Desing and development of a large and high-resolution beach-monitoring program at Balearic Islands Coastal Observing and Forecasting Sytem

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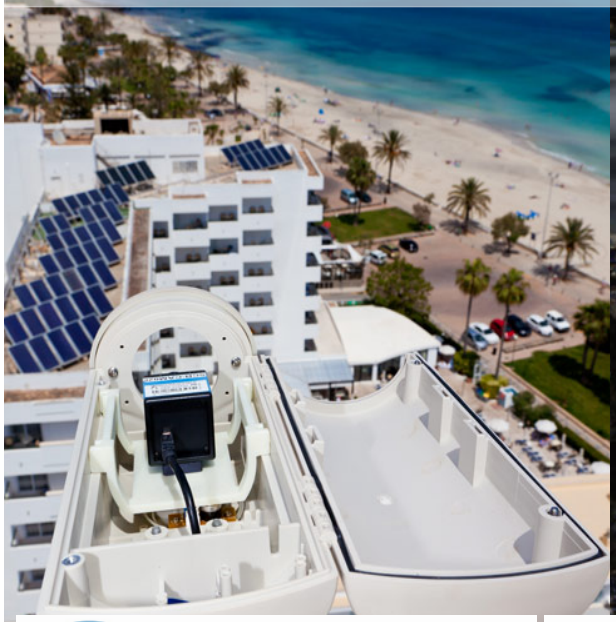
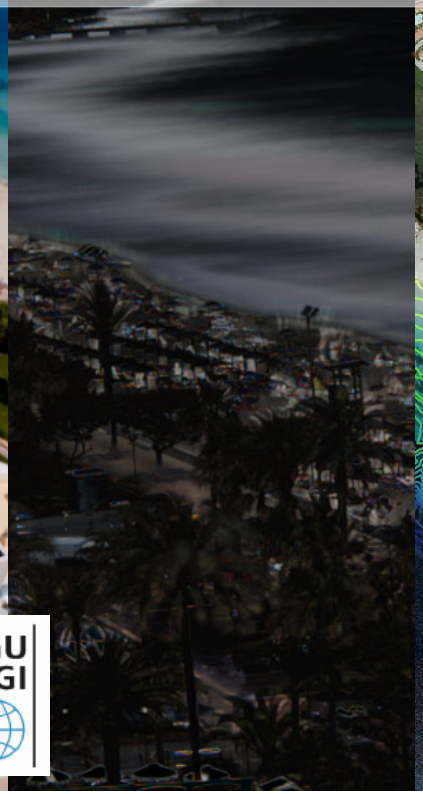
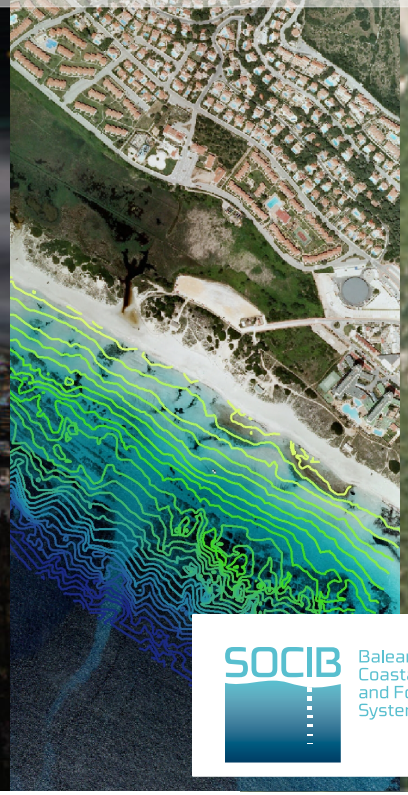
Alejandro Orfila
IMEDEA, Mediterranean Institute for Advanced Studies (CSIC-UIB)

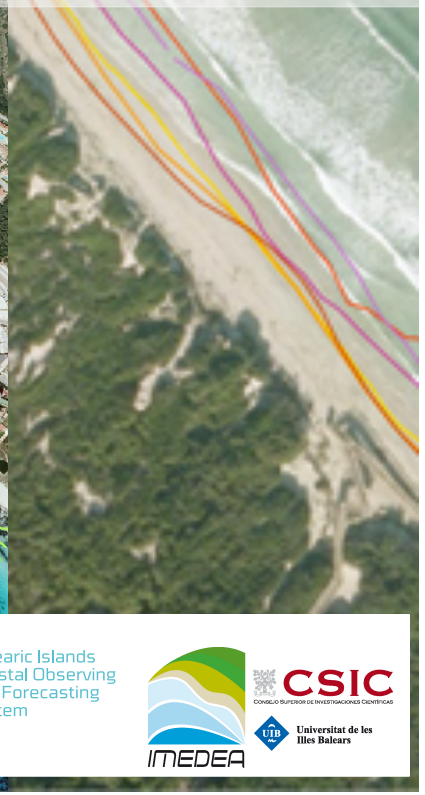
C08.05-08 COASTAL
Coastal Monitoring 3

32nd International Geographical Congress
Cologne, 26-30 August 2012









IGC COLOGNE 2012
DOWN TO EARTH

IGU UGI

SOCIB Balearic Islands Coastal Observing and Forecasting System

IMEDEA

CSIC

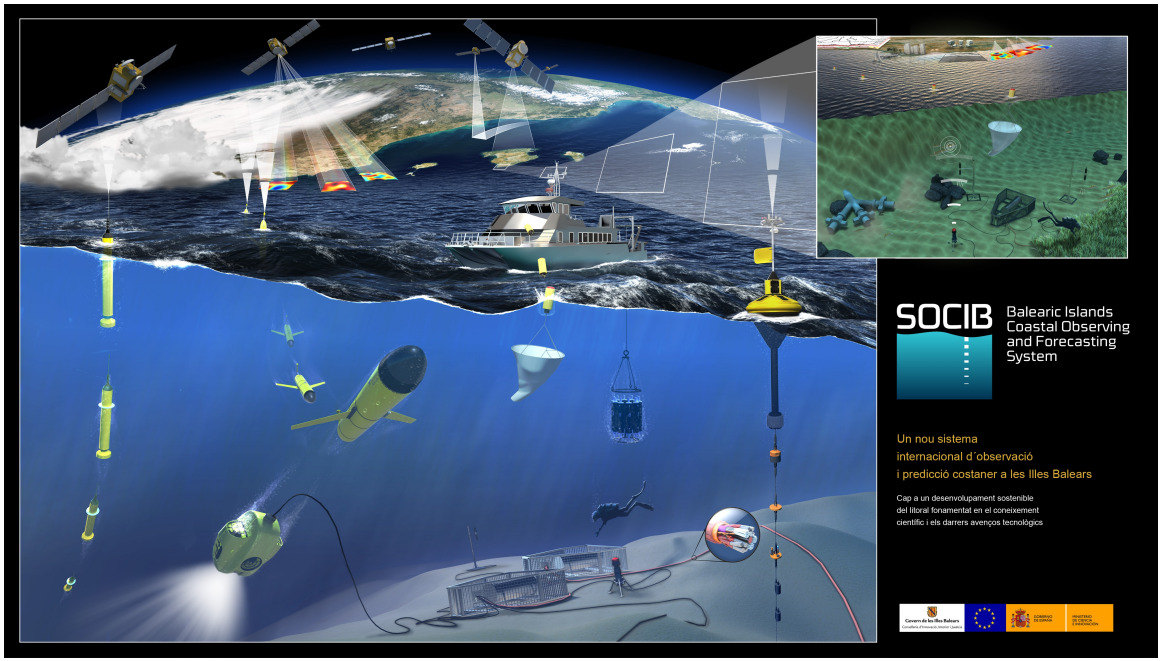
Universitat de les Illes Balears

INTRODUCTION

○ This communication pretends to introduce the Balearic Islands Coastal Observing and Forecasting System, **SOCIB**, focusing on one of their infrastructures: the **BEACH MONITORING FACILITY**.

○ SOCIB is a **multi-platform distributed and integrated Scientific and Technological Facility**, a facility of facilities, **providing streams of oceanographic data and modelling services** in support to operational oceanography and **contributing to the needs of marine and coastal research** in a global change context.

Part of the Spanish System of Scientific and Technological Infrastructures (ICTS)



Operational Oceanography is here understood as general, including traditional operational services to society but also including the sustained supply of multidisciplinary data to cover the needs of a wide range of scientific research priorities.

SOCIB'S MISSION

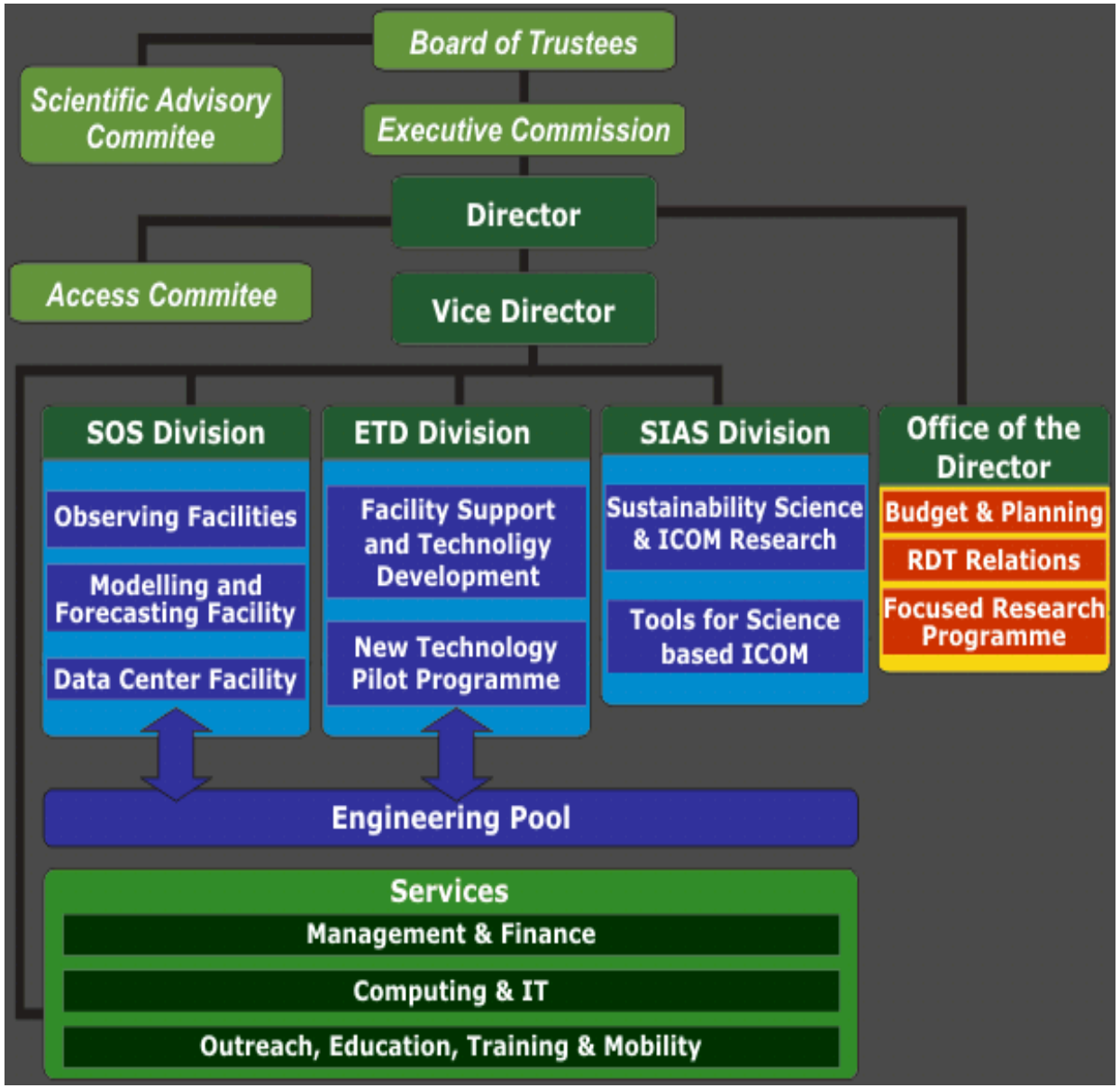
- The mission of SOCIB consists on developing a **scientific and technological infrastructure** which **will provide free, open, quality controlled and timely streams of data** mostly focused in the Western Mediterranean, focus in Balearic Islands and adjacent basins, and **covering from open ocean to nearshore**.

- SOCIB is a **multi-platform distributed and integrated Scientific and Technological Facility**, a facility of facilities, **providing streams of oceanographic data and modelling services** in support to operational oceanography and **contributing to the needs of marine and coastal research** in a global change context.

GENERAL OBJECTIVES

- Support research and technology development:
  - The role of the Mediterranean Sea in the climate system at inter-annual scale,
  - The interaction between currents and eddies at mesoscale and submesoscale, vertical exchanges and physical and ecosystems variability
  - The **variability in nearshore morpho-dynamics** and the sea level variability in response to climate change.

- Support (on a longer term) **strategic needs from society in the context of global change** (providing a continuous multidisciplinary and integrated monitoring of the coastal variability or promoting the development of new tools and technologies for decision support and risk assessment).



OBSERVATIONAL FACILITIES (major elements)

- Coastal Research Vessel
- HR Radar
- Gliders and AUV's
- Moorings and tide gages
- ARGO and surface drifters
- Beach monitoring systems

FORECASTING SYSTEM

- Ocean currents (ROOMS) and waves (SWAN) forced by Atmospheric models (WRF) and ecosystem coupling (NPZ).

DATA CENTRE

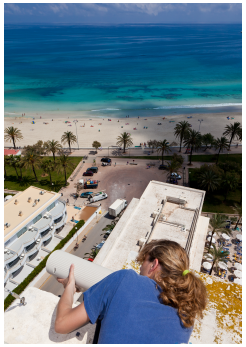
- Quality control and Web access in open source
- Effective data archiving, internationally accepted protocols, delivery and communication.

BEACH MONITORING FOCUS

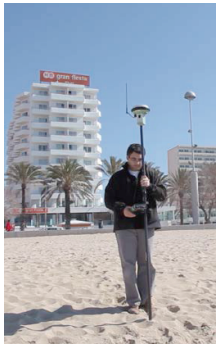
○ A continuous, **large and high-resolution dataset on coastline evolution, nearshore waves and currents, sediments and beach bathymetry** is a key issue in order to characterize and manage coastal systems properly (IPCC, Nicholls et al., 2007). But, there are very few multi-decadal, high-resolution coastal monitoring programmes currently in operation worldwide.

SITE	SURVEYS UNDERTAKEN	PUBLICATIONS
Duck (USA)	1981 – present, biweekly beach profiles 1986 – present, ARGUS intertidal bathymetries	Kroon et al., 2008
Rhode Island (USA)	1962 – present, monthly beach profiles	Lacey and Peck, 1998
Noordwijck (The Netherlands)	1964 – present, annual beach profiles 1995 – to present, ARGUS intertidal bathymetries 2001 – 2004 monthly 3D dGPS	Kroon et al., 2008
Lubiatowo (Poland)	1983 – present, monthly beach profiles	Rozynski, 2005
Collaroy-Narrabeen (Australia)	1976 – present, monthly beach profiles 2004 – to present, ARGUS intertidal bathymetries 2005 – to present, monthly 3D RTK-GPS	Harley et al., 2011
Moruya (Australia)	1972 – present, monthly beach profiles	McLean and Shen 2006
Hasaki (Japan)	1987 – present, daily beach profiles	Kuriyama et al., 2008

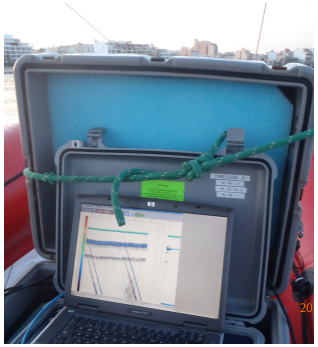
○ The aim of the SOCIB's Beach Monitoring Facility is to contribute to this issue by means of the **Modular Beach Integral Monitoring System (MOBIMS)**, which consists of a video-monitoring system, an Acoustic Doppler Current Profiler (ADCP) and a programme of bathymetric and sediment sampling to develop at 4 beaches of the Balearic Islands.



VIDEOMONITORING (SIRENA)

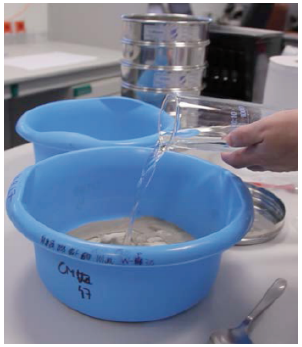


RTK SURVEY



ECHOSOUNDING BATHYMETRY

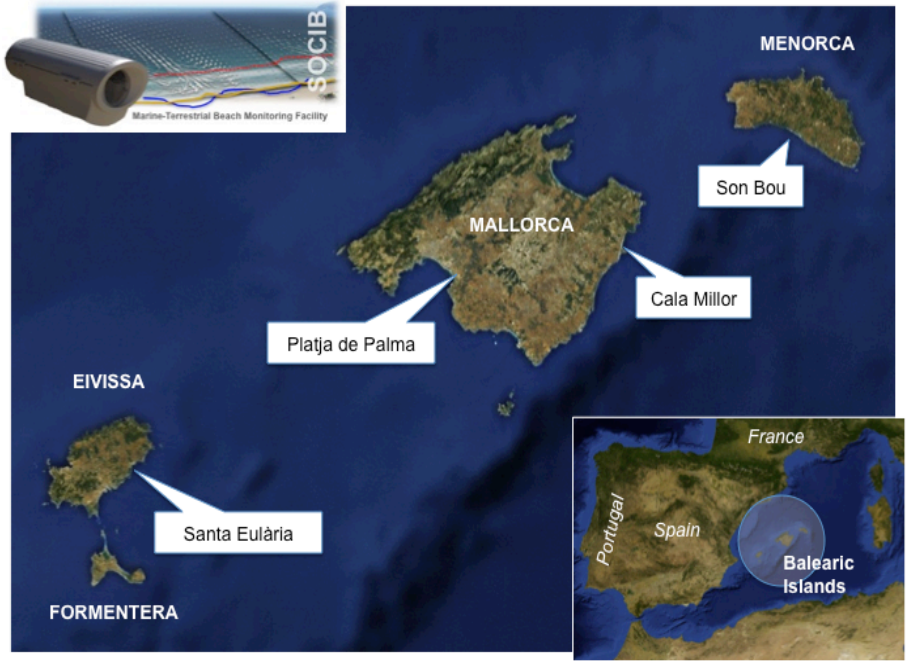
NEARSHORE WAVE & CURRENT MEASURING



SEDIMENT ANALYSIS

WEATHER STATION

MODULAR BEACH INTEGRAL MONITORING SYSTEM (MOBIMS)



	Platja de Palma	Cala Millor	Son Bou	Santa Eulària
Length	5 km	2 km	2.5 km	0.5 km
Operating	Set 2011	May 2011	Oct 2011	n.a.
Type	Urban	Urban	Natural	Inlet

BEACH MONITORING GENERAL AIMS

The objectives of the Beach Monitoring Facility deals with different types of scopes, from scientific and technological development to education or services to society.

- **Scientific objectives**
  - In the large temporal scale, to build up a continuous and coherent time series related to beach morphology, waves and currents and sediment budgets in order to address effects and processes related with climate variability.
  - In the short temporal scale, to provide data and physical variables that allow the study of coastal processes and the development of new models and scientific theories that improve the understanding of coastal and nearshore systems.

- **Technological objectives**
  - Development and improving of coastal videomonitoring technology in terms of software and analytical tools for coastal issues.

- **Services to Society**
  - To offer products and services that contribute to safety and coastal management based on technological development and scientific knowledge.

- **Outreach and education**
  - To offer datasets, products and reports to the public in order to improve they coastal knowledge.
  - To contribute to the formation of MSc and PhD students dealing with beach dynamics and coastal issues.

July'12

May'11

coastal data webserver application

coastal data report programme

real-time monitoring programme

morphodynamics laboratory

Coastal Products & Data Management

Monitoring programme

Beach Monitoring Facility

Coastal Laboratory

Coastal Services

periodic monitoring programme

coastal imaging laboratory

May'11

coastal issues

equipments & technology

EARTH SURFACE PROCESSES AND LANDFORMS
Earth Surf. Process. Landforms 35, 1712–1719 (2010)

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(wileyonlinelibrary.com) DOI: 10.1002/esp.2025

CSIC Consejo Superior de Investigaciones Científicas
IMEDEA
UIB Universitat de les Illes Balears

An open source, low cost video-based coastal monitoring system

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ESPL
Earth Surface Processes and Landforms

ABSTRACT: A low cost, automated, remote monitoring video system built on standard commercial off-the-shelf (COTS) components and implemented with open source software is presented. The system has been implemented in a coastal area to perform image acquisition and processing, generating statistical products and transferring the information from the field to a central node where post-processing and data visualization are made available to the general public. The open structure of the software allows the user to implement new routines and modules appropriate to fit specific needs as well as to adapt the system to study other dynamical processes where continuous observation is required. The software and image data base can be obtained as freeware.

KEYWORDS: video monitoring; remote sensing; coastal zone

Introduction

Several experiments and coastal monitoring facilities have been developed and carried out in the last decade. The most complex approaches are field-based and use coastal oceanographic equipment. These have a broad capacity to produce spatial and temporal measurements of physical and environmental variables being the only way to measure processes responsible for sediment transport. Unfortunately, these facilities require a large time and money investment and have relatively long installation and set-up times before producing useful data-sets. Classical examples of this kind of installations are the Field Research Facility operated since 1980 by the US Army Coastal Engineering Research Centre at Duck (Larson and Kraus, 1994; Miller and Dean, 2007), the US Geological Survey station at the Columbia River Littoral Cell in the Pacific coast (Ruggiero and Voigt, 2000) or the JARKUS data set in the Dutch coast (Wijnberg and Terwindt, 1995). Other recent development that must be considered are the Gold Coast shoreline and wave record obtained by the Northern Gold Coasts Beach Protection Strategy in southeast Australia (Boak *et al.*, 2000) or the POL Liverpool Bay Coastal Observatory (Proctor *et al.*, 2004).

Another alternative to measuring coastal processes is based on remote sensors. In this way, information is acquired automatically, continuously and periodically from high resolution digital images. This alternative to traditional field studies that utilizes a significantly lower amount of human, economic, and computational resources, allows better continuity and frequency in data acquisition. Among optical remote sensors, fixed digital video cameras have proven to be an attractive alternative for coastal monitoring because it provides the possibility to study a range of spatial and temporal scales, from specific cross-shore profiles to several kilometres of coast, with sampling intervals depending on the required measurement. Therefore, a broad number of coastal forms and nearshore processes can be monitored using remote techniques. For instance, researchers have used video images to extract beach and nearshore bathymetry (Stockdon and Holman, 2000; Aarninkhof *et al.*, 2003), the nearshore hydrodynamics (Chickadel *et al.*, 2003), as well as to unravel the formation and displacement of sand bars (Lippman and Holman, 1989; Ojeda, 2008; Ruessink *et al.*, 2000) or the beachface morphodynamics (Almar *et al.*, 2008; Ortega-Sánchez *et al.*, 2007). The capabilities and functionality of video-based coastal monitoring systems are evolving rapidly; more so with the CoastView project (Davidson *et al.*, 2007) that highlighted and standardized the possibilities and future trends of these systems for coastal zone or navigational channels management (Medina *et al.*, 2007; Turner and Anderson, 2007; Koningsveld *et al.*, 2007).

Since the commercialization of ARGUS – a video-based coastal monitoring system developed by the Coastal Imaging Laboratory at Oregon Sate University (Holman and Stanley, 2007) – and because many potential applications to unravel nearshore issues based on video monitoring systems have

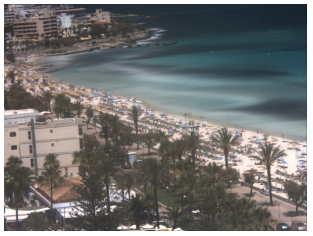
http://imedea.uib-csic.es/tmoos/sirena/

- Real time monitoring consists on the automated collection of coastal videomonitoring images, weather data and waves data.

- The SOCIB Beach Monitoring Facility is using **SIRENA, the open source, low cost video-based videomonitoring system developed at IMEDEA (CSIC-UIB)**. It captures 1500 images of the coast at 4Hz during the first 10 minutes of each hour resulting in a set of different types of images: snapshot, timex, variance and timestack.

- SOCIB videomonitoring real time data is a web based system and images are hourly available from each one of the monitoring sites.

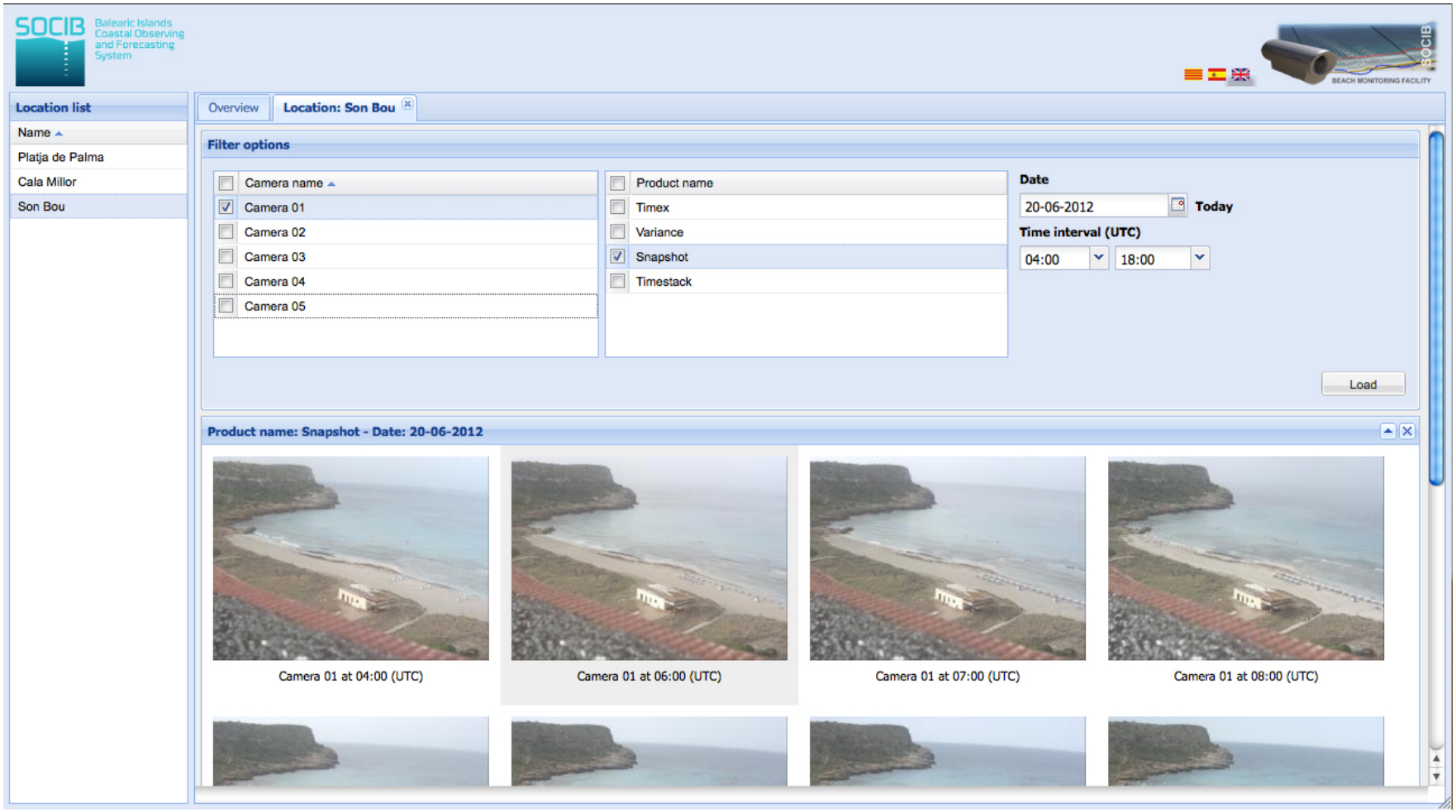
Snapshot



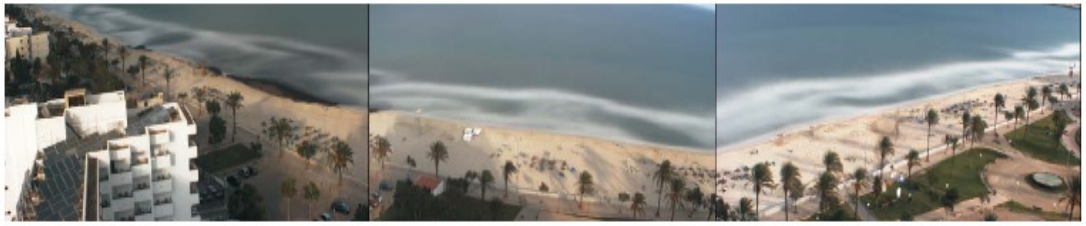
Timex

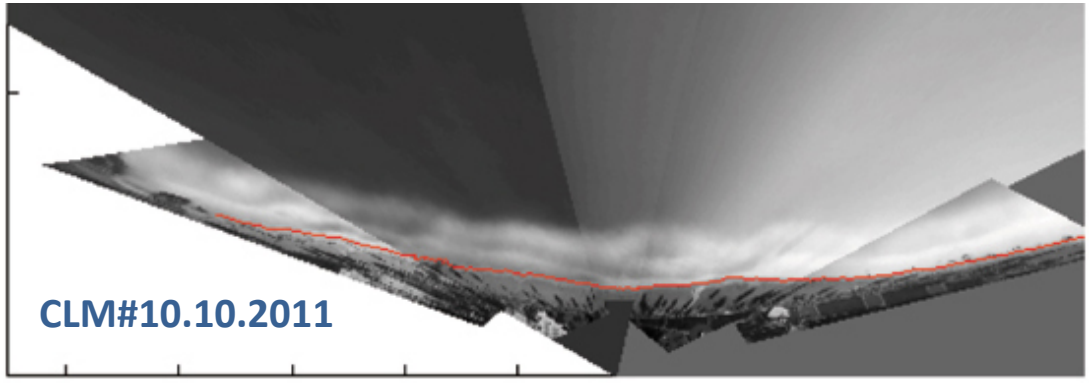
Variance

Time stack



○ Every hour the web site is updated with the latest snap-shot, timex and variance images. These can be viewed to provide and immediate qualitative assessment. A zoom and calendar tool enables more detailed examination and image comparison.





- Each week images (timex) are processed automatically to generate plan-view images of the beaches.
- A weekly plan-view image corresponding with the most favourable sea conditions and quality of images is processed in a automatically-manually batch mode to map the present shoreline position along a pre-defined region.
- This information in then automatically analyse against previous shoreline data to generate a dry beach width analysis.

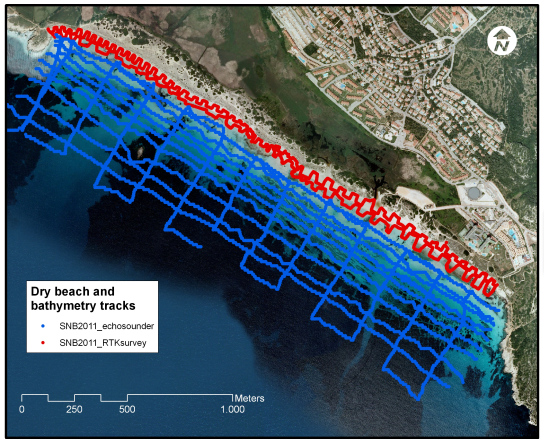
	Platja de Palma	Cala Millor	Son Bou	Santa Eulària
Length and location	5 km, SW Mallorca	2 km, NE Mallorca	2.5 km, SW Menorca	0.5 km, SE Eivissa
Beach type and main interest	Urban	Urban (rips)	Natural (reefs)	Urban, inlet
Equipment	3 SIRENA stations (15 cameras) 1 Weather station 1 AWAC	1 SIRENA stations (5 cameras) 1 Weather station 1 AWAC	1 SIRENA stations (5 cameras) 1 Weather station 1 AWAC	1 SIRENA stations (4 cameras) 1 Weather station 1 AWAC
Operation	09.2011 – to present	05.2011 – to present	10.2011 – to present	In mind 2013

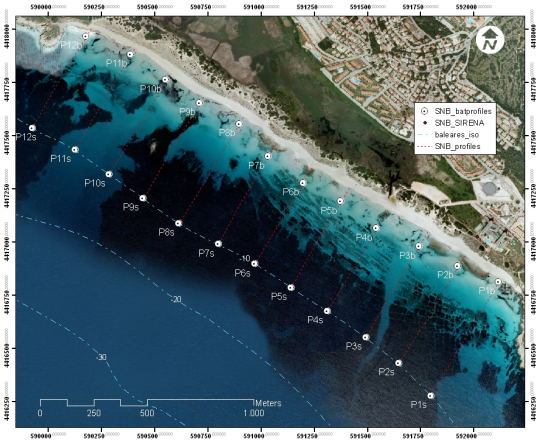
Palma beach s'Arenal (Ma)

Cala Millor Beach (Ma)

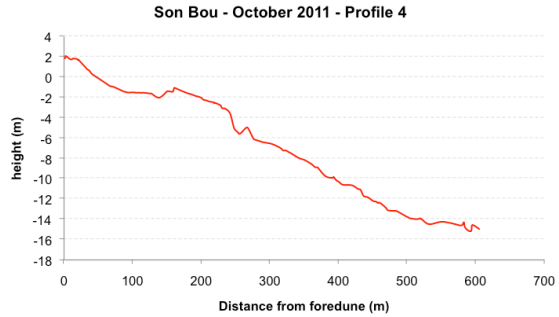
Son Bou Beach (Me)

	Platja de Palma	Cala Millor	Son Bou	Santa Eulària
Length and location	5 km, SW Mallorca	2 km, NE Mallorca	2.5 km, SW Menorca	0.5 km, SE Eivissa
Beach type and main interest	Urban	Urban (rips)	Natural (reefs)	Urban, inlet
Bathymetric survey	12 months	12 months	12 months	12 months
Profile survey	6 months	6 months	6 months	12 months
Sediment survey	12 months	12 months	12 months	12 months
Awac download	4 months	4 months	4 months	6 months
Operation	02.2012 – to present	06.2011 to present	10.201 to present	In mind 2013



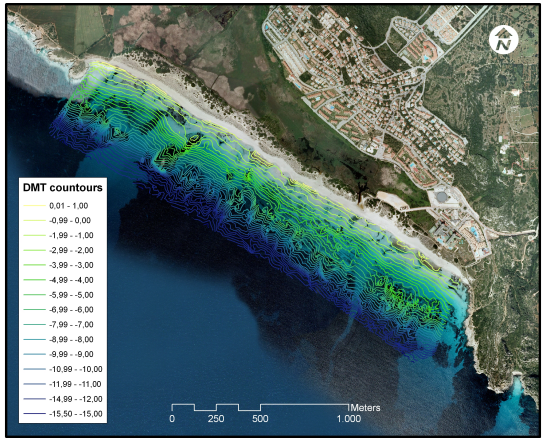


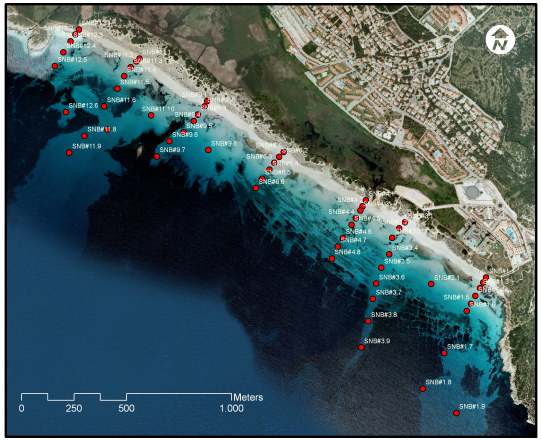
DEM (GIS)

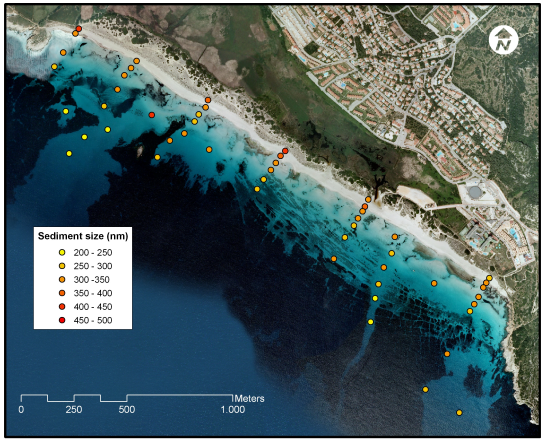


BEACH PROFILES

DEM (GIS)



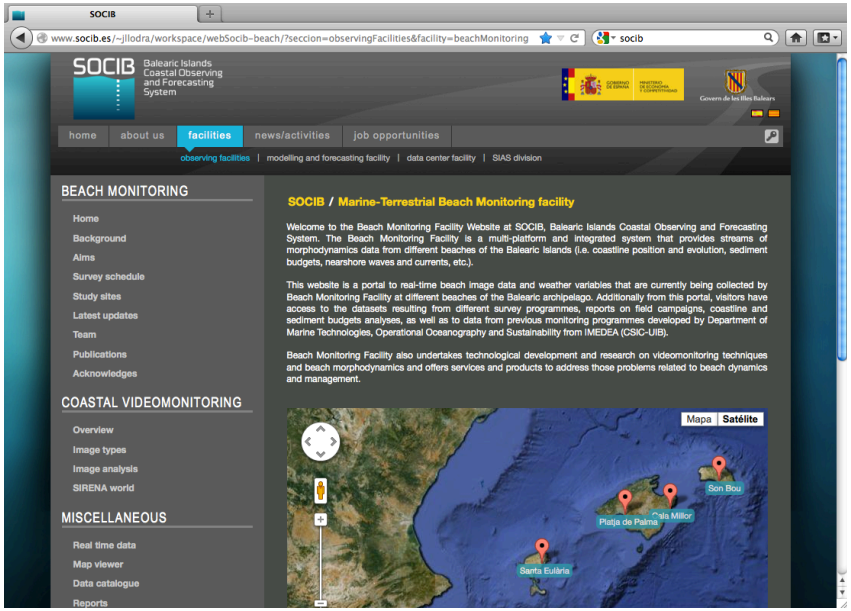




SEDIMENT SIZE CHARACTERIZATION

Information on sediment budgets and sediment properties

A web based products dissemination (www.socib.org)



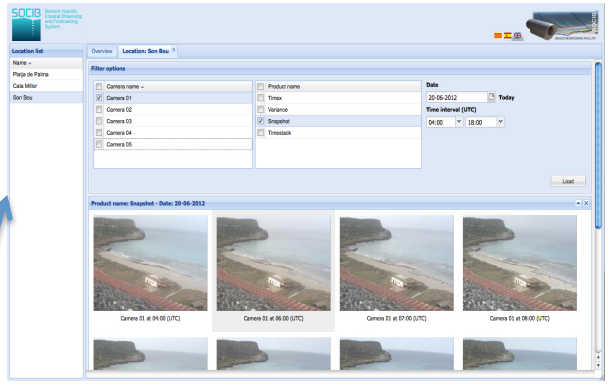
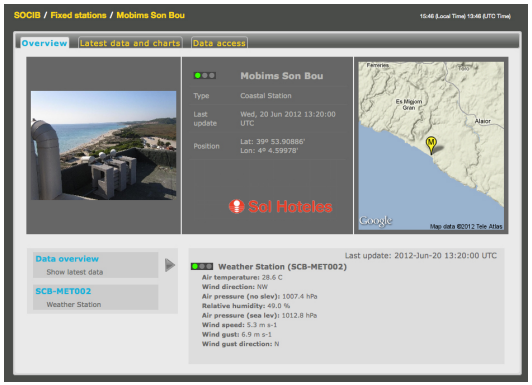
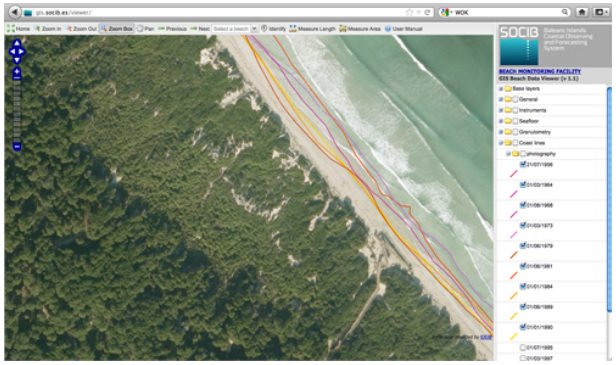


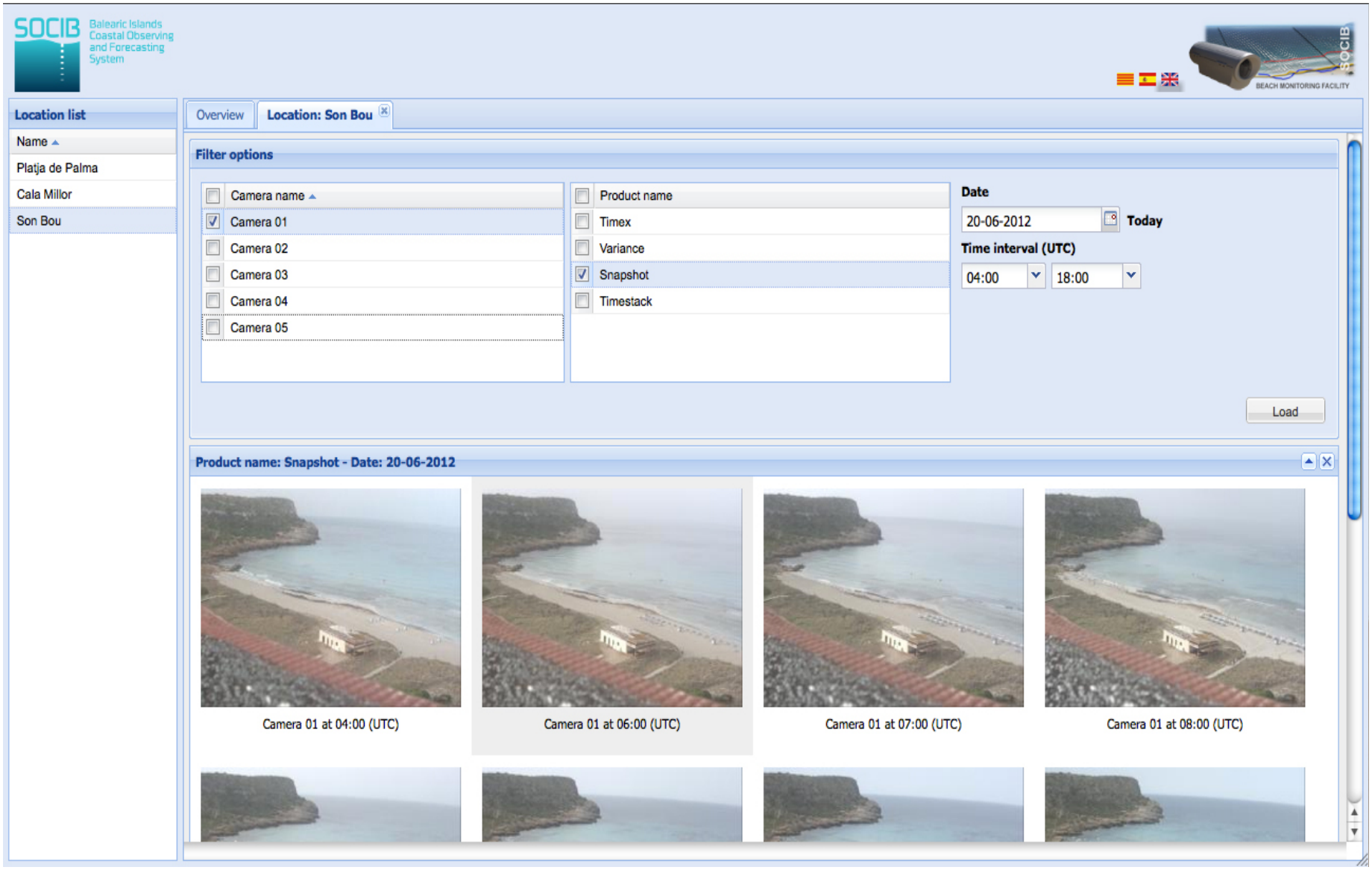
image application

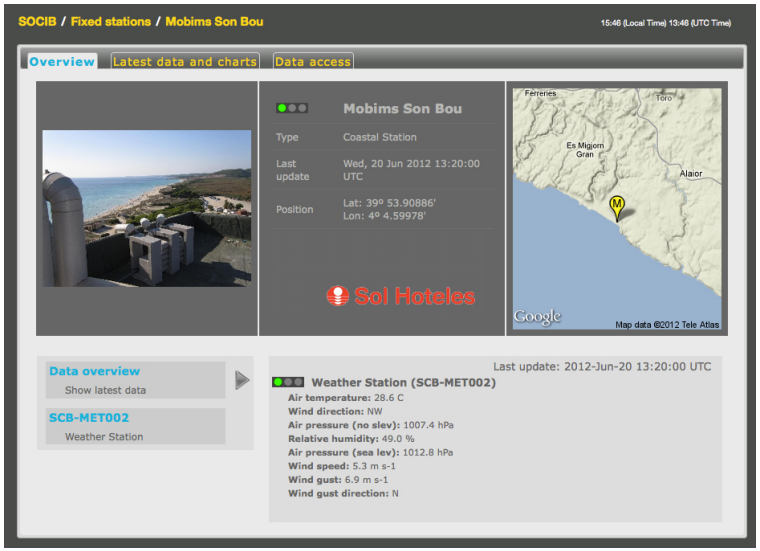


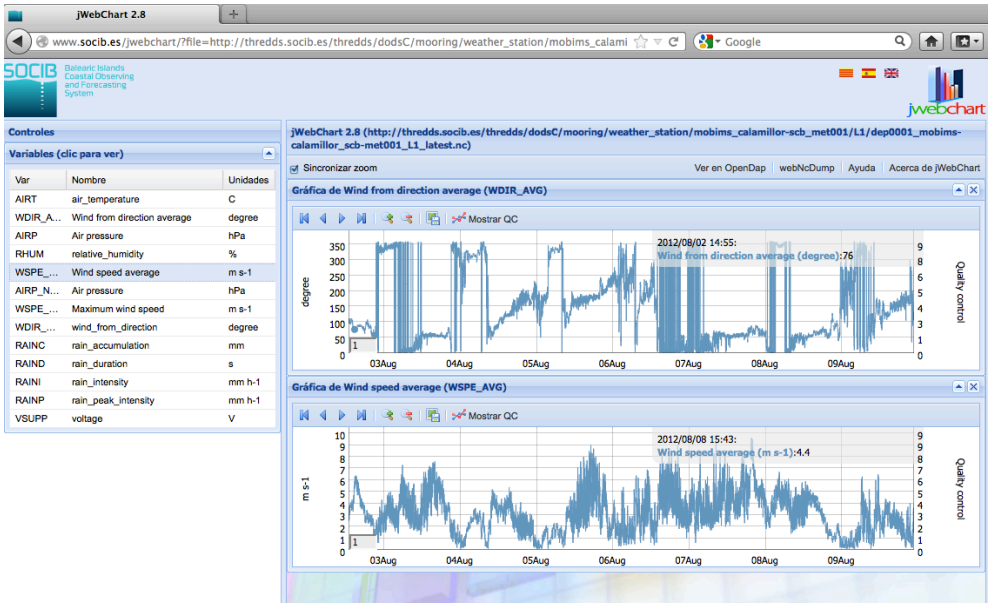
Weather & wave application

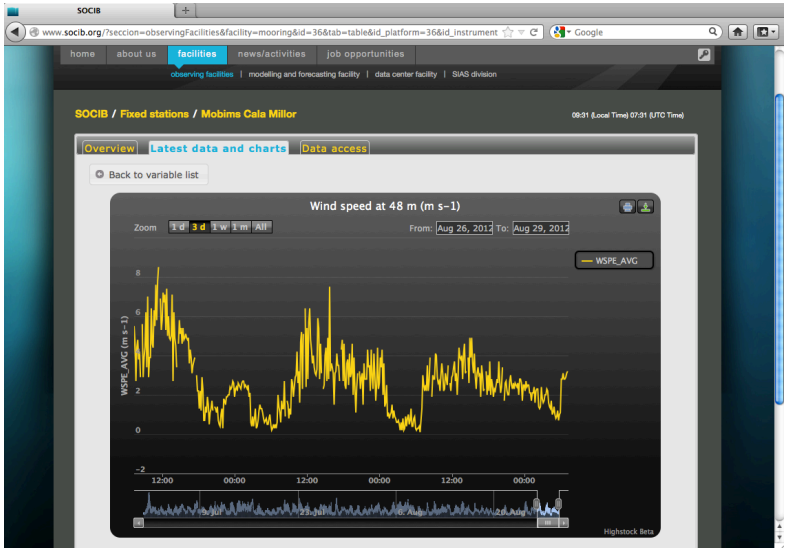


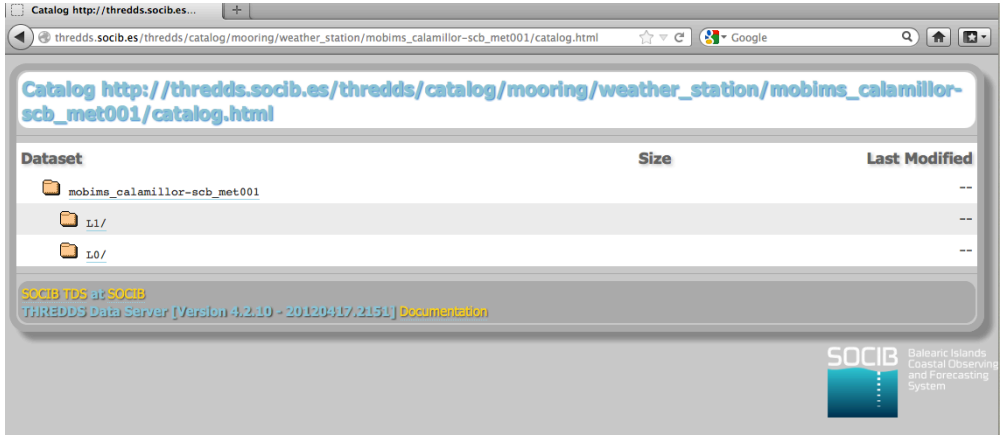
GIS beach maps and data application

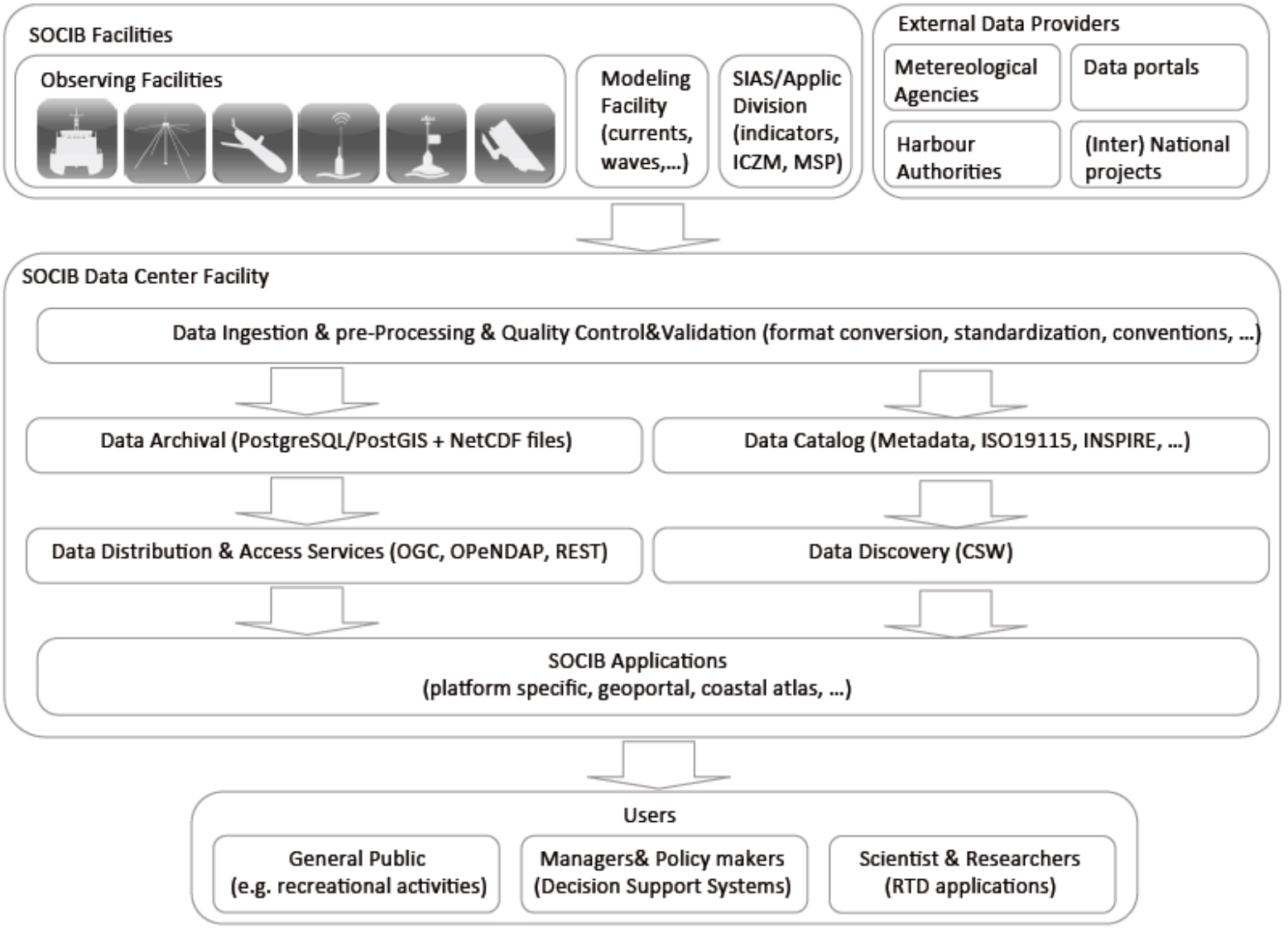

SOCIB
Balearic Islands Coastal Observing and Forecasting System
BEACH MONITORING FACILITY
Location list
Name
Platja de Palma
Cala Millor
Son Bou
Overview
Location: Son Bou
Filter options
Camera name
Camera 01
Camera 02
Camera 03
Camera 04
Camera 05
Product name
Timex
Variance
Snapshot
Timestack
Date
20-06-2012
Today
Time interval (UTC)
04:00
18:00
Load
Product name: Snapshot - Date: 20-06-2012
Camera 01 at 04:00 (UTC)
Camera 01 at 06:00 (UTC)
Camera 01 at 07:00 (UTC)
Camera 01 at 08:00 (UTC)

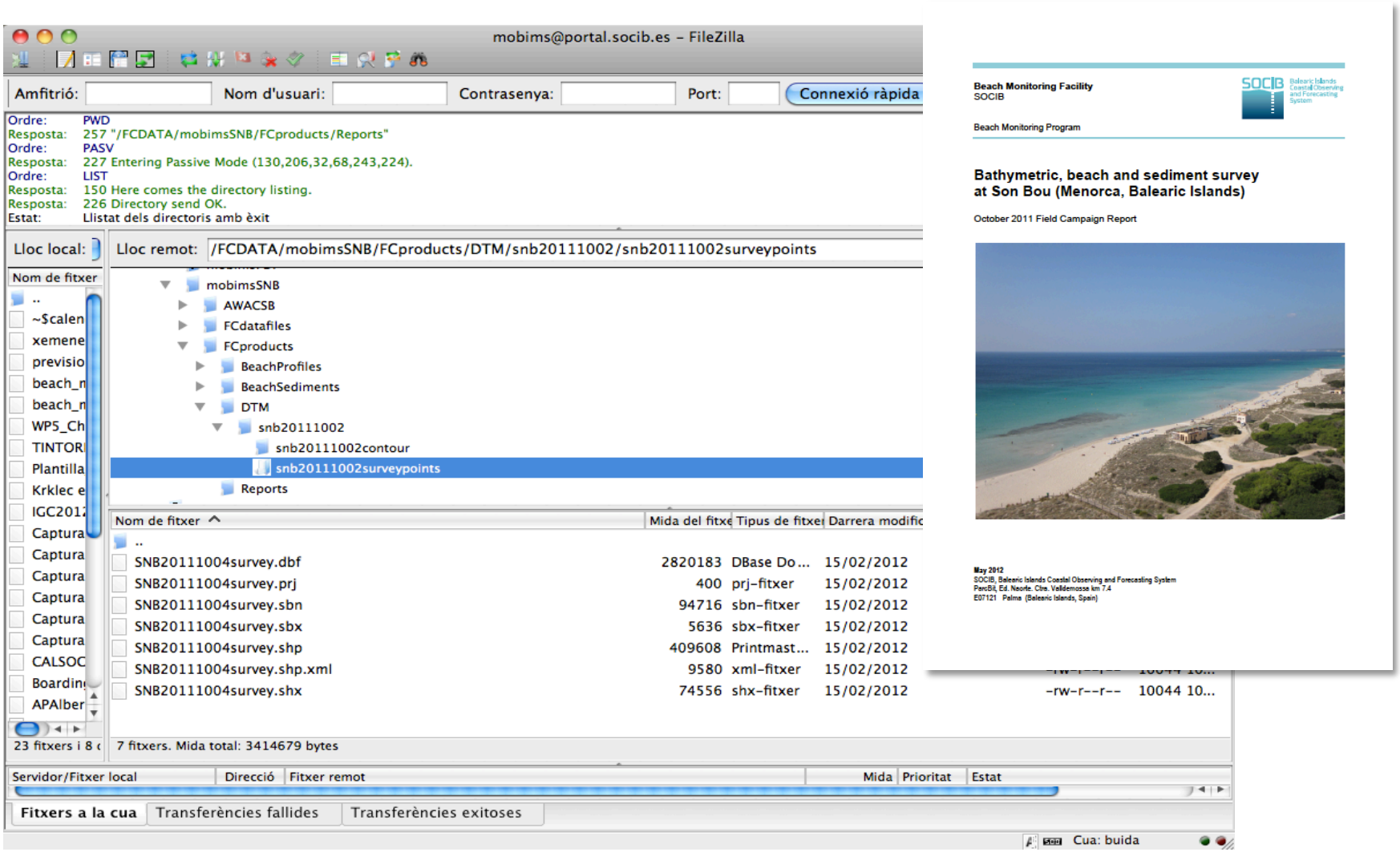

SOCIB / Fixed stations / Mobims Son Bou
15:46 (Local Time) 13:46 (UTC Time)
Overview
Latest data and charts
Data access
Mobims Son Bou
Type
Coastal Station
Last update
Wed, 20 Jun 2012 13:20:00 UTC
Position
Lat: 39º 53.90886'
Lon: 4º 4.59978'
Sol Hoteles
Ferreries
Es Migjorn Gran
Alaior
Google
Map data ©2012 Tele Atlas
Data overview
Show latest data
SCB-MET002
Weather Station
Last update: 2012-Jun-20 13:20:00 UTC
Weather Station (SCB-MET002)
Air temperature: 28.6 C
Wind direction: NW
Air pressure (no slev): 1007.4 hPa
Relative humidity: 49.0 %
Air pressure (sea lev): 1012.8 hPa
Wind speed: 5.3 m s-1
Wind gust: 6.9 m s-1
Wind gust direction: N


jWebChart 2.8
www.socib.es/jwebchart/?file=http://thredds.socib.es/thredds/dodsC/mooring/weather_station/mobims_calami
Google
SOCIB Balearic Islands Coastal Observing and Forecasting System
jwebchart
Controles
Variables (clic para ver)
Var | Nombre | Unidades
AIRT | air_temperature | C
WDIR_A... | Wind from direction average | degree
AIRP | Air pressure | hPa
RHUM | relative_humidity | %
WSPE_... | Wind speed average | m s-1
AIRP_N... | Air pressure | hPa
WSPE_... | Maximum wind speed | m s-1
WDIR_... | wind_from_direction | degree
RAINC | rain_accumulation | mm
RAIND | rain_duration | s
RAINI | rain_intensity | mm h-1
RAINP | rain_peak_intensity | mm h-1
VSUPP | voltage | V
jWebChart 2.8 (http://thredds.socib.es/thredds/dodsC/mooring/weather_station/mobims_calamillor-scb_met001/L1/dep0001_mobims-calamillor_scb-met001_L1_latest.nc)
Sincronizar zoom
Ver en OpenDap | webNcDump | Ayuda | Acerca de jWebChart
Gráfica de Wind from direction average (WDIR_AVG)
Mostrar QC
2012/08/02 14:55:
Wind from direction average (degree):76
degree
Quality control
03Aug 04Aug 05Aug 06Aug 07Aug 08Aug 09Aug
Gráfica de Wind speed average (WSPE_AVG)
Mostrar QC
2012/08/08 15:43:
Wind speed average (m s-1):4.4
m s-1
Quality control
03Aug 04Aug 05Aug 06Aug 07Aug 08Aug 09Aug


SOCIB
www.socib.org/?seccion=observingFacilities&facility=mooring&id=36&tab=table&id_platform=36&id_instrument
Google
home | about us | facilities | news/activities | job opportunities
observing facilities | modelling and forecasting facility | data center facility | SIAS division
SOCIB / Fixed stations / Mobims Cala Millor
09:31 (Local Time) 07:31 (UTC Time)
Overview
Latest data and charts
Data access
Back to variable list
Wind speed at 48 m (m s-1)
Zoom
1 d 3 d 1 w 1 m All
From: Aug 26, 2012 To: Aug 29, 2012
WSPE_AVG
WSPE_AVG (m s-1)
12:00 00:00 12:00 00:00 12:00 00:00
Highstock Beta


Catalog http://thredds.socib.es...
thredds.socib.es/thredds/catalog/mooring/weather_station/mobims_calamillor-scb_met001/catalog.html
Google
Catalog http://thredds.socib.es/thredds/catalog/mooring/weather_station/mobims_calamillor-scb_met001/catalog.html
Dataset
Size
Last Modified
mobims_calamillor-scb_met001 --
L1/ --
L0/ --
SOCIB TDS at SOCIB
THREDDS Data Server [Version 4.2.10 - 20120417.2151] Documentation
SOCIB Balearic Islands Coastal Observing and Forecasting System


SOCIB Facilities
Observing Facilities
Modeling Facility (currents, waves,...)
SIAS/Applic Division (indicators, ICZM, MSP)
External Data Providers
Metereological Agencies
Data portals
Harbour Authorities
(Inter) National projects
SOCIB Data Center Facility
Data Ingestion & pre-Processing & Quality Control&Validation (format conversion, standardization, conventions, ...)
Data Archival (PostgreSQL/PostGIS + NetCDF files)
Data Catalog (Metadata, ISO19115, INSPIRE, ...)
Data Distribution & Access Services (OGC, OPeNDAP, REST)
Data Discovery (CSW)
SOCIB Applications
(platform specific, geoportal, coastal atlas, ...)
Users
General Public
(e.g. recreational activities)
Managers& Policy makers
(Decision Support Systems)
Scientist & Researchers
(RTD applications)



A future debate for coastal geomorphologists: How to define protocols for comparing and disseminating data…

Thanks !

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IMEDEA CSIC Universitat de les Illes Balears

MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD

Govern de les Illes Balears