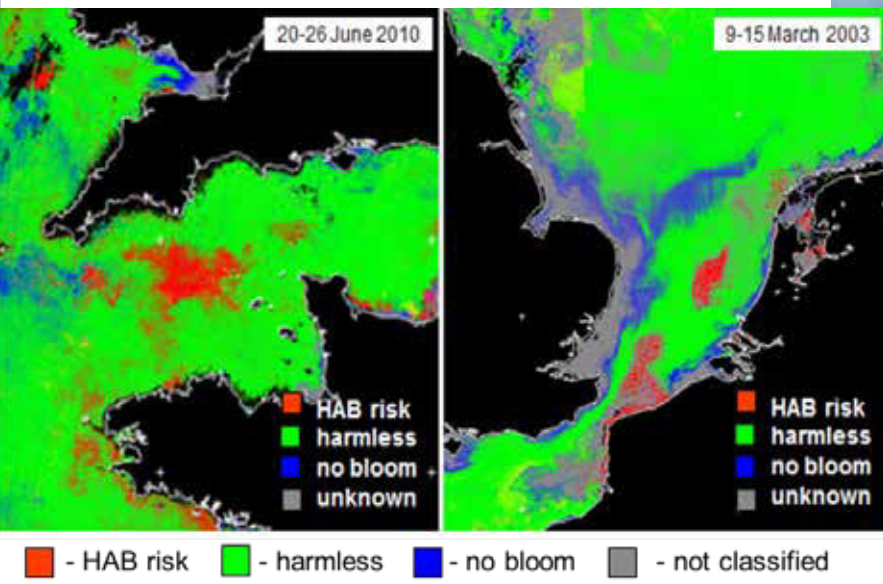
Fishing bulletins for artisanal fisheries

The European Union-funded MESA project (Monitoring for Environment and Security in Africa) provides services to support the fisheries sector in West Africa. This consists of daily forecasts of ocean conditions sent via SMS to small-scale fishermen, as well as maps of potential fishing zones (PFZ) and daily bulletins on fishing vessel activities sent to fisheries managers. The service enables fishermen to increase their efficiency, reduce their costs and avoid venturing out to sea when the conditions are too dangerous. It also benefits policy makers of beneficiary countries, enabling them to better manage their fishery resources. EUMETSAT and the EU Copernicus Marine Service contribute ocean model and satellite products (satellite-measured sea surface temperature, wave heights and currents, ocean colour data, validated by in situ measurements) to the MESA programme.

PFZ advisories are also well established in India, and are contributing to the global project SAFARI (Societal Applications in Fisheries and Aquaculture of Remotely sensed Imagery).

"The SMS messages have saved my life and that of my crew as well as our investment on a number of occasions when we did not go to sea because of the alerts. The SMS service also helps us to conserve fuel since we are able to determine when not to go to sea, thus improving our livelihoods."

Nana Kwesi Ackon, Chief Fisherman of Shama Apo in the Western Region of Ghana



What are the economic benefits of ocean observations and services?

Ocean observations and services support economic growth in a variety of sectors, including - but not limited to - the "Blue Economy". They can prevent or mitigate economic losses, improve efficiency and productivity, and also enable maritime industries to comply with environmental regulations.

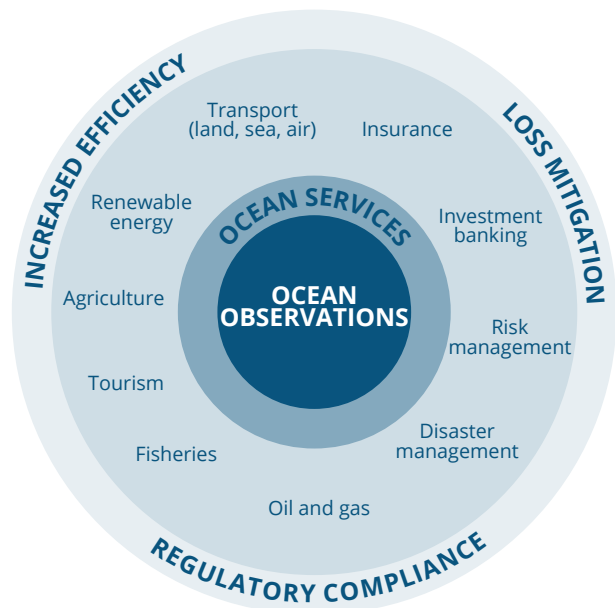
The benefits of various weather-related services have been estimated at 2 to 10 times the cost (up to 36 times for developing countries)

What is missing and where?

- Inadequate coverage and coordination of ocean observing systems (Pacific, Indian, Southern, and Arctic Oceans)
- Biological observations and related services lagging far behind physical ones
- Need to expand most services from local/regional to global
- Need to fully operationalise many services
- Need early warning systems to augment monitoring systems
- Need to implement and maintain observations and services in developing countries
- Performance of ocean models still limited by a lack of observations



Different sectors of economy that benefit from ocean information



The economic benefits of weather forecasting in Europe alone exceed \$10 billion per year. The benefits of all of ocean information globally would far outweigh the costs. The cost to create an adequate global monitoring system has been estimated at \$10-15 billion in assets, with \$5 billion in annual operating costs.



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POGO is a consortium of oceanographic research institutes working to enhance global ocean observations through training, scientific collaboration and advocacy

GEO Blue Planet is a network of networks collaborating to ensure the sustained development and use of ocean and coastal observations for the benefit of society