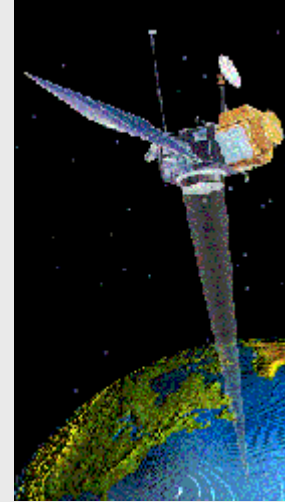
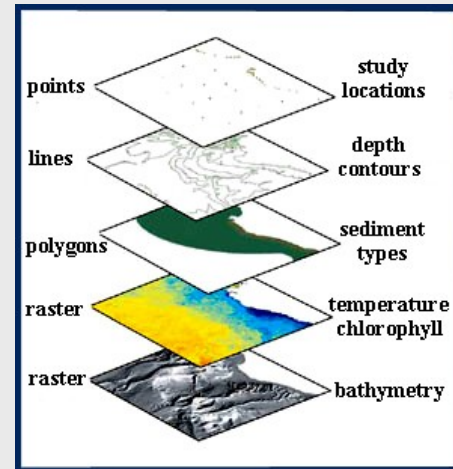


MARINE SATELLITE REMOTE SENSING

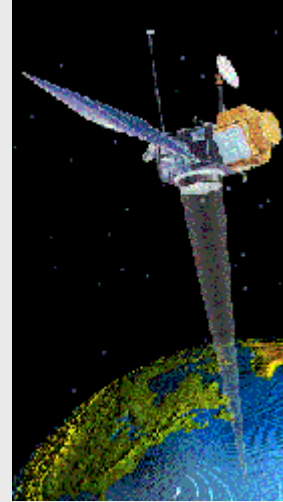


MARINE GEOGRAPHIC INFORMATION SYSTEMS



MARINE SATELLITE REMOTE SENSING

- Capabilities
- E/M Spectrum
- RS Process
- Sensors
- Satellites
- Sensor Types
- Orbits
- Data & Data Archives
- Final Image Products Issues



Unique Capabilities

Remote - global coverage possible

Non-intrusive and wide coverage - economical

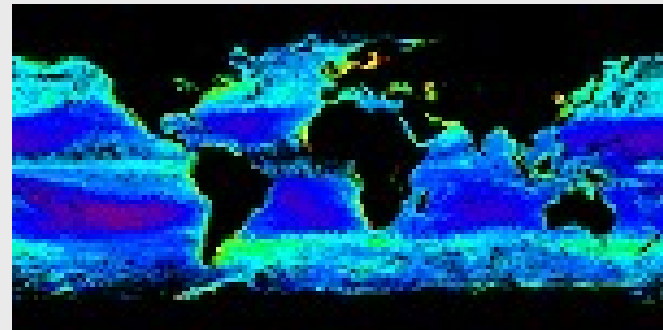
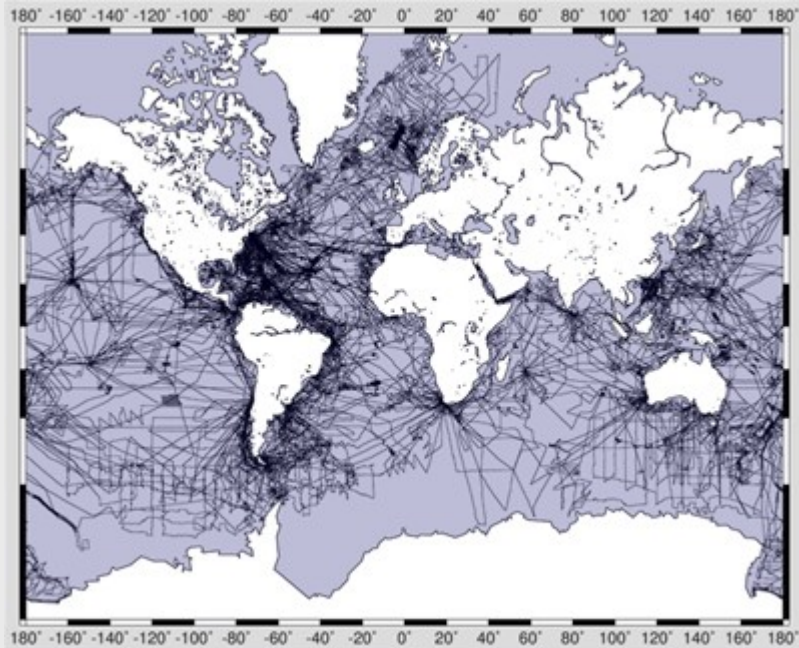
Multiple scales - ideal different applications

Wide spectral range - thermal, microwave

Hyperspectral - more applications

Repetitive coverage - ideal for environmental monitoring

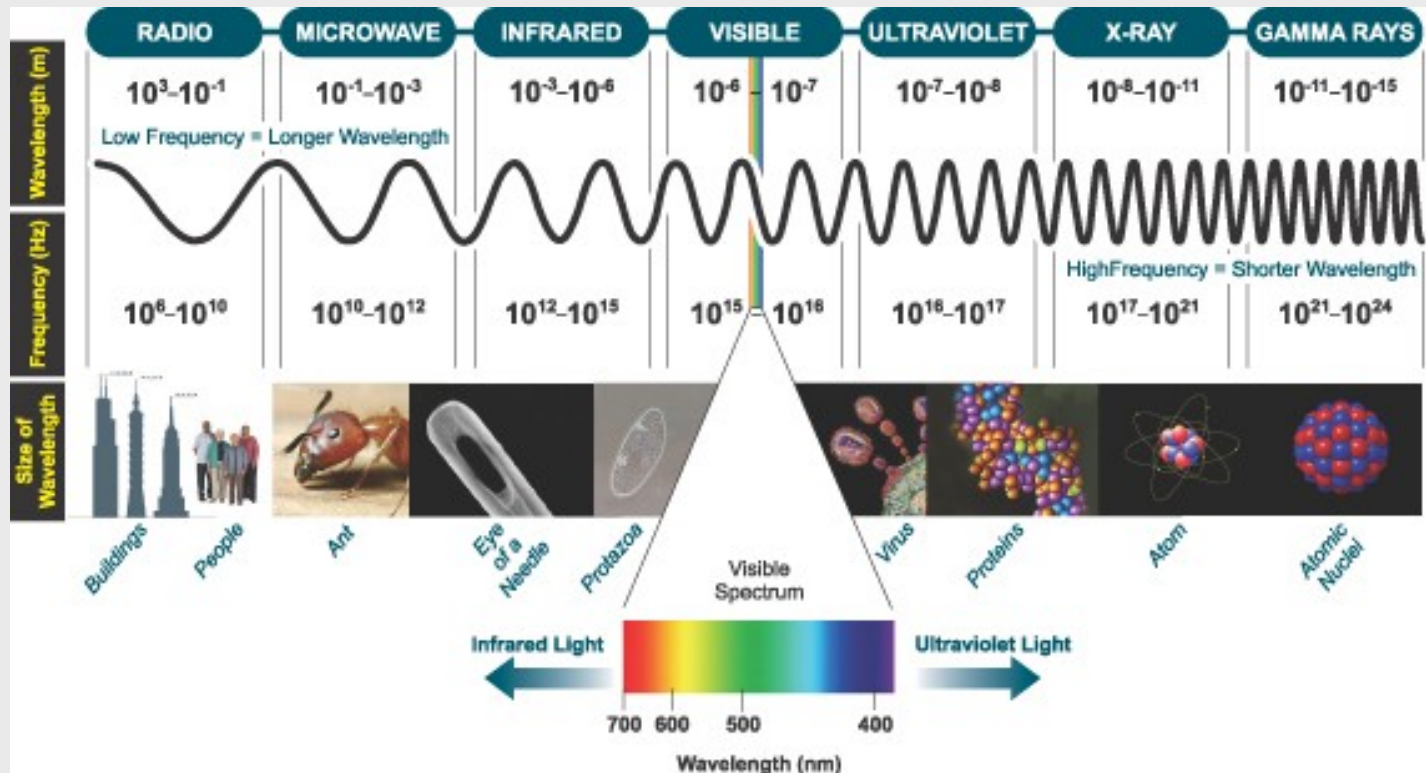
Earth's rotation and gravity on their best!



Radio waves, microwaves, x-rays, gamma rays, and the spectrum of visible colors are all really the same thing: electromagnetic energy.

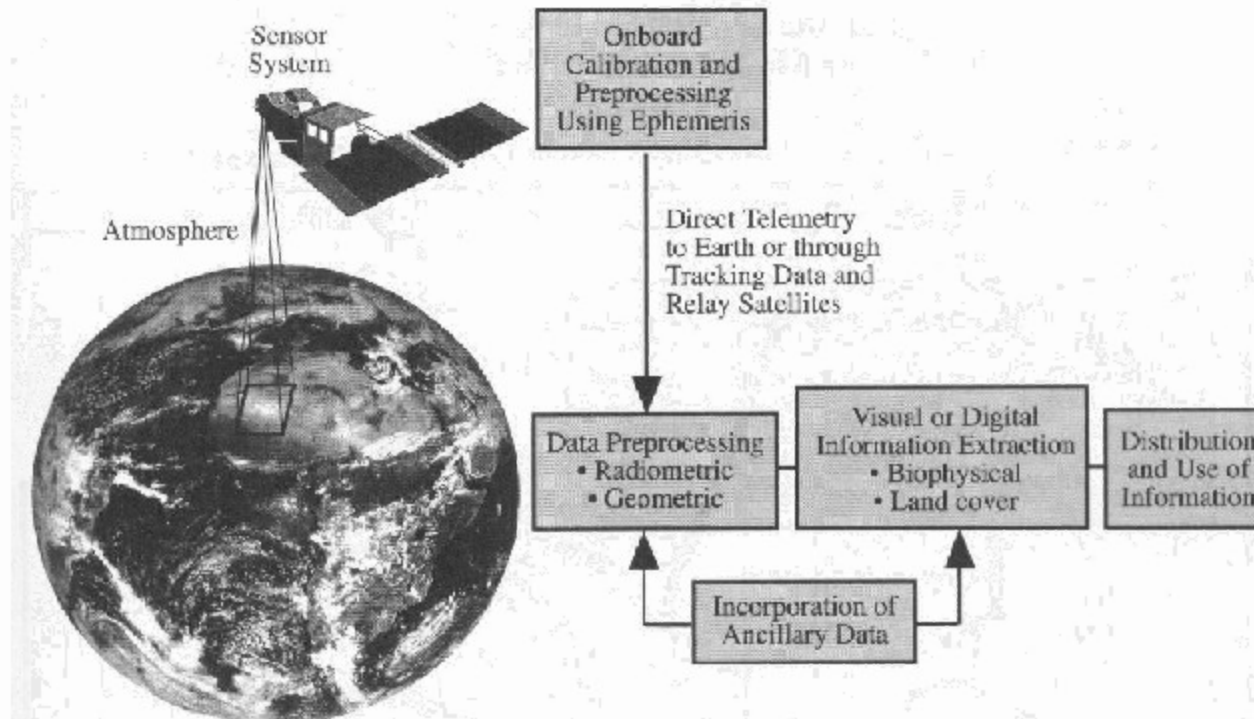
The differences are their wavelengths.

A photon of shorter-wavelength light packs and emits more energy than a photon of longer-wavelength light.



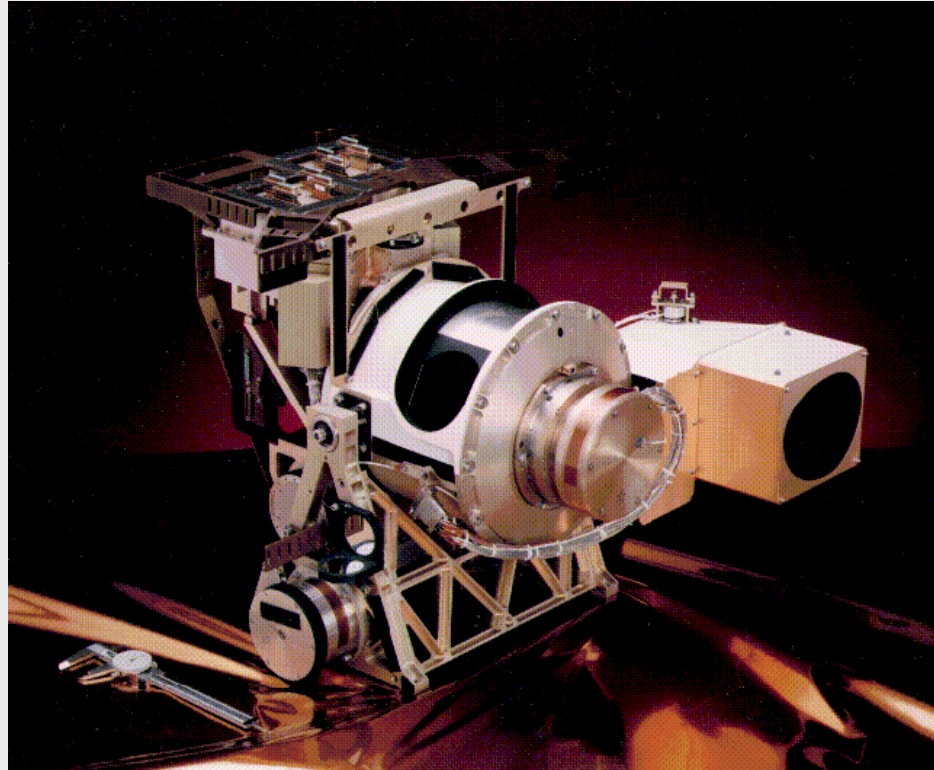
Light is part of the electromagnetic spectrum, fluctuations of magnetic and electric fields

Remote Sensing Processes



The SeaWiFS Sensor

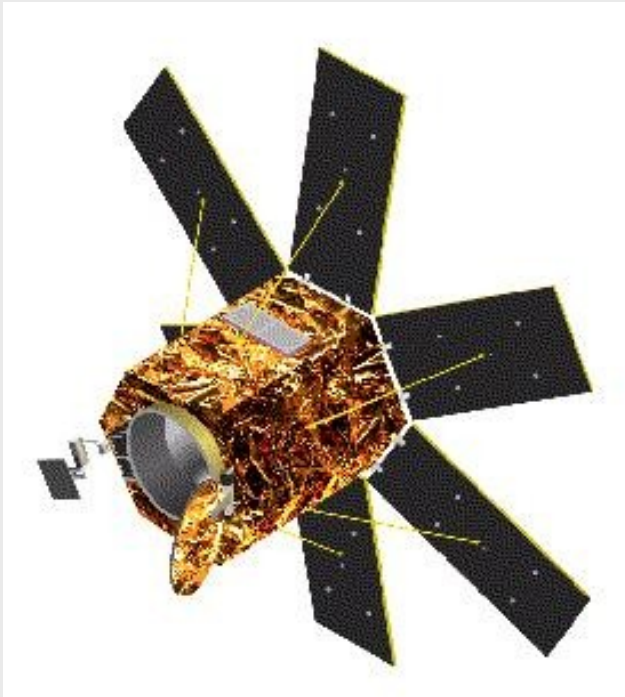
Sea-viewing Wide Field-of-View Sensor



Most remote sensing instruments (sensors) are designed to measure photons based on the photoelectric effect (reason for Nobel to Einstein): When a beam of light hits a material, electrons are emitted and scattered as reflectance. These are measured by the sensor's detector. The magnitude of the electric current produced (number of photoelectrons per unit time) is directly proportional to the light intensity.

Different materials undergo photoelectric effect release of electrons over different wavelength intervals.

The OrbView - # satellite carrying SeaWiFS sensor



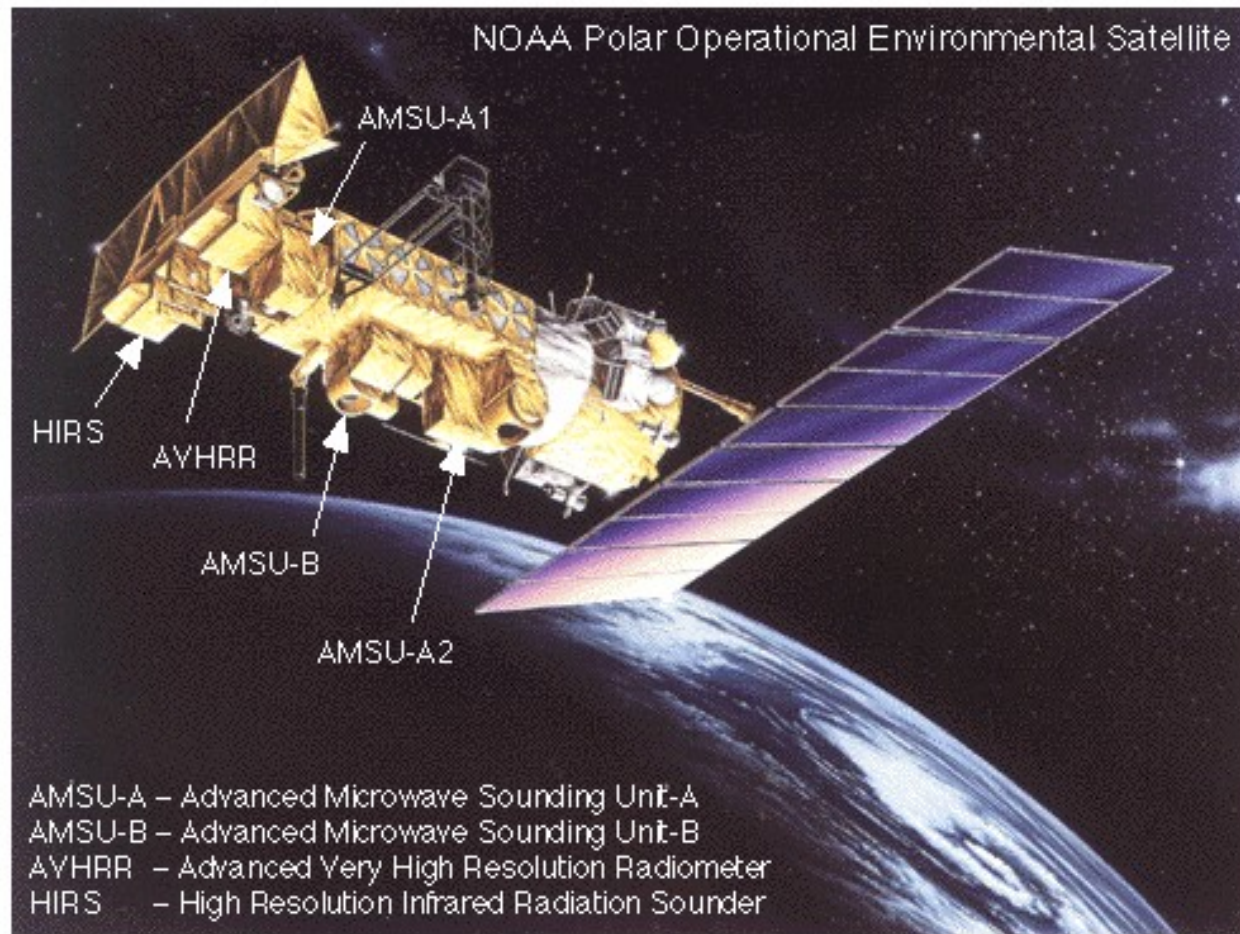
OrbView - 4



OrbView - 2

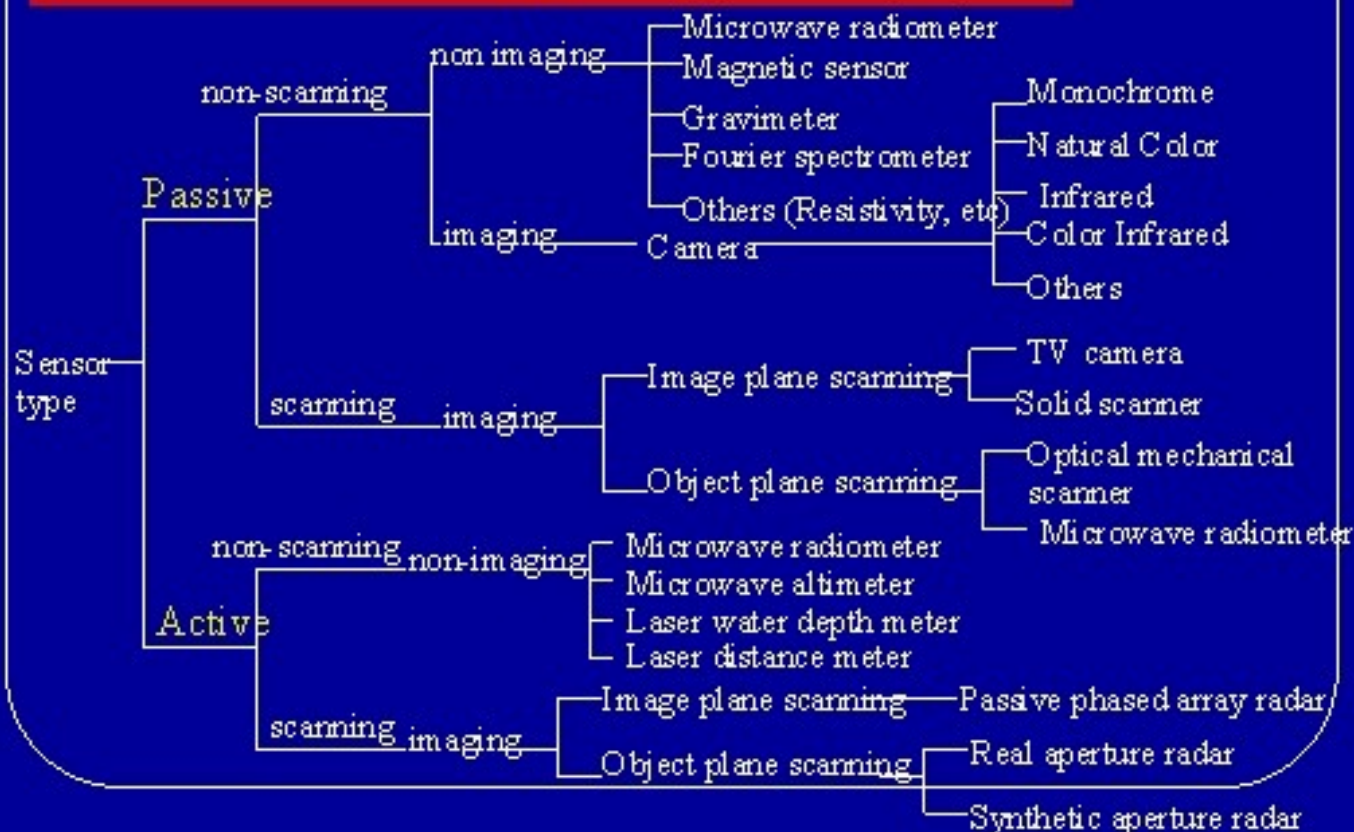
Solar panels for energy – electronics – calibration equipment – antennas – reflectors – emitters – receivers – sensors – detectors. Ground control stations.

A satellite may carry many sensors



Different ways satellite sensors measure the Earth

There are many remote sensors



Sensors:

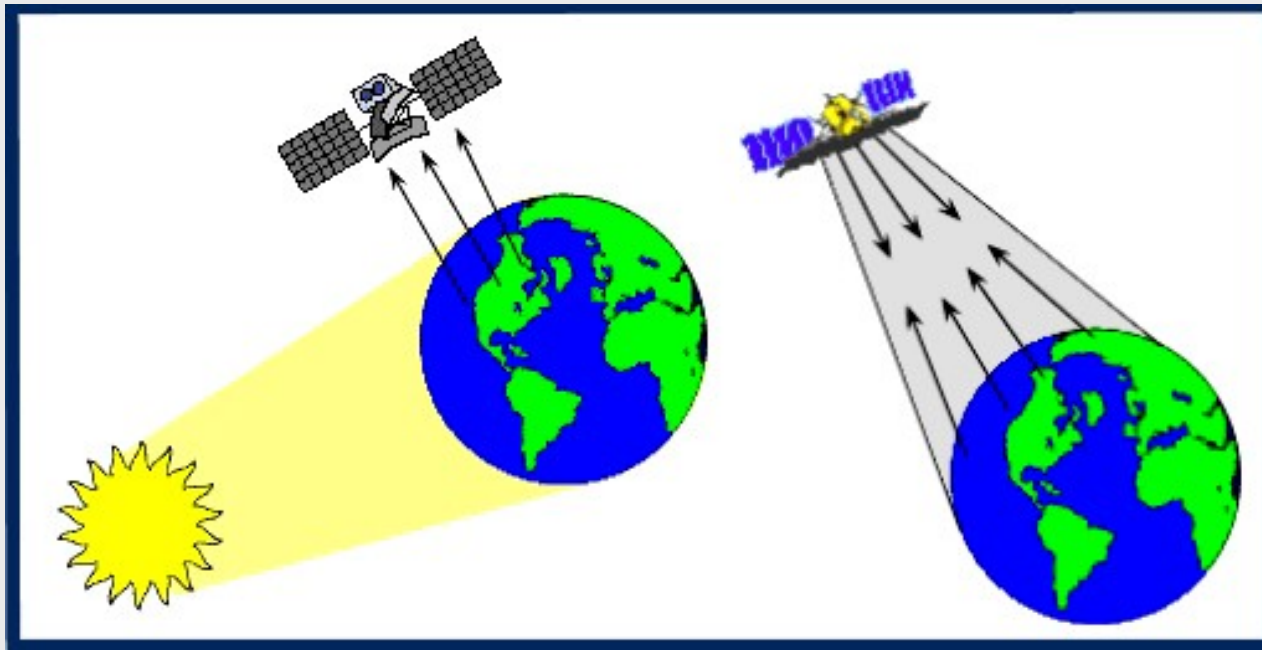
Non-imaging: measure radiation received from all points in the sensed target, integrate this, and reports the result as an electrical signal strength or some other quantitative attribute, such as radiance (astrometric and geodetic applications).

➤ **Imaging:** the electrons released are used to drive an image producing device (like TV) guided by electronic detectors; since the radiation is related to specific points in the target, the end result is an image (environmental applications).

Radiometer is a general term for any instrument that quantitatively measures the EM radiation in some interval of the EM spectrum. If the sensor includes a component, such as a prism that can break radiation extending over a part of the spectrum into discrete wavelengths and separate them at different angles to detectors, it is called a **spectrometer**.

Spectroradiometer tends to imply that the dispersed radiation is in bands rather than discrete wavelengths. Most space sensors are spectroradiometers.

SATELLITE REMOTE SENSING

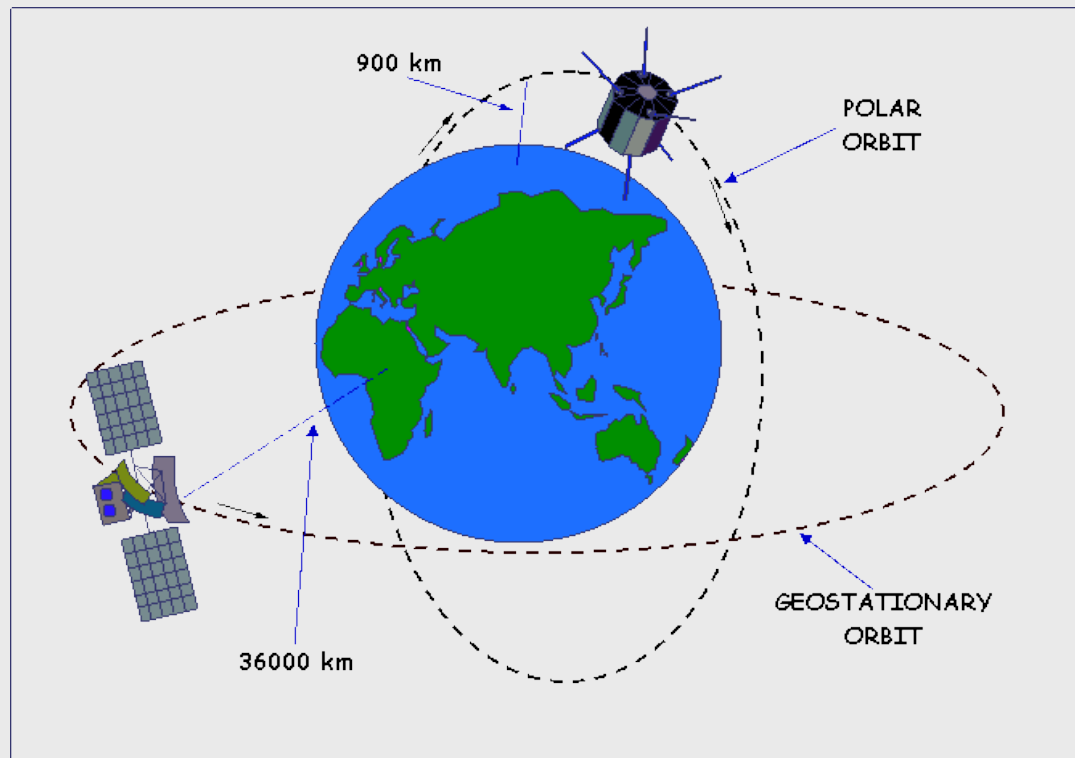


The passive and active Remote Sensing sensor systems.

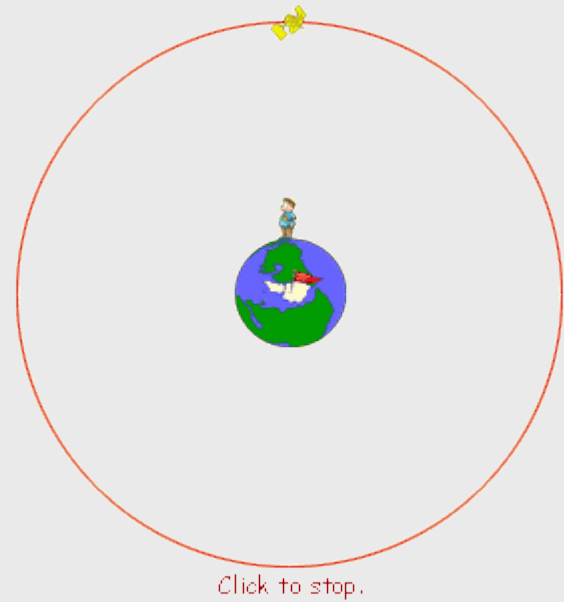
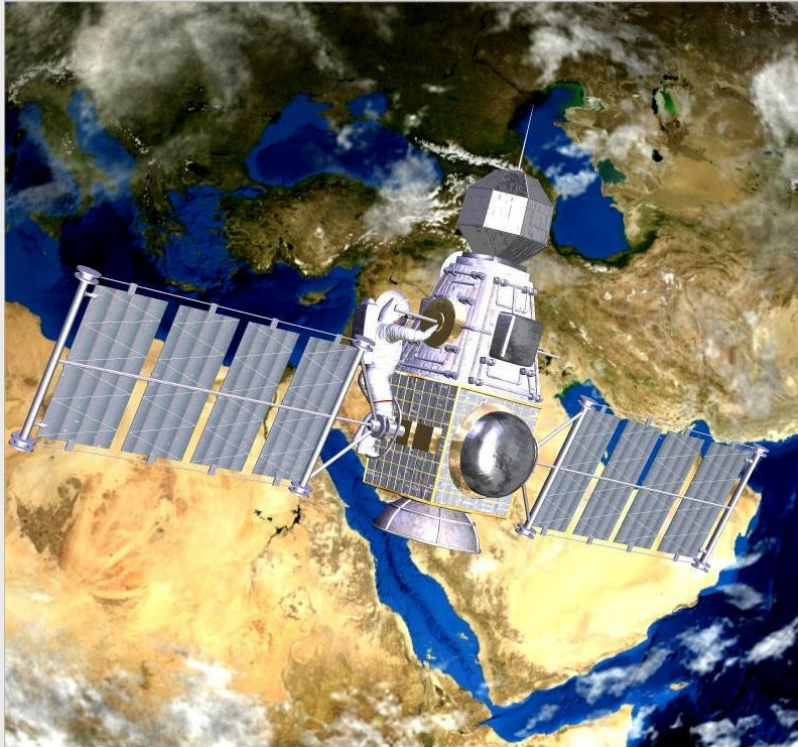
Sensors absorb either the sun's light reflectance to the earth (passive) or they transmit and absorb their own signal (active).

Different environmental parameters are measured by each sensor system.

The **geostationary** and **polar orbits** of environmental satellites.
Sensors in geostationary orbit constantly monitor the same area of the Earth while sensors in polar orbit provide data for essentially all Earth's surface.

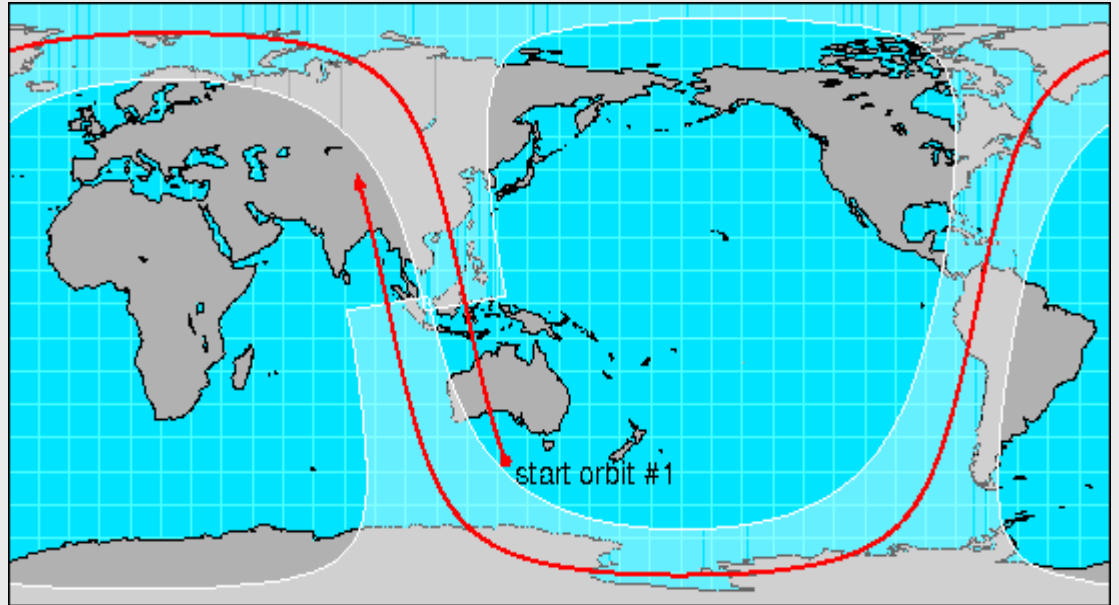
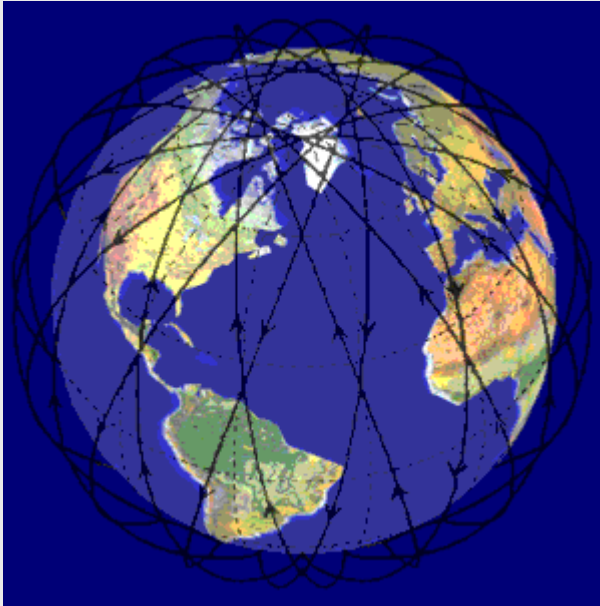


Geostationary satellite



A geostationary orbit is a geosynchronous orbit directly above the Earth's equator. From the ground, a geostationary object appears motionless in the sky.

Polar orbits



Click to stop.

Satellite has a fixed orbital plane perpendicular to the planet's rotation. It will pass over a region with a different longitude on each of its orbits.

MARINE SATELLITE REMOTE SENSING

Main Measured Parameters

Current:

- ✓ SST (Sea Surface Temperature distribution)
- ✓ Chl-a (Sea Surface Chlorophyll-a concentration)
- ✓ PAR (Photosynthetically Active Radiation)
- ✓ ALT (Altimetry)
- ✓ WIND (Wind Speed & Direction)
- ...and a variety of derived measurements (sea level anomalies, sea currents, suspended sediments, etc)

Near-Future:

- SSS (Sea Surface Salinity)
 - Soil Moisture and Ocean Salinity (SMOS) by ESA: 2008
 - Aquarius by NASA & Space Agency of Argentina: 2009

MARINE SATELLITE REMOTE SENSING

Main Satellite Sensors

- ✓ Advanced Very High Resolution Radiometer (AVHRR): SST
- ✓ Sea-viewing Wide Field-of-view Sensor (SeaWiFS): Chl-a, PAR
- ✓ Moderate-resolution Imaging Spectroradiometer (MODIS): SST, Chl-a
- ✓ QuikSCAT (Quik Scatterometer): WD, WS
- ✓ SeaWinds: WD, WS
- ✓ T/P (TOPEX/Poseidon): SL
- ✓ ERS1/2 (Earth Resources Satellite): SL
- ✓ Jason1: SL
- ✓ EnviSAT (Environmental Satellite): SL

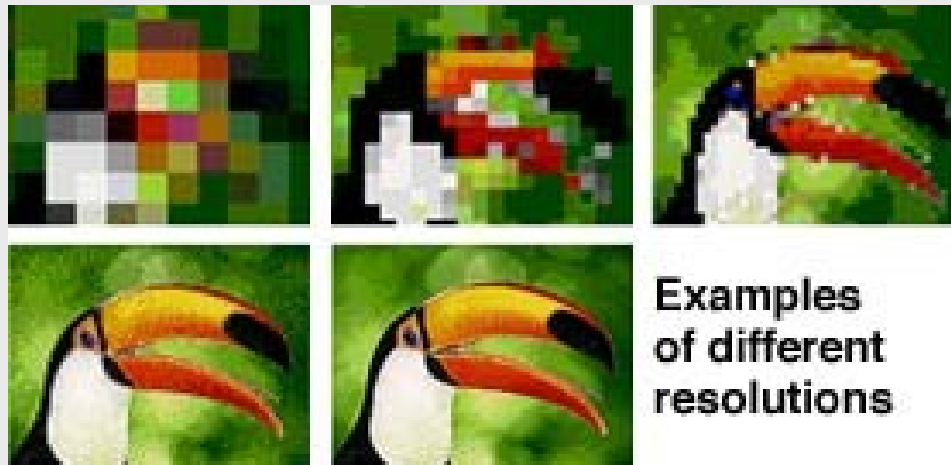
MARINE SATELLITE REMOTE SENSING

Measured Environmental Parameters

2 or 4 things to note

1. SPATIAL RESOLUTION (pixel size)

Is the spatial extent of our study area represented adequately by available satellite data?



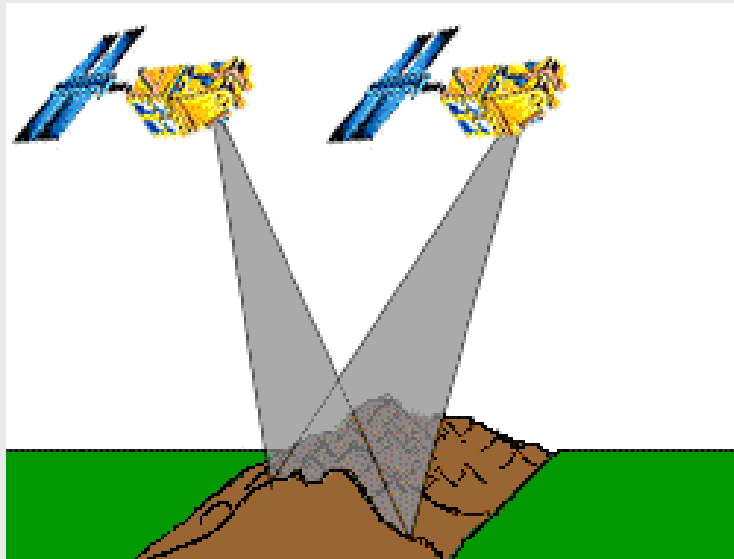
MARINE SATELLITE REMOTE SENSING

Measured Environmental Parameters

2 or 4 things to note

2. TEMPORAL RESOLUTION (daily, weekly, monthly, seasonal)

Is the time period of our study represented adequately in the available time series of satellite data?



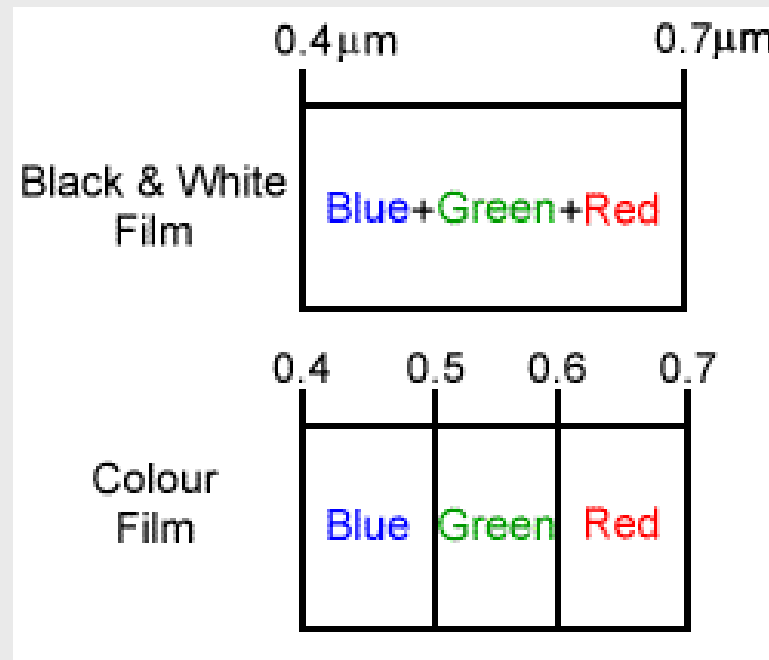
MARINE SATELLITE REMOTE SENSING

Measured Environmental Parameters

2 or 4 things to note

3. SPECTRAL RESOLUTION (how many different spectral bands)

Are available spectral bands of our satellite data adequate to describe our parameter of interest? Mostly yes!



MARINE SATELLITE REMOTE SENSING

Measured Environmental Parameters

2 or 4 things to note

3. RADIOMETRIC RESOLUTION (intensity sensors detect)

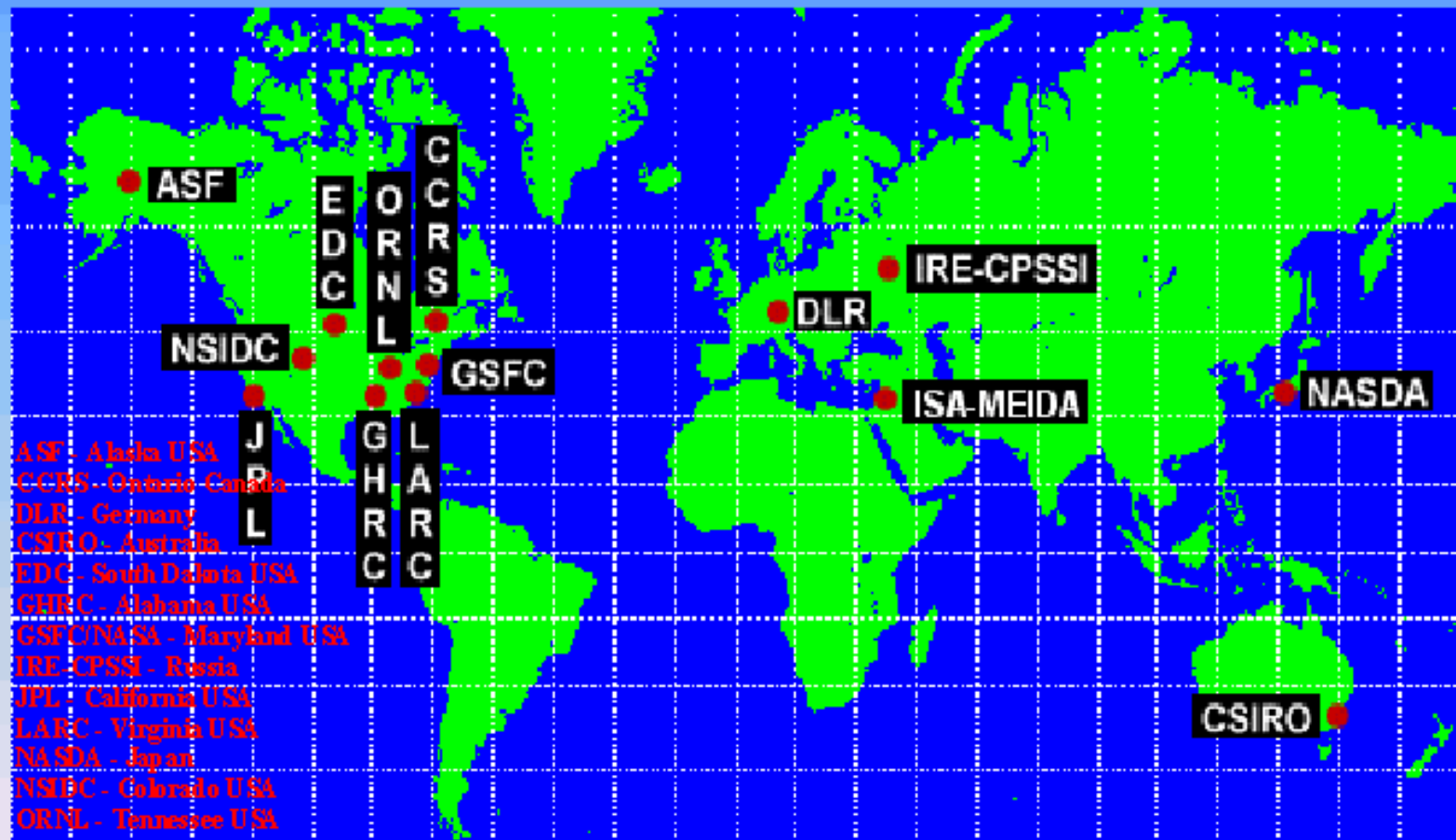
Is the resulted satellite image adequate to describe our parameter of interest?



MAJOR ONLINE RS DATA ARCHIVES



EOSDIS Data Gateway Locations

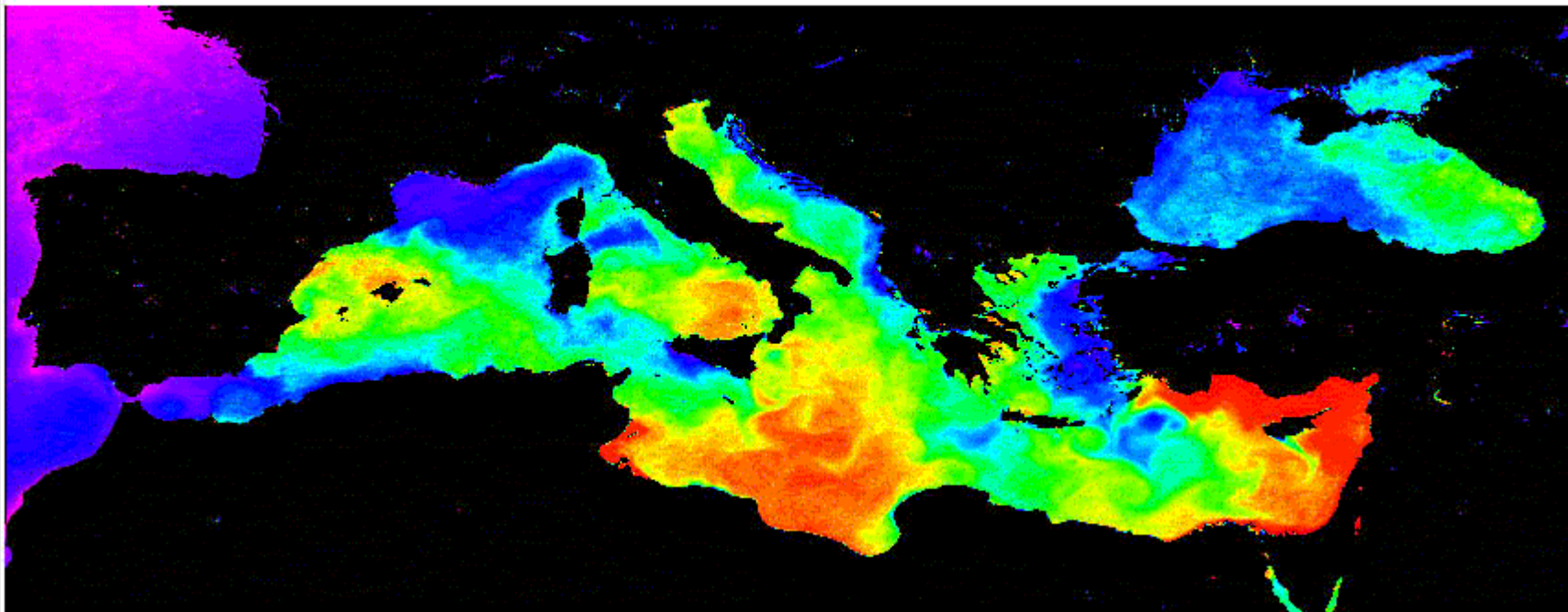


...and growing

MARINE SATELLITE REMOTE SENSING

Data Sources

Sea Surface Temperature



DLR-EOWEB, Germany

<http://eoweb.dlr.de:8080/index.html>

Spatial Resolution: 1.2km

Temporal Resolution: daily, weekly, monthly, 1993-onwards

EOWEB – DLR - SST

EOWEB - Earth Observation Data Service - Netscape

File Edit View Go Bookmarks Tools Window Help

http://eoweb.dlr.de:8080/servlets/template/welcome/entryPage.vm

Search

DLR Cluster Angewandte Fernerkundung

Home Impressum Contact

EOWEB

Login Register Logout Help Data in EOWEB

You are logged in as anonymous user.

Catalogue UserSet ShopCart

Collections :

☐ Deselect all ☐ Expand/collapse 1 Collection selected

☐ Atmospheric Sensors

☒ Thematic Maps

☐ Chlorophyll Maps Baltic Sea (MOS)

☐ Ozone Maps (GOME LEVEL 3 PRODUCTS)

☐ Vegetation Index NDVI (NOAA AVHRR)

☐ Land Surface Temperature (NOAA AVHRR)

☒ Sea Surface Temperature (NOAA AVHRR)

☐ Sea Surface Temperature (NOAA AVHRR) monthly map

☒ Sea Surface Temperature (NOAA AVHRR) weekly map

☐ Sea Surface Temperature (NOAA AVHRR) daily maps

☐ Sea Surface Temperature (NOAA AVHRR) daily maps

Query Mode: Standard

Date: Choose a Date

Area: Rectangle

From: 2007-04-01 00:00:00 To: 2007-05-03 23:59:59

Center Lat/Lon: 37.858 18.411

Extension Lat/Lon: 7.948 19.191

Step by range

3 out of 3 items returned

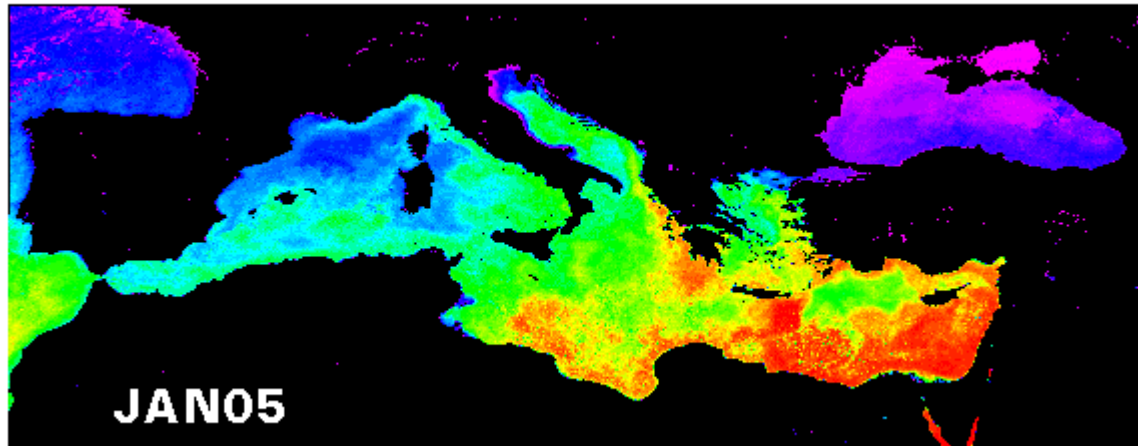
Id	Abstract	Product Type	Start Date	End Date	Item De
1	Sea Surface Temperature NOAA-18 AVHRR	Week_Composite	2007-04-02	2007-04-08	PID_ARC_Sea_Surface_Temperature_(N
2	Sea Surface Temperature NOAA-18 AVHRR	Week_Composite	2007-04-09	2007-04-15	PID_ARC_Sea_Surface_Temperature_(N
3	Sea Surface Temperature NOAA-18 AVHRR	Week_Composite	2007-04-16	2007-04-22	PID_ARC_Sea_Surface_Temperature_(N

[DLR-EOWEB, Germany](http://eoweb.dlr.de)

<http://eoweb.dlr.de:8080/index.html>

MARINE SATELLITE REMOTE SENSING

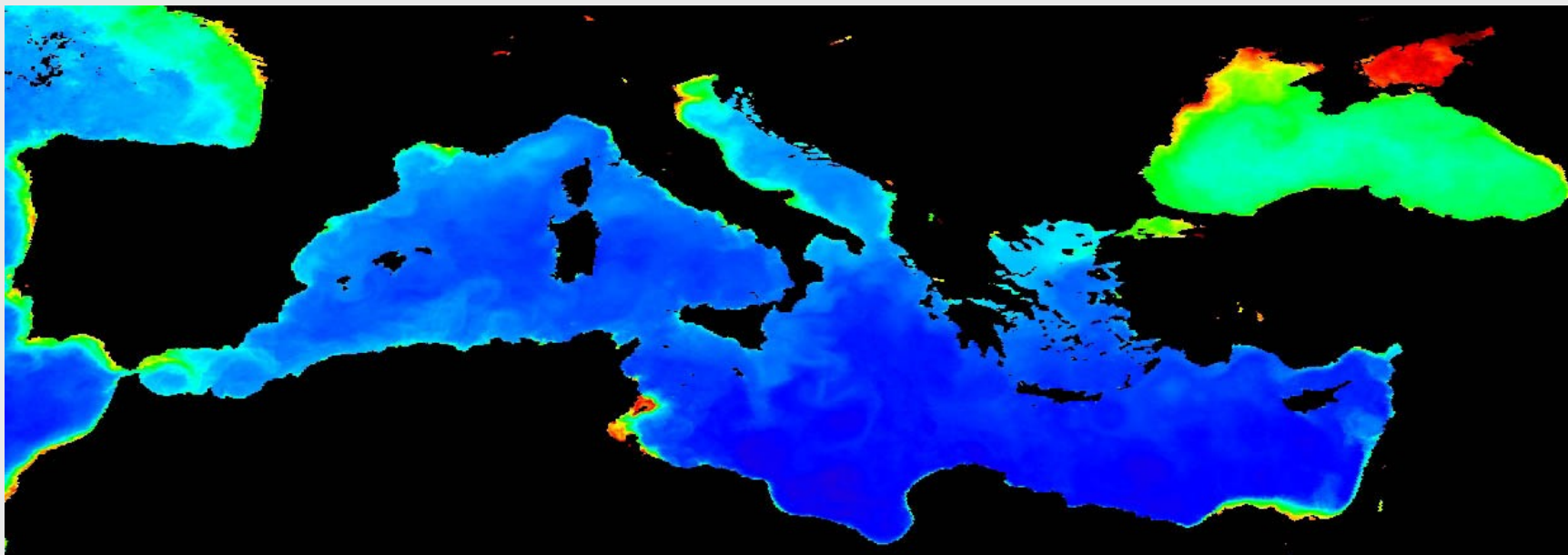
SST 2005



MARINE SATELLITE REMOTE SENSING

Data Sources

Sea Surface Chlorophyll-a



NASA-OceanColorWEB, USA <http://oceancolor.gsfc.nasa.gov/>

Spatial Resolution: 4km and 9km

Temporal Resolution: daily, weekly, monthly, 1998-onwards

OCEANCOLOR - SeaWiFS

Level-3 Standard Mapped Images (Chlorophyll (SeaWiFS)) - Mozilla Firefox
http://oceancolor.gsfc.nasa.gov/cgi/level3.pl?DAY=8PER=YSM8&TYP=swch&RRW=7

Level-3 Standard Mapped Images

[Color scales](#)
[Rolling 32-day composites](#)
["Filled-in" rolling 32-day biosphere composites](#)
[Climatologies](#)
[SeaWiFS anomaly images](#)

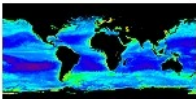
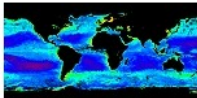
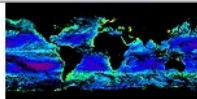
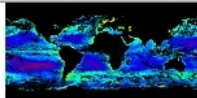
Aqua-MODIS	Chlorophyll	Diffuse attenuation	nLw at 551 nm	Aerosol optical thickness	Angstrom coefficient	SST [11 μ day]	SST [11 μ night]	SST [4 μ night]
Terra-MODIS	Chlorophyll	Diffuse attenuation	nLw at 551 nm	Aerosol optical thickness	Angstrom coefficient	SST [11 μ day]	SST [11 μ night]	SST [4 μ night]
SeaWiFS	Chlorophyll	Diffuse attenuation	nLw at 555 nm	Aerosol optical thickness	Angstrom coefficient			
	Biosphere	PAR	NDVI	Land Reflectance				
OCTS	Chlorophyll	Diffuse attenuation	nLw at 565 nm	Aerosol optical thickness	Angstrom coefficient			
CZCS	Chlorophyll		nLw at 550 nm	Aerosol optical thickness	Angstrom coefficient			
Evaluation Products	Merged Chlorophyll	Calcite	Fluorescence Line Height					

Sep 1997
Oct 1997
Nov 1997
Dec 1997

Jan 1998	Feb 1998	Mar 1998	Apr 1998	May 1998	Jun 1998	Jul 1998	Aug 1998	Sep 1998	Oct 1998	Nov 1998	Dec 1998
Jan 1999	Feb 1999	Mar 1999	Apr 1999	May 1999	Jun 1999	Jul 1999	Aug 1999	Sep 1999	Oct 1999	Nov 1999	Dec 1999
Jan 2000	Feb 2000	Mar 2000	Apr 2000	May 2000	Jun 2000	Jul 2000	Aug 2000	Sep 2000	Oct 2000	Nov 2000	Dec 2000
Jan 2001	Feb 2001	Mar 2001	Apr 2001	May 2001	Jun 2001	Jul 2001	Aug 2001	Sep 2001	Oct 2001	Nov 2001	Dec 2001
Jan 2002	Feb 2002	Mar 2002	Apr 2002	May 2002	Jun 2002	Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002
Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003	Aug 2003	Sep 2003	Oct 2003	Nov 2003	Dec 2003
Jan 2004	Feb 2004	Mar 2004	Apr 2004	May 2004	Jun 2004	Jul 2004	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004
Jan 2005	Feb 2005	Mar 2005	Apr 2005	May 2005	Jun 2005	Jul 2005	Aug 2005	Sep 2005	Oct 2005	Nov 2005	Dec 2005
Jan 2006	Feb 2006	Mar 2006	Apr 2006	May 2006	Jun 2006	Jul 2006	Aug 2006	Sep 2006	Oct 2006	Nov 2006	Dec 2006
Jan 2007	Feb 2007	Mar 2007	Apr 2007	May 2007							

[Previous](#)
Chlorophyll (SeaWiFS)

rows in the rightmost column
[Next](#)

Yearly	Seasonal	Monthly	Weekly	D
	 <p>Winter-2007 9km png HDF</p>	 <p>Mar-2007 9km png HDF</p>	 <p>06Mar2007 to 13Mar2007 9km png HDF</p>  <p>14Mar2007 to 21Mar2007 9km png HDF</p>	

OCEANCOLOR – Aqua-MODIS

Level-3 Standard Mapped Images (Chlorophyll (Aqua-MODIS)) - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://oceancolor.gsfc.nasa.gov/cgi/level3.pl?DAY=&PER=Y5M8&TYP=mach&RRW=7

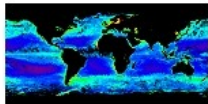
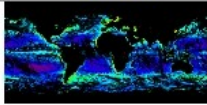
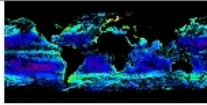
Level-3 Standard Mapped Images [Help](#)

[Color scales](#) [Rolling 32-day composites](#) ["Filled-in" rolling 32-day biosphere composites](#) [Climatologies](#) [SeaWiFS anomaly images](#)

Aqua-MODIS	Chlorophyll	Diffuse attenuation	nLw at 551 nm	Aerosol optical thickness	Angstrom coefficient	SST [11 μ day]	SST [11 μ night]	SST [4 μ night]
Terra-MODIS	Chlorophyll	Diffuse attenuation	nLw at 551 nm	Aerosol optical thickness	Angstrom coefficient	SST [11 μ day]	SST [11 μ night]	SST [4 μ night]
SeaWiFS	Chlorophyll	Diffuse attenuation	nLw at 555 nm	Aerosol optical thickness	Angstrom coefficient			
	Biosphere	PAR	NDVI	Land Reflectance				
OCTS	Chlorophyll	Diffuse attenuation	nLw at 565 nm	Aerosol optical thickness	Angstrom coefficient			
CZCS	Chlorophyll		nLw at 550 nm	Aerosol optical thickness	Angstrom coefficient			
Evaluation Products	Merged Chlorophyll	Calcite	Fluorescence Line Height					

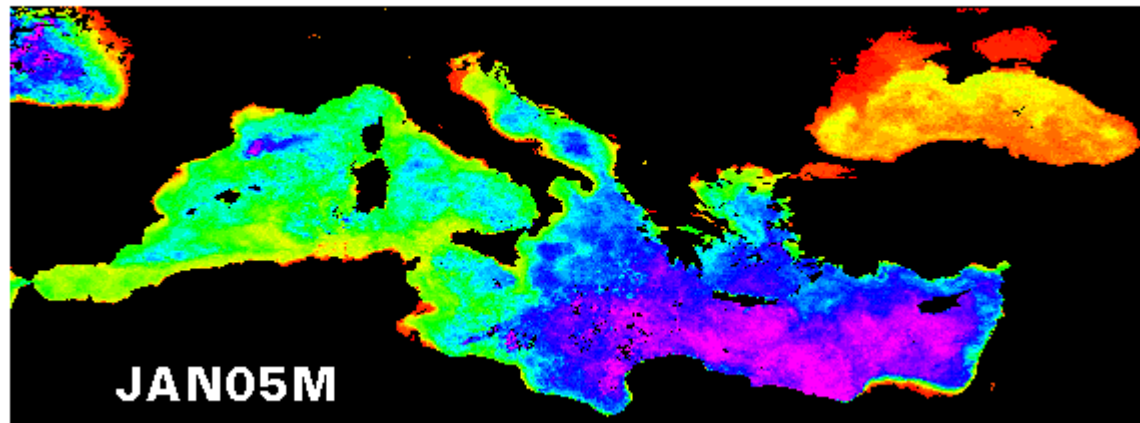
						Jul 2002	Aug 2002	Sep 2002	Oct 2002	Nov 2002	Dec 2002
Jan 2003	Feb 2003	Mar 2003	Apr 2003	May 2003	Jun 2003	Jul 2003	Aug 2003	Sep 2003	Oct 2003	Nov 2003	Dec 2003
Jan 2004	Feb 2004	Mar 2004	Apr 2004	May 2004	Jun 2004	Jul 2004	Aug 2004	Sep 2004	Oct 2004	Nov 2004	Dec 2004
Jan 2005	Feb 2005	Mar 2005	Apr 2005	May 2005	Jun 2005	Jul 2005	Aug 2005	Sep 2005	Oct 2005	Nov 2005	Dec 2005
Jan 2006	Feb 2006	Mar 2006	Apr 2006	May 2006	Jun 2006	Jul 2006	Aug 2006	Sep 2006	Oct 2006	Nov 2006	Dec 2006
Jan 2007	Feb 2007	Mar 2007	Apr 2007	May 2007							

[Previous](#) **Chlorophyll (Aqua-MODIS)** rows in the rightmost column [Next](#)

Yearly	Seasonal	Monthly	Weekly	D3
	<p>Winter-2007 A20063552007079.L3m_SNWI_CHLO_9 not available</p>	 Mar-2007 9km png HDF	 06Mar2007 to 13Mar2007 9km png HDF 4km png HDF  14Mar2007 to 21Mar2007 9km png HDF 4km png HDF	

MARINE SATELLITE REMOTE SENSING

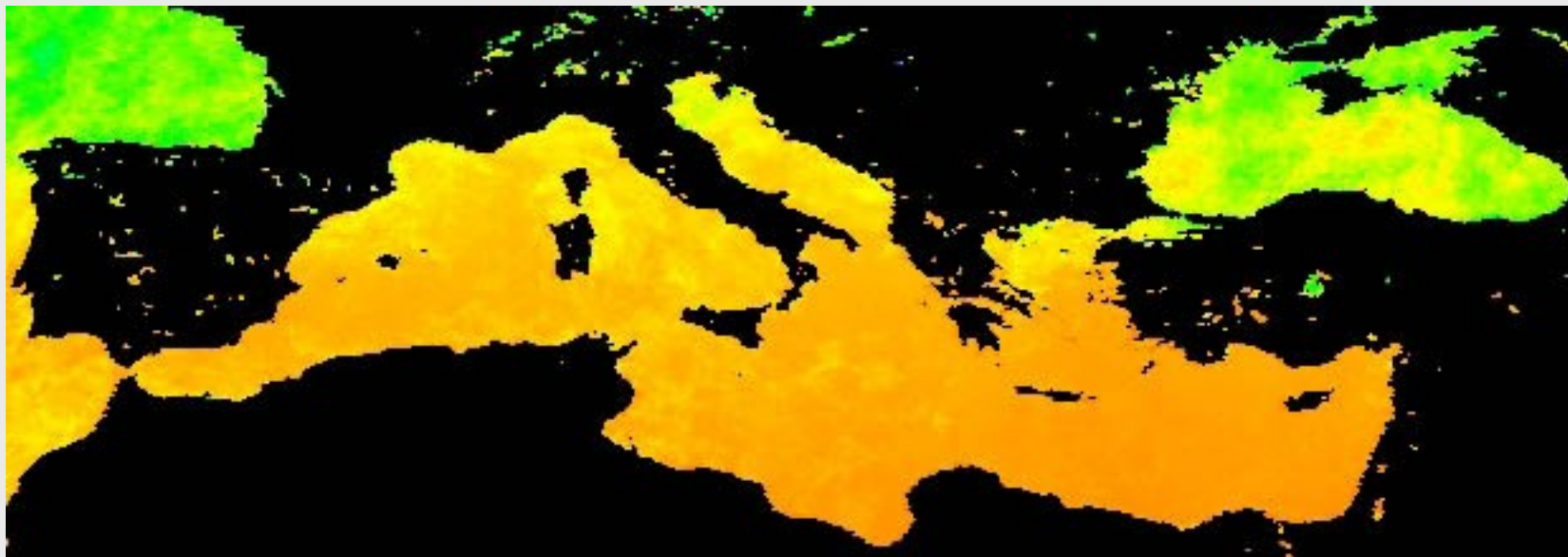
Chl-a 2005



MARINE SATELLITE REMOTE SENSING

Data Sources

Photosynthetically Active Radiation



NASA-OceanColorWEB, USA

<http://oceancolor.gsfc.nasa.gov/>

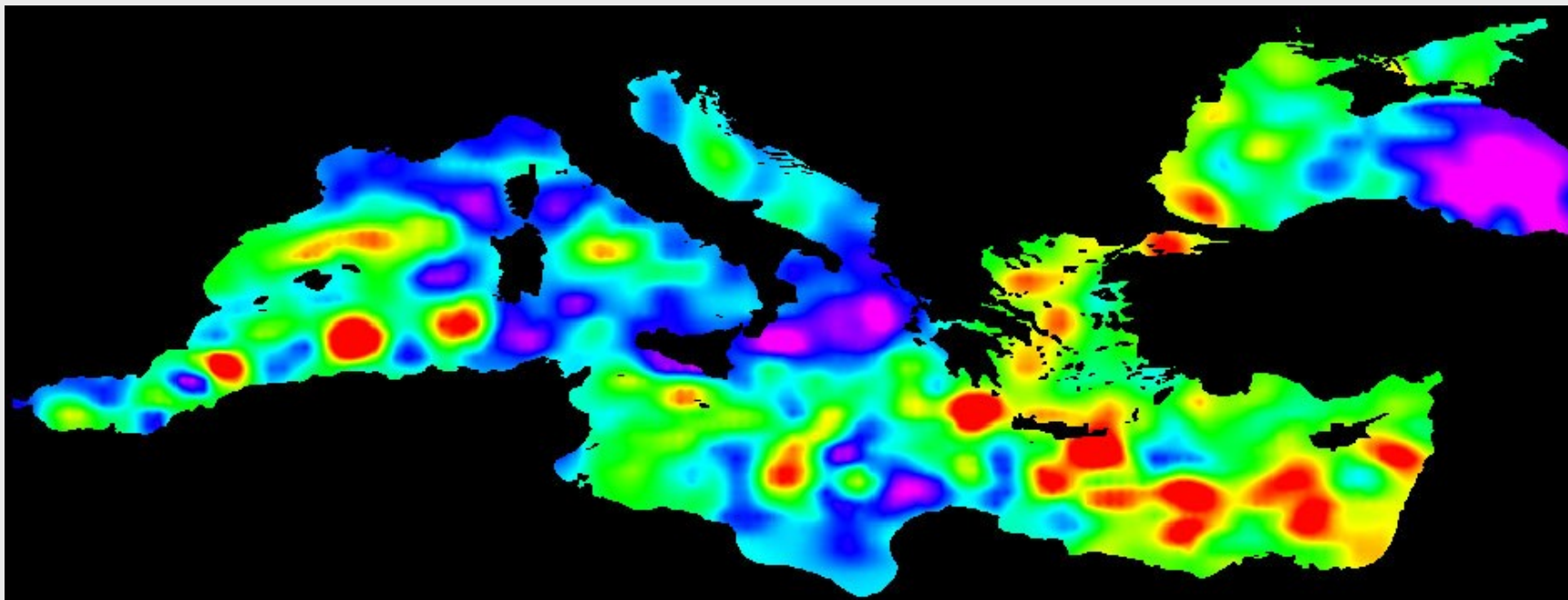
Spatial Resolution: 9km

Temporal Resolution: daily, weekly, monthly, 1998-onwards

MARINE SATELLITE REMOTE SENSING

Data Sources

Sea Level Anomaly



CNES-CLS-Aviso, France

<http://www.aviso.oceanobs.com/>

Spatial Resolution: ~15km



Temporal Resolution: weekly, 1993-onwards

AVISO – FR Sea Level Anomaly

Aviso LAS server - Netscape

File Edit View Go Bookmarks Tools Window Help

http://las.aviso.oceanobs.com/las/servlets/constrain?var=4



Live Access Server

Search dataset/variable: **Go**

single data set **compare two**

Datasets

Variables

Constraints

Output

Output Options

Previous Output

Define variable

About

LAS UI Version 6.4.2

Datasets > SSALTO/DUACS near-real time Maps of Sea Level Anomalies

Variable(s): **Maps of Sea Level Anomalies Merged**

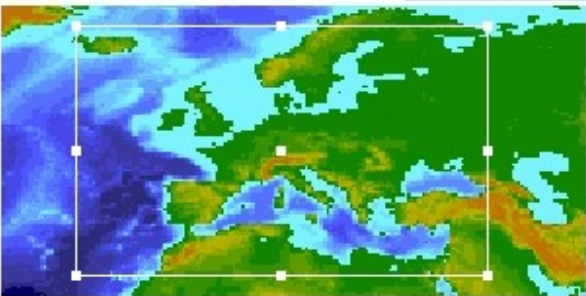
Select your desired view (geometry of output) and output (type of product). Then set the 4-D region (lon-lat-depth-time) and any additional constraints. [Help](#)

Select view:

Select output:

Select region: **Go**

[Don't use map applet](#)



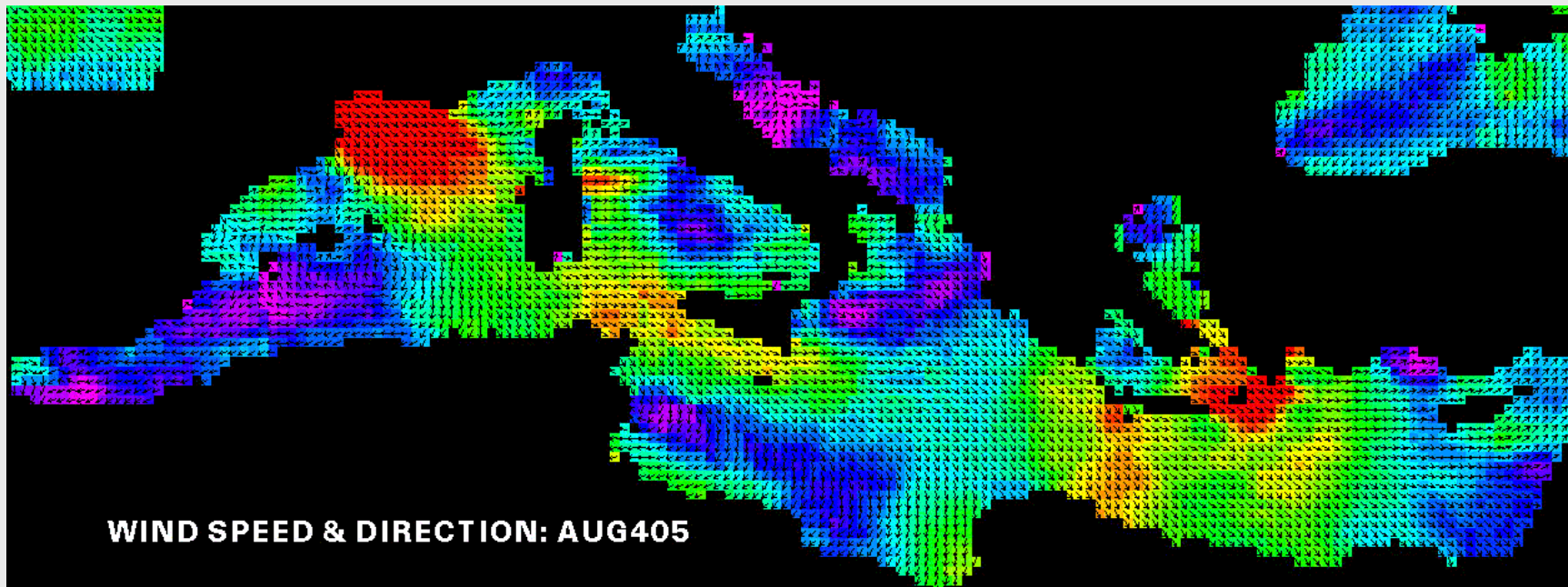
Select time:

Next >

MARINE SATELLITE REMOTE SENSING

Data Sources

Wind Speed & Direction



RS Systems, USA

<http://www.ssmi.com/>

Spatial Resolution: ~15km

Temporal Resolution: daily, weekly, monthly, 1999-onwards

RSDATA SYSTEMS - WIND SPEED & DIRECTION

The screenshot displays the Core FTP LE application window. The title bar reads "Core FTP LE - ftp.ssmi.com:21". The menu bar includes "File", "View", "Sites", "Manage", and "Help". The toolbar contains various icons for file operations. The main text area shows the following FTP session log:

```
227 Entering Passive Mode (198,120,16,66,13,57)
LIST
Connect socket #724 to 198.120.16.66, port 3386...
150 Opening ASCII mode data connection for /bin/ls.
226 Transfer complete.
Transferred 737 bytes in 0.008 seconds
NOOP
200 Command okay.
PWD
257 "/qscat/bmaps_v03a" is current directory.
```

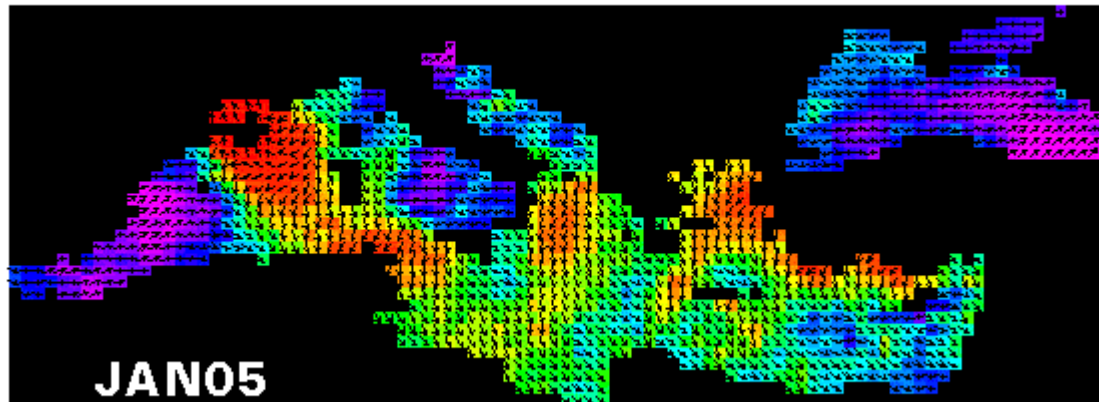
Below the log, there are two file explorer panes. The left pane shows the local drive "C:\\" with a list of files and folders. The right pane shows the remote directory "/qscat/bmaps_v03a/" with a list of files and folders.

Filename	Size	Date
\$VAULT\$.AVG		04/27/07 08:52
ADOBEAPP		02/16/04 12:56
arcexe80		12/23/03 12:20
ARCH		02/17/07 13:08
ATI		01/28/05 12:07
Borland		04/15/05 12:26
Config.Msi		04/21/07 13:14
covers		04/25/07 13:29
cpf_editor2.8.2		06/23/05 11:18
Documents and Settings		12/18/06 16:05
downloads		04/27/07 12:03
ESRI		12/23/03 12:35
F77		01/30/04 13:31
F90		06/23/05 11:21
flexlm		05/02/07 16:41
FPlus examples		06/23/05 11:07
gfortran		06/24/05 10:28
HCMR		05/02/07 16:59

Filename	Size	Date	Permissions
<..>			
..			
weeks		05/02/07 20:08	drw-rw-rw-
y1999		10/10/06 00:00	drw-rw-rw-
y2000		09/14/06 00:00	drw-rw-rw-
y2001		09/14/06 00:00	drw-rw-rw-
y2002		09/14/06 00:00	drw-rw-rw-
y2003		09/14/06 00:00	drw-rw-rw-
y2004		09/14/06 00:00	drw-rw-rw-
y2005		09/14/06 00:00	drw-rw-rw-
y2006		09/14/06 00:00	drw-rw-rw-
y2007		12/05/06 22:31	drw-rw-rw-

MARINE SATELLITE REMOTE SENSING

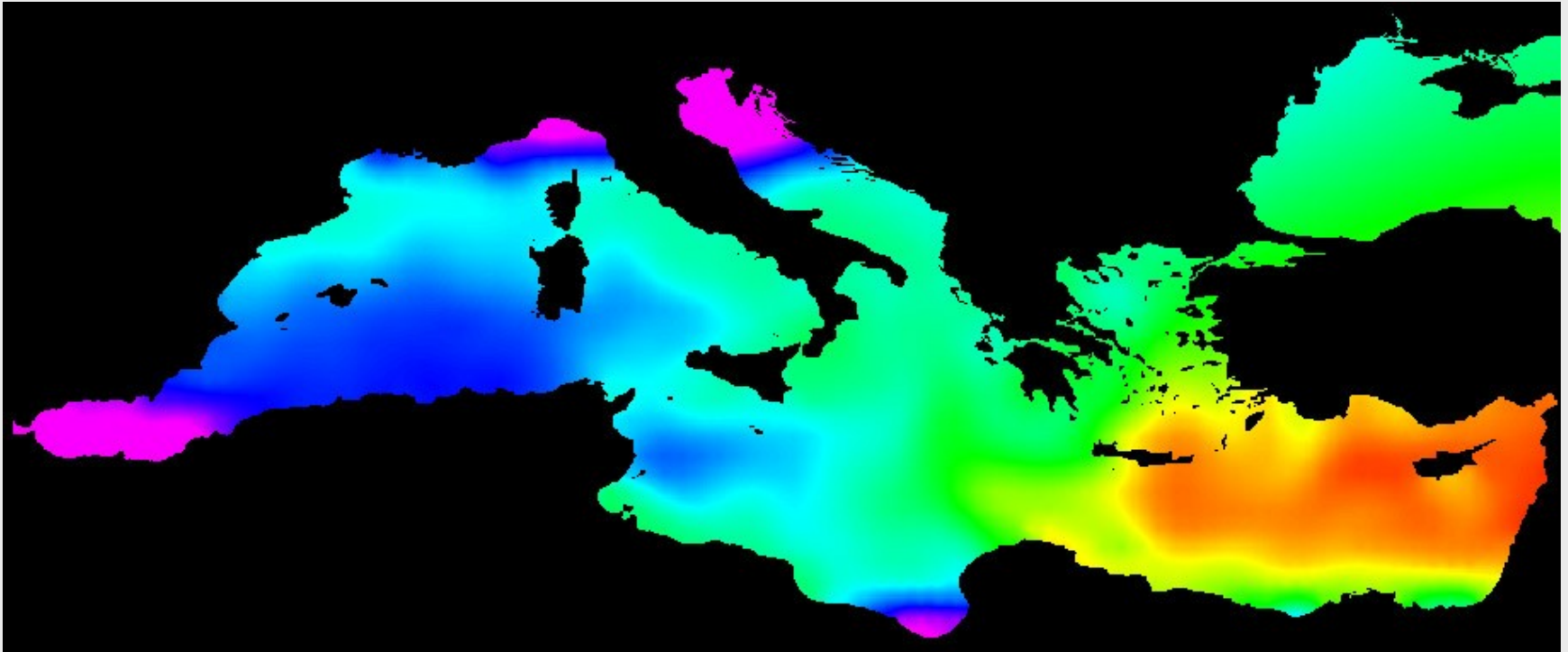
WIND SPEED & DIRECTION 2005



Modelled Data

Data Sources

Sea Surface Salinity



IRI-LDEO-CDL, USA

<http://ingrid.ldeo.columbia.edu/>

Spatial Resolution: ~40km

Temporal Resolution: daily, weekly, monthly, 1999-onwards

UNIV. COLUMBIA - Salinity

Datasets By Category - Oceanographic Data - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://iri.ldeo.columbia.edu/docfind/databrief/cat-ocean.html

Oceanographic Data in the IRI Data Library

Dataset Name	Spatial Resolution (Lon/Lat) / Number of Stations	Spatial Extent	Time Period	Temporal Resolution
<u>ARCTIC STATION</u>	35 STATIONS	[14.855W,163.68E], [70N,88.333N]	NA	NA
Description: Oceanic station data for the Arctic Region.				
<u>CARTON-GIESE SODA</u>	0.5x0.5	GLOBAL [75.25S,89.25N]	Jan 1958-Dec 2001, Jan 2000-Dec 2004	MONTHLY
Description: Simple Ocean Data Assimilation: A Reanalysis of Ocean Climate.				
<u>CMA BCC GODAS</u>	1.875x1.860121	GLOBAL [79.271S,90N]	Jan 1982,Mar 2007	MONTHLY
Description: Global Ocean Data Assimilation Operational System.				
<u>CORAL</u>	2 STATIONS	NA	VARIOUS: 1846-1995	MONTHLY
Description: Isotope d18O from coral colonies in Seychelles and Tarawa.				

IRI

Finding Datasets

By Category
By Source
By Search

help@iri

IRI-LDEO-CDL, USA

<http://ingrid.ldeo.columbia.edu/>

3D DATA SOURCE BASED ON RS DATA + SURVEYED DATA

Mercator Ocean, Operational Ocean Forecasting - Products and Services - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://www.mercator-ocean.fr/html/products/description/welcome_en.html

MERCATOR
OPERATIONAL OCEANOGRAPHY

Products

Mercator Ocean

News

Products

- Access terms
- Handbooks
- Images bulletin
- Interpreted bulletin
- Live Access Server
- Opendap Server
- HTTP Server
- Maps Server

Applications

Science

Collaborations

Publications

Glossary

Site map

Search

France Français

Printable version

Products ▾

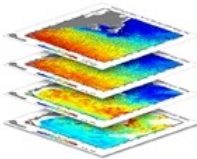
[Access terms](#) | [Handbooks](#) | [Images bulletin](#) | [Interpreted bulletin](#) | [Live Access Server](#) → | [Opendap Server](#) → | [Maps Server](#) →

Mercator products

Current and forecast 3D ocean products : web images and digital products

Mercator web image bulletins are designed for a wide audience, while digital products target professional ocean users such as scientists, fishermen, military users, oil producers and racing yachtsmen.

Images bulletin




Find out about all the web products available:

- [Visualize the weekly bulletin](#)
- [Tutorial](#)
- [The illustrated Mercator system](#)
- [A voyage of discovery](#)

Digital products

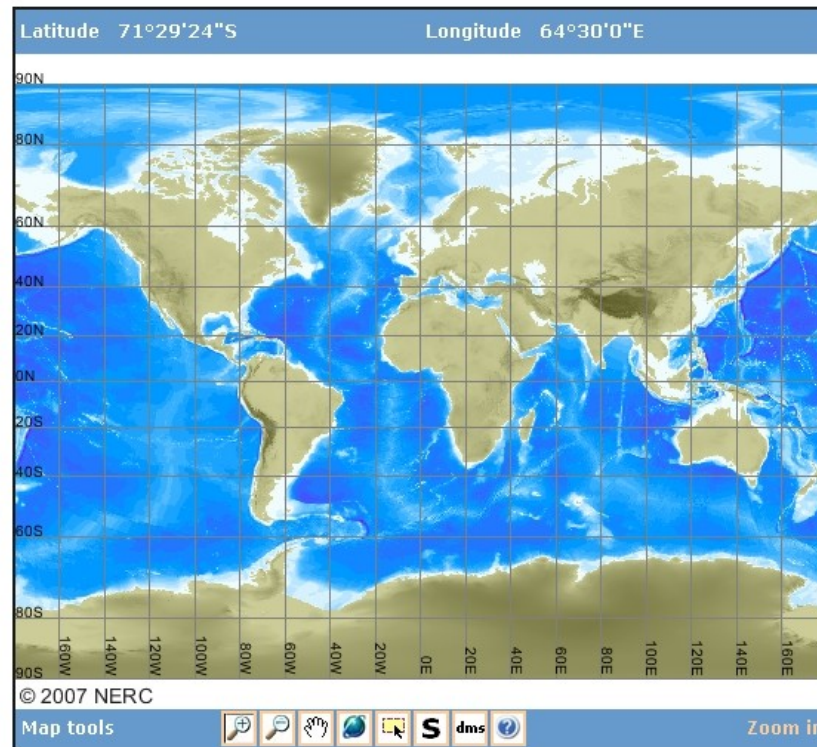
Digital products are files for professional users and are available on a remote server. Please make an e-mail request to products@mercator-ocean.fr or [download](#) a request form.

- [Digital products handbook](#)
- [Access Opendap Server](#) (authorized access : see [conditions](#))
- [Live Access Server](#) : Draw your own map and retrieve the data (authorized access : see [conditions](#))



BATHYMETRY DATA SOURCE

http://www.bodc.ac.uk/data/online_delivery/gebco/select/



Northernmost
latitude 55° 0' N

Westernmost
longitude

5° 0' W

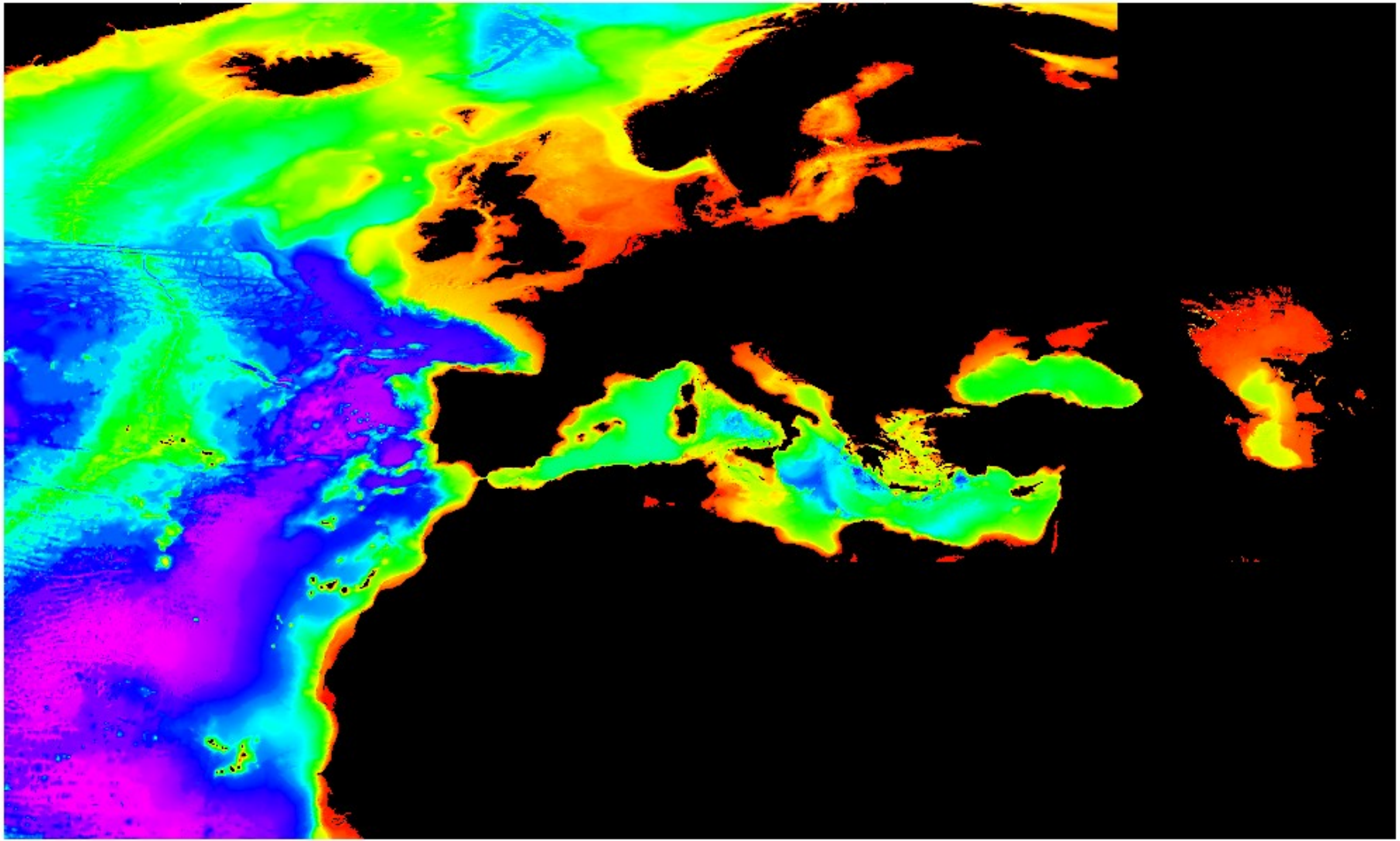
Easternmost
longitude

0° 0' E

Southernmost
latitude

50° 0' N

BATHYMETRY – EUROPEAN SEAS



FINAL IMAGE PRODUCTS (L3)

- ✓ L1 (raw data), L2 (corrected), L3 (image data)
- ✓ L3 ready-to-use
- ✓ Provided in different distribution formats
- ✓ Provided with image values 0-255
- ✓ ...with image-to-real values tables or equations
- ✓ Classification

Classification Techniques

✓ Unsupervised

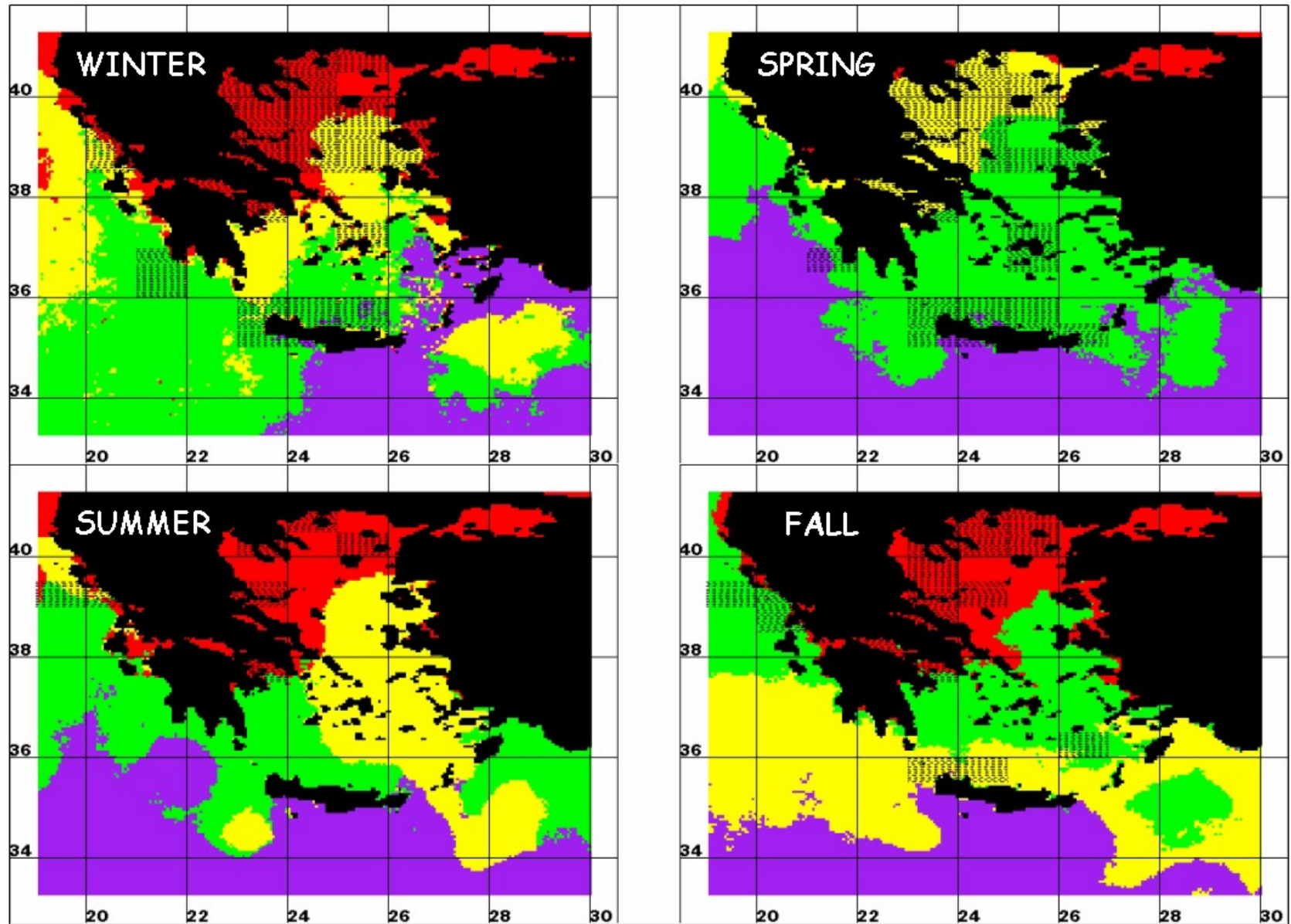
Clustering does not require the user to specify any information about the features contained in the images but just the cluster number

✓ Supervised

Spectral signatures are developed from specified locations in the image. Such locations are 'training sites' and are defined by the user.

Combined Classification

Combined Classification of SST ↓, Chl-a ↑, SAL ↓



RS L3 IMAGE DATA PROCESSING IN GIS

image processing basic routine

```
imagegrid may07.tif may07a
```

```
may07b = select(may07a, 'value > 0 & value < 255')
```

```
gridwarp may07b linkdd.txt may07
```

```
joinitem may07.vat sst.lut may07.vat value
```

georeference

4095.500	-0.500	42.855	28.052
2047.750	-0.500	16.500	28.052
-0.500	-0.500	-9.846	28.052
3455.500	4.928	34.574	28.104
3485.798	131.470	34.941	29.503
3163.239	129.842	30.815	29.504
3295.095	168.897	32.571	29.977
2256.027	199.196	19.125	30.277
22.832	200.087	-9.641	30.297

1,0.13
2,0.25
3,0.38
4,0.50
5,0.63
6,0.75
7,0.88
8,1.00
..
..
..
249,31.13
250,31.25
251,31.38
252,31.50
253,31.63
254,31.75

image-to-real_value conversion

DATA HOLDINGS BY HCMR

- ✓ Sea Surface Temperature
- ✓ All SeaWiFS Products (Chl-a, PAR, etc)
- ✓ Sea Surface Salinity
- ✓ Sea Level Anomaly
- ✓ Wind Speed & Direction
- ✓ Bathymetry
- ✓ Coastlines

Resolutions: European Seas, weekly, monthly



Marine GIS Intro and some examples

GIS

GI SCIENCE

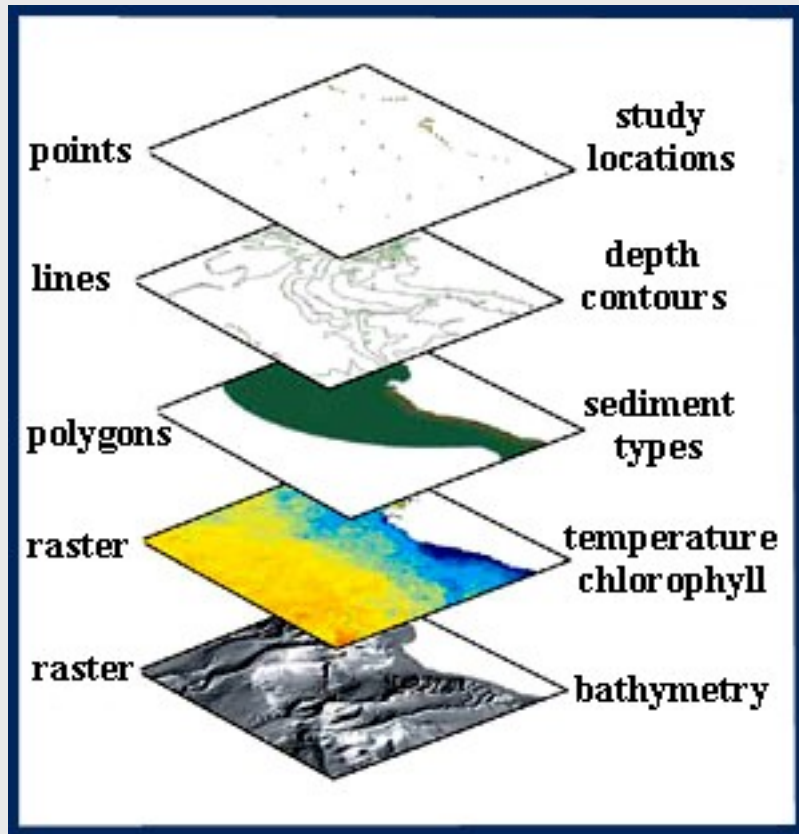


GI SYSTEMS

Geographic Information Science (GI Science), the scientific content to Geographic Information Systems (GI Systems), the technical content of GI Science, are both emerging and coherent science and technology fields with two important research streams:

- **research in basic GI Science (e.g. software integration, data scale and resolution, process models)**
- **research using GI Systems (e.g. data modeling and integration, decision support)**

GEOGRAPHICAL INFORMATION SYSTEMS



Examples of the variety of data types handled by Marine GIS.

Points, lines and polygons are vector data type while satellite imagery and model output are raster data type.

Under GIS relational databases, different data formats are uniformly stored and referenced through a common geo-reference system. Then, spatial integration and GIS analysis of different data types is applied.

GIS RELATIONAL DATABASE (attribute data)

Hypothetical Relational Database Model

PubID	Publisher	PubAddress
03-4472822	Random House	123 4th Street, New York
04-7733903	Wiley and Sons	45 Lincoln Blvd, Chicago
03-4859223	O'Reilly Press	77 Boston Ave, Cambridge
03-3920886	City Lights Books	99 Market, San Francisco

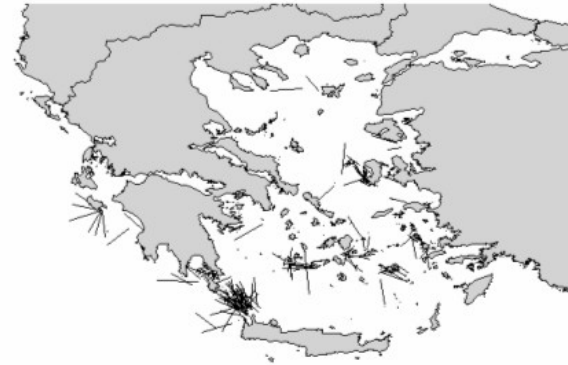
AuthorID	AuthorName	AuthorBDay
345-28-2938	Haile Selassie	14-Aug-92
392-48-9965	Joe Blow	14-Mar-15
454-22-4012	Sally Hemmings	12-Sept-70
663-59-1254	Hannah Arendt	12-Mar-06

ISBN	AuthorID	PubID	Date	Title
1-34532-482-1	345-28-2938	03-4472822	1990	Cold Fusion for Dummies
1-38482-995-1	392-48-9965	04-7733903	1985	Macrame and Straw Tying
2-35921-499-4	454-22-4012	03-4859223	1952	Fluid Dynamics of Aquaducts
1-38278-293-4	663-59-1254	03-3920886	1967	Beads, Baskets & Revolution

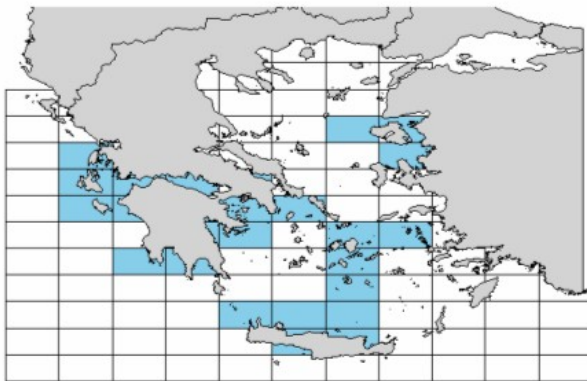
Examples of a **vector GIS database** including fisheries attribute data represented spatially by **points**, **lines** and **polygons**.



POINT DATA (e.g. *Fish Acoustic Survey*)



LINE DATA (e.g. *Fish Longlines*)



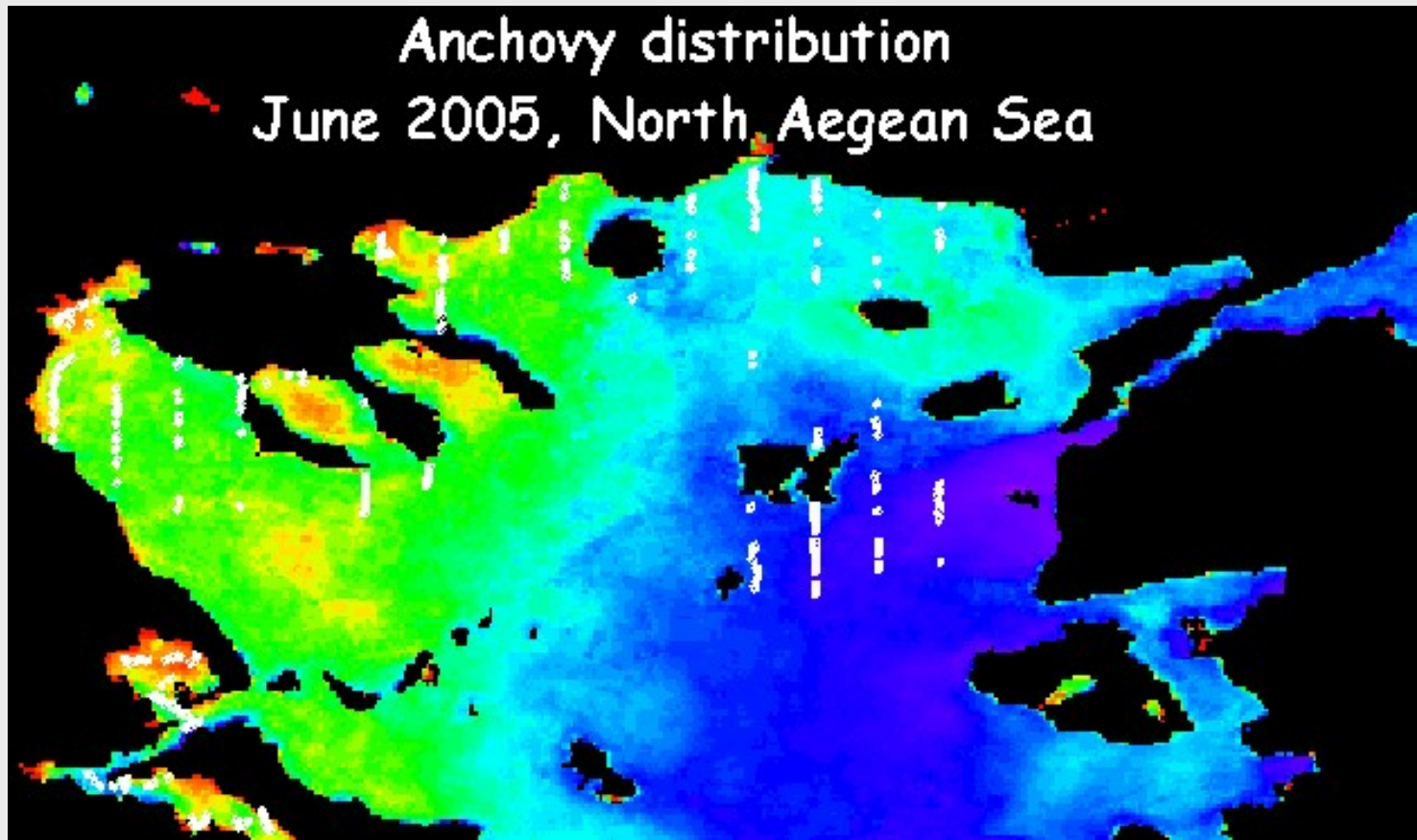
POLYGON DATA (e.g. *Fish Production*)

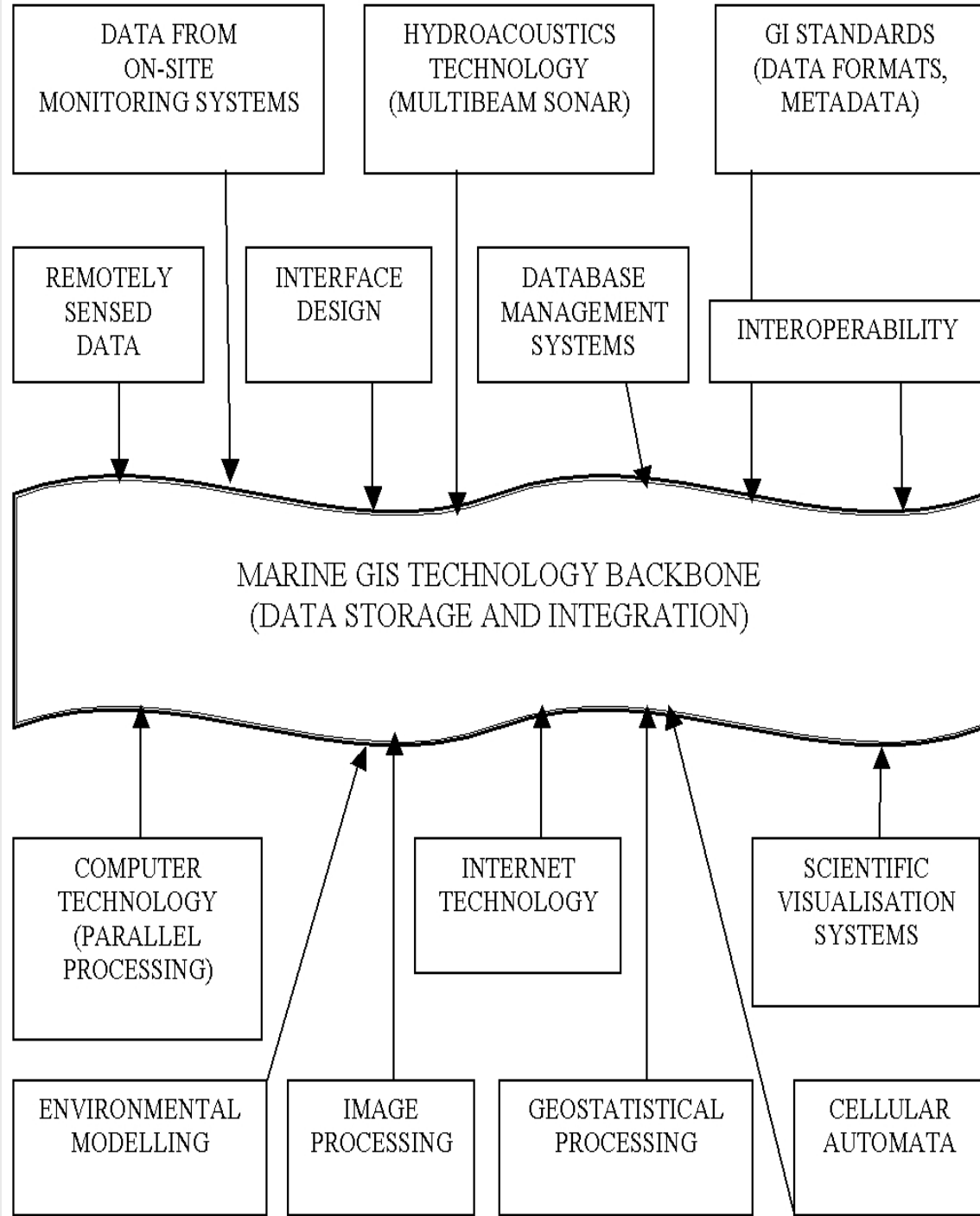
Each spatial feature (point, line, polygon) is linked through an identification number (id) to an associated attribute table that stores fisheries data:



Id = 102
Area = 1800sqm
Fish = 35kg
Date = 15Sep05

Overlay of **vector** and **raster** GIS datasets including anchovy attribute data (vector-points) and sea surface temperature (raster-colors).

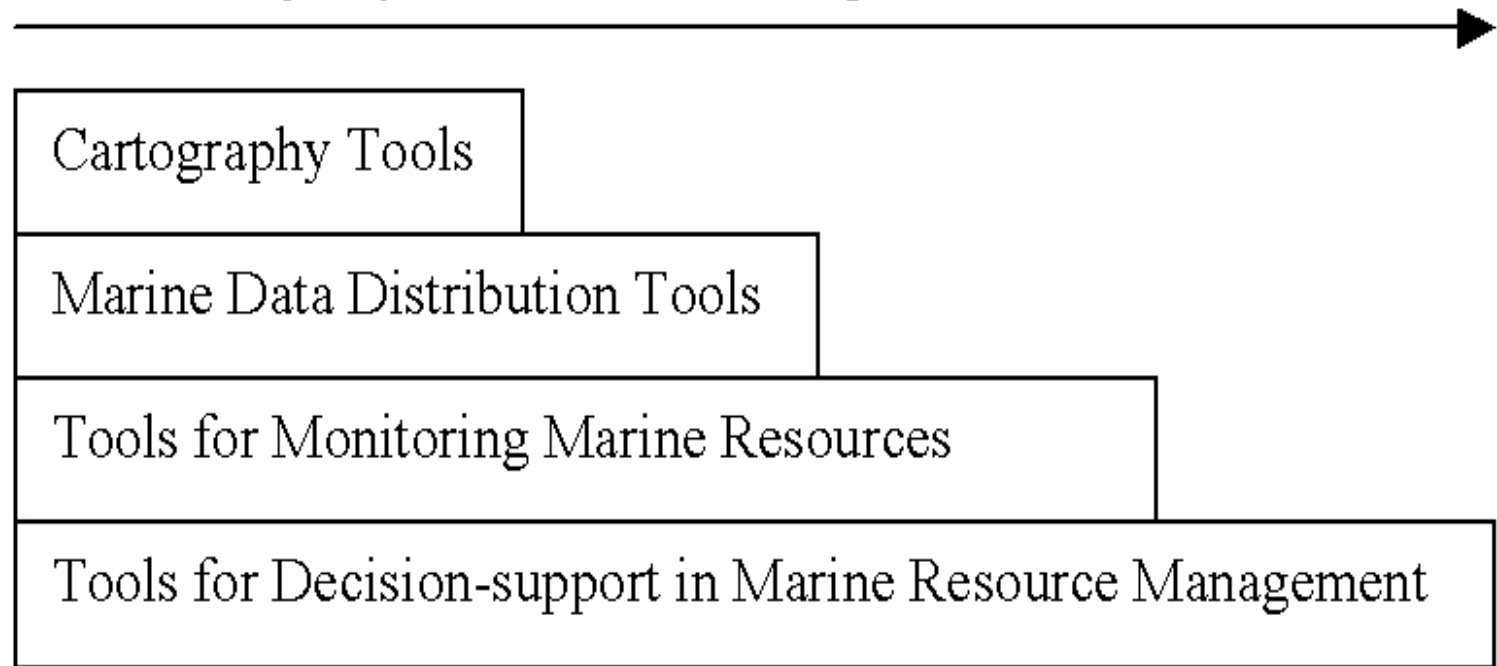


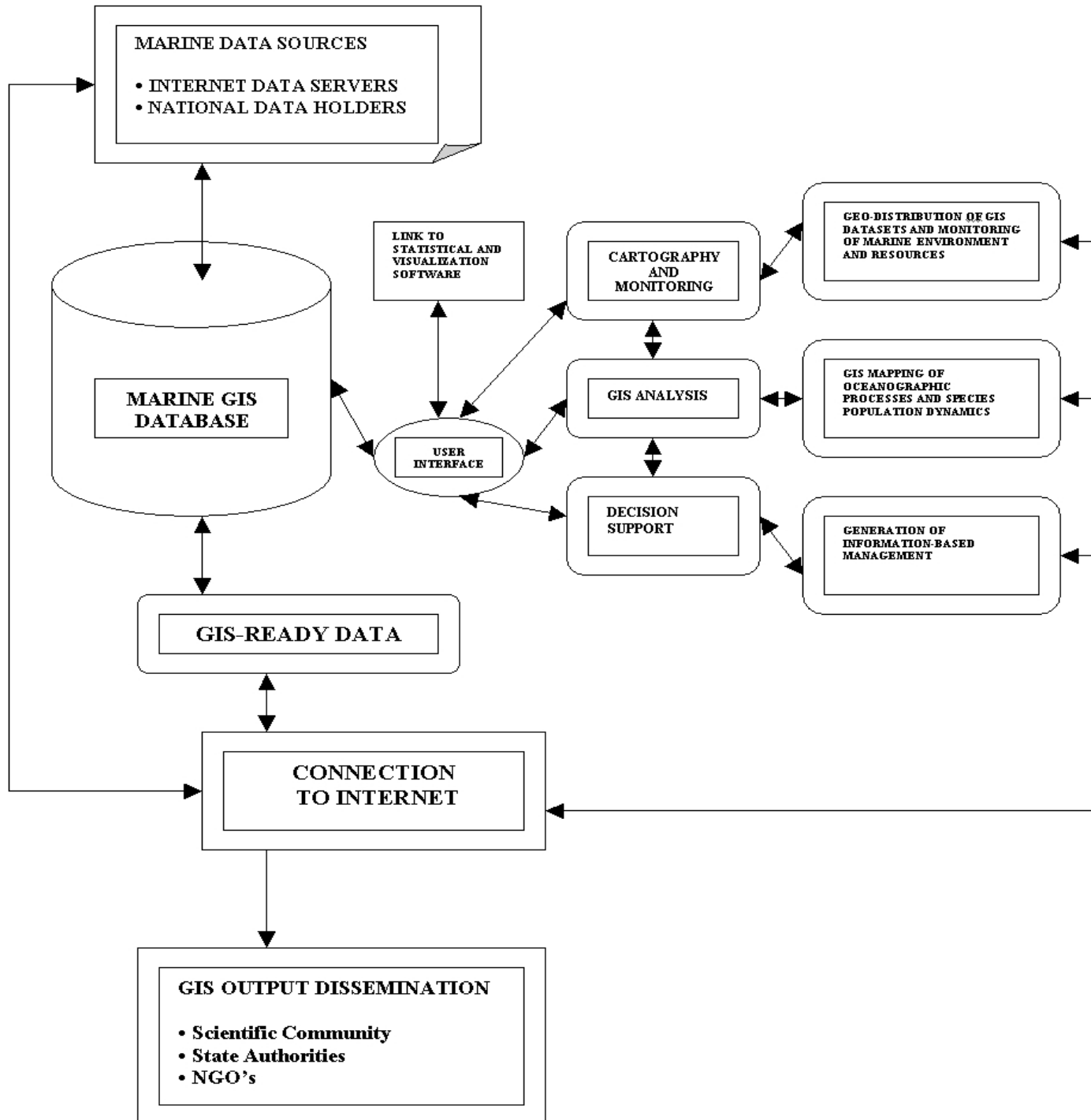


GIS
are
linked to
many
other
disciplines

The Essential Goal of Marine GIS

Increase in complexity of GIS database, GIS integration routines, and GIS user-interface





Conceptual Model of Marine GIS Development

First GIS
Publications
early '90s

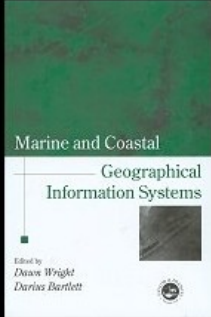
Manley, T.O. and Tallet, J.A. (1990). Volumetric visualization: An effective use of GIS technology in the field of oceanography. *Oceanography* **3**, 23-29.

Meaden, G. (1994). The One That Got Away? GIS in Marine Fisheries. *Mapping Awareness* **8(7)**, 20-23.

Marine and Coastal Geographical Information Systems - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://dusk2.geo.orst.edu/book/



Click to read back cover

Marine and Coastal Geographical Information Systems

© 2000

Hardcover ISBN: 0-7484-0862-2
Paperback ISBN: 0-7484-0870-3

"This landmark text should be an integral part of any academic curriculum encompassing marine and coastal sciences and should be on the bookshelf of any geographic information or marine scientist."
-- InReview, *Geospatial Solutions*, September 2000 issue

Edited by **Dawn Wright** (Oregon State University, USA) and **Darius Bartlett** (University College Cork, IRELAND)

Foreword by **Mike Goodchild**

Geographic Information Systems in Oceanography and Fisheries - Mozilla Firefox


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http://arch.her.hcmr.gr/announce.html

(ISBN-10: 0415284635 -- ISBN-13: 978-0415284639 -- Dewey: 551.46/00285 21 -- LCCN: GC38.5 .V35 2002 GC38.5 .V35 2002)

- ♦ [Table of Contents](#)
- ♦ [Foreword](#) by Dr Geoff Meaden (Canterbury Christ Church University College, UK)
- ♦ [Preface](#)
- ♦ [Book Review I](#) by Mr Darius Bartlett (University College Cork, Ireland)
(Published in *Fish and Fisheries* **4(2)**, 192-193, June 2003)
- ♦ [Book Review II](#) by Dr Dawn Wright (Oregon State University, USA)
(Published in *International Journal of Geographical Information Science* **17(6)**, 599-600, September 2003)

[Errata](#) from First Edition



Geographic Information Systems in Oceanography and Fisheries
-- Published May 23, 2002 by Taylor & Francis --

Author: Vasilis D. Valavanis, Hellenic Center for Marine Research, Greece

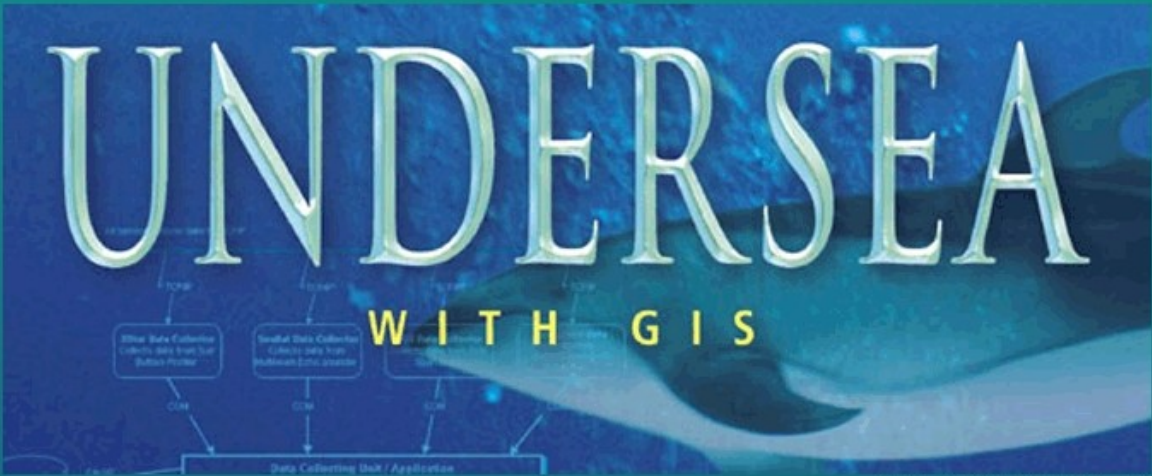
Marine GIS applications share only about a fifth of GIS history. They created a new application theme in the field of Geographical Information Systems posing several challenges in the domain of Geographical Information Science. These new challenges originate from the fact that a computerized application is called upon to model the dynamics of marine environment and provide meaningful explanations about these dynamics. The opposing strength of marine GIS is that it fully develops the central point of GIS technology, that of geo-referenced data integration, to explain the dynamic relations between marine processes and species population characteristics.

Geographic Information Systems in Oceanography and Fisheries (ISBN-10: 0415284635 and ISBN-13: 978-0415284639), a publication by [Taylor & Francis](#) / [Spon Press UK](#) / [Routledge USA](#) under the [GIS and Remote Sensing Arena](#), overviews existing marine GIS developments and presents new innovative approaches of using GIS in the examination of the dynamic relations that characterize the marine world including marine GIS macro routines for the development of Oceanography and Fisheries GIS applications.

Undersea With GIS - Mozilla Firefox

File Edit View History Bookmarks Tools Help

http://dusk2.geo.orst.edu/undersea/



The book cover features the title 'UNDERSEA' in large, white, serif capital letters. Below it, 'WITH GIS' is written in smaller, yellow, sans-serif capital letters. The background is a deep blue underwater scene with a large, white, curved object (possibly a whale's tail) visible on the right. A faint diagram of data collection systems is overlaid on the left side of the cover.

Last update: October 2, 2005

Table of Contents	Published by ESRI Press © 2002
Book Cover	
Theme Song	Edited by Dawn Wright , Oregon State University
Order online from ESRI Press	Foreword by Sylvia Earle , National Geographic Society Explorer-in-Residence (and keynote speaker at the 1999 User Conference Special Exhibition on Ocean GIS)
Downloads/Links	ISBN: 1-58948-016-3
ArcNews Press Release	
ESRI Press	

Geographic Information Systems in Fisheries - Mozilla Firefox

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American Fisheries Society

SEARCH

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[monographs](#)

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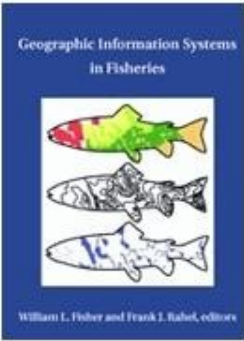
[professional and trade](#)

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[Home](#) > [professional and trade](#) > Geographic Information Systems in Fisheries

Geographic Information Systems in Fisheries



William L. Fisher and Frank J. Rahel, editors

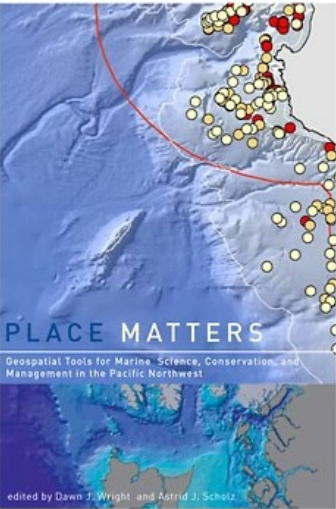
276 pages, hardbound Published by American Fisheries Society Publication date: February 2004

Place Matters Table of Contents - Mozilla Firefox

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http://dusk2.geo.orst.edu/aaas/

[[Main Ecotrust Book Site](#) | [Place Matters Listserv](#) | [OSU Press](#) | [Questions/Comments](#)]



click cover art above to go to main Ecotrust site

Place Matters: Geospatial Tools for Marine Science, Conservation, and Management in the Pacific Northwest
forthcoming in Spring 2005, Oregon State University Press

Chapter	Title/Authors	Lead	Word Count
Foreword	Sylvia Earle		1177
Preface (pdf)	Dawn J. Wright, Astrid J. Scholz		865

Reference Book for Arc Marine: the ArcGIS Marine Data Model - Mozilla Firefox

File Edit View History Bookmarks Tools Help



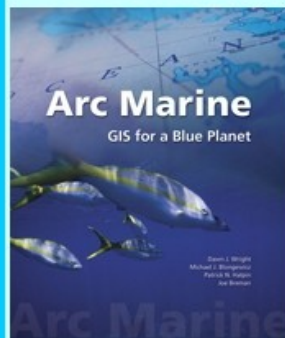
http://dusk2.geo.orst.edu/djl/arcgis/book.html



Arc Marine Reference Book



[Home](#) | [About](#) | [People](#) | [Book](#) | [Diagrams & Data](#) | [Docs](#) | [Links](#)



Draft cover of Arc Marine book

Click image to enlarge

Reference Book in Press (due out June 1, 2007)

Wright, D.J., Blongewicz, M.J., Halpin, P.N. and Breman, J., in press, 2007. *Arc Marine: GIS for a Blue Planet*, Redlands, CA: ESRI Press, ~275 pp. ISBN 978-1-58948-017-9

At a time when the health of our oceans is seen as crucial to our very existence, marine researchers have developed a data model that supports seafloor mapping, fisheries management, marine mammal tracking, monitoring of shoreline change, and water temperature analysis. Our ability to measure change in oceans and along coasts has increased as marine GIS has grown more complex. *Arc Marine: GIS for a Blue Planet* presents the initial results of a successful effort to create and define a data model for the marine community—that group of academic, government, military, and private oceanographers, resource managers, conservationists, geographers, nautical archaeologists and others who support better management of complex spatial analysis in marine applications. The data model not only provides structure to storing and analyzing marine data but helps users create maps and 3-dimensional scenes of the marine environment in ways invaluable to decision making. The standards and best practices that emerged from the case studies in *Arc Marine: GIS for a Blue Planet* help form a diverse set of resources to draw from as the marine community strives to understand, illuminate, chart, and explore the unknown depths. As a teaching tool, *Arc Marine: GIS for a Blue Planet* serves as a perfect starting point for the intermediate student or as a resource for the expert in marine GIS and its implementation.

Marine Geographic Information Systems Theory and Applications

By

Valavanis V.D., Wright D., Georgakarakos S., Kitsiou D.

To be published by
Springer-Verlag

A University Textbook targeting close-to-BSc and MSc-PhD fellows
including theoretical background on GIScience
and applied GISystems exercises in accompanied CDROM & website

A joined effort of:

–Hellenic Center for Marine Research, Greece:
–Oregon State University, USA:
–University of Aegean, Greece:
Management Lab

Lab

–Marine GIS Lab (furniture just received!)
–Davey Jones' Locker Lab
–Fisheries Resources

–GIS and Remote Sensing

GIS Mapping of Ocean Processes

1. Marine Productivity Hotspots

Measurements: location, area, DSST, DChl-a

2. Mesoscale Thermal Fronts

Measurements: location, length, DSST, DChl-a

3. Ocean Gyres

Measurements: location, area, DSST, DChl-a

Marine Productivity Hotspots (MPH)

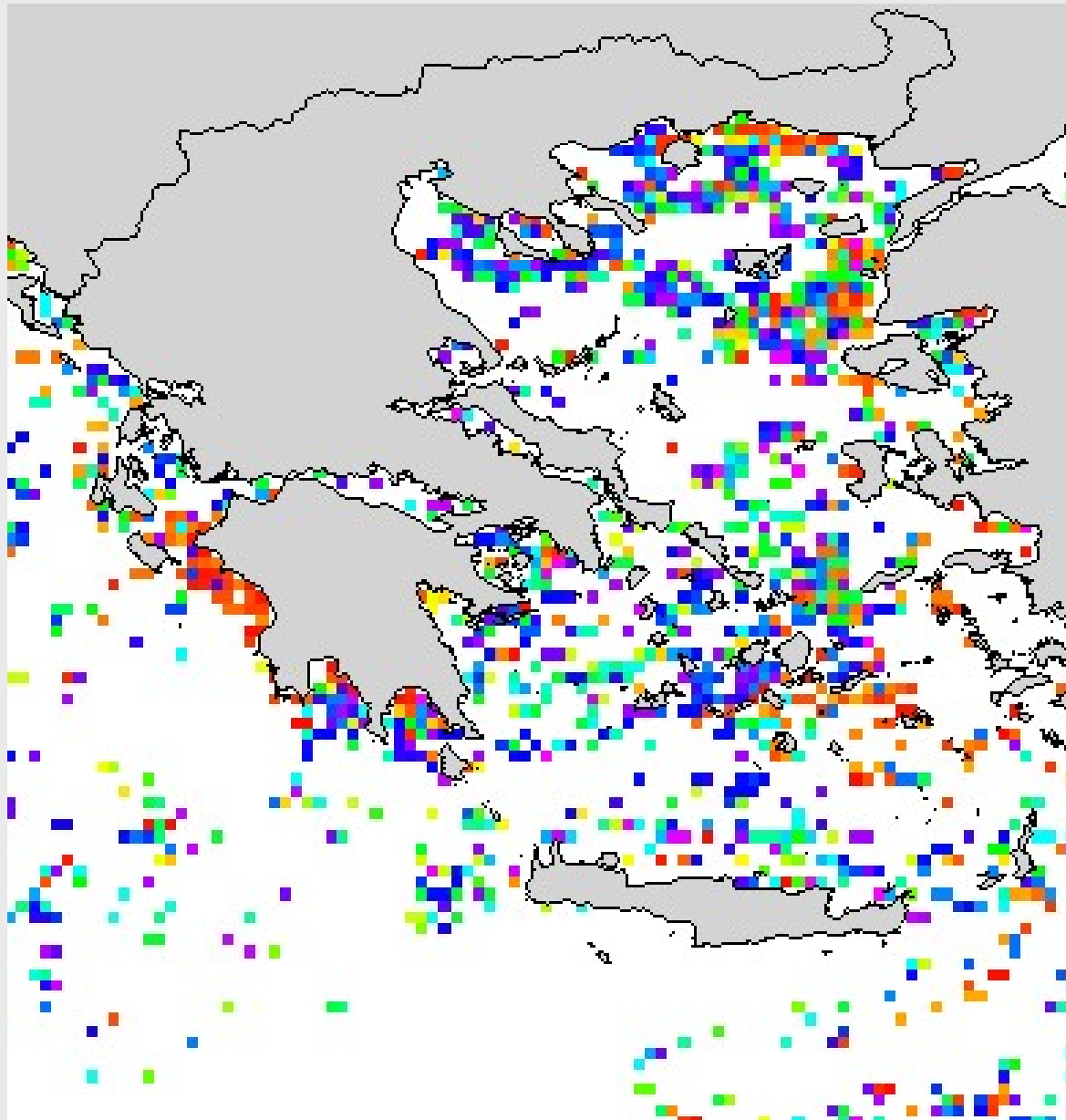
MPH: lowSST/highChl-a anomalies

How are they computed:

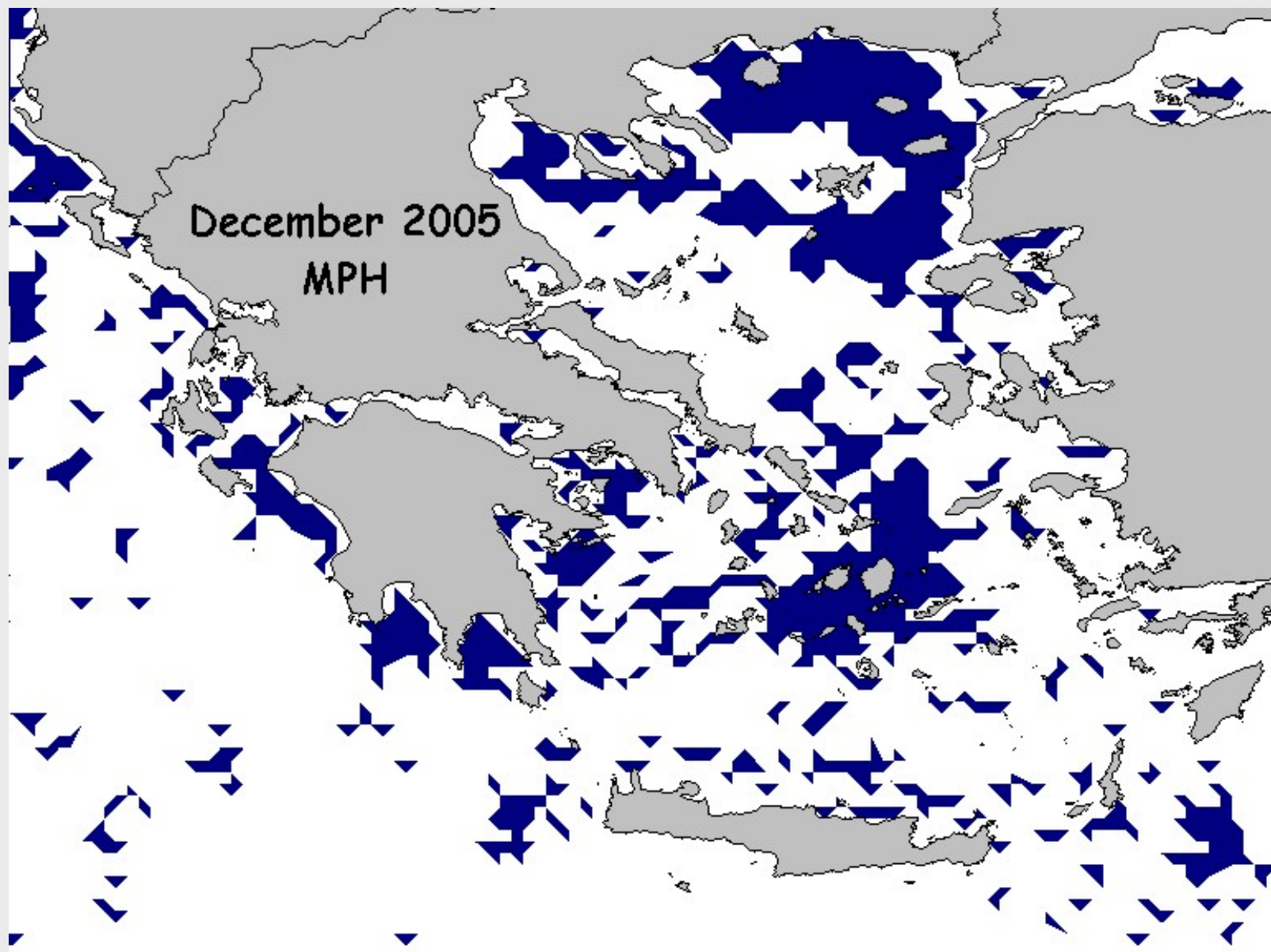
- 1. Initial data: Monthly AVHRR SST and SeaWiFS Chl-a imagery**
- 2. Production of climatology for SST and Chl-a**
- 3. Production of monthly anomaly in SST and Chl-a**

MPH: Selection in anomaly maps of simultaneous below-average SST and above-average Chl-a patterns

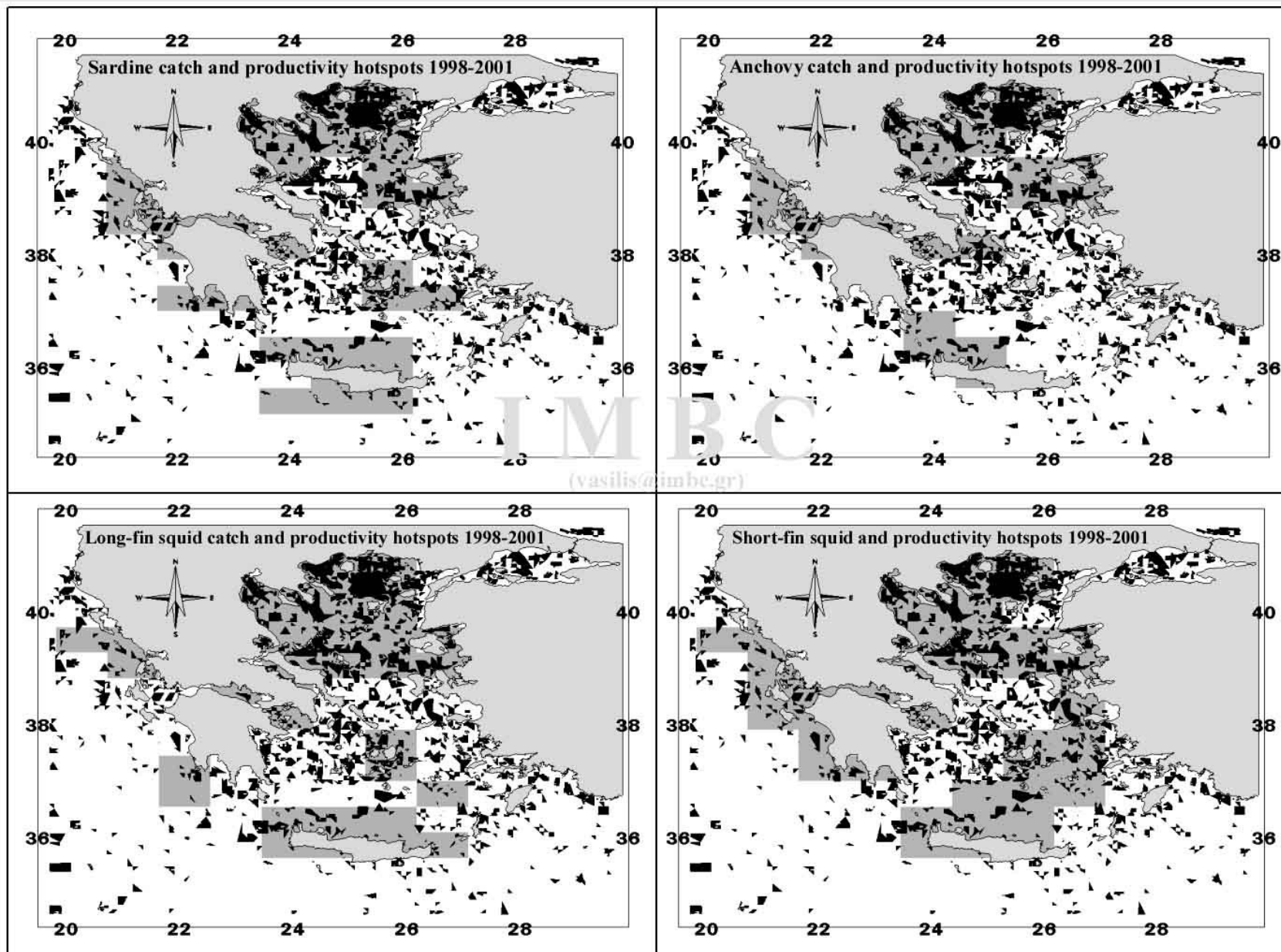
Marine Productivity Hotspots (grid)



Marine Productivity Hotspots (polygons)



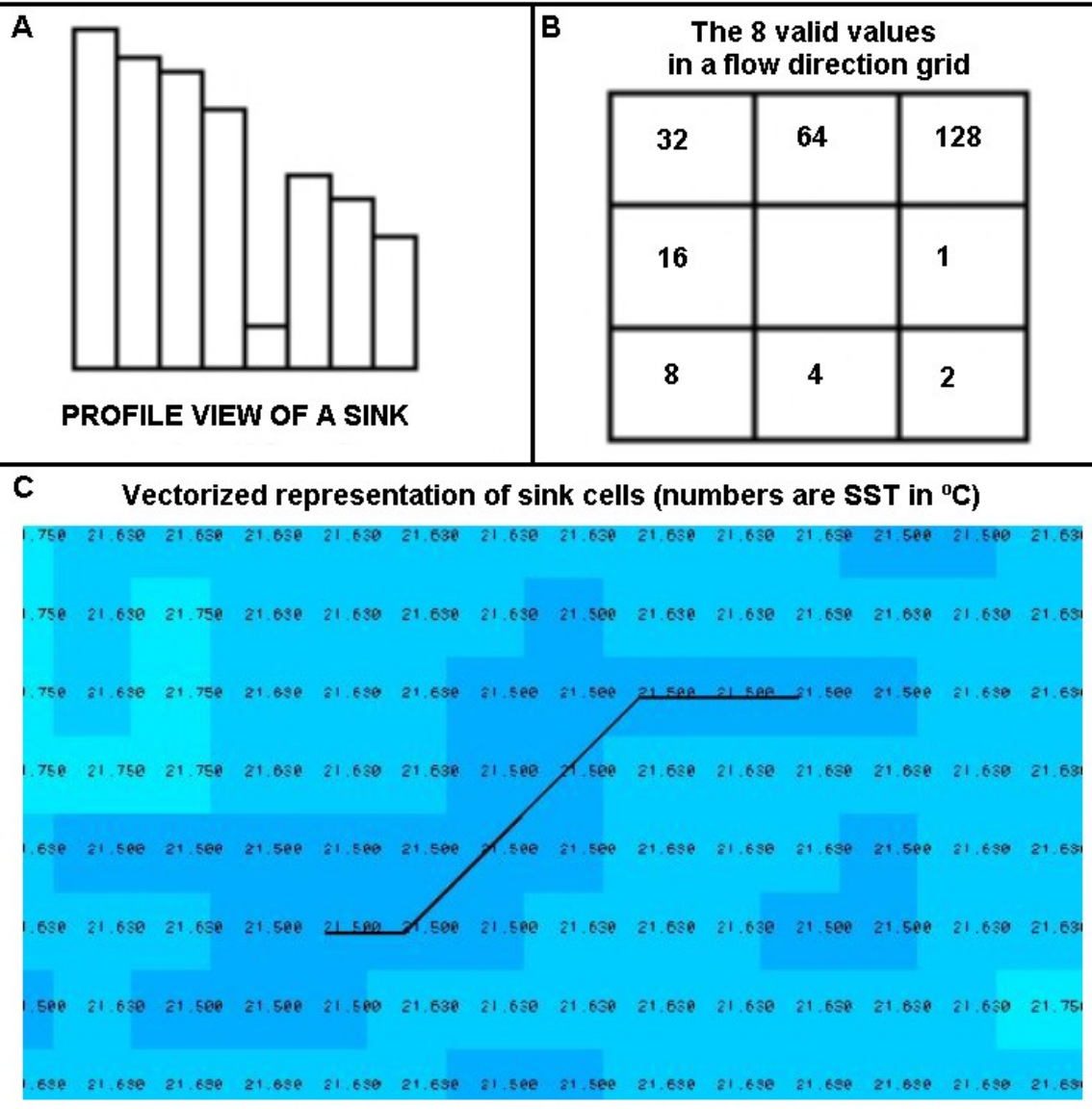
Marine Productivity Hotspots with Fisheries Production



Marine Productivity Hotspots

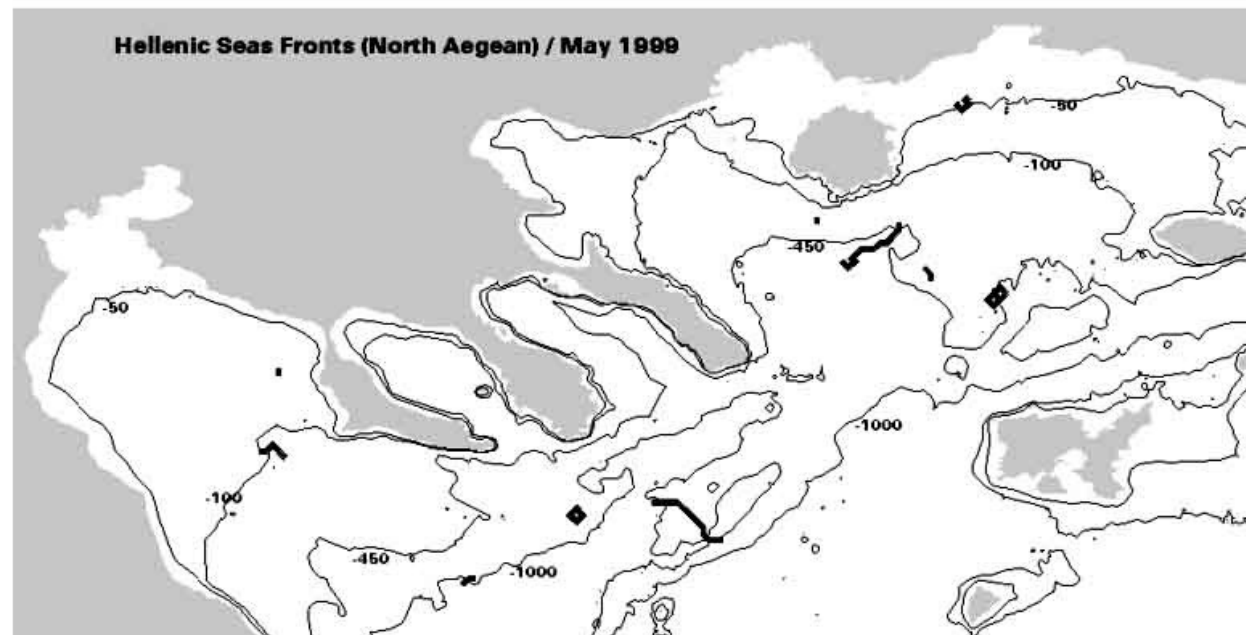
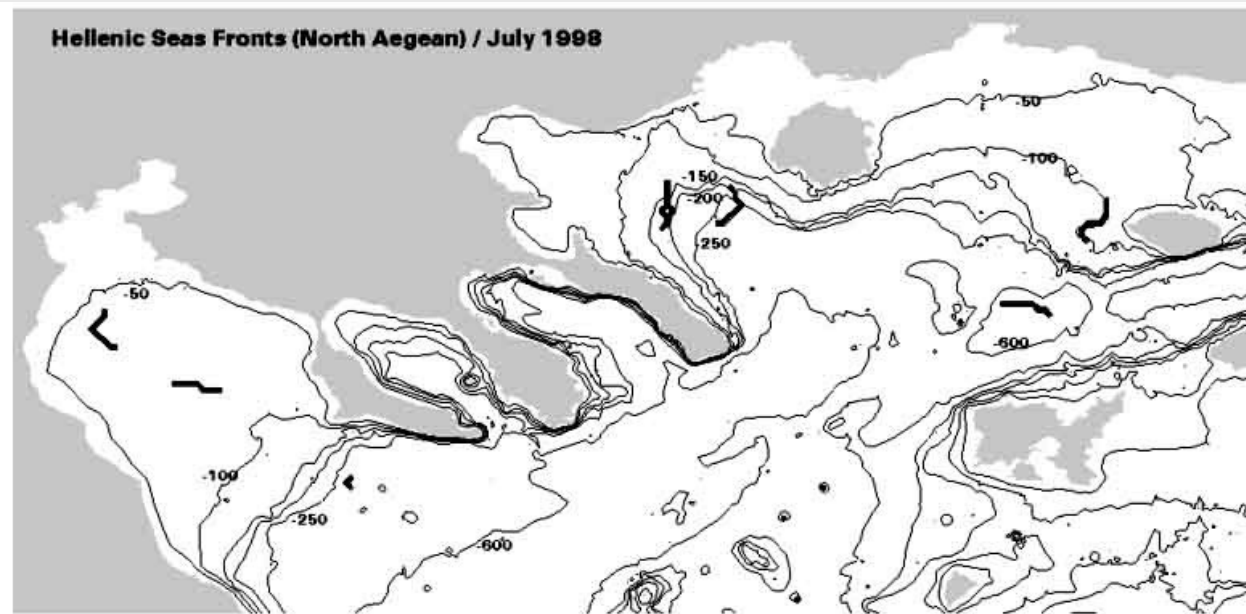


Mesoscale Thermal Fronts (MTF)



**Spatially connected sinks
with simultaneous
 $DSST < 0$ and $DCHL > 0$
patterns
are mapped as mesoscale
thermal fronts**

Mesoscale Thermal Fronts (coastal, shelf-break, open-water)



Ocean Gyres

(cyclonic/anticyclonic eddies)

Major Gyre/Eddy formations in SE Mediterranean:

- 1. Pelops Anticyclone**
- 2. West Cretan Cyclone**
- 3. Ierapetra Anticyclone**
- 4. Rhodes Cyclone**

METHOD:

ON-SCREEN DIGITIZING FROM SST IMAGES

WHERE GYRE THERMAL SIGNALS ARE STRONG

Mapping Area for Ocean Gyres

PELOPS ANTICYCLONE:

warm water trap - low productivity

WEST CRETAN CYCLONE:

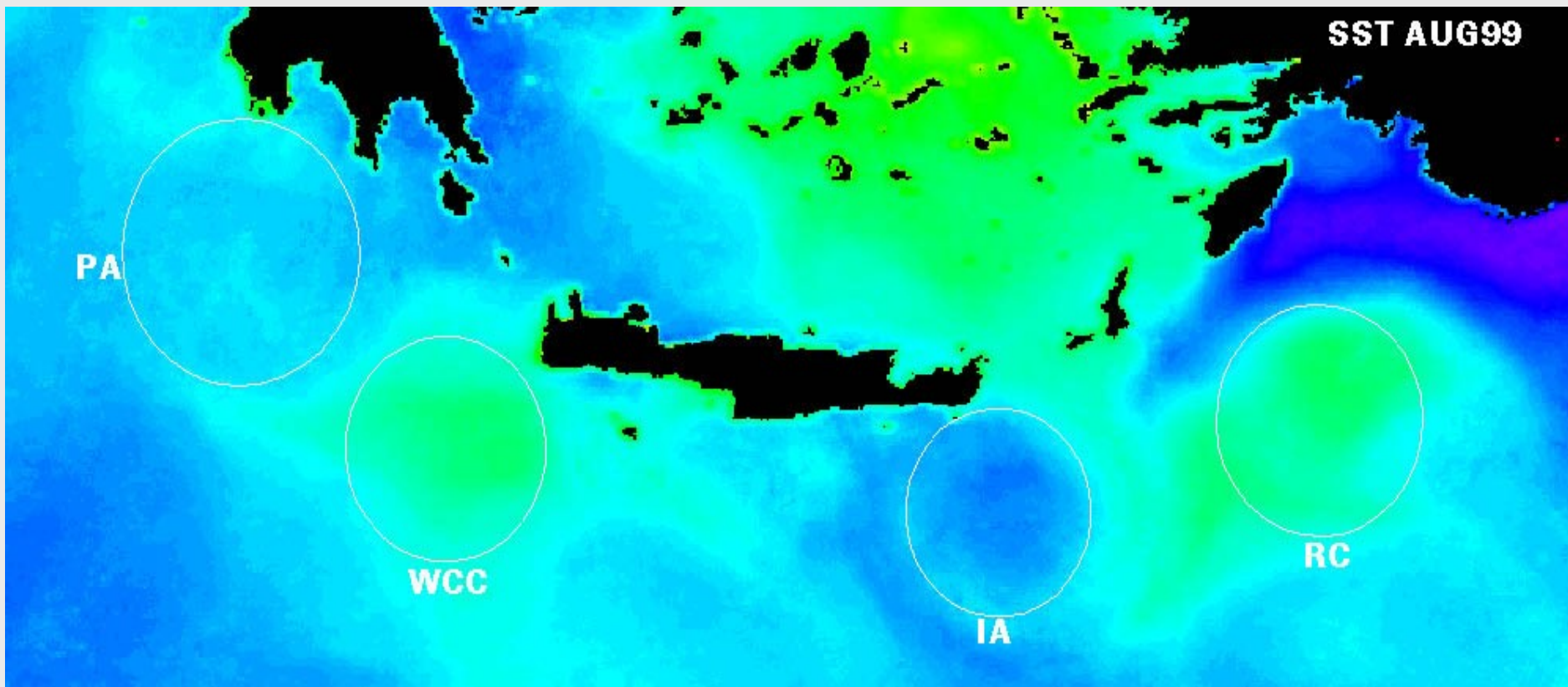
cold water pump - high productivity

IERAPETRA ANTICYCLONE:

warm water trap - low productivity

RHODES CYCLONE:

cold water pump - high productivity



Ocean Gyres (cyclonic/anticyclonic eddies)

Aegean Gyres: JAN01

**Small-scale
Gyre/Eddy
Formations
in the Aegean
Sea**

METHOD:

**HERE GYRE
THERMAL SIGNALS
ARE WEEK BUT
DEPICTED WELL IN
ALTIMETRY DATA.**

**METHOD IS BASED
ON CONTOURING
OF SLA IMAGES.**

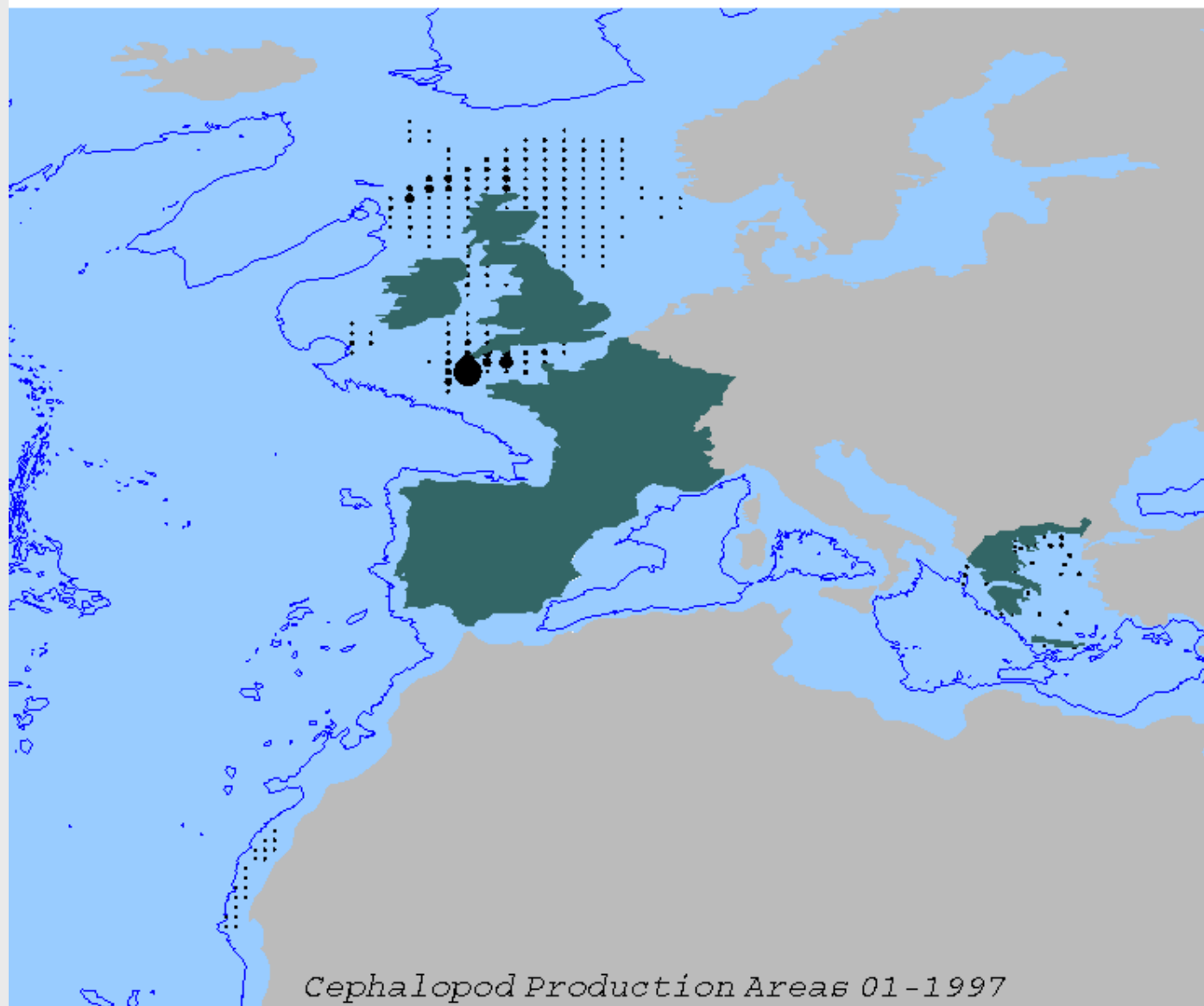
GIS Mapping in Fisheries

Fish Distributions

Species Life history data

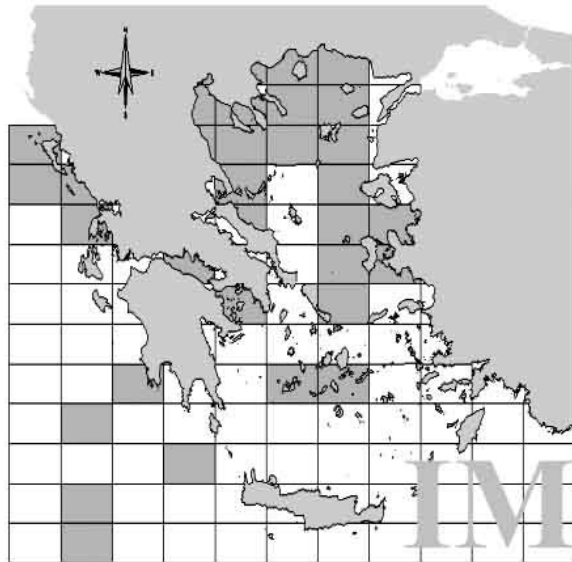
Essential Fish Habitats

Animation of cephalopod production data

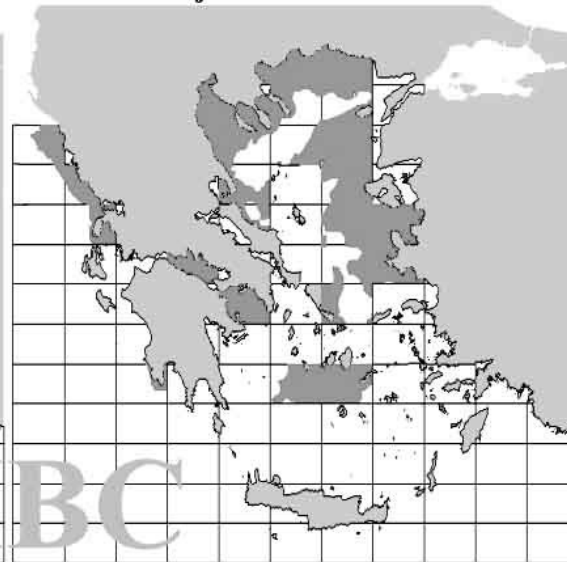


Mapping of Major Catch Areas based on abiotic life history parameters

Illex coindetti monitored catch distribution 97-98

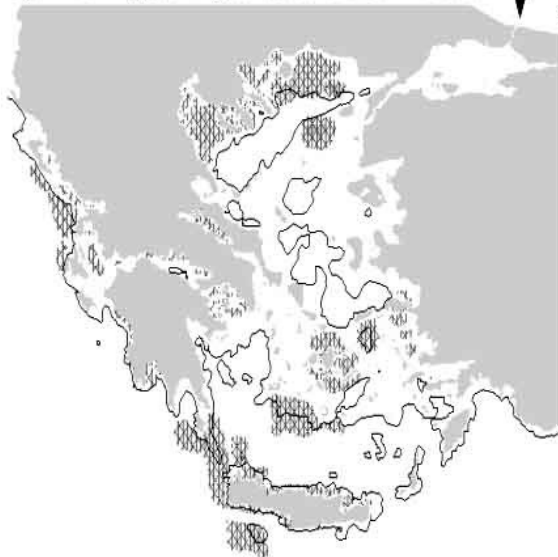


Major occurrence areas

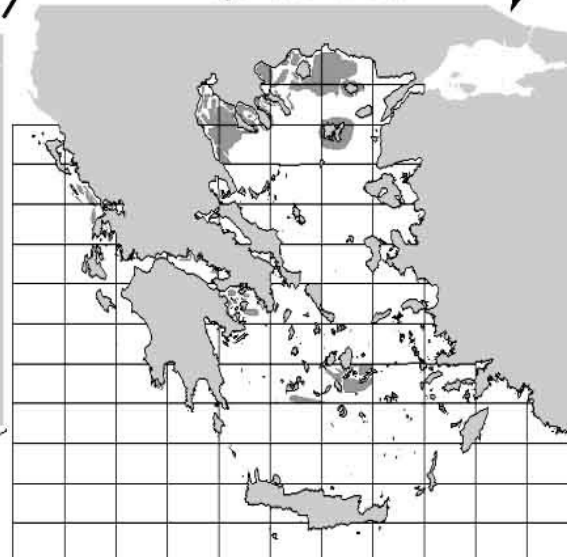


(vasilis@imbc.gr)

Major fishing activity areas and 350m isobath



Major catch areas

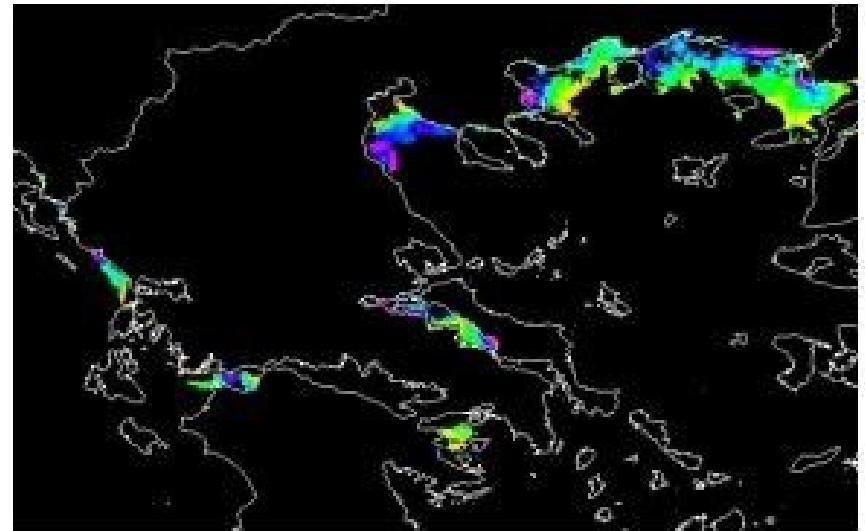


Mapping of Essential Fish Habitats (EFH) based on environmental parameters



INITIAL DATA:

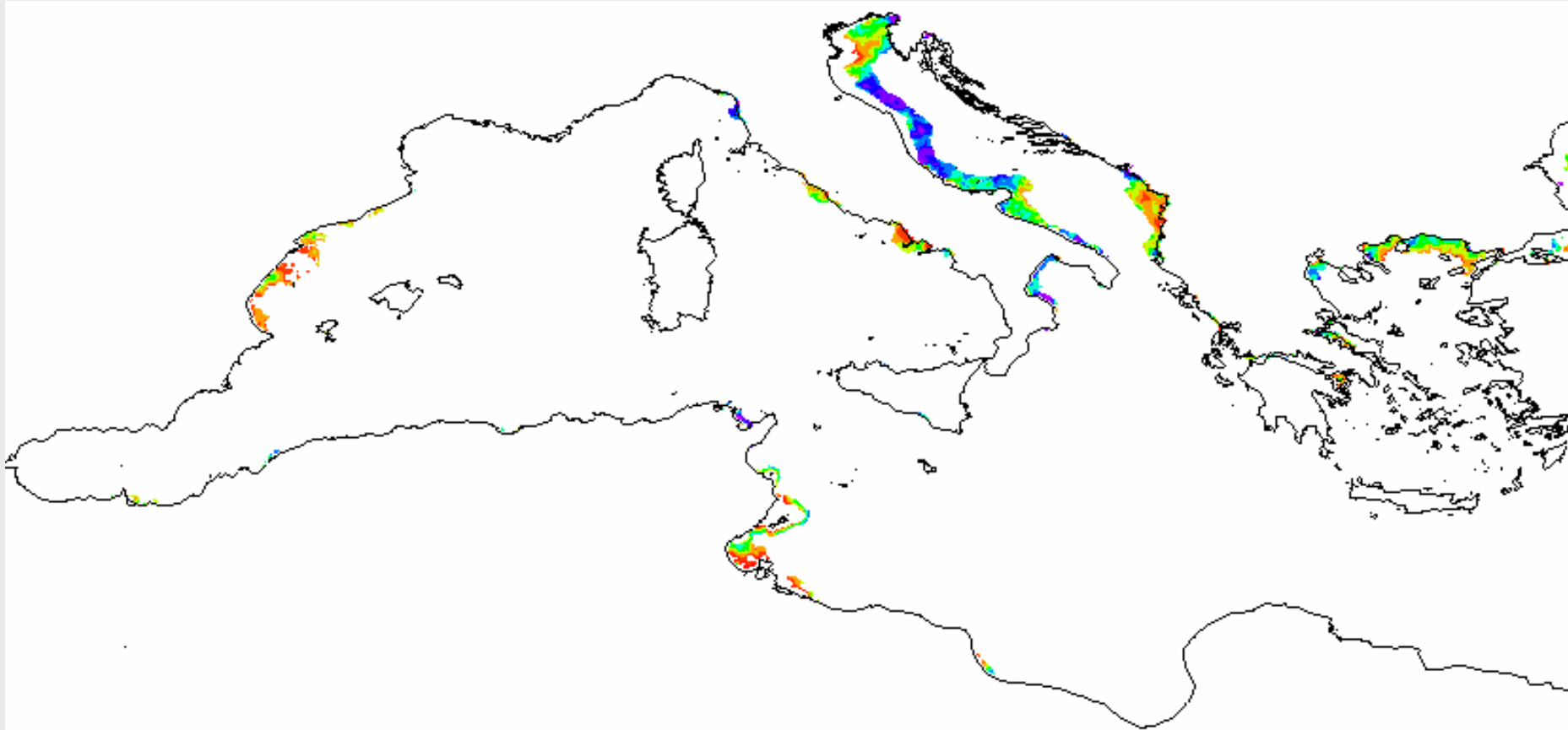
Surveyed acoustic presence/absence data (July 2004)



RESULTING EFH MAP:

EFH Map based on habitat environmental descriptors

Mapping of Essential Fish Habitats (EFH) based on environmental parameters



Environmental Approach to EFH Designation

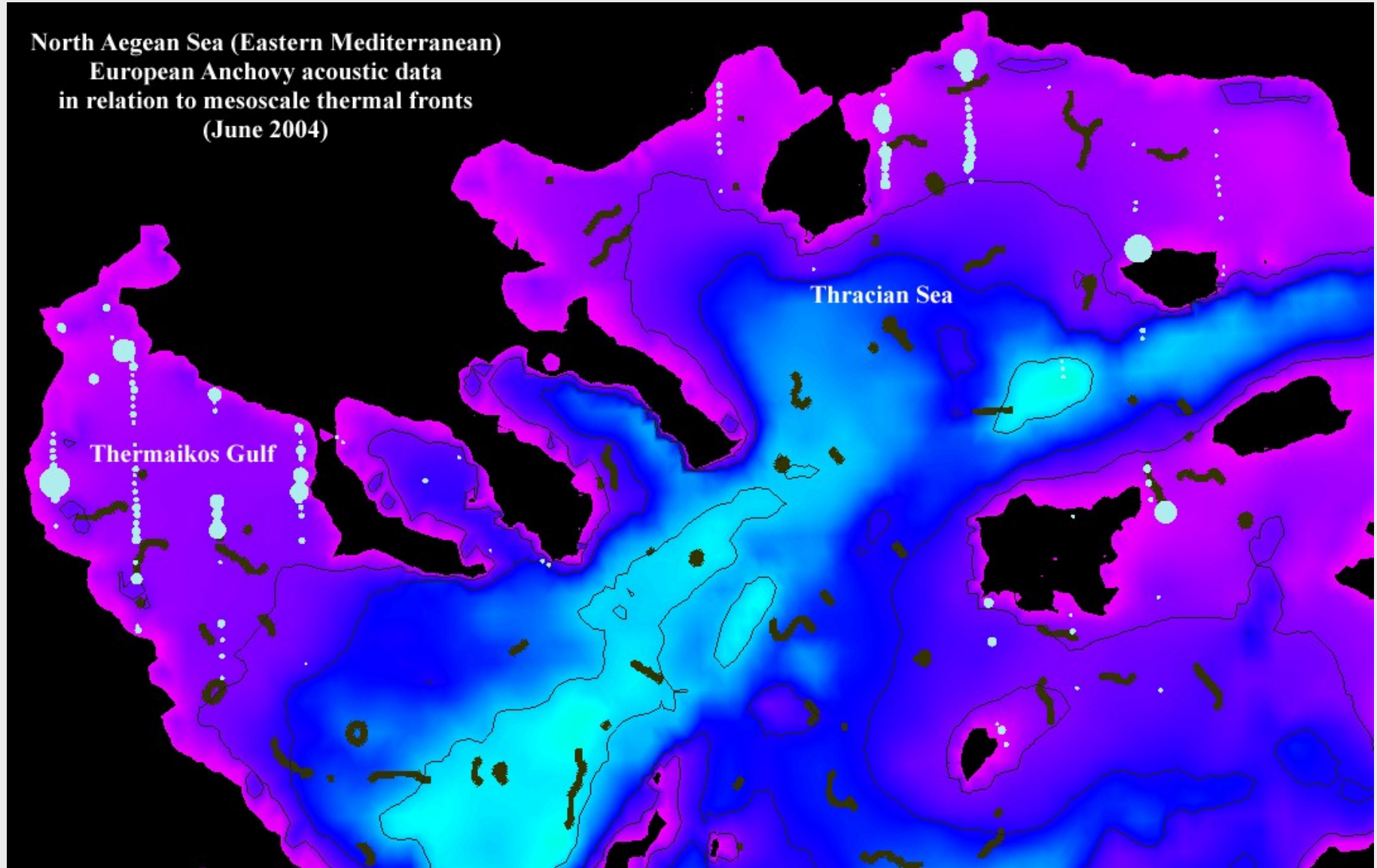
Method overview: Surveyed data→satellite data→GAMs→env. ranges→GIS

EFH mapping:

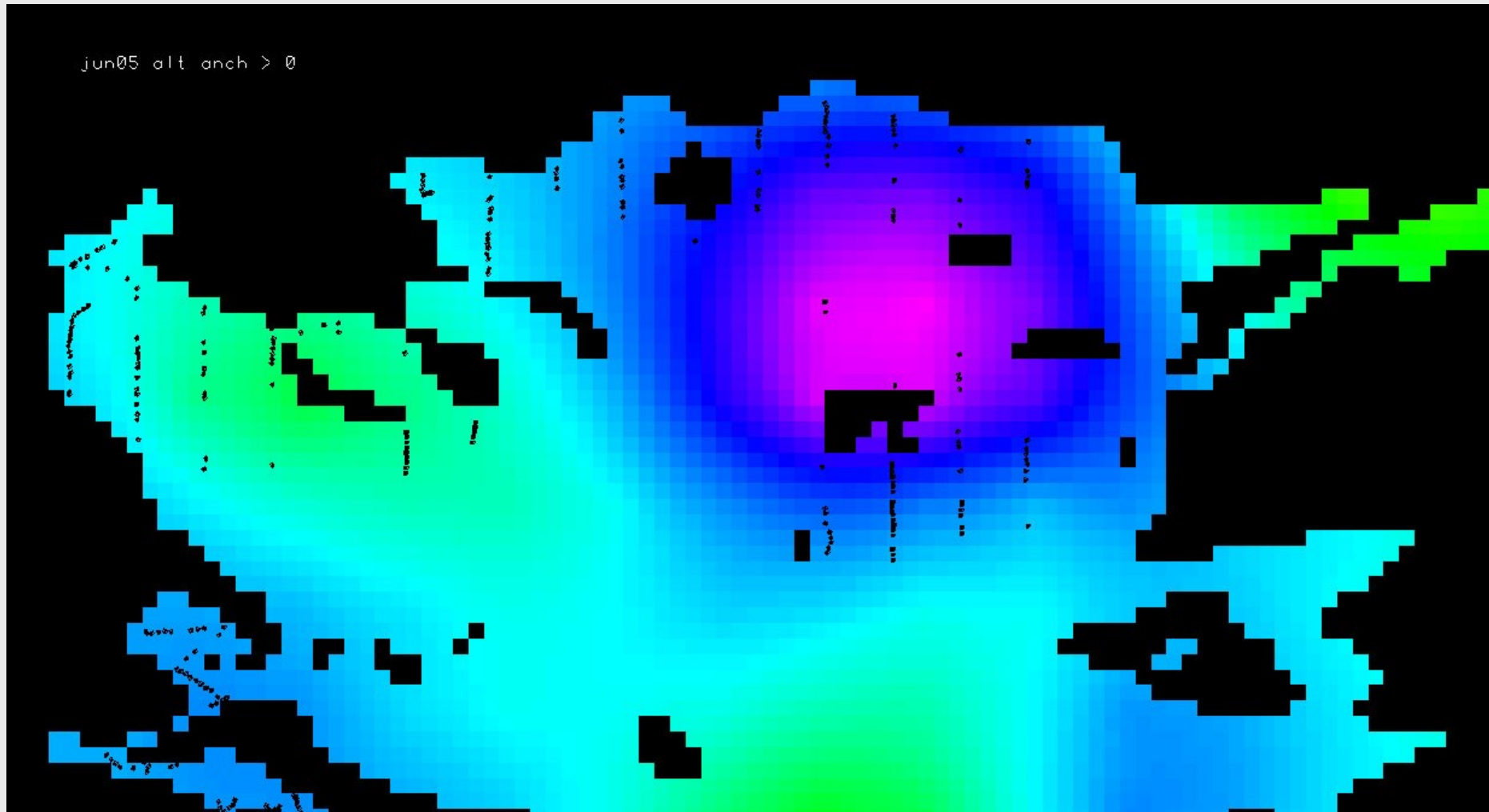
- ✓ Presence/Absence surveyed data
- ✓ Extraction of environmental parameters from satellite data
- ✓ Development of GAMs
- ✓ GAMs extraction of minimum and maximum environmental ranges
- ✓ Application of ranges to satellite images through GIS
- ✓ GIS selection of areas that are simultaneously characterized by all input environmental ranges

Relation of mesoscale fronts to the distribution of fish populations

North Aegean Sea (Eastern Mediterranean)
European Anchovy acoustic data
in relation to mesoscale thermal fronts
(June 2004)

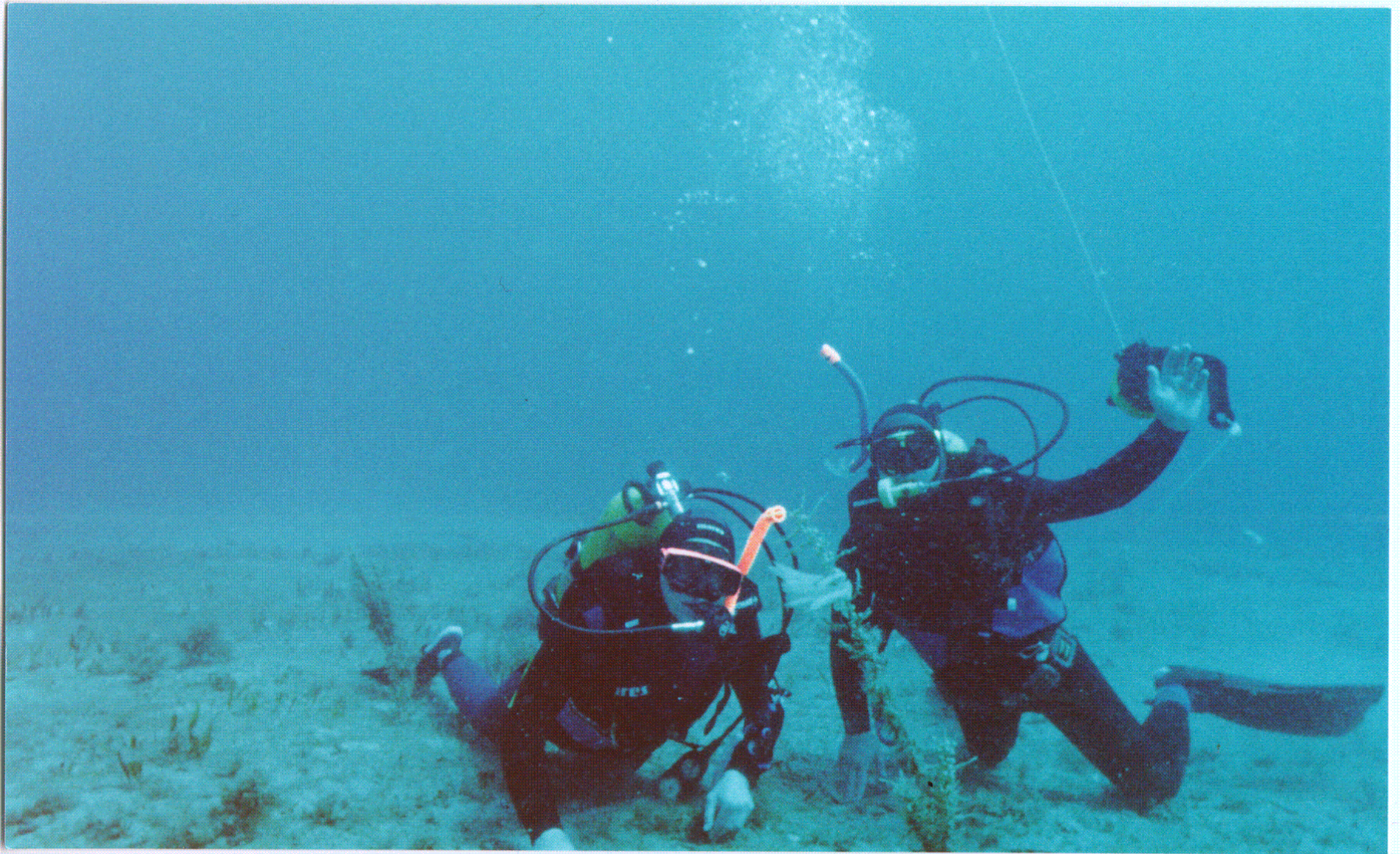


Relation of small-scale gyres to the distribution of fish populations



HCMR HOLDINGS OF GIS PRODUCTS

- ✓ Mesoscale Thermal Fronts
- ✓ Marine Productivity Hotspots
- ✓ Ocean Gyres/Eddies
- ✓ Essential Fish Habitats



Loligo vulgaris unhatched eggs attached on arrowhead (*Sagittaria* spp.)
Heraklion, Mononaftis Bay, Crete Island, Greece (February 2000)

ECOSUMMER-Crete is over! Many thanks for making it great!