

An aerial photograph of a vast, deep blue ocean. The water is textured with small waves and a prominent white-capped wave in the foreground. A splash of white water is visible in the upper right quadrant. The horizon is visible in the distance under a pale, overcast sky.

Institute of Marine Sciences
Marine Technology Unit

Mediterranean Centre for Marine and Environmental Research

Spanish National Research Council

Institute of Marine Sciences Marine Technology Unit

Mediterranean Marine and Environmental Research Centre

Barcelona



CONSELL SUPERIOR
D'INVESTIGACIONS CIENTÍFIQUES
I TÈCNOLÒGIC DE LES ILLES BALEARS
CENTRE MEDITERRANIL D'INVESTIGACIONS
MARINES I AMBIENTALS

Mediterranean Marine and Environmental Research Centre

The Mediterranean Marine and Environmental Research Centre [*Centre Mediterrani d'Investigacions Marines i Ambientals*, CMIMA], which was opened in Barcelona in autumn 2001, belongs to the Spanish National Research Council [*Consejo Superior de Investigaciones Científicas*, CSIC]. The Center houses the Institute of Marine Sciences [*Institut de Ciències del Mar*, ICM] and the Marine Technology Unit [*Unitat de Tecnologia Marina*, UTM], for which it provides administrative, technical and maintenance support services.

The research carried out by the ICM and the UTM is aimed at furthering scientific knowledge of oceans and seas and determining their role in the context of the planet. As public institutions, the ICM and the UTM are also committed to communicating and disseminating the knowledge acquired through their activities.





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Institute of Marine Sciences

The Institute of Marine Sciences [*Institut de Ciències del Mar, ICM*] is dedicated to studying oceans and seas using an integral, interdisciplinary approach. The Institute's long experience and a team of over 200 specialists in different fields of oceanographic research (physics, chemistry, geology and biology) give the ICM a broad vision of the marine ecosystem, and the ability to assess changes and human impacts on the environment and seek appropriate solutions.

The ICM is constituted by four departments: Marine Biology and Oceanography, Marine Geology, Physical Oceanography and Renewable Marine Resources. The researchers of these departments take part in competitive national and international projects and in oceanographic surveys in almost all the seas and oceans of the world. The annual budget for these projects

is obtained from external sources such as the Spanish National Research Plans, the European Union, the Autonomous Communities, International Research Agencies, and agreements with public and private companies.

The Institut attracts researchers from all over the world. It receives a large number of students from different countries, many of whom develop doctoral theses and postdoctoral research under the supervision of ICM's researchers. It also organizes meetings, conferences and courses, promoting cooperation with other public and private institutions and organizations.

To facilitate the scientific work of its staff, the ICM also has various technical and support services, which are presented briefly below. Some of these services (Chemical Analysis, Coastal Ocean Observatory, Electron Microscopy, Biological and Geological Collections and Flow Cytometry) can be used by researchers from other institutions and by the general public (Library).

Finally, in conjunction with the CSIC's publications service, the ICM publishes *Scientia Marina*, the only scientific journal dedicated to oceanography that is published in Spain.



Deployment of the submersible JAGO to study the seabed life up to 500 metres depth.



Experiment to determine the effect of light on the metabolism of microorganisms, using bottles with different transparencies.



*The first home of the Fisheries Research Institute
in the Barceloneta district.*

A brief history of the Institute of Marine Sciences

- 1951** The *Instituto de Investigaciones Pesqueras* (IIP) was created on 3 October under the direction of Dr. Francisco García del Cid. It consisted of a group of laboratories distributed along the Spanish coast, with two main lines of marine research: marine biology and renewable marine resources.
- 1955** The scientific journal of the IIP was set up under the name *Investigación Pesquera* (now *Scientia Marina*).
- 1957** A new building was built for the Barcelona laboratory in the Barceloneta district: the ground floor was fitted out as aquarium open to the public, and the upper floors as research laboratories.

- 1977** The CSIC's first oceanographic vessel, *García del Cid*, was launched with the name of the first director of the IIP.
- 1979** The other laboratories became independent but the Barcelona laboratory kept the original name, the *Instituto de Investigaciones Pesqueras* (IIP).
- 1980-1985** The IIP extended its research lines with the creation of the departments of Physical Oceanography and Marine Geology.
- 1987** The old aquarium facilities were closed and the Institute changed its name to the *Institut de Ciències del Mar* (ICM).
- 1988** A group of scientists from the ICM set up the first Spanish Antarctic station, the Juan Carlos I (BAE JCI).
- 1990** The oceanographic vessel *Hespérides* was launched.
- 1994** The *Unidad de Gestión de Barcos Oceanográficos e Instalaciones Polares* (UGBOIP) was created to provide logistic support to Spanish maritime operations and to the Antarctic stations. It was located in the ICM building.
- 2001** A new building was inaugurated in the Olympic Village district of Barcelona and the *Centre Mediterrani d'Investigacions Marines i Ambientals* (CMIMA) was set up. The CMIMA comprises the *Institut de Ciències del Mar* and the *Unitat de Tecnologia Marina*, a remodeling of the former UGBOIP that added a research and development department to the existing services.
- 2011** The ICM celebrated its 60th anniversary.



The IIP's chemical laboratory.



Researchers working in the dissection laboratory.

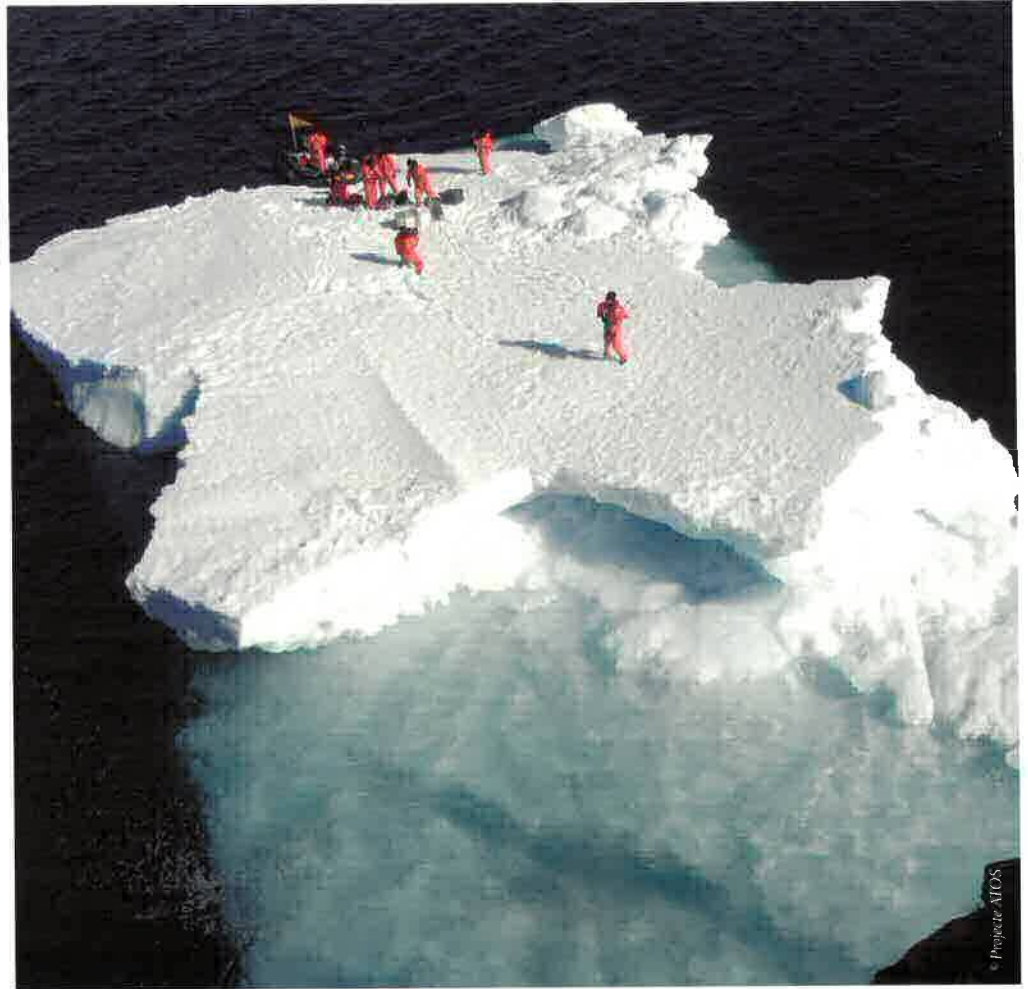


Research lines

Marine biogeochemical cycles

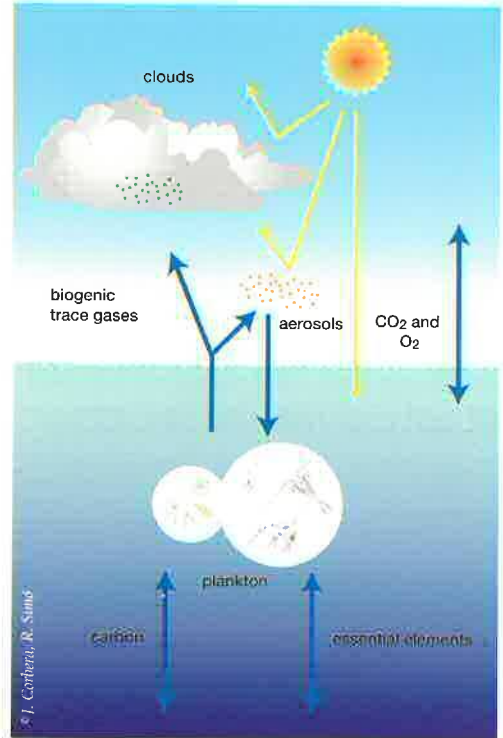
This research line deals with the role of oceans as transporters and processors of chemical elements that are essential to the functioning of the planet, such as carbon, nitrogen, phosphorus, oxygen, sulfur, silicon and iron. The aim is to determine how these elements, which are mobilized by natural and anthropogenic sources, are distributed and flow among the water masses, the seabed, particulate matter, living organisms, and the food webs of which these organisms form part.

Particular attention is paid to the processes that occur across the interfaces between compartments (water-particles, water-organisms, water-sediment, water-atmosphere), because this is where a large proportion of the flows of matter take place.

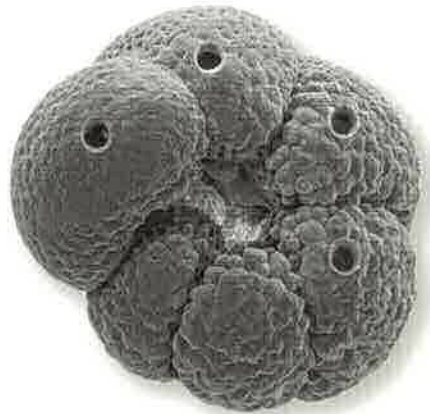




The environmental conditions of the past are also studied through the geochemical “footprints” stored in the seabed. The ultimate aim is to determine the role of the marine biosphere, today and yesterday, in the biogeochemical and climatic cycles of the oceans and the Earth, and to document—or even predict—the effects of global change on life in the oceans.



Solar radiation modulates the physiology and activity of plankton. In turn, the metabolism of planktonic organisms affects the Earth's climate.



A planktonic foraminifer: this electron microscope image shows the holes made during the laser analysis of the shell.

© E. Celino / ICM

Science for the conservation of natural marine resources

This research line aims to provide the basic scientific knowledge necessary for the conservation and sustainable management of the marine environment and its natural resources. It therefore assesses the vulnerability of coastal areas and deep-sea ecosystems to human activities (fishing, trawling, pollution and changes in coastal and deep-sea morphology) and their modulation by natural factors.

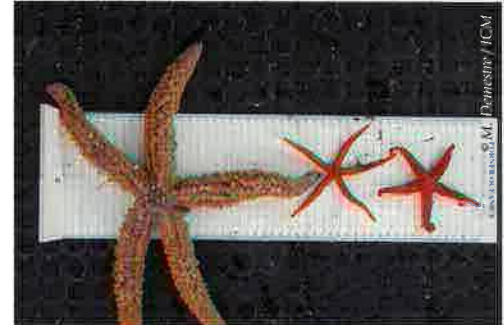
It also studies the potential of Marine Protected Areas as essential habitats for breeding and protection of endangered species.



© D. Castañero / ICM



*Larvae of the squid *Illex coindetii* obtained by fertilization in the laboratory.*



Measurement and classification of starfish taken from the sea bottom with experimental fishing techniques.

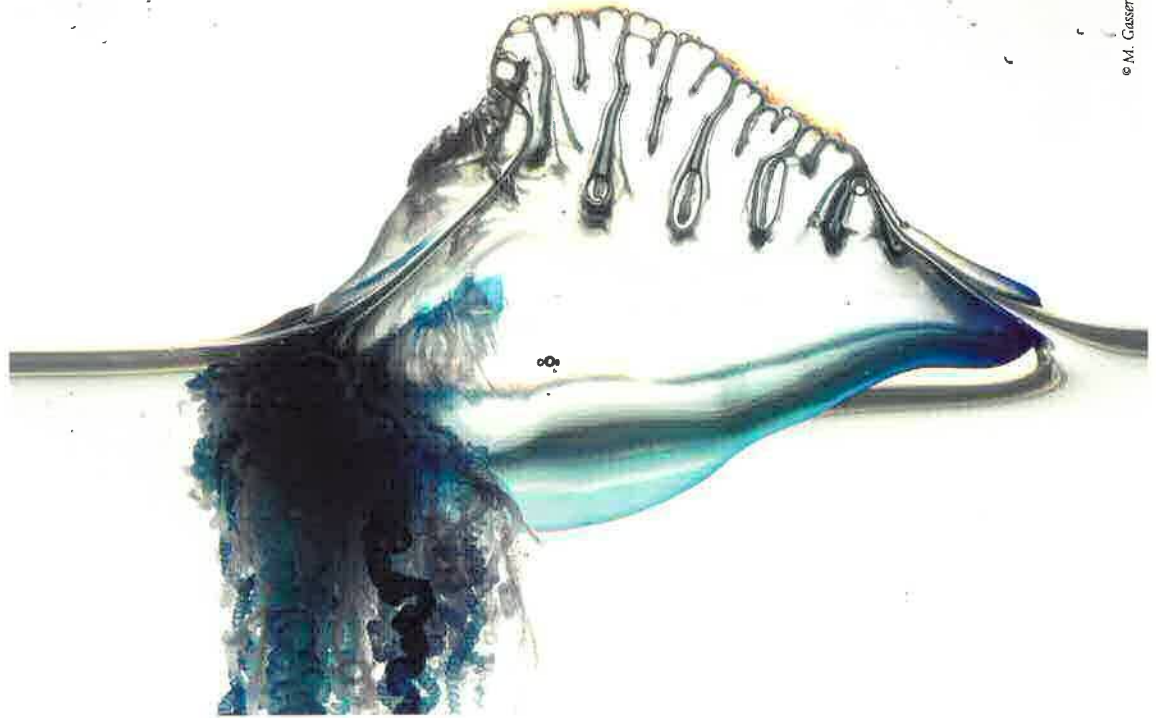
The research is aimed at improving basic knowledge of exploited species ecology and determining the interactions between the components of food webs.

In order to assess changes in biodiversity and the exploitation of living resources, research is also aimed at identifying indicators of ecosystem impact and developing and applying models using bioeconomic and ecosystem approaches.

Finally, the development of new biotechnological applications is studied in order to move towards an ecologically sustainable and profitable aquaculture.

A Longhurst Hardy Plankton Recorder: a device with two fishing nets for collecting plankton of different sizes simultaneously at different depths.





Structure and dynamics of marine ecosystems

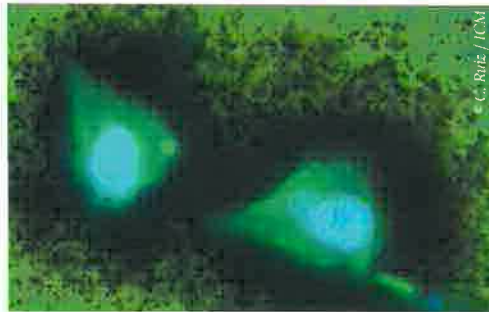
The objective of this research line is to understand the processes that occur in the marine environment and their variability. This will allow to detect the most significant natural changes and to assess their possible implications in the global change.



Gorgonian mortality in the Mediterranean, one of the consequences of climate change.



Centropages violaceus, a marine copepod. Scientists are studying its role in the ecosystem within the food webs.

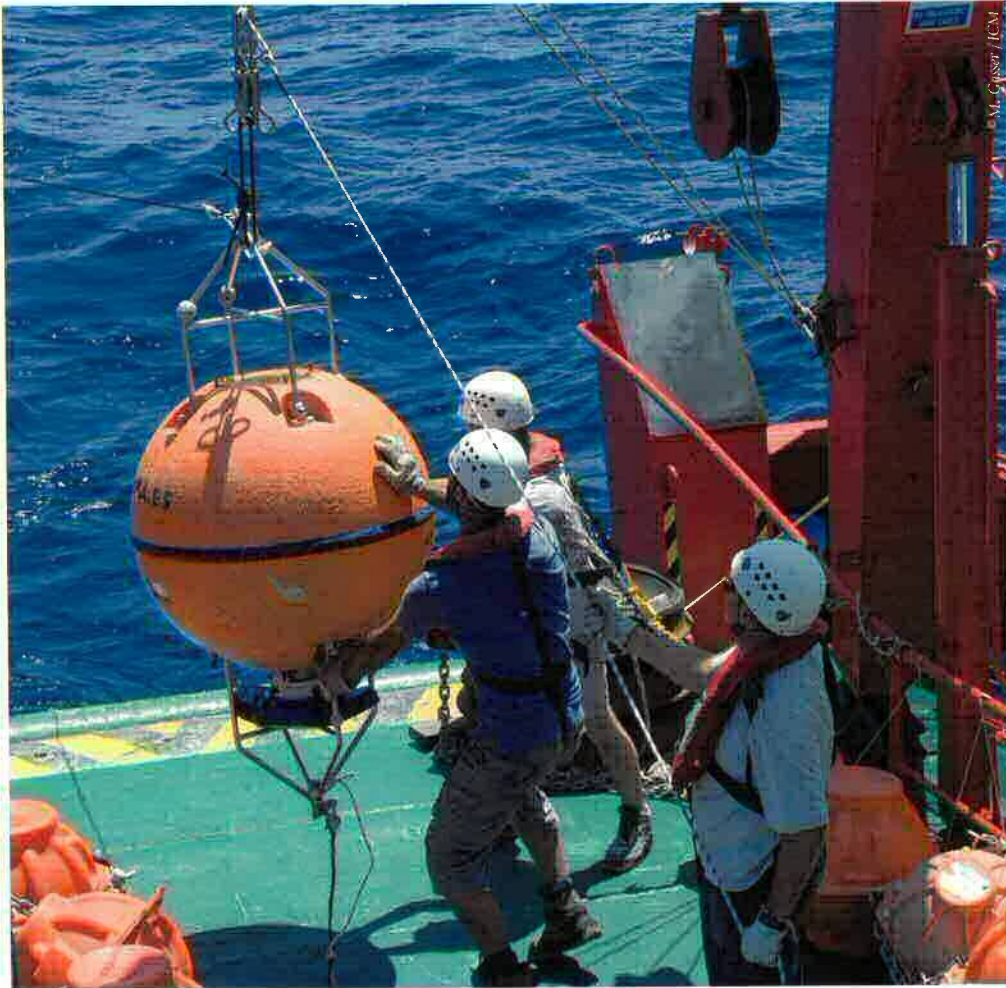


New methods that combine microscopy with autoradiography techniques for studying the feeding of marine organisms.

The research aims to determine the main feedback mechanisms between environmental forcings (climate, UV radiation, hydrodynamics, etc.) and biological processes (reproduction, life cycles, food chains, benthos-plankton coupling) in order to quantify the productivity, diversity and stability of the ecosystems.

The investigations analyze the relationships of the microbial and zooplankton components with the marine biogeochemical cycles, in order to assess their ability to respond and to establish what are called “points of no return”.

The studied processes occur at spatio-temporal scales ranging from hours and a few meters to tens of years and hundreds of kilometers and can be modulated by global climate forcings.

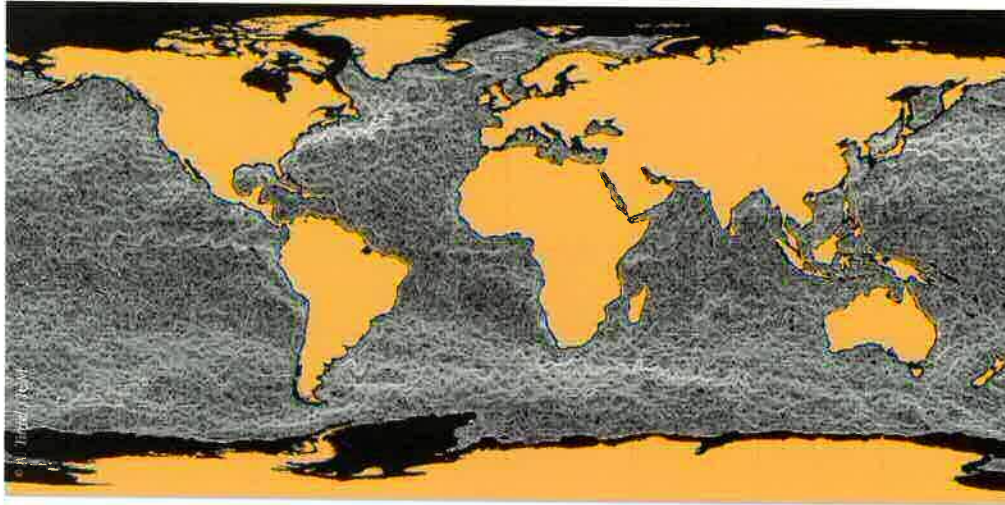


Physics of the ocean and climate

The aim of this research line is to describe and explain the physical behavior of the ocean and its role in the Earth's climate, using the principles of fluid mechanics and thermodynamics.

Variations in temperature and salinity and in the density patterns in the oceans are observed and analyzed in order to develop models to explain the dynamic interaction between climate forcing and the state of the ocean.

Studies of water movement (waves and currents), the transfer of energy and momentum between the ocean and the atmosphere, and the special properties of sea water (such as the propagation of electromagnetic energy) are used to improve knowledge of the physical processes of the ocean, ranging from its microstructure to global-scale climatic events such as *El Niño* and the North Atlantic Oscillation.

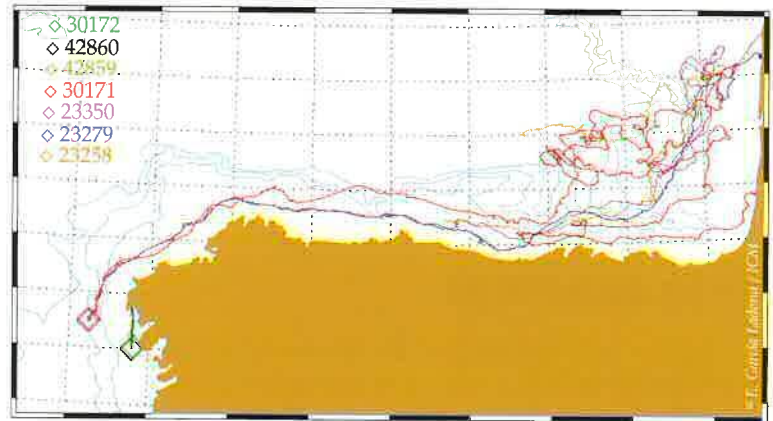


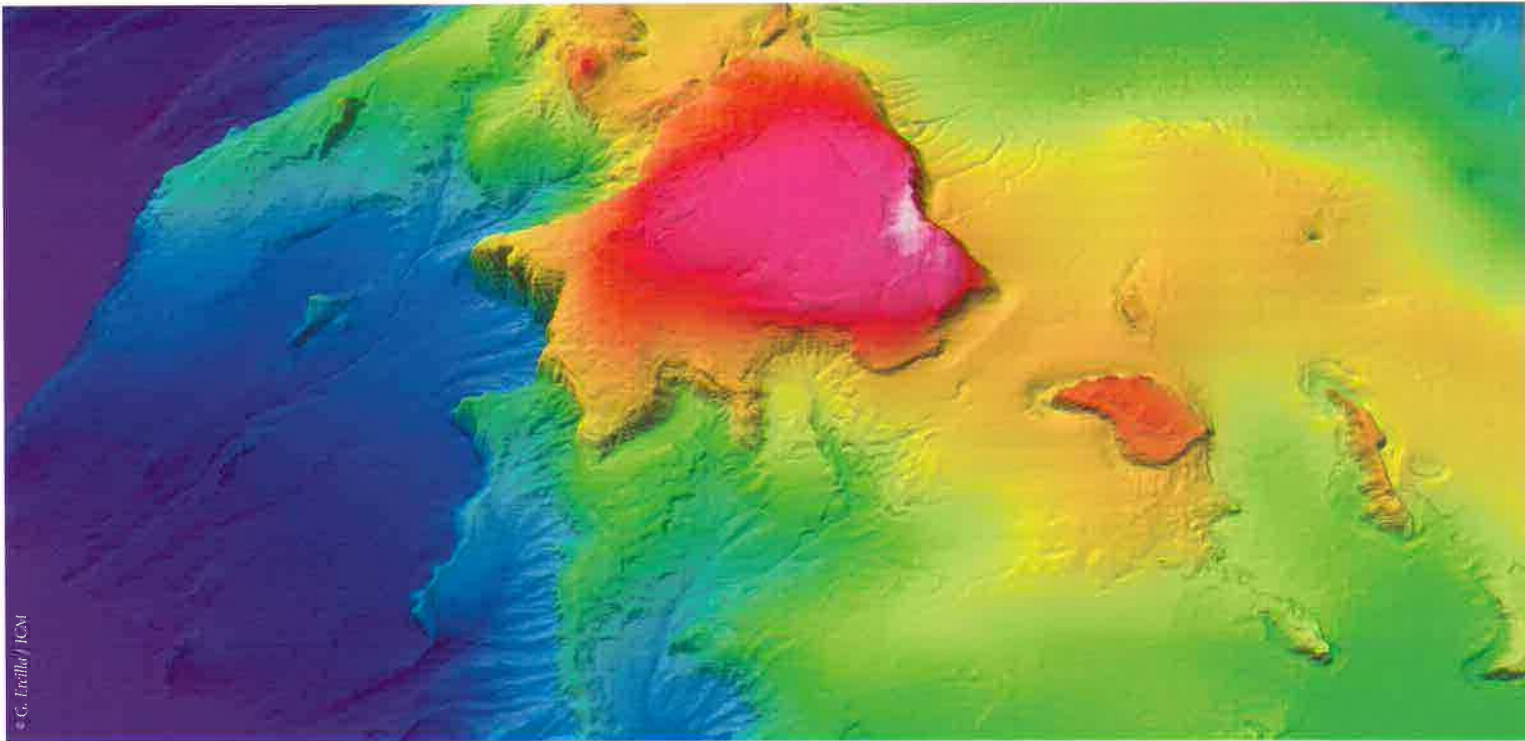
This line also includes technical analyses of oceanic data obtained from space, especially data on surface salinity, measured since 2009 by the European Space Agency's SMOS satellite. Finally, it deals with the design of oceanographic instrumentation and the development of advanced numerical models for studying various aspects of ocean dynamics.

The structure of ocean currents obtained through the application of singularity analysis to a satellite image.



Lagrangian trajectories of buoys in an experiment to track surface currents in the area affected by the Prestige spill.





Marine geosciences

This research line studies the geomorphology, sediment dynamics, geochemical fluxes, stratigraphy and tectonics of coastal regions, continental margins and ocean basins at all spatial and temporal scales.

This research includes the analysis of present-day sedimentary processes in response to natural and anthropogenic phenomena, the study of stratigraphy and the processes that gave rise to ancient deposits in different climatic conditions, the study of the morphology and structure of the seabed, and the assessment of geological hazards in coastal zones, continental margins and basins.

It also includes the development and design of new strategies and methods for studying sediment dynamics, for studying the structure and physical and mechanical properties of the seabed, and for visualizing geological and geophysical data.

In order to improve the general management of the seabed, some applications of this research line address issues such as the vulnerability of coasts, marine pollution, coastal and offshore facilities, oil and gas exploration, geological hazards, climate change and associated changes in sea level.



Benthic tripod for the monitoring of sediment transport near the sea bottom.



Taking aboard the multicore, a device used to study sediments and particle fluxes.

Monitoring the morphodynamic evolution of beaches in Barcelona.

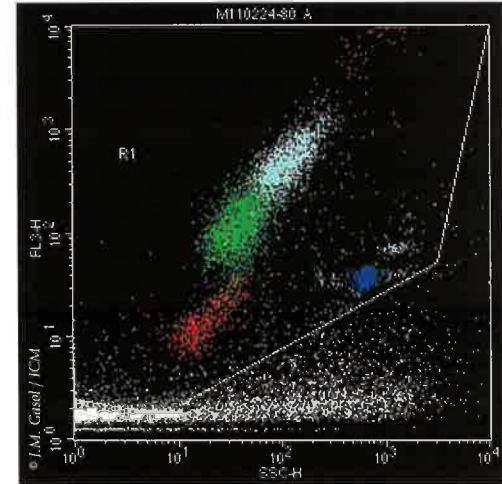


Research support services



Chemical analysis

This service carries out routine determinations in chemical oceanography and water quality control, mainly dealing with inorganic nutrients, dissolved organic carbon, and total nitrogen and phosphorus.



Flow cytometry

Flow cytometry is used to detect and enumerate viruses, bacteria and small phototrophic and non-phototrophic protists in marine and freshwater environments. It is also used to analyze the viability of organisms with fluorescent physiological probes and to separate populations that have previously been labelled radioactively. In the last ten years it has been used to analyze over 60,000 samples of aquatic environments worldwide.



© M. Grasser / ICM

Biological reference collections

These collections contain more than 1800 species of fish, crustaceans and cephalopods from all over the world and are a reference for taxonomic and faunistic studies. Queries on all the inventoried species can be made on site or via the internet.

Geological collections

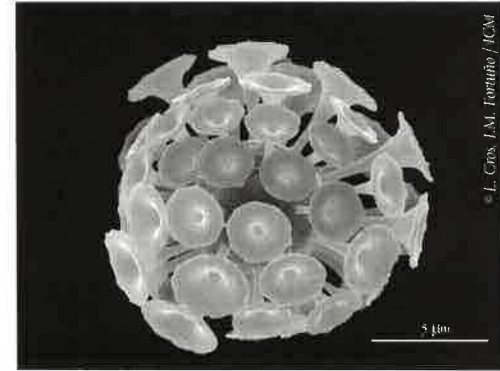
These include the Collection of Seismic Reflection Profiles obtained over a period of more than 20 years through various systems (sediment profilers, side-scan sonar, etc.) and the Collection of Marine Sediment Cores, with samples from continental margins and basins surrounding the Iberian peninsula and island areas, and from areas of Antarctica, the Atlantic and the Pacific.



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Electron microscopy

The ICM has two scanning electron microscopes, a conventional one (SEM) and a variable pressure one (VPSEM). Both are equipped with backscattered and secondary electron detectors. The VPSEM has an energy-dispersive detector for performing X-ray microanalysis and a cryo-SEM for studying cryofixed samples. The laboratory also contains the equipment necessary for sample preparation.



Instrumentation

This service advises the research groups on the acquisition and installation of oceanographic instruments, and participates in their design or construction. In addition, it maintains the existing equipment and calibrates the oceanographic measuring instruments using the Experimentation and Calibration Tank with 70,000 liters of seawater.

Coastal Marine Observatory

This facility is dedicated to the acquisition, management and real-time display of time series of oceanographic parameters. The scientific instruments of the observatory include current meters (speed and direction), temperature, salinity, turbulence and pressure sensors, a EUMETCast receiving station in collaboration with the UTM, two video-monitoring stations, a weather station and a small boat.



Area of Aquariums and Experimental Chambers (ZAE)

One of the most modern facilities in the Mediterranean region, this area is designed to hold various types of aquatic organisms and to facilitate research in different aspects of their biology. It occupies an area of 650 m² and consists of a machine room, several rooms with aquariums, eleven thermoregulated chambers, wet and dry laboratories. The water is obtained from an underwater intake at 300 meters from the coast and 10 meters depth.

A storage tank of 7000 liters can be used to work with water from other areas. The facility is computer-controlled and monitored 24 hours a day by a system of sensors connected to alarms. The Mediterranean water can be customized to different treatments of filtration, temperature and salinity and can be supplied to 150 aquariums with capacities of 15 to 5000 liters. The controllable environmental variables are light intensity and photoperiod, dissolved oxygen and nutrients. This area makes possible to simulate a wide range of



aquatic environmental conditions from subpolar to tropical habitats.



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Communication and documentation services

Outreach Area

The Area organizes activities addressed to adults and children, such as Open Days and the World Ocean Day. It prepares travelling exhibitions and educational material for schools, and works as a connection between scientists and the press. It also maintains a web portal aimed at the general public, ICMDivulga, which offers information on research projects carried out at the ICM, the oceanographic cruises in which its researchers take part, the latest results of the scientific work and the dissemination activities carried out by the Institute.



Library

The Library is open to the public and forms part of the CSIC's library network. It houses one of the largest collections of scientific literature on oceanography and marine sciences in Spain, with a deposit of about 8300 books and 1800 journals, 500 of which are current subscriptions. It also offers access to 9000 electronic journals.

Scientia Marina journal

The ICM, together with the CSIC Publications Service, publishes the international journal *Scientia Marina*, which is dedicated to marine sciences and oceanography. It was first published in 1955 under the name *Investigación Pesquera*.

It publishes original papers on marine research and monographs on the following areas: physical and chemical oceanography, geology, biology and ecology, engineering, coastal management and fisheries. The volumes are also available online. Of all the journals that are published in Spain, *Scientia Marina* is one of the few that is listed in the Science Citation Index.







Marine Technology Unit

The Marine Technology Unit [Unitat de Tecnologia Marina, UTM] was created in 2000 within the Natural Resources Division of the Spanish National Research Council (CSIC), after a reorganization of a previous national marine service (UGBOIP, 1994), to meet the increasing needs and challenges of the Marine Science, and as a long-term commitment in marine and polar research technologies. The main mission is to provide to the National Large Scale Marine and Polar Infrastructures belonging to the Spanish Government, the logistic and technological assistance necessary for the marine and polar research within the National R+D Plan, European Projects, and other International projects.

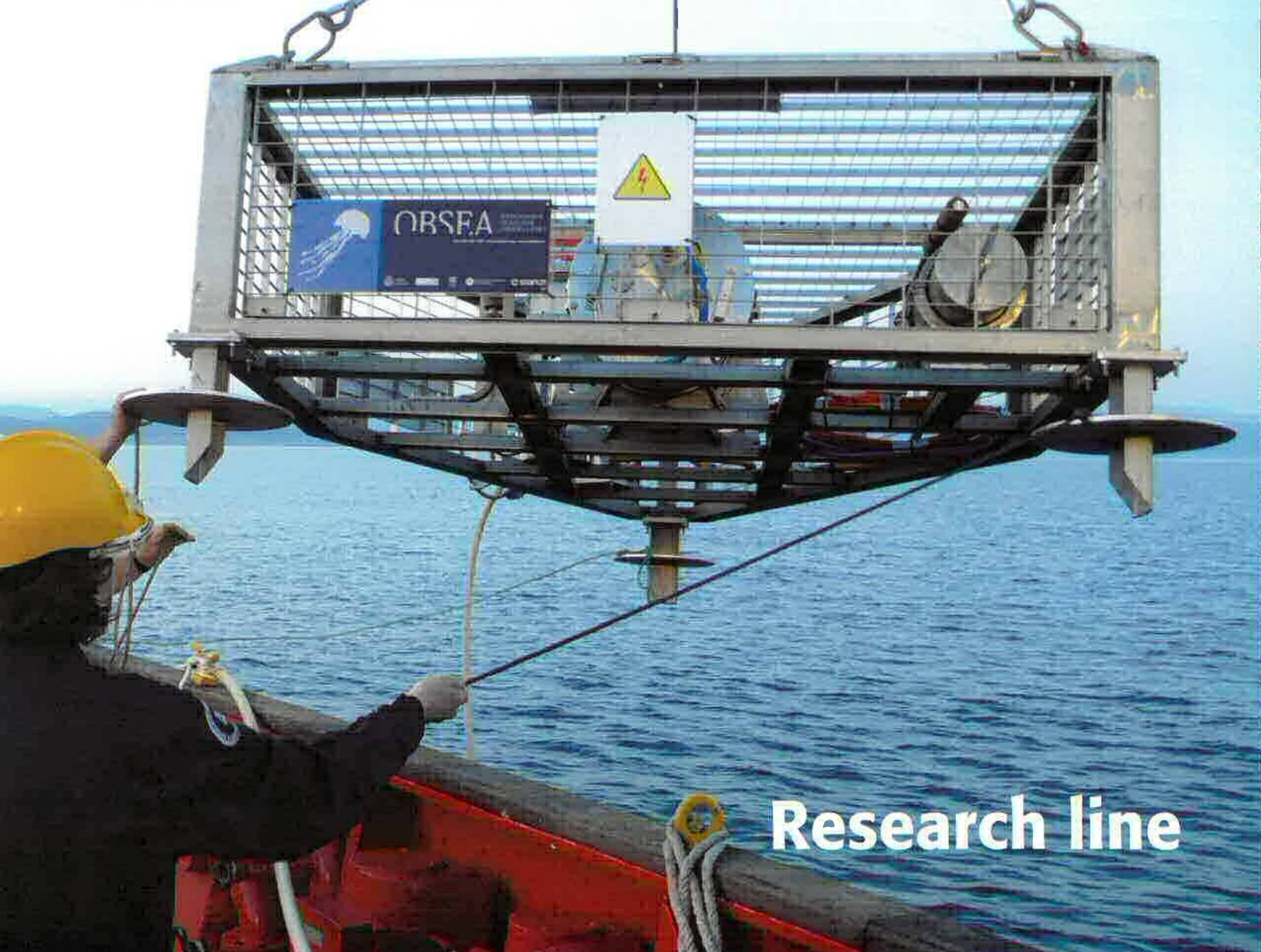
Currently, under the responsibility of the UTM a team of over 74 people deal with the technical management of laboratories dedicated to marine and polar sciences, such as the Oceanographic Research Vessels (ORV) *Hespérides* (global), *Sarmiento de Gamboa* (oceanic), and *García del Cid* (regional), and the Spanish Antarctic Station Juan Carlos I (BAE JCI). The first two vessels are marine infrastructures working for 24 hours a day during 300 days, that together with the BAE JCI are among the Large National Scale Facilities (ICTS). Providing support to these large-scale facilities involves the maintenance, calibration and handling of scientific instruments, technical assistance and systematic acquisition of data during oceanographic and polar campaigns. Furthermore, the UTM research department is involved in technological development in collaboration with other CSIC institutes, public institutions and universities.

To support these infrastructures, UTM has an office in the Atlantic, in Vigo, for the crew management, repairs and maintenance of the ORVs *Sarmiento de Gamboa* and *García del Cid*, and a warehouse in Porriño, with more than 1000 m² of modern and well equipped premises for the storage, long-term maintenance, and control of heavy equipment. Moreover, it also has a large store, in the Mediterranean, in Cartagena, for supplying the ORV *Hespérides* and the BAE JCI.

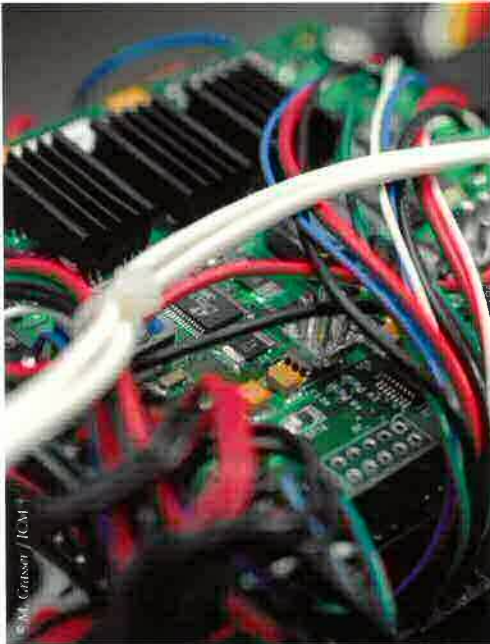
The UTM's technicians provide technical and logistical support to the scientific projects carried out at the BAE JCI during the austral summer season, from mid-November to early March. They also ensure the functioning of all the BAE's services after the nine-month austral winter, while it is closed, and of the systems of long term monitoring data recording, which work throughout the whole year.



A radiometer is released from the Hespérides.



Research line



Research and development in new marine technologies

The overall objective of this line is the research on new observation technologies to improve the capability to extract information from the marine environment, either by estimating new parameters or improving the quality of the measurement. The research line covers a broad spectrum of applications, including the design of new data analysis methods and new sensors, improvements in data transmission and storage, the incorporation of instruments on measurement platforms such as research vessels, buoys, remotely operated underwater vehicles (ROVs), autonomous underwater vehicles (AUVs), airborne systems and satellites, and the emerging field of cabled and autonomous submarine laboratories.

The research and development department focuses on knowledge and lead to the formation of marine researchers and technicians to improve the understanding of the marine environment and to progress in the sustainable development of oceans and coastal areas, fulfilling the observation requirements to implement new technologies in various marine disciplines. It includes three main sub lines of R+D: Technological innovation related to research in marine geology and geophysics, Advanced remote sensing technologies applied to physical oceanography, Development of new information and communication technologies to meet the needs of biological oceanography and marine biology.

Oceanographic Research Vessels





ORV *Sarmiento de Gamboa*

The ORV *Sarmiento de Gamboa*, launched in 2007, is fully managed by the UTM. She has the latest technology in navigation systems, dynamic positioning, propulsion systems with low radiated noise, a retractable double keel, and capacity to maneuver any type of unmanned underwater vehicles (ROVs, AUVs, etc.).

The characteristics that make the *Sarmiento de Gamboa* a unique ship include a retractable double keel and an acoustic gondola. The design and location of the keel give the ship greater flexibility to work and allow to avoid acoustic perturbations. Sensors are installed in the keel to estimate biomass, determine ocean currents and positioning ROVs. The acoustic gondola, located on the bow and under the hull, has high-resolution oceanographic and acoustic sensors for mapping the seabed.

The main areas of the ship include more than 450 m² dedicated to laboratories and sundry facilities, and about 150 m² for general use by the crew and scientists in their free time. In addition to the main laboratory, the vessel has different laboratories (thermo-regulated, analysis, chemical, fishing, dissection and wet). The facilities include a control center for the electronic equipment, a hangar for operations with the current-temperature-depth (CTD) profiler, a room for the gravimeter and reference units, cold stores at -20 and 4 °C, a pre-freezing chamber, a fish pen park and a hold.

The zones for general use consist of a meeting room, a processing room and a leisure area containing the TV rooms and library.

Also noteworthy are the anti-heeling tanks with automatic correction to keep the ship on an even keel at all times, offering greater comfort to the crew.





ORV *Hespérides*

The ORV *Hespérides*, launched in 1990 and delivered to the Spanish Navy in 1991, was built to carry out Spanish polar research. In the last 20 years, the *Hespérides* has conducted hundreds of oceanographic campaigns in different seas (Antarctic, North and South Atlantic, Eastern Pacific and Mediterranean). Each year she has been used for scientific studies in the southern hemisphere, mostly in Antarctic regions, and in 2007, actively participated in the 4th International Polar Year, conducting its first research studies in the Arctic region. The ship's spaces are distributed on different levels or decks. The work deck, of 280 m², was designed to take into account the multidisciplinary research and to facilitate campaigns in remote areas. The ship is provided with modern acoustic sensors, a multibeam echosounder system for mapping the ocean floor and an acoustic profiler for sub bottom imaging. She has eleven wet and dry laboratories with a total size of 345 m². These laboratories allow research in physics, chemistry, ecology, biology, meteorology and marine geosciences.

ORV *García del Cid*

The ORV *García del Cid* belongs to the CSIC and was built in Tarragona in 1977. It is based in the port of Barcelona and is wholly managed by the UTM. Since launched, she has conducted over 300 oceanographic campaigns in the Mediterranean and the eastern Atlantic, which means more than 3000 days of oceanographic research at sea. The ORV *García del Cid* was originally designed to work in oceanography, and especially in fisheries, so it was fitted out with the necessary equipment to work with bottom, pelagic and semi-pelagic trawling gear. In the 1980s she was modified: a folding crane was installed, the laboratory was extended and the two fishing winches were replaced with a single one. In recent years, its facilities and equipment have continued to be updated in line with the research.



The Spanish Antarctic Station





© Fons UTM

The Spanish Antarctic Station Juan Carlos I (BAE JCI) is located on Hurd Peninsula at the Livingston Island in the South Shetland archipelago.

The BAE JCI was opened during the 1987-88 campaign, a year after four CSIC scientists set up the first Spanish camp in Antarctica. It was originally limited to a scientific laboratory and a small dining room built in isothermic containers isolated from the soil with cement blocks. In 1989, a wooden porch was added as a meeting place for the expedition members, and a permanent shelter was added for storing materials and instrumentation at 100 m altitude

at the foot of the glacier. Though the first structure housed only 12 people, modules and igloos added later have increased the capacity to 22 scientists and technicians.

Since its foundation, the BAE JCI has paid special attention to ensuring the protection of the environment, following the Protocol on Environmental Protection to the Antarctic Treaty (1991). This protocol establishes basic principles applicable to human activities in Antarctica, prohibiting activities related to mineral resources unless they have scientific purposes. It also recognizes Antarctica officially as a “natural reserve, devoted to peace and science”.

Thus, for actions and research projects to be carried out at the station, a prior environmental impact study must be submitted, in accordance with Spanish legislation and the recommendations of the Antarctic Treaty. Since the starting of research activities, the BAE JCI incorporates clean an alternative energy using different systems based on wind and solar systems. It has several wind turbines and a solar



New accommodation module in the Spanish Antarctic Station Juan Carlos I.

Inauguration of the first scientific laboratory of the station in 1987.



panels to ensure the energy needed to keep track of various sensors during the long winter.

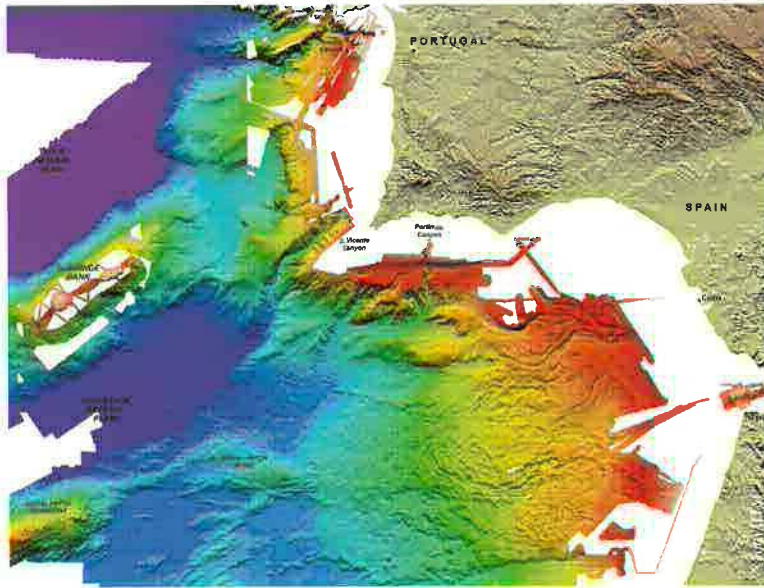
The BAE JCI is currently being remodeled, using modern construction materials that minimize the maintenance and increase the efficiency of the station. The new station will be a up-to-date facility with a capacity for 45 people and 9 buildings divided into three areas: Accommodation, Science and Services. As always, environmental Protection was taken into account in the refurbishment. In order to substantially reduce the energy consumption a cogeneration system was implemented, using the heat from the generators to heat the modules. The new station represents a challenge and a boost for Spanish polar research.



UTM services

Data processing laboratory

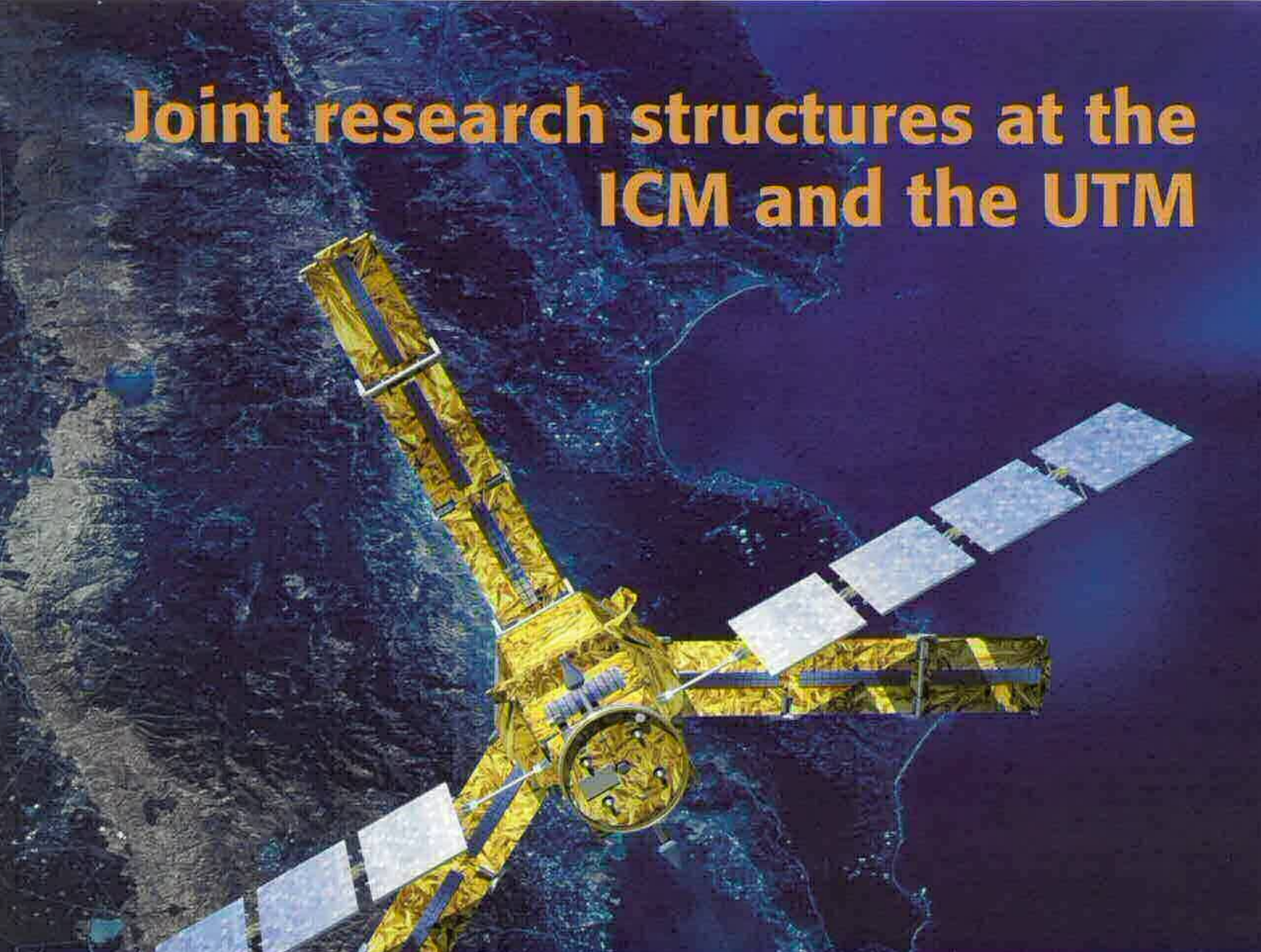
This laboratory provides the research groups with the technical support and resources to process and analyze data acquired by research vessels. It also offers a quality control of the data obtained with instruments such as multibeam echosounder, parametric probes, side-scan sonars and CTD profilers.



Autonomous platform laboratory

The purpose of this laboratory is to develop new sensors and research methods using high-resolution, autonomous platforms. It currently has two autonomous underwater vehicles. The first is used for underwater imaging systems (side-scan sonar, sonar and video), and the second for monitoring water quality (with temperature, conductivity, fluorescence, pH and dissolved oxygen sensors). In parallel, work is being done to develop custom-built instrumentation systems for incorporation in these new submarines and to develop autonomous platforms such as high-resolution profilers, Lagrangian buoys and high-precision GPS equipment.

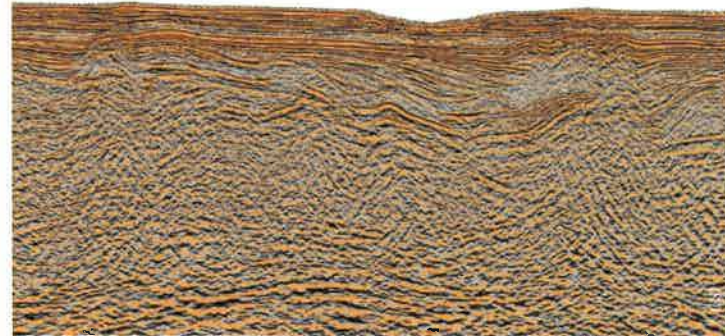
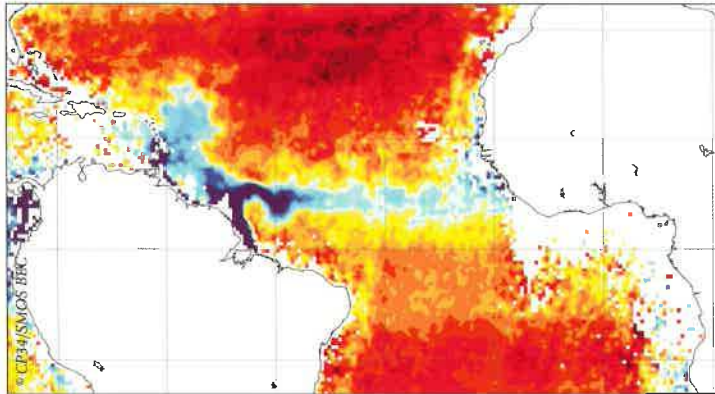
Joint research structures at the ICM and the UTM



Among the various research activities carried out jointly by researchers from the ICM and the UTM, some form specific structures within the CMIMA:

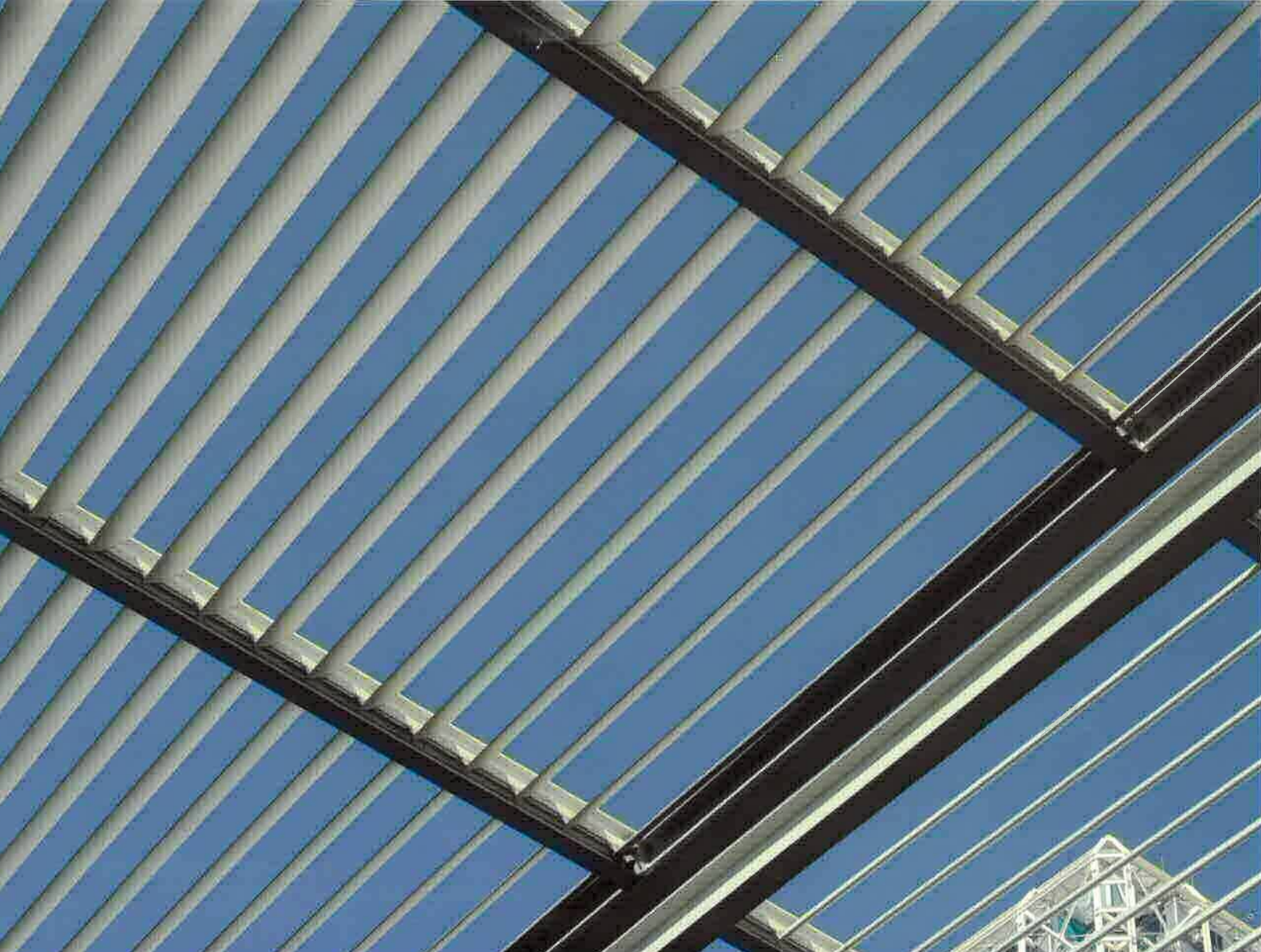
Barcelona Expert Center on Radiometric Calibration and Ocean Salinity (SMOS-BEC)

This is the result of an agreement between the CSIC and the Universitat Politècnica de Catalunya. It carries out activities related to calibrating the instrumentation of the European Space Agency's SMOS satellite and develops and improves algorithms for determining the surface salinity of oceans and the soil moisture of continents on the basis of radiometric measurements.



Barcelona Center for Subsurface Imaging (CSI)

This center is formed by geoscientists from the ICM, the UTM and the ICTJA (CSIC). The center develops in geophysical methods and technology are combined with the analysis of real data for seismic imaging and estimation of subsurface physical properties. The integration of those results with a wide range of observations is used to study geological processes.



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