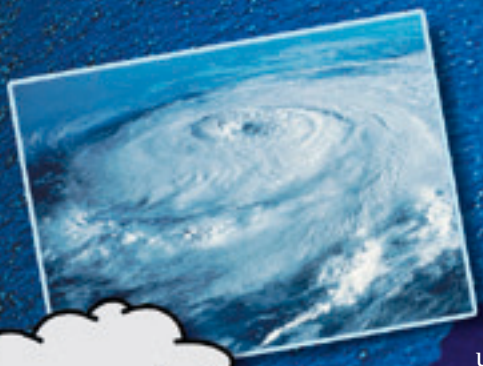
Observing the oceans from space

Predicting currents, forecasting the ocean



Blue skies, westerly winds, rain, fog? We all like to know what the weather holds in store. It can have a big impact on the daily lives of farmers, aircraft pilots, construction workers and sailors, and on a whole range of activities. Sailors have to contend with the changing mood of the oceans, dictated by the waves, swell, and turbulent currents. Rapidly changing sea-state conditions affect not only shipping but also fishing, scientific research, coastal engineering, offshore operations, and more besides.

A major oceanography research effort is now under way to enable us to forecast ocean conditions much as we do the weather. Thanks to the large volume of high-quality satellite data acquired chiefly by the TOPEX/POSEIDON altimetry satellite, we now have a much better understanding of the oceans and ocean-atmosphere exchanges, and we can predict patterns and movements more accurately. Close international cooperation is being pursued to ensure that in future nobody sets sail without first consulting their ocean bulletin, and to bring the benefits of reliable climate prediction to all.

National Aeronautics and Space Administration
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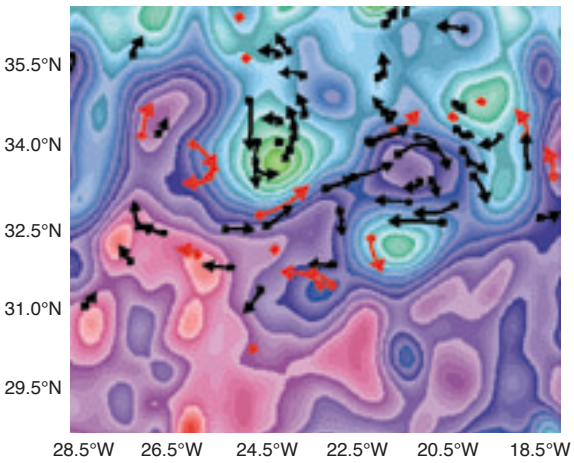
Ocean weather

In the atmosphere, zones of high and low pressure drive the incessant aerial ballet that dictates the strength and direction of winds. Movements in the ocean below may be slower, but the underlying forces are the same—and forecasting these movements is also possible and useful.

Turbulent seas, turbulent atmosphere

The oceans and the atmosphere are turbulent places. Currents and winds vary in direction and intensity, and eddies in the ocean may persist for days or weeks. Eddies generate exchanges of heat with the atmo-sphere, causing sharp temperature variations, mixing of ocean waters, and changing environmental conditions.

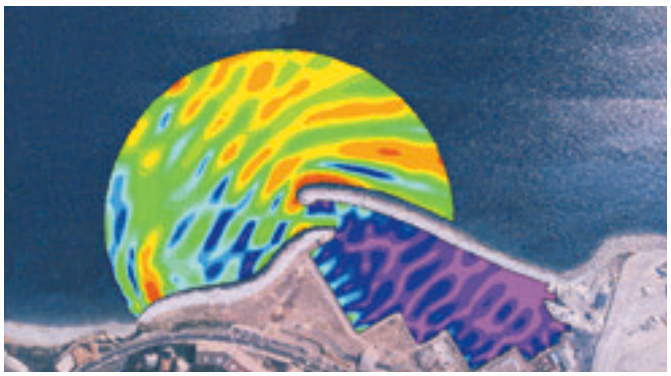
A cyclonic eddy in the ocean



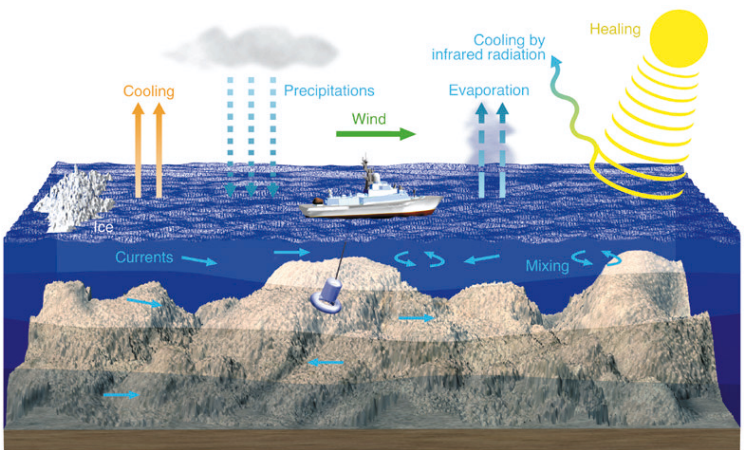
Areas of high and low atmospheric pressure are mirrored by hills and valleys in the ocean surface, where eddies, perturbations, and anticyclones form, creating cold and warm fronts.

Close to shore

Where sea meets shore, a third factor affecting exchanges between the ocean and the atmosphere comes into play. Coastal relief shapes the tides, waves and currents. Coastal areas are precisely where the largest concentrations of economic and ecological interests—and associated risks—are found. Today, predicting drift of pollutants, building suitably designed breakwaters and protecting the coastline are just some of the major challenges facing operational oceanography.



Forecasting swell helps to design breakwaters to reduce wave heights in harbours.



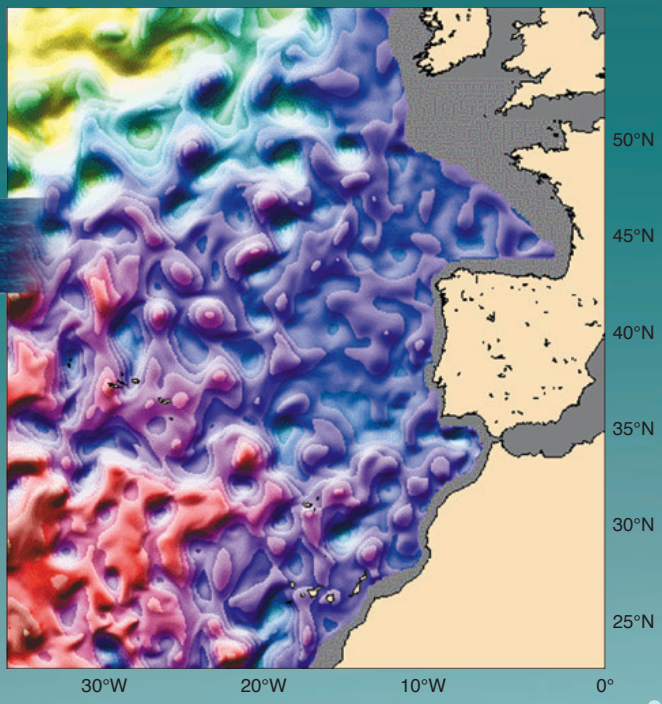
Ocean-atmosphere interactions

Climate shaped by water and air

Humankind has always sought to identify weather patterns for the seasons and years ahead. These patterns—drought or heavy rains, extreme cold or heat—shape our climate, which is strongly affected by ocean circulation. Ocean currents transport and distribute water from the Equator to the poles, after it has been warmed by the Sun in the Tropics.

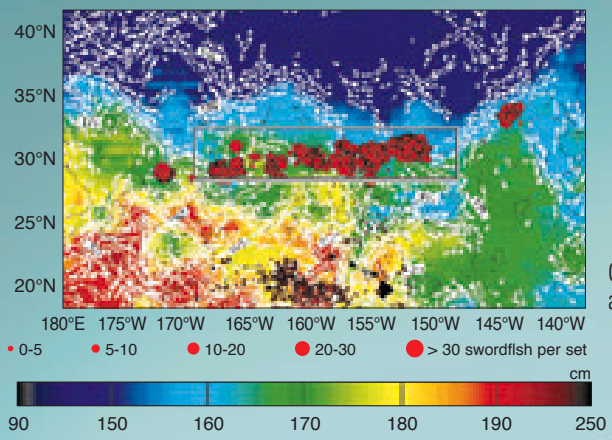
Operational oce

Eddies in the Northeast Atlantic (SOPRANE project, SHOM).



For sailors

Ocean current forecasts help sailors to choose the best route, thus saving them valuable time. Oceanographers also obtain useful information from current forecasts complemented by data on deep ocean circulation.



Correlation between ocean fronts and fish feeding grounds.

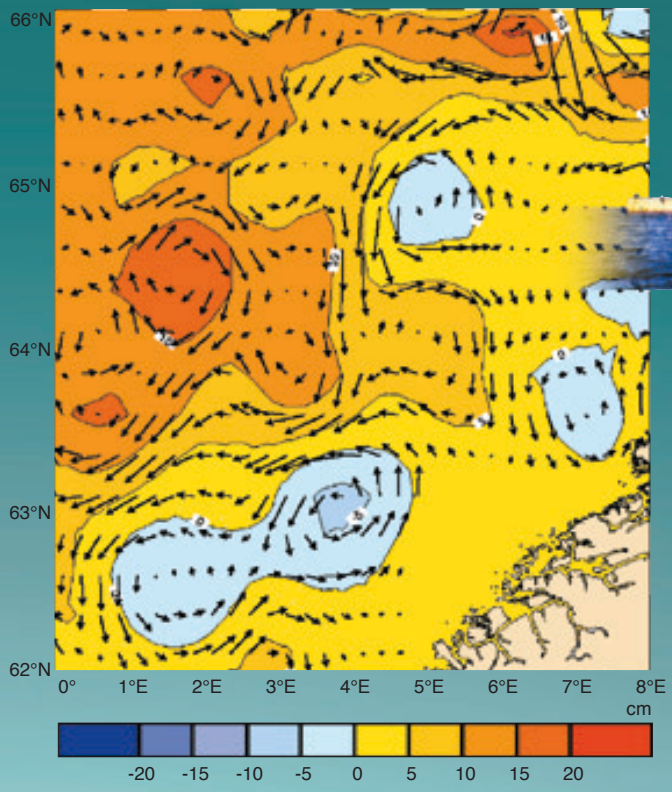
For better management of fish stocks

Fish move about, feed and reproduce in oceans that are themselves in perpetual motion. To understand and predict fish stocks, we need to improve our knowledge of the marine environment and anticipate how it is likely to evolve.

For climate prediction

Forecasting variations in ocean circulation is essential to predict climate patterns accurately, which can prove vital for human activities: depending on trends identified, farmers can decide which crops to plant and planners can locate where strengthening or irrigation work is needed. This kind of information takes on added importance in countries that suffer from the extreme effects of climatic phenomena such as El Niño.

anography for all



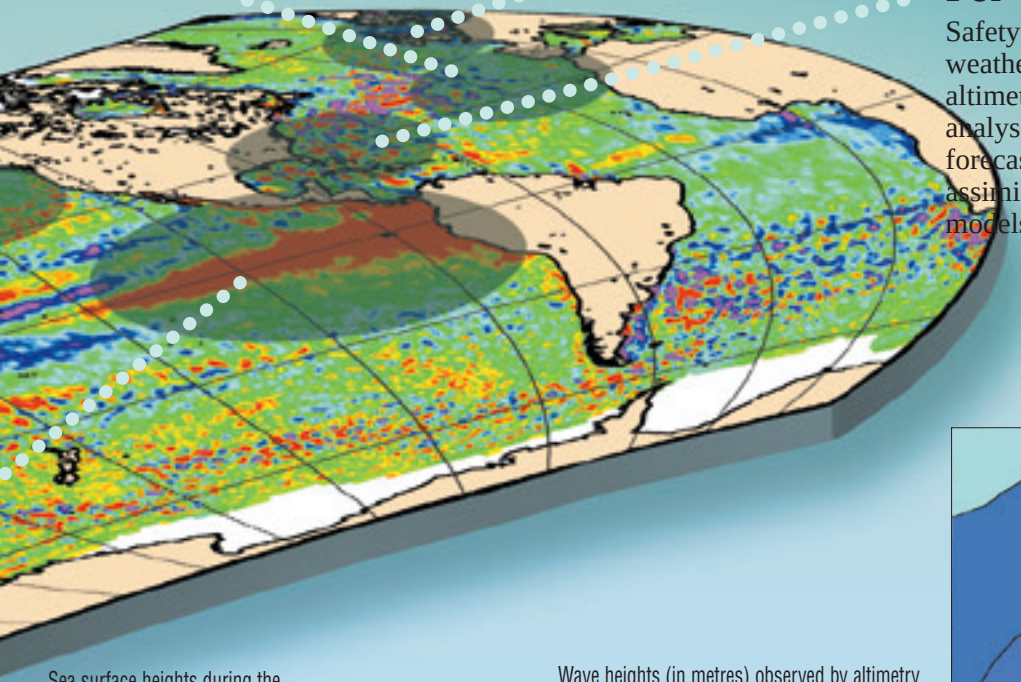
Eddies and currents in the Norwegian Sea (OPERALT project).

For offshore construction

A precise knowledge of ocean currents is vital when designing the structure of an offshore platform. Accurate forecasting is also a valuable aid in planning operations and maintenance, which require calm seas.

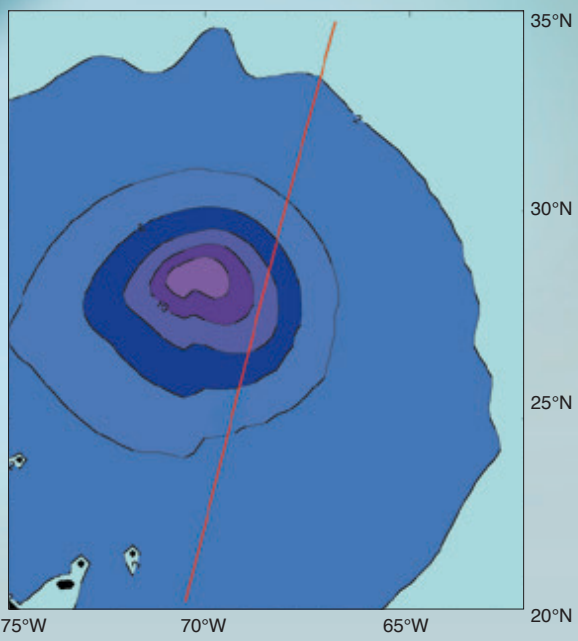
For marine meteorology

Safety at sea is highly dependent on weather conditions. Forecasters feed altimetry data into prediction models to analyse their performance and improve forecasting accuracy. Now, we are able to assimilate altimetry data directly into these models in real time.



Sea surface heights during the 1997-98 El Niño (DUACS project).

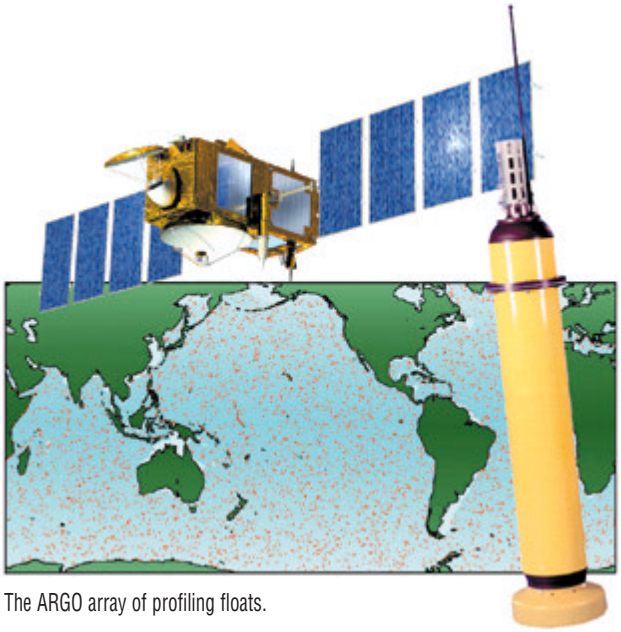
Wave heights (in metres) observed by altimetry during cyclone Opal (Météo-France).



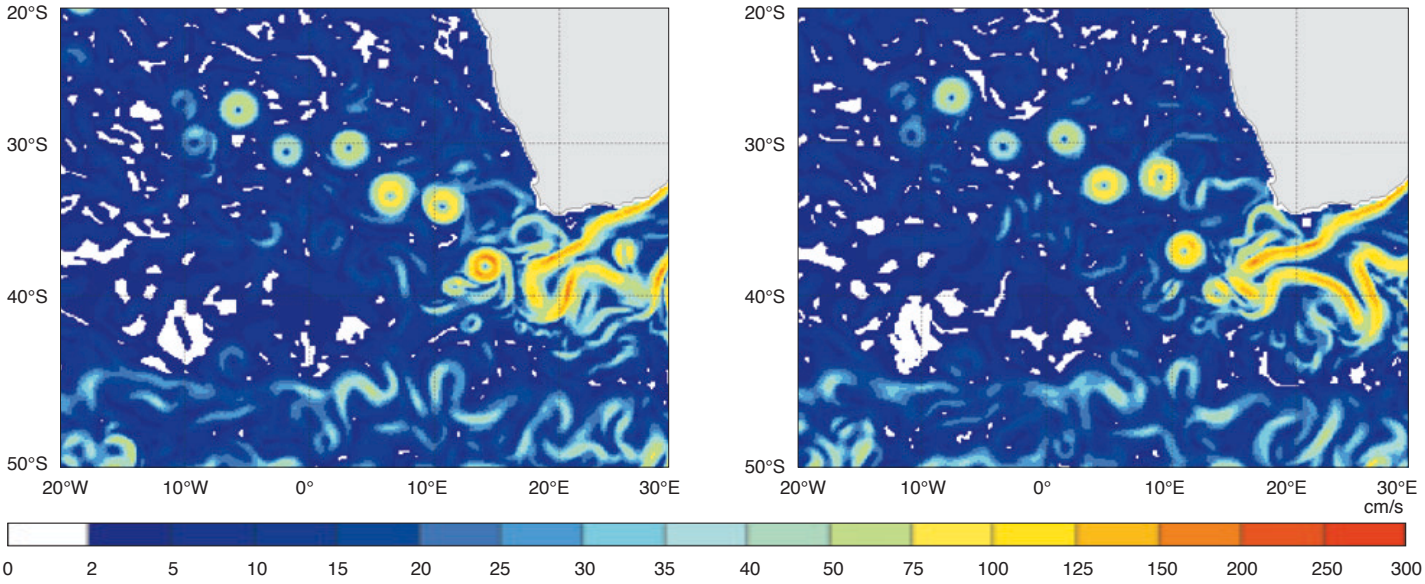
Observe, understand, predict

Observing the turbulent movements in the oceans and the atmosphere is essential for forecasters. Satellites provide a broad and continuous picture that is complemented by in situ data and assimilated in prediction models.

To make prediction models as reliable as possible, we have to assimilate a large volume of frequently updated measurements. Consequently, it is important to sustain satellite-based observation programmes capable of providing global data at regular intervals over periods of several years.

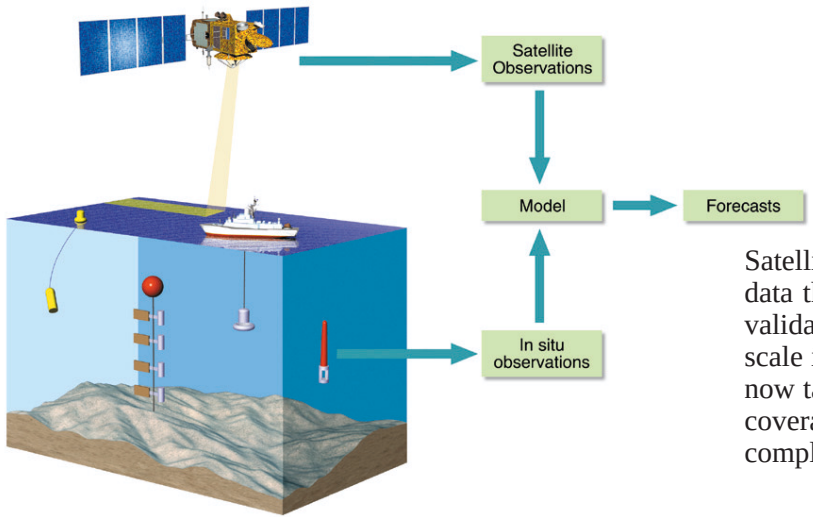


The ARGO array of profiling floats.



Eddies (output from model) in August and forecast for September (CLIPPER project).

Satellite altimetry is a precious aid for observing the oceans. Altimetric measurements of sea surface height mirror what is happening from the ocean floor to the surface, allowing us to chart ocean circulation and to determine wave heights and wind speed. Altimetry satellites such as Jason give us rapid access to the high-quality data needed for weather and ocean forecasting, and for climate prediction.



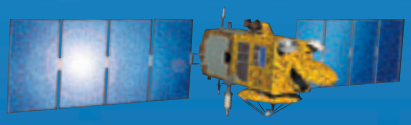
Satellite measurements are complemented by in situ data that enable us to plumb the ocean depths and validate and calibrate satellite instruments. Large-scale international programmes such as ARGOare now taking shape to provide the widest possible coverage of the oceans by in situ instruments, to complement spaceborne programmes.

International cooperation

Working towards operational oceanography

The international GODAE programme (Global Ocean Data Assimilation Experiment) is seeking to improve our understanding of ocean circulation and enhance our ability to predict it using combined data from satellites (Jason, ENVISAT), in-situ instruments (ARGO and CORIOLIS projects) and models.
The MERCATOR project, France's contribution to this effort, aims to set up a global ocean forecasting system. MERCATOR is capitalizing on the experience acquired from the SOAP and SOPRANE projects in the North Atlantic by SHOM, the French Navy's hydrography and oceanography department, and on the expertise of oceanographers. By 2005, this project will enable us to describe the global circulation at the sea surface and in the ocean depths, and to analyse and predict it from in-situ and spatial data. This operational forecasting system will produce regular ocean bulletins.
For MERCATOR and projects with similar ambitions led by other nations, GODAE will be the main focus of research activities in the coming years.

MERCATOR partners are: CERFACS, CLS, CNES, CNRS/INSU, IFREMER, IRD, Météo-France and SHOM.



For more information:

- AVISO/Altimetry: http://www-aviso.cnes.fr
- AVISO Vent/flux: http://www.meteo.fr:80/aviso/
- MERCATOR: http://www.mercator.com.fr
- SOAP/SOPRANE http://www.shom.fr/sci/cmo/cmo_tlse/activite/sopran_f.html

Sources:

ACRI, CERFACS, CLS, CNES, CNRS, IFREMER, IRD, Météo-France, NASA, NOAA, SHOM.

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