

CEDEX PROPOSAL FOR CHRIS/PROBA ACTIVITIES IN 2004 ON VALIDATION OF MERIS MODELS

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ABSTRACT

This paper presents the CEDEX proposed activities for 2004, in the frame of a Project funded by the Spanish Environment Ministry for Monitoring of Water Quality, specifically Cyanobacteria dynamics and toxicity in reservoirs, related to ESA AO-594 MERIS project.

Objectives using CHRIS/Proba mode 2:

Mapping of Cyanobacteria temporal and spatial distribution.

Validation of Algorithms developed for MERIS bands.

Testing and improvement of MERIS atmospheric correction models.

Using the multiangular capabilities of PROBA to improve the model accuracy and study the Fresnel reflectance effects.

Methods:

Ground campaigns measuring: Phytoplankton taxonomic composition and biomass; Phytoplankton pigment composition (HPLC, etc.); Nutrients concentration; Physicochemical parameters analysis; Cyanotoxins toxicity tests; Water optics: Above water and in water radiometry, Inherent optical properties measurement, reflectance measurements; Atmospheric optical measurements.

Area of work:

Rosarito reservoir, Tiétar river, Tajo river basin, central Spain.

Several Partners of the project:

CEDEX (Heading the Project), three Universities, Netherlands Institute of Ecology, Tajo Basin Authority, one consultant; INTA and ICC.

1. SCOPE AND OBJECTIVES

Last year the CEDEX proposed the inclusion in the CHRIS/Proba activities for 2004, the acquisition of some images sets over an Spanish site, in the frame of a Project funded by the Spanish Environment Ministry for Monitoring of Water Quality, specifically

Cyanobacteria dynamics and toxicity in reservoirs, related to ESA AO-594 MERIS project.

1.1 CHRIS-PROBA objectives

Mapping of Cyanobacteria temporal and spatial distribution, testing several algorithms for Phycocyanin and other Phytoplankton pigments.

Validation of Algorithms developed for MERIS bands.

Testing and improvement of MERIS atmospheric correction models, considering the adjacency and aerosols effects.

Using the multiangular capabilities of PROBA to improve the model accuracy and study the Fresnel reflectance effects.

1.4 Area of work



Fig. 1. Map of Spain showing the biggest reservoirs

In Spain there are almost 1500 reservoirs very important for the adequate balancing between mean precipitation and water demand.

In that frame is essential to preserve the water quality in condition as good as possible, and also provide the most accurate assessment of ecological status of water bodies.

The CEDEX proposed as area of work the Rosarito reservoir, located in the Tiétar river, Tajo river basin, central Spain, at foot of the Gredos mountains.

Center Lat/Lon: 40° 06' 06" N / 05° 16' 47" W
Top level area: 12.824 km².
Top level elevation: 311.23 aslm.
Maximum capacity: 92 hm³.

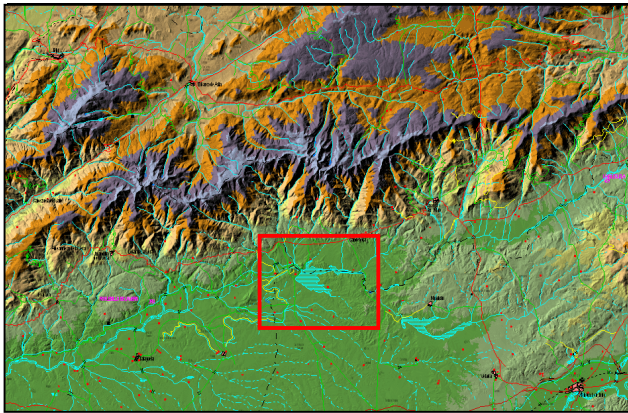


Fig. 2. Location of Rosarito reservoir

1.5 Partners of the project

The Centre for Studies and Experimentation on Public Works (CEDEX), through his Centre for Hydrographic Studies, will be the Coordinator of the Project.

In the beginning of the proposal, stimulating the initiative and supporting the activities, mainly the atmospheric correction and processing, the University of Valencia is involved now in the project and will be an essential contribution to these topics.

In addition the Centre for Limnology of the Netherlands Institute of Ecology will be very important support in the photosynthetic pigments analysis and modelling.

Otherwise is fundamental the collaboration of the Confederación Hidrográfica del Tajo, Tajo Basin Authority, opening the facilities and helping to the lake and field operations.

A consultant is charged of field campaigns on the water quality in swimming areas and cyanobacterial toxicity assessment.

Autonomous University of Madrid. Biology. Will contribute with his experience in phycobiliproteins analysis methodology.

ICC. Institut Cartogràfic de Catalunya, acquisition and processing of Airborne Hyperspectral sensor CASI imagery.

INTA. Instituto Nacional de Técnica Aeroespacial. acquisition and processing of Airborne Hyperspectral sensor AHS imagery.

SAR. Air Forces. Rescue Helicopter Unit. Ministry of Defence of Spain

2. METHODOLOGY

2.1 Ground campaigns tasks

Each 15 days from May 2004 until October 2006 (adapted to CHRIS-Proba calendar and, if possible, to MERIS calendar), measuring:

The campaigns comprise many different observations, measurements and water sampling for analytical and taxonomic determinations.

Phytoplankton taxonomic composition and biomass, pigment composition (HPLC, etc.); Nutrients concentration; Physicochemical parameters analysis; Cyanotoxins toxicity tests;

Will take Pigment concentration measurements vertical profiles: Temperature, conductivity and induced fluorescence of chlorophyll a, CDOM (Coloured Dissolved Organic Matter) and phycobiliproteins (phycocyanin and phycoerythrin) using a typical Multiparametric probe with CTD sensor and several associated fluorimeters.

In addition will take in vivo absorption coefficients of phytoplankton, detritus and CDOM.

Water Sampling for HPLC determinations of chlorophyll and carotenoids and for Phytoplankton composition and biomass assessment.

The water samples for analytical laboratory measurements and taxonomic assessment are taken in the first optical depth for the PAR radiation. According to Gordon and McCluney (1975), this depth (also called penetration depth) is where 90% of the remotely sensed light originates.

Using an ASD FR field spectroradiometer as detector, an commuter to alternate sensors and an integrating sphere to scattering determination, will be taken several Water optics measurements:



Fig. 3. Radiometric instrumentation in the boat

In order to guarantee the same conditions in every radiometric data (following the most accepted protocols), the optical fiber of spectroradiometer is mounted over an Above Water Measurement Device, incorporating both Azimuthal and Zenithal angle Controller, following the sun position.

Above water radiometry (multiangular reflectance measurement).

In water radiometry (upwelling and downwelling irradiance profiles).

Inherent optical properties measurement (absorption coefficients).

Surrounding land targets reflectance measurement; Atmospheric optical measurements (transmittance, aerosol optical thickness).

2.2 Multimission campaigns

In some dates we will try to coordinate several sensors and platforms over Rosarito reservoir, in order to rise the objective of complement, compare and improve the understanding of accuracy level and confidence interval in the fit, depending the applied sensor in each case.

Platforms/sensors:

CHRIS/Proba hyperspectral sensor image
 MERIS sensor image
 Airborne CASI hyperspectral sensor campaign (ICC)
 Airborne AHS hyperspectral sensor campaign (INTA)
 Helicopter (SAR) validation campaign with radiometry and sampling data collection.

2.3 Imagery acquisition proposal

Quantity: desirable 1 image per month, preferably may-november (to be defined)

Type: Water bands (Mode 2)
 Full Swath
 High Resolution
 Multiangular (5 angles)

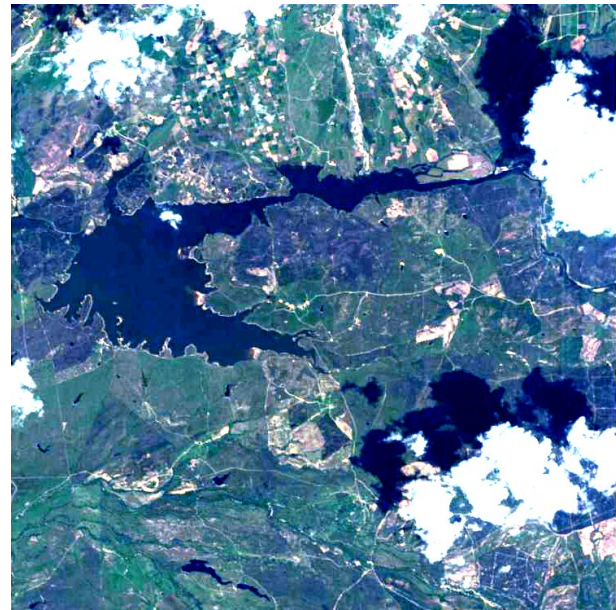


Fig. 4. First image CHRIS/Proba (2004.04.10)

Sent the proposal by December 5th 2003, the sensor CHRIS/Proba was taken successfully the first image set over Rosarito reservoir the past April 10th 2004.

3. SOME RESULTS FROM THE FIELD DATA

Progressing in the MERIS Project, many radiometric data has be integrated in a database in order to relate that measurements with the other “in situ” water information.

As an initial approach to algorithm development, we have examined the relationships between ratios of MERIS bands and pigment concentrations through simple linear regression analysis.

The band selection process was based on the spectral properties of each pigment and a peak analysis of the Radiation spectra.

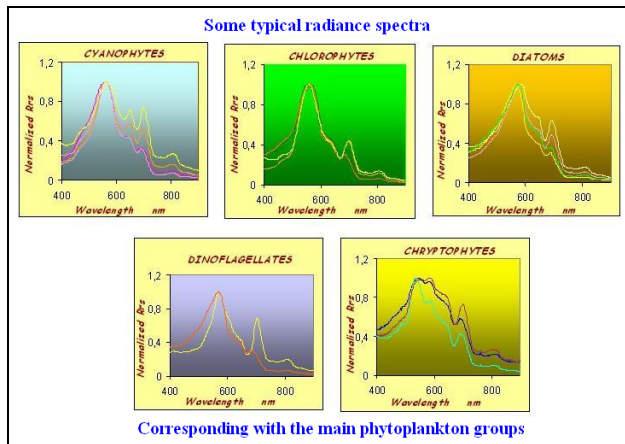


Fig. 5. Algal groups radiometric information

We found a very good linear relationship for chlorophyll a, ($R^2=0.919$) using the ratio between MERIS bands 9 and 7. Similar results are found using band 8 instead of 7.

The ratio between MERIS bands 9 and 6 (CHRIS/Proba 11 & 7) for cyanobacteria detection (the latter being centred at 620 nm) shows a good correlation ($R^2=0.723$) with phycocyanin concentration measured fluorometrically, and an even better correlation ($R^2=0.945$) with zeaxanthin measured using HPLC.

The correlation of other indicator pigments with MERIS band ratios is not as good, but it is still possible to develop some different algorithms more accurate for algal bloom monitoring.

In same direction, our Project has proposed, following the invitation of ESA, a dedicated MERIS experiment campaign to use the spectral programmability of the MERIS instrument to evaluate information (about photosynthetic pigment composition in Spanish Inland Water) from a modified MERIS band set.

4. REFERENCES

1. Gower, J.F.R, and S. King (this volume), "Validation of chlorophyll fluorescence derived from MERIS on the west coast of Canada"
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