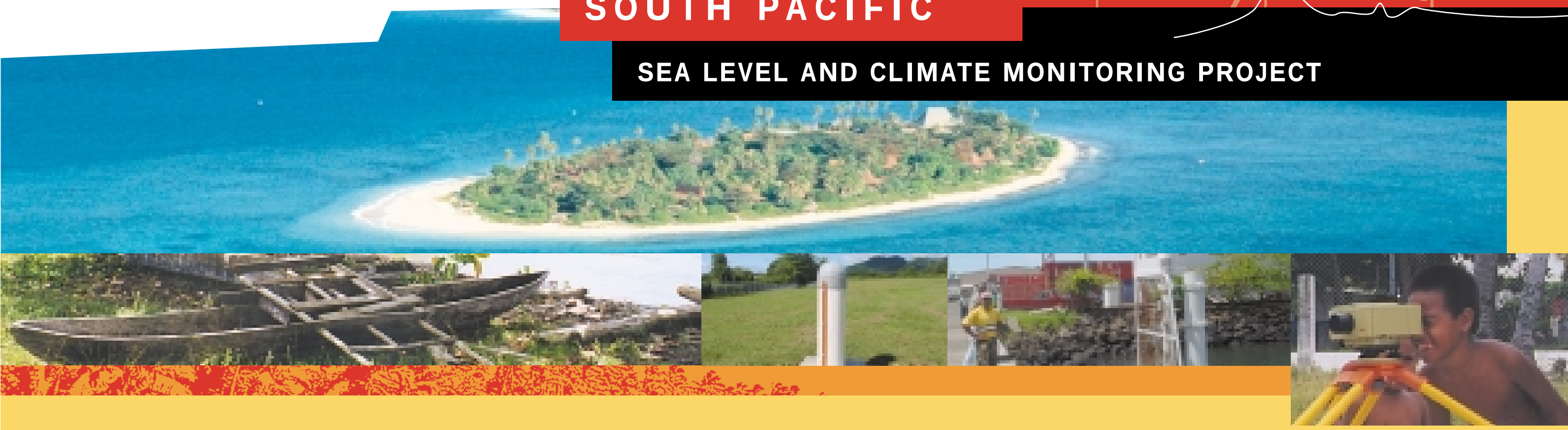
SOUTH PACIFIC

SEA LEVEL AND CLIMATE MONITORING PROJECT



A Project supported by the Australian Government

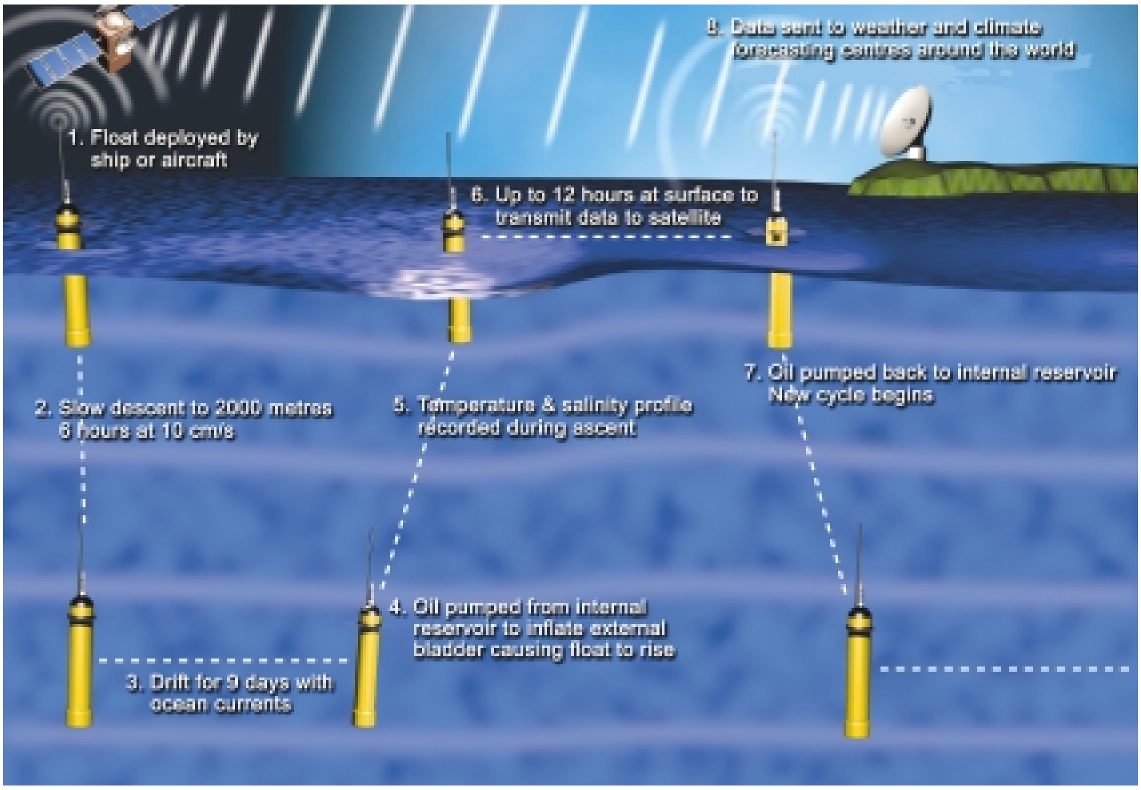
FISH: THE 'INNER OCEANS–OUTER SPACE' CONNECTION

For more than 20 years earth observation satellites have been feeding back images of the Pacific Ocean. These images clearly recognise features at the surface such as warm ocean currents, the upwelling of cold water and nutrients near the coast and now, a view from space of the health and productivity of the oceans.

OCEAN COLOUR

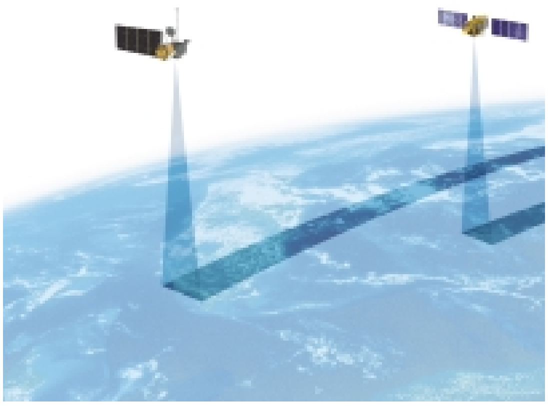
Today, marine biologists and oceanographers can also assess this productivity by the extent of phytoplankton, minute single cell plants that form the foundation of the ocean food chain. This is done by measuring the colour of the ocean and checking it against historical samples of phytoplankton collected from ships and vessels.

Ocean colour instruments aboard satellites measure very precisely the range of light reflected from the oceans. For example, as phytoplankton increases through ocean upwelling and brings nutrients to the surface, the colour of the reflected light shifts from deep blue to green. Newer satellites with much higher resolution can even distinguish the species of phytoplankton and other substances in the water.



An important tool in monitoring ocean conditions is the Argo float, which cycles every 10 days between the surface and a depth of two kilometres, recording ocean data. In an international program a number of these floats have been deployed in the western Pacific. (Image: Southampton Oceanography Centre, United Kingdom)

Deploying an Argo float before it begins its cycle of ocean monitoring. (Image: Institute Fuer Meereskunde, Kiel, Germany)



The footprints of satellites Topex-Poseidon and Jason-1 satellites. The satellites are on parallel orbits as they measure ocean conditions. (Image: CLS/CNES)

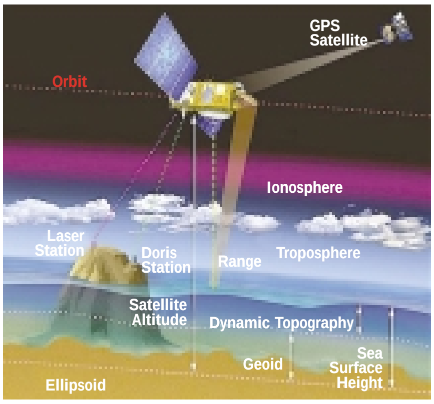
STORMS AND CURRENTS

In the fishing grounds, areas of high phytoplankton production attract nekton and small fish, which in turn attract larger predatory fish.

These areas of high production are dynamic and respond to the passage of storms and ocean current systems.

For some fisheries, such images offer much promise in enabling scientists and fishers to understand the dynamic processes controlling phytoplankton and fish distribution.

With this new information and computer models, scientists are now well advanced in understanding how various species such as tuna respond to the ever-changing conditions of the oceans. The new technology also now makes it possible to predict daily changes in the distribution of major high seas fisheries and to disseminate the information out to managers and the fishing fleet within hours of receiving the information.



Satellite-based instruments have revolutionised ocean observation, including measuring the sea surface to detect the presence of ocean currents and eddies. (Credit: CLS/CNES)

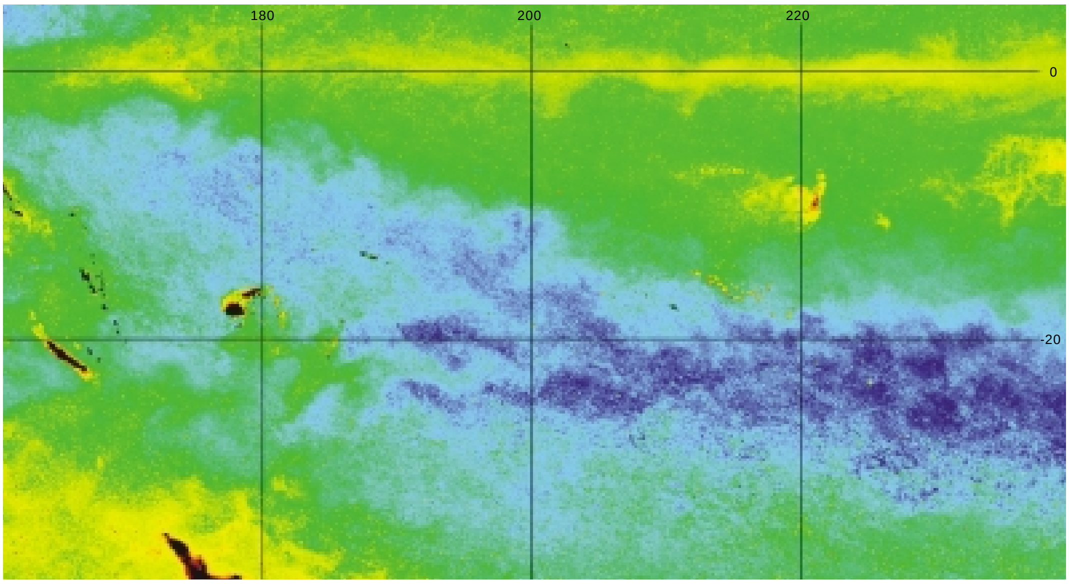
Crew on a Pacific islands trader contribute to monitoring ocean conditions, here using instruments that record data in the upper one kilometre of the ocean.

Links between constantly changing ocean conditions such as water temperature, salinity and ocean currents, and the location of commercial fish stocks will be made in the future as satellite and computer technology continue to advance. These advances are enabling scientists to begin linking fluctuations in fishery yields to changing environmental conditions.

As scientists find out more about the marine environment, they will also find more answers to how biological processes are environmentally-controlled, and then more accurately predictions of future stock levels.

CLIMATIC VARIATION

Climatic variations, stronger or weaker ocean currents, rising or falling ocean temperatures and varying levels of salinity and nutrients affect the breeding, abundance and distribution of all species in the marine food chain.



Satellite-borne ocean colour instruments detect phytoplankton—minute single cell plants at the base of the ocean food chain—using a range of light reflected from the ocean. In this image from the western Pacific in June, 1999, the least productive region is shown as dark blue grading to yellow in regions of higher production.
(Credit: Courtesy of NASA SeaWiFFS project, Orbimage and CSIRO)

On land, variations in rainfall, sunshine and temperature can affect the quantity, quality, harvesting time and economic return from a crop and growers often have long records of production factors.

In the marine environment where people are predominantly still hunters, such long records of environmental variables critical to harvesting fish do not yet exist.

However, making and recording observations—enhanced significantly in the past decade with satellite technology—is relatively new.

The commercial fishing industry is keenly aware that environmental variability such as ocean eddies and fronts affects their operations.

While catch limits and fish stock assessments have historically been based on mathematical models to indicate how stocks grow or decline, the point is being reached where environmental factors will be included in these computer models to assess conditions affecting fertility, and the growth and movement of larvae.

SOUTH WESTERN PACIFIC TUNA

Satellite instruments, which detect changes in ocean conditions and behaviour, are shaping as a new tool for fisheries managers to understand changes in the distribution of fish in the South West Pacific.

For example, recently a team of scientists used satellite images to assist managers of Australia's fisheries as well as predict fish distribution.

The project team worked with the east coast fishing industry to test measurements of sea surface temperatures and ocean plankton as a means of predicting the location of yellowfin, big eye and skipjack tuna and billfish.

Critical to the success of the project was an extensive decade-long database of daily satellite images carefully maintained by the Remote Sensing section of CSIRO Marine Research, Hobart, and the database of fish catches, over several decades, maintained by the Australian Fisheries Management Agency in Canberra.

The speed and substantial storage capacity of modern computers was employed to analyse these massive datasets, providing new insights into how tuna distributions change in the high seas.

Two specific options of interest to the commercial catching sector were identified by scientists.

- Fisheries managers can potentially now utilise much better information about the areas which are favorable for various tuna species.
- By using the new information, fishers can increase their operational efficiency and reduce catches of non-target species.

PACIFIC OCEAN LINKS

The influence of environmental factors such as *El Nino* or *La Nina* conditions in the Pacific Ocean, for example, extends far beyond the Pacific.

Scientists have established there is a much better distribution of larvae down the coast of Western Australia when the Leeuwin Current is stronger than when it is weaker. By knowing that, and other conditions such as winds, managers know the likely strength of the fish harvest up to four or five years ahead—important information for both managers and those who have invested in the industry.

Skipjack tuna (Katsuwonus pelamis)
(Photo credit: CSIRO Marine Research)

Bringing aboard a haul of skipjack tuna
(Photo credit: Peter Sharples, Oceanic Fisheries Programme, Secretariat of the Pacific Community)

SUMMARY

In some Pacific fisheries, the fishers say that catch rates are mainly influenced by day-to-day environmental conditions: low catch rates imply that the fish are somewhere else, not necessarily that there are no fish left.

Over a lifetime of fishing, fishers develop an understanding of how ocean variability and marine environment affects the behaviour of adult fish.

Evolving scientific tools such as satellites and computer models are closing the knowledge gap on factors influencing coastal and open ocean fishing, and sustainability.

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