

PREVIMER – COASTAL OBSERVATIONS AND FORECASTS

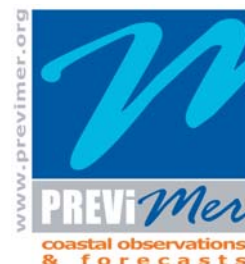
2 YEARS MAKING-UP AND FUTURE PERSPECTIVES

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Abstract

This paper presents the PREVIMER project which aims to provide a wide range and ever-growing number of coastal area users with observations, modelling tools and real-time forecasts, taking account of the statutory context.

PREVIMER is based on observations and coastal ocean modelling. The www.previmer.org website displays forecasts for the French coastline of current strength and direction, wave height and direction, sea levels, storm surges, temperature, salinity, nutrients and phytoplankton concentrations. These data and their analyses will provide essential information for coastal zone usage or management.

Cet article présente le projet PREVIMER qui a pour objectif de fournir les observations, les outils d'observation et de modélisation et les prévisions en temps réel nécessaires aux usagers des zones côtières, toujours de plus en plus nombreux, en tenant compte du contexte réglementaire.

Basé sur l'observation et la modélisation, le site Internet www.previmer.org offre pour les côtes françaises les prévisions sur la direction et l'intensité des courants, la hauteur, la fréquence et la direction des vagues, les niveaux de la mer, les surcotes/décotes, la température et la salinité, la concentration en nutriments et en phytoplancton. Ces données et les analyses rétrospectives vont devenir des outils essentiels pour la gestion et l'usage des zones côtières.

Keywords

PREVIMER, coastal observations, coastal forecasts, current, temperature, sea level, storm surge, waves, salinity, nutrients and phytoplankton concentration, MARS, data centre.

1. Introduction

As the majority of maritime activities are concentrated in coastal zones and along their shorelines, these environments are subject to increasing anthropogenic pressure.

This pressure makes it essential for us to know the state of the environment, as much for the security of activities and management of resources as for the handling of conflicts of interest that may arise, with the aim of achieving sustainable development.

The PREVIMER project was initiated in order to meet these needs. All the operational developments and their implementations are carried out in the framework of partnership agreements between public institutions (the French public institute for marine research (Ifremer), the French Naval Hydrographic and Oceanographic Service (SHOM), the French National Weather Service (Météo-France), the French public science and technology research institute (IRD), the European Institute of Marine Studies (IUEM)) and private companies (R&D departments, small to medium-sized companies manufacturing oceanographic instruments). The PREVIMER project is listed within the "Five-year plan drafted between the State and the region, i.e. Brittany, for 2000-2006" which will be renewed until 2012.

PREVIMER was set up as an **Operational Coastal Oceanographic Centre** with the **aim of providing observation data, modelling tools and real time forecasts** as required by the fast growing number of users working in coastal zones, with respect to the regulations in force.

The validation of modelling results or data assimilation, are supported by research laboratories (Ifremer, IRD and UBO). In addition, the Regional High Performance Computer System based on the powerful CAPARMOR supercomputer located at Ifremer's Brest Centre, is used for all modelling tasks and data processing.

PREVIMER aims to encourage the development of services, mainly oriented towards fulfilling the requirements of local authorities, institutions in charge of environmental management and diverse users of coastal zones.

PREVIMER's main objective is to produce routine analyses and forecasts on the marine environment's state in coastal zones on a range of scales (from continental shelf to bay) with a capacity for zooming-in on specific areas. Timescales include both hindcast analyses and short-term forecasts (from 48 hours to 6 days for waves, as delimited by detailed forecasts provided by the French National Weather Service (Météo-France) and the European Centre for Medium-Range Weather Forecasts).

2. Local pilot models and seafront models

The PREVIMER system is primarily based on demonstration sites that enable the concept to be validated over diverse geographical areas and on a variety of themes.

Each pilot model relies on implementing numerical models developed or improved by project partners.

One of the themes covers the physical aspects of the coastal ocean, i.e. forecasting **currents**, sea levels, storm surges and water temperature. One model covers the Bay of Biscay, zooming in on the Iroise Sea west of Brittany which features strong currents and a remarkable - and hard to model - temperature front. It was extended to the Channel in January 2008. The French North-western Mediterranean seafront is also covered, thanks to a complementary partnership with the Provence-Alps-Côte d'Azur regional council.

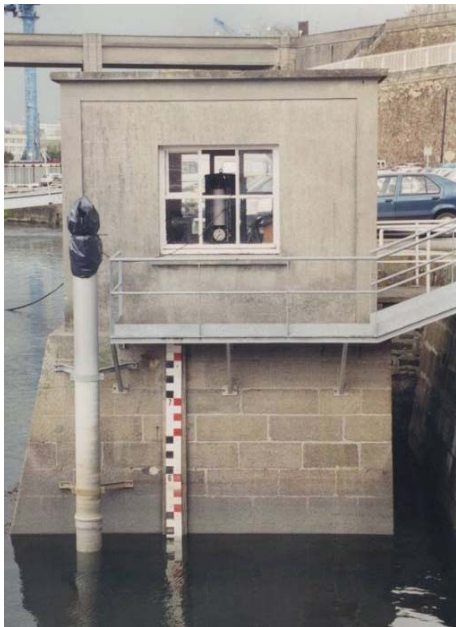


Figure 2: Automated processing of data from the SHOM's tide gauges provides real-time information for sea level and surge monitoring (photo © SHOM)

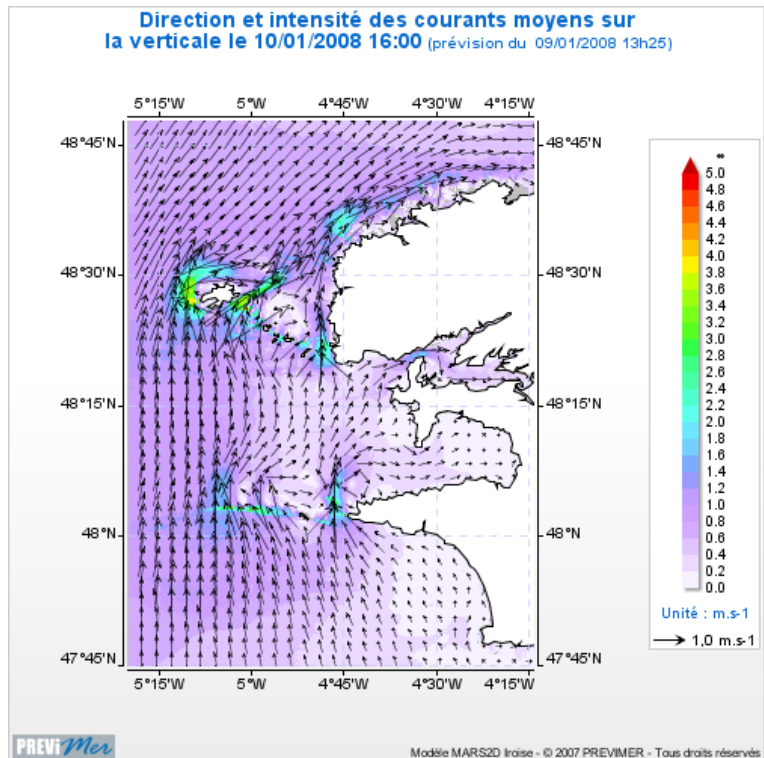


Figure 1: Current intensity in the Iroise Sea

PREVIMER also uses Météo-France data to assess **storm surges**. They are the difference between the true level and the predicted astronomical levels indicated in tide tables. These storm surges (which can be positive or negative) can reach 2m in places and become critical events for coastal zones.

The PREVIMER project has also contributed to developing the real-time processing string for SHOM tide gauge data, ensuring that tidal information (sea water level, positive or negative surges) from French tide gauges is constantly available. This helps foresee and prevent the impacts of sea level variations on shore. The data is also supplied via Internet streaming or as files on a server for use by surge and tsunami monitoring organisations.

The models also simulate the **temperature and salinity** of water masses, their vertical stratification, and their potential for mixing and thus dispersal or confinement. The latter factor is important for life forms in the area and for pollution tracking. All of these phenomena are guided by the tide, the weather and the impact of major river plumes. Fields produced by models are compared to in situ or satellite observations.

Modelling forecasts are based on the **MARS** (Model for Application at Regional Scale) code developed by Ifremer, whose resolution can reach 300m. The www.previmer.org website provides a detailed description of the physical phenomena and the numerical models employed [1].

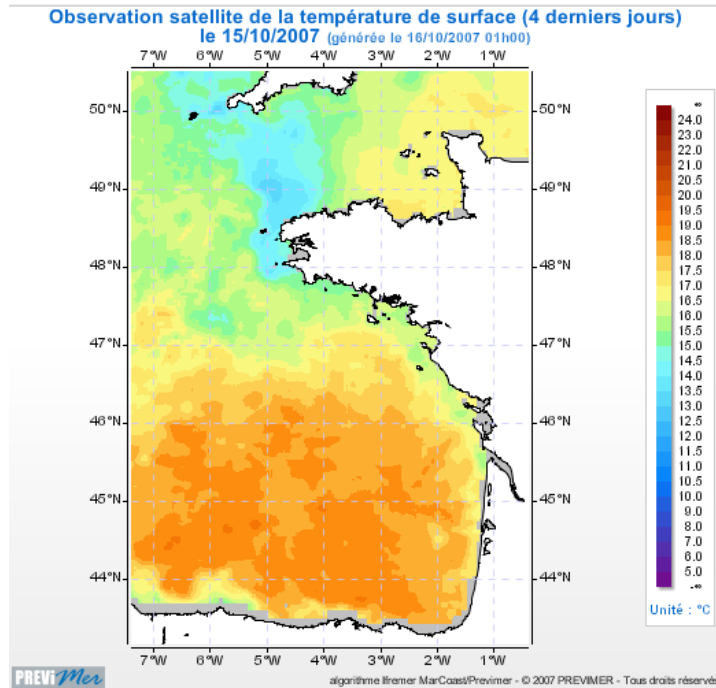


Figure 3: Temperatures observed in the Bay of Biscay, where the Ushant cold front can be clearly seen

The www.previmer.org site also contains **wave forecasts** calculated by SHOM, updated twice a day. Large-scale global forecasts are drawn up using wind predictions and ice-pack position observations made by the European Centre for Medium Range weather forecasts and supplied by Météo-France. The WAVEWATCH III code is used for these large-scale calculations. It was developed cooperatively between the US NOAA/NCEP service and the SHOM, as well as other partners. Two propagation codes are used for high resolution calculation of wave transformation in coastal zones: the REF-DIF version by Eloi Melo (University of Florianopolis, Brazil) and the CRESTp ray-tracing code developed at SHOM.

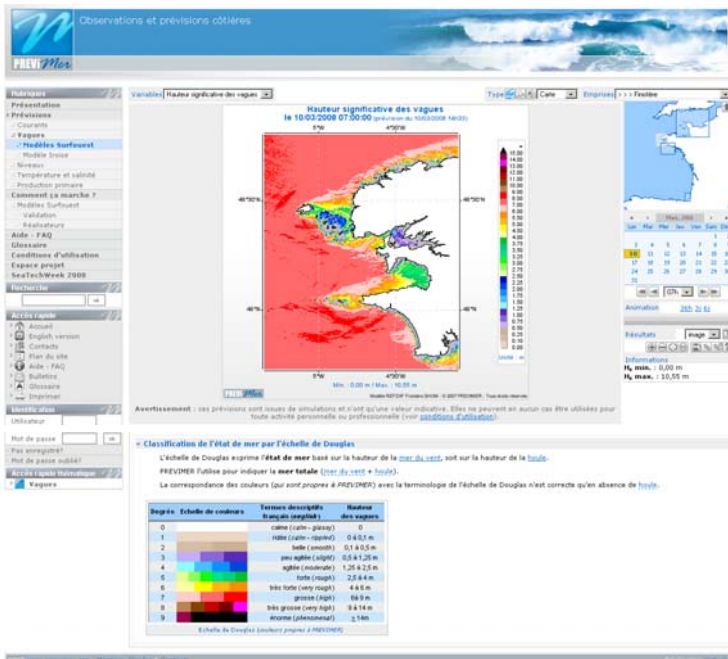


Figure 4: Wave forecast for the Finistère region during the 10 March 2008 storm. Each colour range corresponds to a sea state on the Douglas scale

Of course, this remains a very simplified model of the pelagic ecosystem which cannot hope to simulate the numerous and fleeting phytoplankton events shown by satellite images.

It is simply designed to reproduce some major trends and provide a dynamic explanation for them. Therefore, it must be used carefully at this stage, rather as a tool to help understand the phenomena. A description of how it works is found on the website [2].

Along with the forecasts, a monthly **analytical report** is supplied, explaining major events that may be exceptional or fall within seasonal trends.

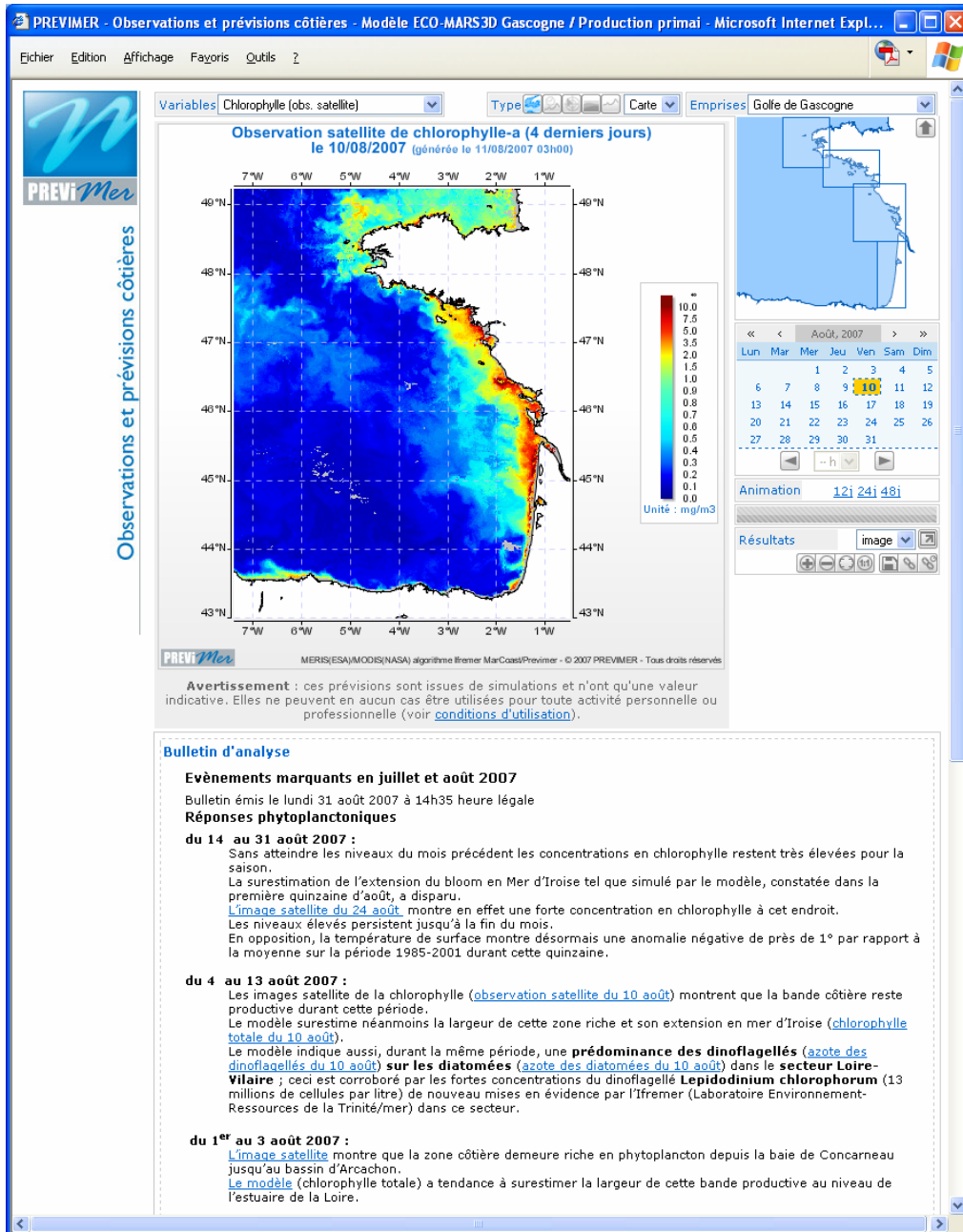


Figure 5: An example of the report analysing phytoplankton modelling

Other themes or geographical areas are **progressively being added** to the forecasts on-line at www.previmer.org. For instance, simulations of ocean circulation and offshore-lagoon exchanges in New Caledonia will be put on line in 2008, using the ROMS and MARS3D models and working in partnership with IRD. Primary production modelling (coastal phytoplankton and green ulva macro algae) in Brittany, with a resolution of 3 km, will also be available.

3. The technical resources needed

PREVIMER relies on Ifremer's computational cluster, linked to the coastal oceanography data centre which pools observations and stores the model outputs which are put on-line daily.

PREVIMER also helps perfect new observation facilities (buoys and autonomous vehicles for environmental measurements, shipboard probes, etc.) and render experimental systems operational.

One example of this is a buoy called MOLIT with a high-capacity instrument payload which was moored in the Bay of Vilaine in October 2007. It is specially streamlined for use in the open sea. It has sensors to measure nutrients and ammonium, as well as temperature, salinity, dissolved oxygen, chlorophyll and turbidity probes with whose data are transmitted to the data centre in real time. Near-bottom samples are pumped to the buoy through the umbilical which also moors it. This means that surface and bottom measurements are performed alternatively by the instrumentation and the system can act as a docking station for the testing of new sensors, analyzers, samplers or measurement protocols.

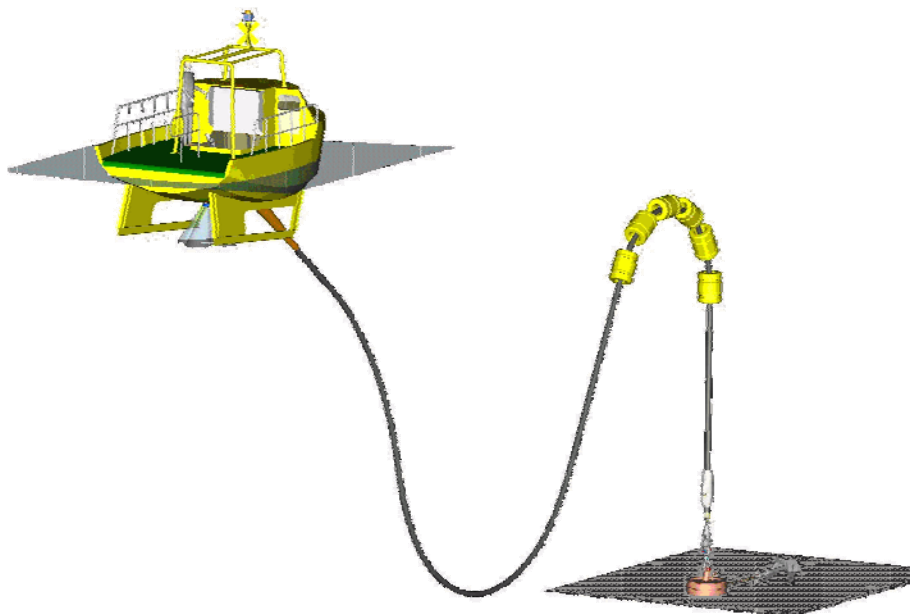


Figure 6: MOLIT buoy: station used to measure several bottom and surface parameters, deployed for PREVIMER in the Bay of Vilaine

4. Analyses and information available to everyone

The observations and forecasts are for everyone: the general public, professionals (shellfish farmers, fishermen, shipping and the offshore industry), coastal ocean managers (local authorities and administrations), scientists and environmental consultancies.

The methods used for measurements and the models needed to establish the forecasts are presented in the educational section of the web site.

Thanks to PREVIMER, these various users will progressively enjoy access to increasingly sophisticated information, either directly on the web site or through web-based services. This information will serve for recreational uses (bathing, diving, rock-pool fishing, water sports) as well as in improving maritime and naval safety, management of aquaculture areas, managing energy production systems, drawing up preliminary diagnoses for response in the case of an accident, managing the risk of exposure to accidental chemical or oil pollution or monitoring the environmental and health quality of coastal waters.

The outputs will also enable suspended particle transport in the marine environment (sediments, eggs and larvae, plankton, macro-algae, etc.) to be tracked. Thus they will help produce coastal climatology studies, and enable abnormal environmental events or situations which could be harmful for maritime economic sectors like fisheries or shellfish farming to be detected.

5. Conclusions and outlook

As the project unfolds, we will be able to deploy a more comprehensive strategy for more frequent observation of our coastal seas, with a greater spatial resolution. To this end, we are counting on improving measurement networks - measuring more parameters, especially for biology, and real-time transmission - as well as models incorporating data assimilation techniques, which will lead to confidence intervals for results which are exclusively deterministic today. By introducing retroactive sea-atmosphere, or hydrology-biology couplings, we will be able to represent processes not shown by currently-used models.

Therefore, the system's outputs will become more comprehensive and of higher quality, while remaining generic. Ensuring the lastingness of their production could grow a downstream commercial field, based on highly specialised services. A website that stays active and attentive to users' comments is also a guarantee for constant progress.

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