Multiparametric approach to water quality management: Project WARMER

Project partners:

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YSI Hydrodata, UK
The University Court of the University of Aberdeen, UK
Institute of Electron Technology, Poland

http://www.zetaced.com/projectwarmer

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WARMER project goals

WARMER is a research project funded by European Commission to develop a real-time water quality monitoring system for Risk Assesssment.
It will be based on a set of modular multiparametric in-situ probes, to be integrated in a field deployable monitoring platform.
Field measurement data will be linked to remote sensing Earth Observations using a Web based management system.

The new water monitoring system will be used as a decision tool, to support the management of hazardous pollution events in coastal areas and large rivers.

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Main R&D activities

- Improvement, prototype testing of miniaturized chemical sensors, constructed using different measuring technologies integrated in modular flow-cells
- Design and development of new in-situ measuring probes, to manage a set of sensors using automated analytical procedures and data processing algorithms
- Integration of these new probes in a water monitoring platform, together with conventional water quality measuring probes, physical sensors and a GPS module. TCP-IP on GPRS communication will be used for remote data transmission

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Main R&D activities (2)

- Measured data will be transmitted to a Web server on the Internet; the operator will be able to easily analyse and validate collected data
- Specific in-situ measuring data will be used to calibrate remote sensing data, collected from satellites and processed using the same Web server
- Spatial and short-medium term water pollution forecasts will be produced to address the user to make decisions on accidental spills in water bodies (coastal areas, large rivers and lakes).

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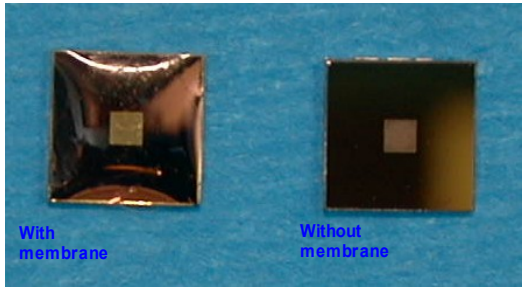
Measuring technology

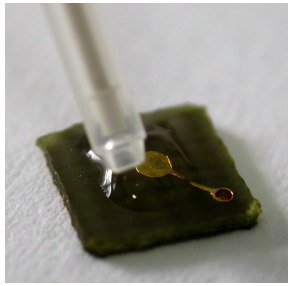
Potentiometric sensors

- **Planar selective microelectrodes:**



Gold microelectrodes

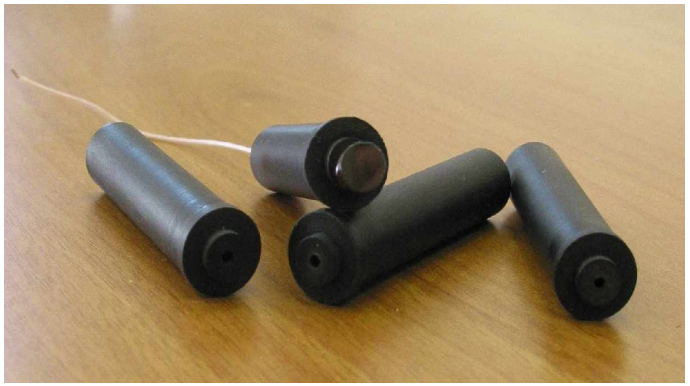
Measured parameters:
NO_3^-, NH_4^+,
K^+, Na^+, Cl^-



Au or Ag/AgCl microelectrodes

- **Chalcogenide glass electrodes:**

Measured parameters:
Pb^{2+}, Cd^{2+}, Cu^{2+}, Zn^{2++}



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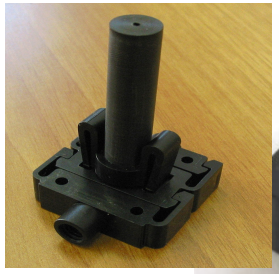
Measuring technology (2)

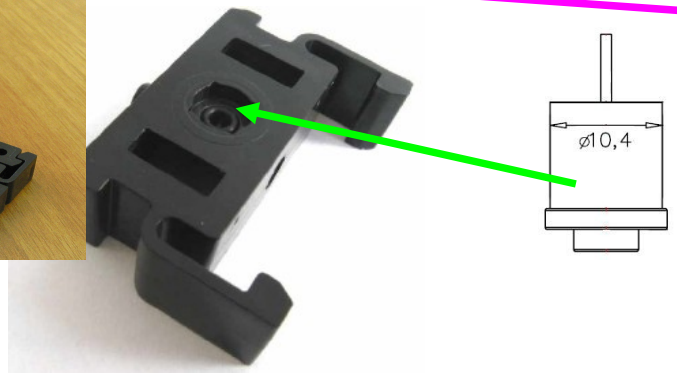
Integration of potentiometric sensors in modular flow-cells

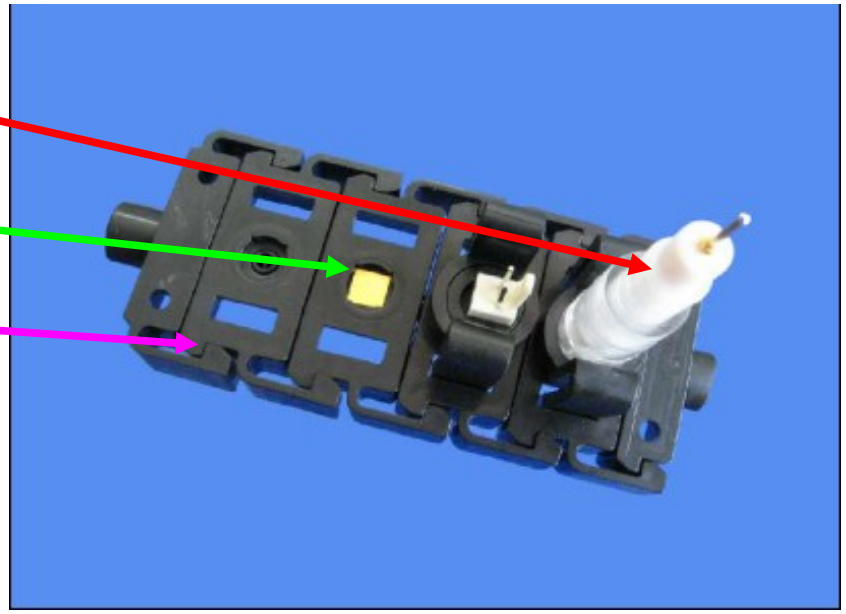
Reference Ag/AgCl electrode

Planar sensor

Flow cell module







Main goal: enhance sensitivity minimizing cross interferences between electrodes

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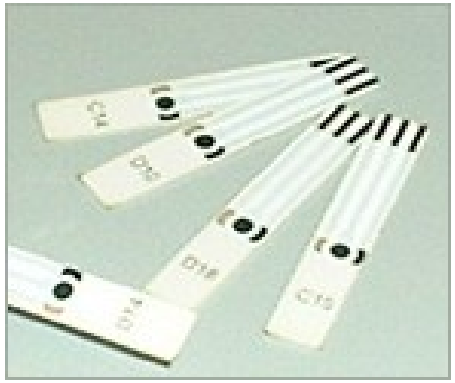
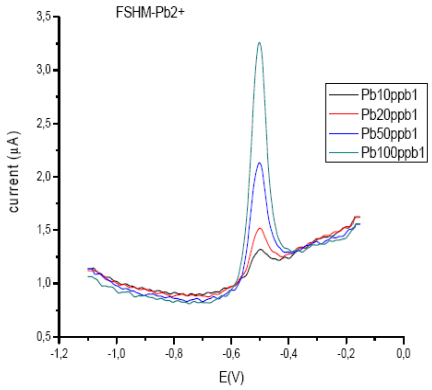
Measuring technology (3)

Stripping voltammetry sensors

Screen printed electrodes

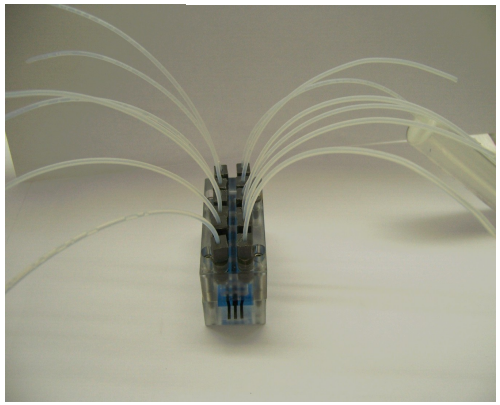




Measured parameters:
Pb^{2+}, Cd^{2+}, Cu^{2+}, Zn^{2+}

Main goal: enlarge life time

Perspectives: biosensors
Phenols, organics, toxicity



Cartridge chip prototype for screen-printed sensors

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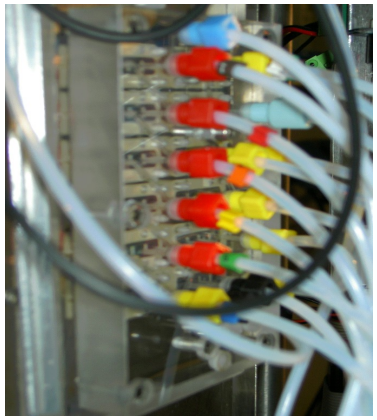
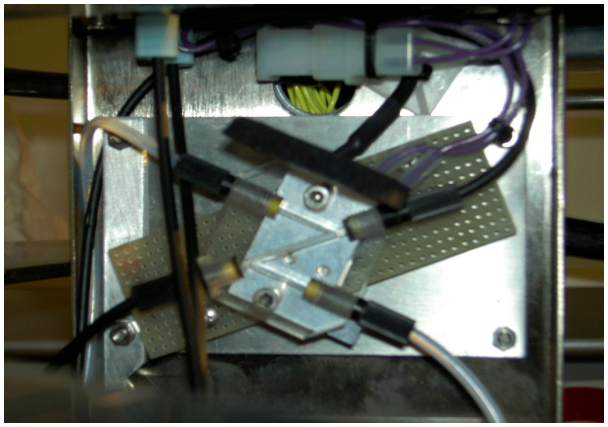
Measuring technology (4)

Colorimetric / fluorimetric methods



µLFA hydraulic manifold



Miniaturized colorimetric flow-cell with fiber optics couplings

Main goals:

- reduce size and reagents consumption,
- increase reliability and autonomy

Measured parameters:

NH_3, NO_3+NO_2 ,NO_2 , PO_4

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Measuring prototypes

Potentiometric sensors

LFA test unit:

- to perform the test of the sensors during production
- to test these sensors working in the multiparametric flow-cell

µLFA benchtop analyzer:

- to test the sensors using the same hydraulics, hardware and software to be used in the probe

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In-situ multiparametric modular probes

Main technical characteristics

- Each probe is designed to manage one of the following analytical technologies: potentiometry, stripping voltammetry & colorimetry / fluorimetry
- Internal calibration and sensor conditioning
- The probe can be used as a stand-alone system too, using internal battery power and memory
- It will integrate the necessary hardware and algorithm correlations to provide as reliable data output for short-medium term deployment
- Easy to be integrated in water monitoring platforms or coastal buoys

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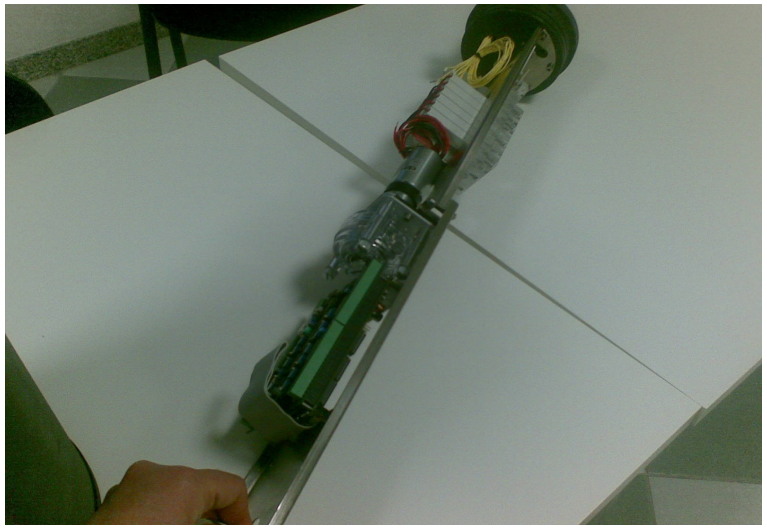
Colorimetric / fluorimetric probe

Applied analytical methods

- **AMMONIA:**
  OPA fluorimetric method, 1 ppb
- **NITRITE: NED-SAA, 1 ppb**
- **NITRATE + NITRITE:**
  UV reduction method + NED-SAA, 5 ppb
- **ORTOPHOSPHATE:**
  Molibdate-Antimony, 2 ppb



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Integration in the platform

Nutrients probe

Online filtration

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Platform characteristics

- GPRS remote data communication, with remote configuration capability over the Internet
- Suitable to be quickly deployed in large rivers and lakes or coastal areas (transportable by a car trolley)
- Integrates the whole set of sensors and instruments, allowing short-medium term monitoring campaigns
- Data visualization and validation over the Internet:

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Parameters to be measured by the water monitoring system

Parameter	Measuring method	Measuring unit
Physical		
Temperature	PT-١٠٠	Celsius
Conductivity	ROX	mS/cm
Salinity	Calculated parameter	ppt
pH	Potentiometic	pH
Redox	Potentiometic	mV
Dissolved Oxygen	Optical	mg/l
Turbidity	Optical, nephelometric	NTU
Meteorological		
Wind direction		
Wind Speed	Wind vane with potentiometer	m/s
Air temperature	Thermistor (PT-١٠٠)	Celsius
Relative humidity	Film capacitor element	RH %
Air pressure	Pressure sensor	atm
Solar radiation	Passive radiation shield	W / sqm
Rain fall	Rain collector (Tip bucket)	mm
Coordinate X	GPS	decimal
Coordinate Y	GPS	decimal
Water temperature	Thermistor (PT-١٠٠)	Celsius
Water flow (direction)	Current meter	degrees
Water current	Current meter	m/s

Parameter	Measuring method	Measuring unit
Chemical		
(Nutrients)		
Orthophosphate	Colorimetric, Molybdenum blue	ug/l
Ammonium	OPA method + fluorimetric	ug/l
Ammonium	potentiometric WUT BS	mg/l
Nitrate+nitrite	UV reduction + colorimetric NED-SAA	ug/l
Nitrite	Colorimetric, NED+SAA	ug/l
Nitrate	potentiometric WUT BS	mg/l
Potassium	potentiometric WUT BS	mg/l
Sodium	potentiometric WUT BS	mg/l
Metals		
Lead	UV dig. + stripping voltammetry	mg/l
Cadmium ٢+	UV dig. + stripping voltammetry	mg/l
Copper	UV. dig + potent. SPU CGG	mg/l
Zinc	UV dig. + potent. SPU PVC	mg/l
Organic compounds		
Hydrocarbons		
Total hydrocarbons	Optical, fluorescence	ug/l
Phaeopigments		
Chlorophyll-a	Optical, fluorescence	ug/l
Cyanobacterial pigmen	Optical, fluorescence	ug/l

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Parameters to be measured by the water monitoring system (2)

Parameter	Measuring method	Measuring unit
Remote sensing		
Chlorophyll-a	Optical band ratio - images – ESA MERIS	mg/m^{3}
Turbidity	Optical neural net - images – ESA MERIS	g/m^{3}
CDOC (Col. Diss. Org. Matter)	Optical neural net - images – ESA MERIS	^{1}/m
Surfactants/film	Images and structures – ESA ASAR	N/A
Roughness	Images and structures – ESA ASAR	dB
Sea surface temperatu	Near infrared - bulk temperature – NASA MODIS	Celsius
Water direction	Visual contrasts – ESA ASAR - High res. images	N/A

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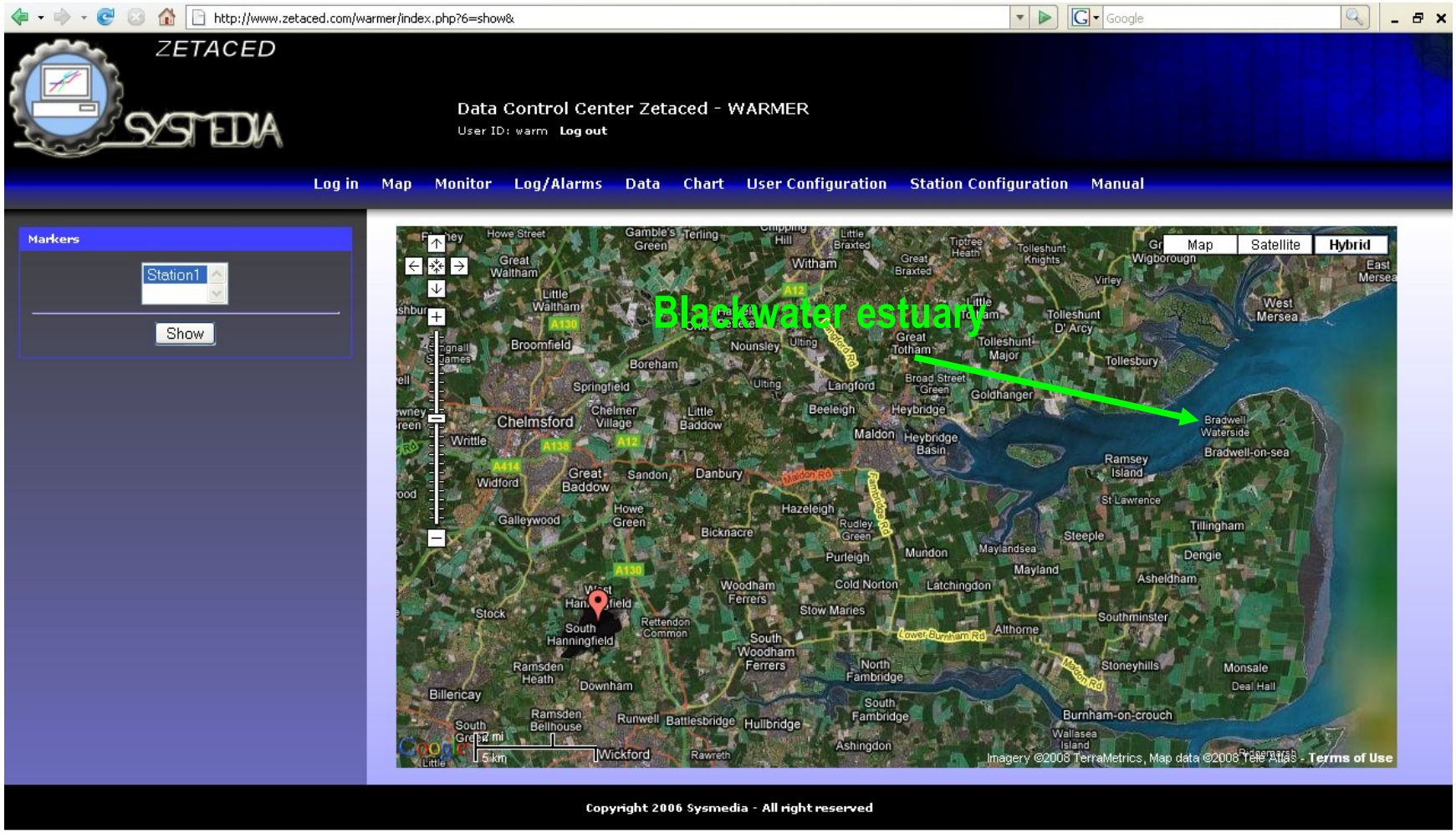
First pilot study in UK



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Intercalibration of remote sensing data with in-situ measurement data

- **Observed parameters using remote sensing:**
  - Chlorophyll-a
  - Totals Suspended Matter
  - Dissolved Organic Matter
  - Transparency
  - Sea Surface Temperature
- **Ideal procedure for data validation**
  - Field sampling/measurements of the above parameters
  - Sampling within ± 2hrs. of satellite pass
  - Avoid sun-glint region in satellite sensor swath
  - Flow-through/probe instruments used on site
  - Waters sampling for laboratory analysis
  - Calibration and stability of methods used

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DISPRO Web service by NERSC

- A user interface presenting remote sensing measurements in the form of raster images
- A distributed system composed of multiple DISPRO nodes which provide measurements
- A catalogue which contains meta information of available measurements

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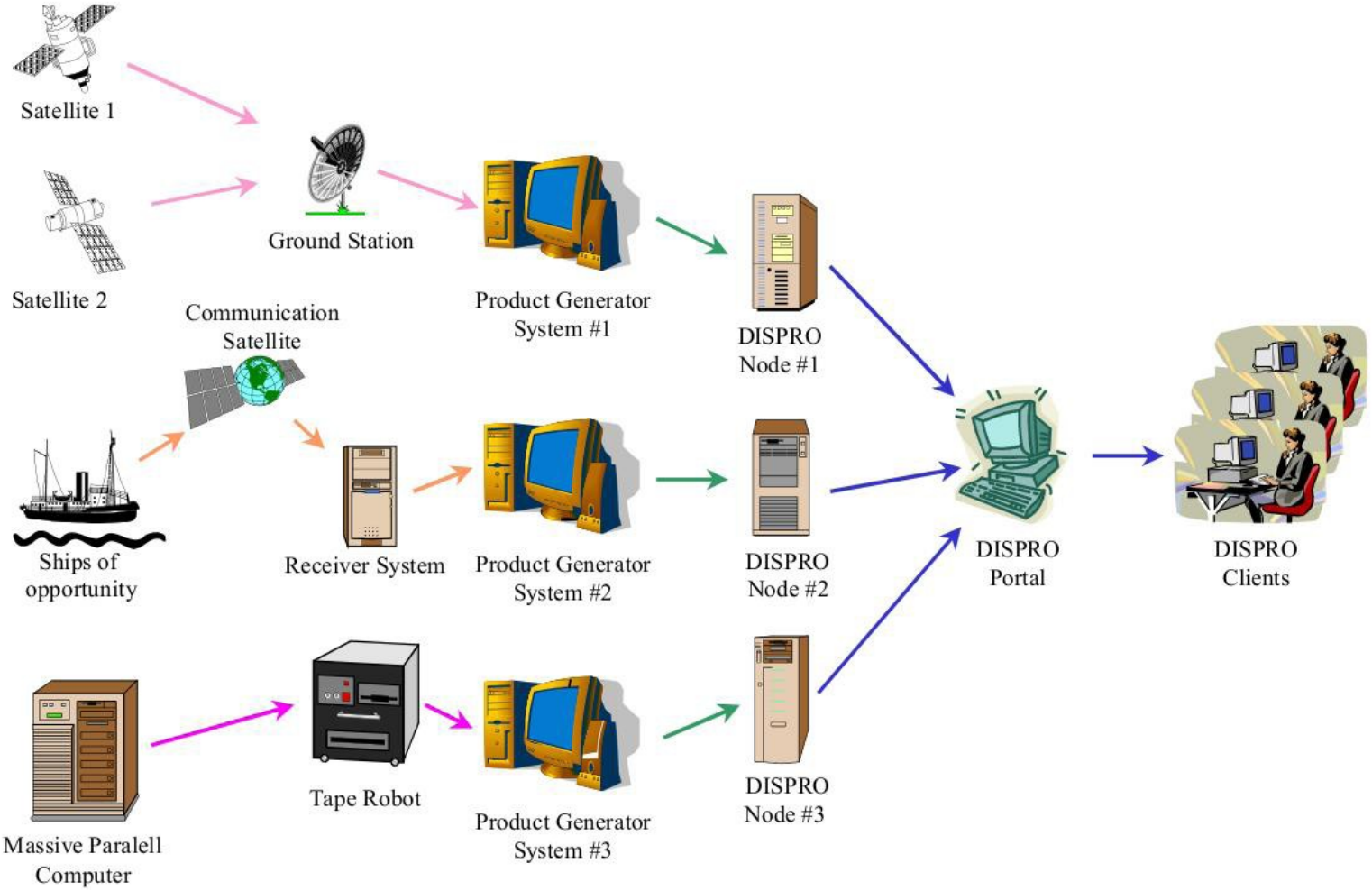
DISPRO system structure



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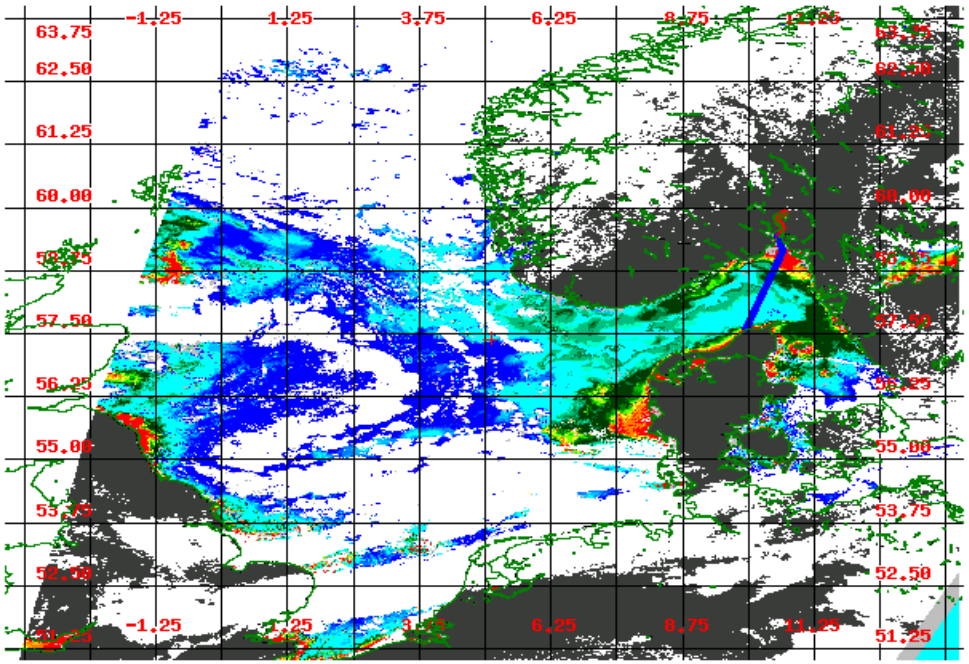
Remote sensing data (DISPRO - NERSC); Web Mapper Server: North Sea / Skagerrak



Intro || Updates || News || Notes || Summary

Notes

Chlorophyll-20050610 (Source: NERSC) Chlorophyll-a concentration derived from MERIS data, 10 June 2005, 10:21z.

algal_1 [mg/m^3] Chl-a
0 1.0 2.0 3.0 4.0 5.0

Layers

- ☐ Chlorophyll-20050608
- ☐ Chlorophyll-20050609
- ☑ Chlorophyll-20050610
- ☐ Chlorophyll-20050611
- ☐ Chlorophyll-20050612
- ☐ Chlorophyll-20050613
- ☐ Chlorophyll-20050614
- ☐ Chlorophyll-20050615
- ☐ Ferrybox chla-020604
- ☑ Ferrybox chla-fluoresc-140605
- ☐ hab-fish-tox-020604

Refresh Map

0 350 km

Controls

Zoom: Size 2 ◉ In ○ Out

Pan ○

DISPRO Home

original extent

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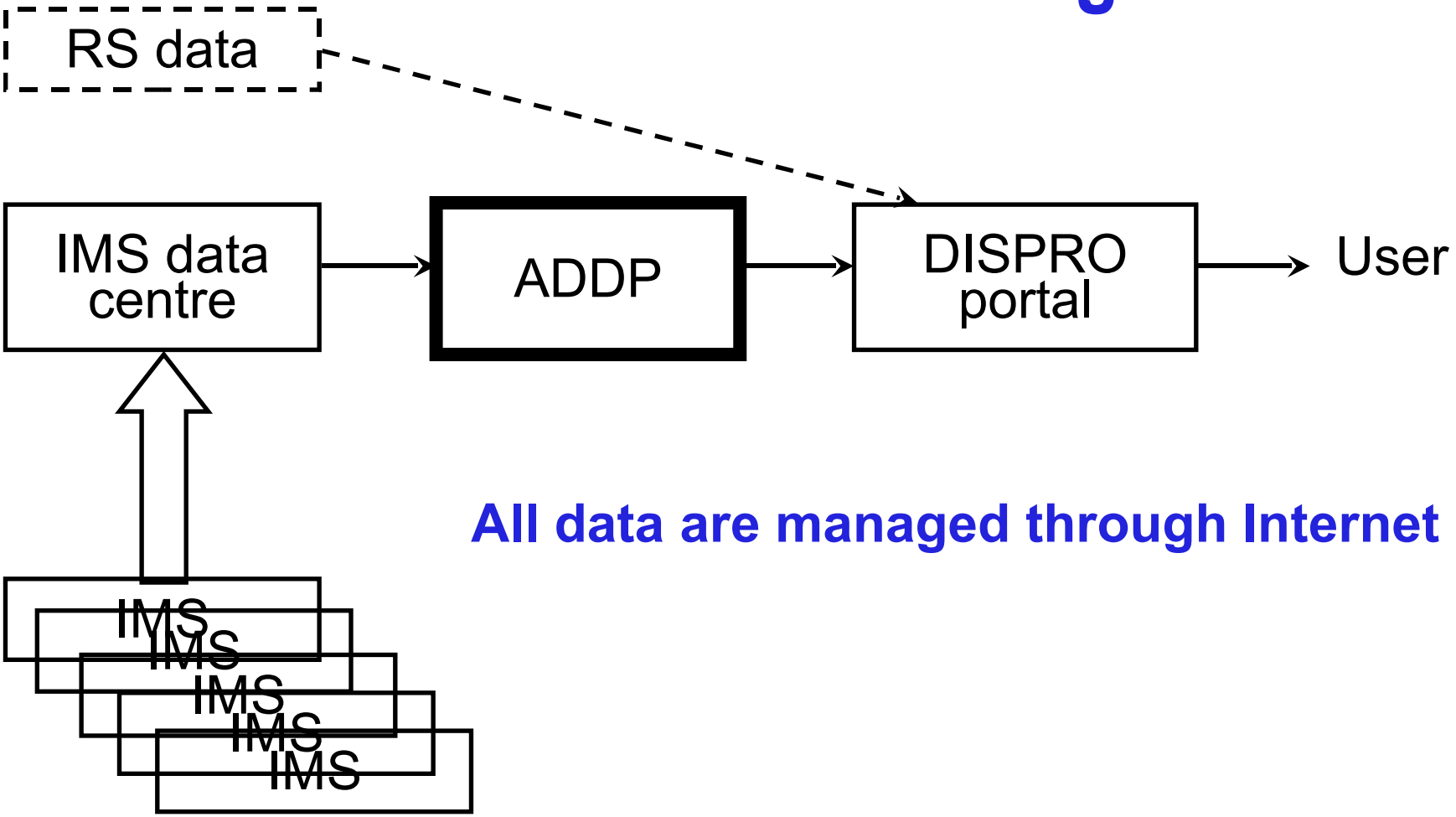
ADDP – a new interface to integrate in-situ and remote sensing data



All data are managed through Internet

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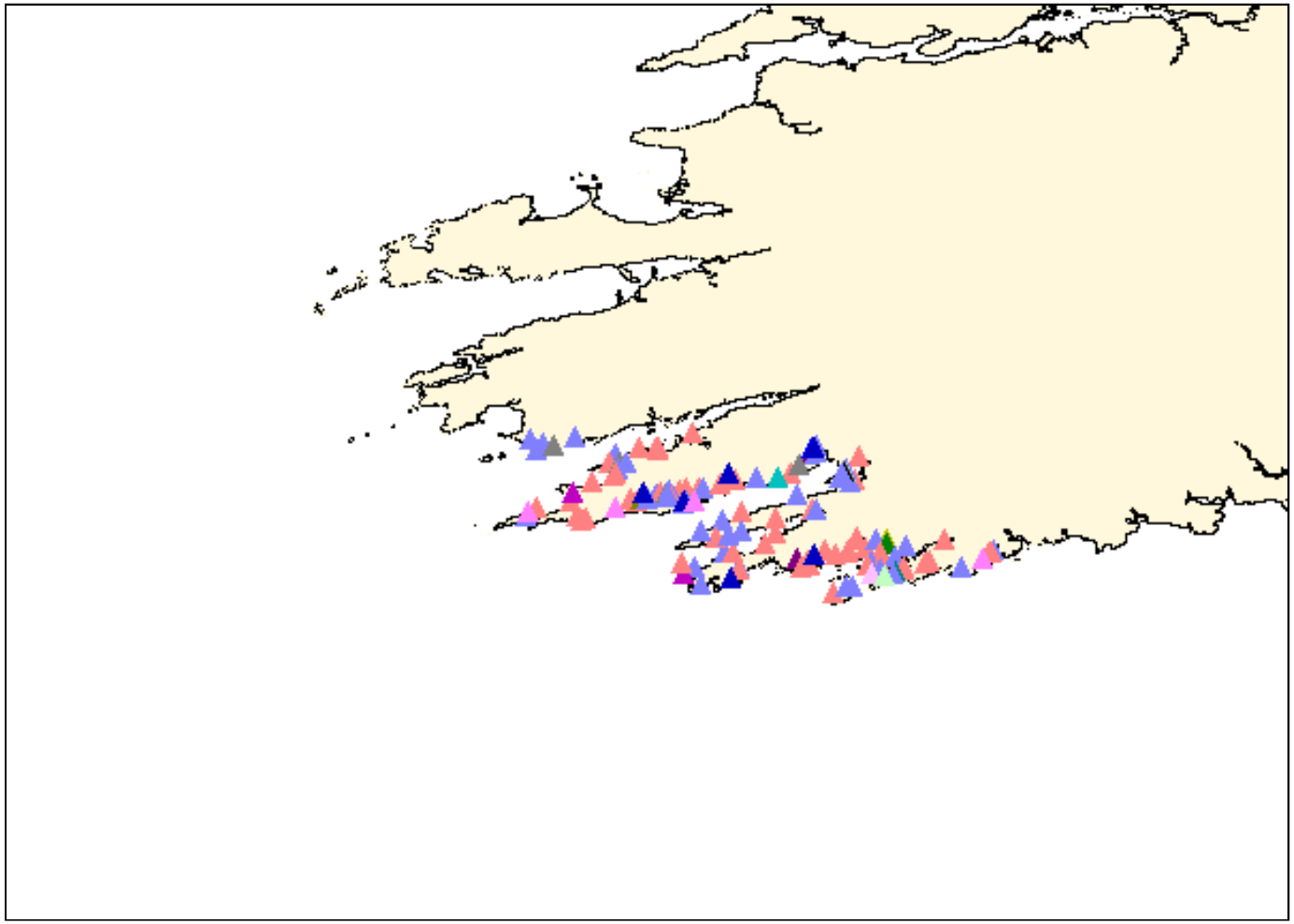
Integration results of in-situ measurements in DISPRO



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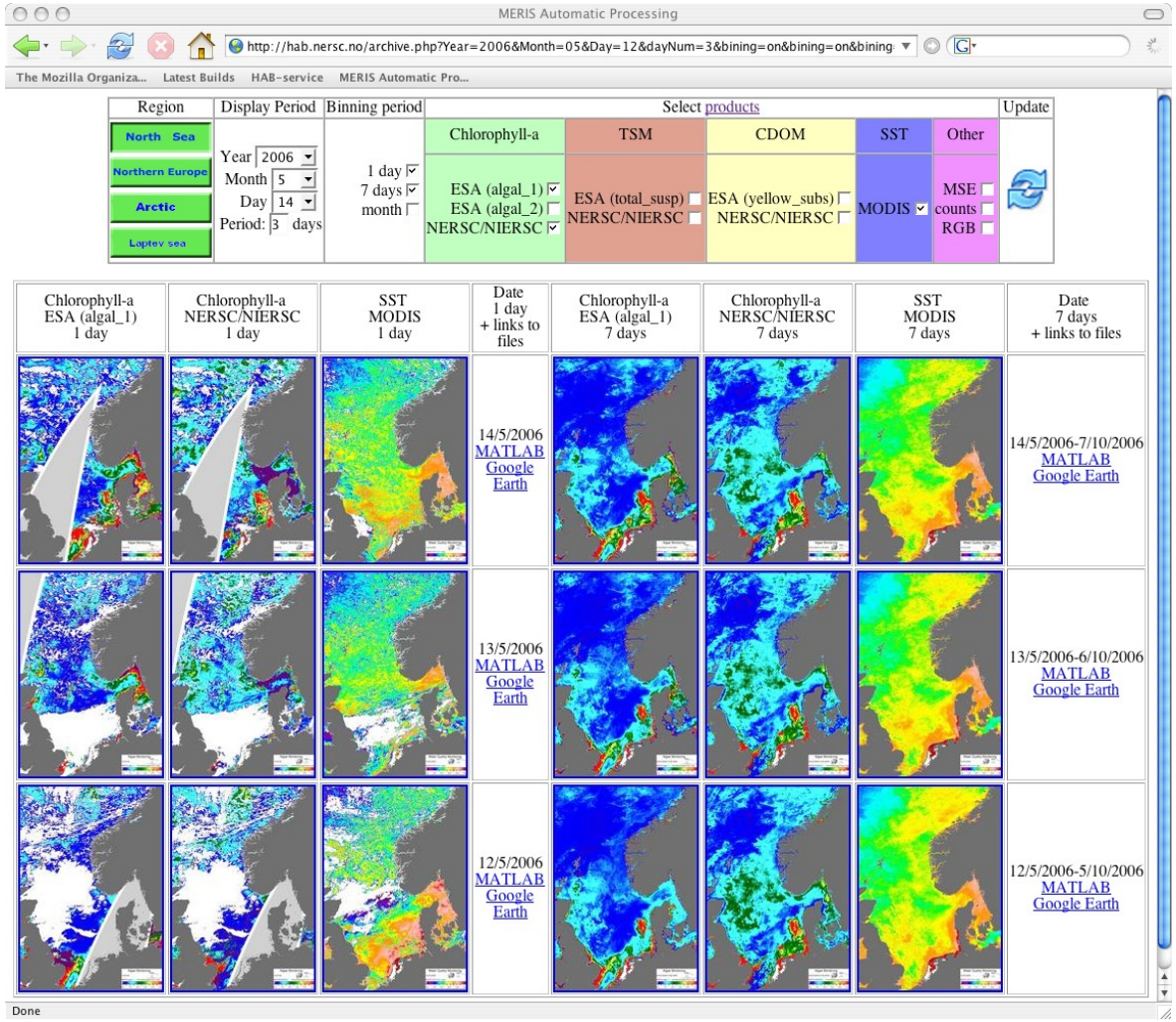
Chl-a Products selection



http://HAB.nersc.no

Chlorophyll-a (*2)

1-, 7- and 30-days averages

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Thank you for your kind attention

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