

HICO Data User's Proposal

Title of Proposal

“USE OF HICO DATA TO STUDY THE WATER QUALITY OF COASTAL AND INLAND WATER BODIES”

Principal Investigator

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Abstract/project summary

The goal of the present project is to develop and validate algorithms what can be used by the user community to estimate water quality variables and parameters in coastal and inland waters, with HICO data.

In order to achieve this goal the project will be organised around the following main themes:

- Collection and compilation of inherent optical properties (IOP's) of lake water as well as aerosol characteristics on Spanish water bodies in the area under investigation.
- Improvement of the atmospheric correction of HICO images over coastal and inland waters.
- Validation of the atmospheric correction and the retrieval of IOP have and water constituents.

The work will be performed by a team which comprises good knowledge in remote sensing of inland waters, atmospheric correction, retrieval algorithms and software development for EO data processing.

All team members have been working with MERIS/Envisat, CHRIS/Proba, and other sensors and platforms for many years and they have shown in various publications and conference presentation their understanding of remote sensing data and its application to inland waters. The team is lead by the Valencia University (UV) and includes other Spanish institutions involved in this field of work, well organised with clearly defined responsibilities.

The proposal is focused in the lake Albufera de Valencia, eastern coast of Spain, including the very close coastal water and several inland water bodies, reservoirs, very abundant in this country (around 1500 reservoirs).

This proposal will try to provide basically algorithmic elements with more emphasis into the collection of IOP's and validation of the algorithms, applied to inland waters in Spain.

1. Statement of work/project description

Inland waters are of high economical and ecological value. They serve as drinking water reservoirs, recreation areas and ecosystems for rich fauna and flora. The human activities affect lakes in many ways. The main problem in Spanish lakes is the eutrophication process due to increasing nutrient load from agriculture, and industrial and municipal waste waters. Eutrophication can lead to increasing occurrence of cyanobacterial blooms, which can be toxic to humans and other organisms. Eutrophication also reduces ecosystem biodiversity.

Monitoring of a large number of lakes by conventional methods is a huge and expensive task. For example, less than 10% of the 1500 natural or man made lakes in Spain are annually monitored by conventional methods. In the global

scale, a recent study (Downing et al., 2006) shows that the extent of natural lakes is twice as large as previously known. This emphasizes the importance of considering lakes in global analyses of rates and processes, and getting reliable estimated of their water quality. Because of the wide spatial coverage, satellite remote sensing is the only affordable technique for the monitoring of a large number of lakes.

Monitoring of lakes is essential for Spain and is precisely and compulsory defined in the European Water Framework Directive (European Communities, 2000). In Annex V, Table 1.2.2 of the directive the biological quality component is defined – among other parameters - by phytoplankton biomass, taxa (species composition) and water transparency. Remote sensing, and HICO as very advanced hyperspectral sensor, can provide basic key information for these parameters, namely the optical properties of the water, which can be converted into transparency as well as chlorophyll-a concentration and further phytoplankton biomass. Monitoring of species composition may be possible by remote sensing, because recent results indicate that Phycocyanin, the Cyanobacteria specific pigment, can be estimated from satellite data (Gons, 1999; Simis et al. 2007 - 2009).

This project has a basic character experimental, to try to use if possible, the excellent radiometric capabilities of HICO sensor with the limitations in terms of frequency of scenes and repeatability of angle and consequently the ground area included in the images.

In order to achieve the objective, the project will be organised around the following main themes:

The proposal is focused in the lake Albufera de Valencia, shallow lagoon in the eastern coast of Spain, including the very close coastal water and several inland water bodies, reservoirs, very abundant in this country (around 1500 reservoirs).

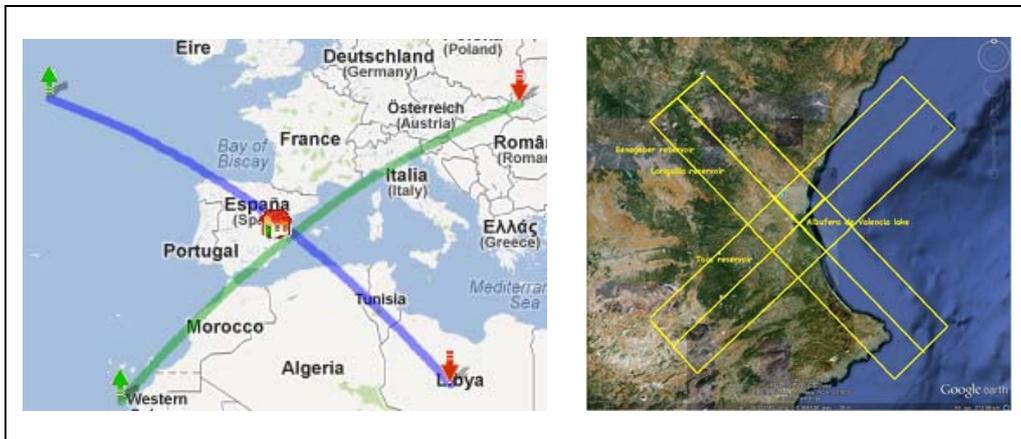


Fig. 1.- Proposed HICO scene as study area, around the lake Albufera de Valencia (coordinates: 39.33 N, -0.36 W), showing some different water bodies in the scene corresponding to alternative orbits.

Although the HICO sensor has been designed with a ground resolution of 100 m and an excellent spectral band setting which makes it ideal for measuring water quality parameters in inland waters, is very important to develop algorithms to retrieve the limnological parameters with known and good quality.

The use of HICO data is a very important advantage for the running projects of the University of Valencia on water bodies in the territory of Valencia region. Usually the works and its algorithms are using imagery from MERIS/Envisat (Guanter, et al., 2010, Ruiz-Verdú, et al., 2007, 2008; Peña-Martinez, et al., 2003, 2005) and CHRIS/Proba (Ruiz-Verdú, et al., 2007, 2008) sensors, with different spatial and radiometric resolution (300 m – 15 bands and 18 m – 18 bands, respectively), but the radiometric precision of HICO sensor (90 m - 102 bands, 380 to 960 nm sampled at 5.7 nm). These characteristics are excellent for water quality application, pigment estimation, etc., the most important goal in this Proposal. Main objectives:

- Collection and compilation of inherent optical properties (IOP's) of lake water as well as aerosol characteristics Spanish water bodies in the area under investigation.
- And it is possible to accurate as well as possible using the radiometric information taken “in situ”, validation of the atmospheric correction and developing and validating tools for the retrieval of IOP's and water constituents.
- Improvement of the atmospheric correction of HICO images over coastal and inland waters, using the tools and facilities from HICO technical team (imagery Levels: L1B, L2A, L2B).
- As the orbits of HICO are following very different azimuthal angles, the geographical orientation of the image will define, in each case, the water bodies surveyed in the scene, in addition to Albufera of Valencia, positioned to be always in the central line of the image.

The phytoplankton composition and sequential variations in the algal dominance (Romo, et al. 2008) increased the interest of pigment mapping to identify along the time the alternatives and quantify the evolution of pigment concentration values.

2. Biographical sketch and available facilities

Jose F. Moreno, P.I.

Jose F. Moreno is presently teaching at the Faculty of Physics, University of Valencia, as Professor of Earth Physics, and head of the Laboratory for Earth Observation of the Image Processing Laboratory-Scientific Park, University of Valencia. He is working on the development of data processing algorithms for multisource data integration and multisensor/multiresolution studies, including optical/microwave synergy and optical hyperspectral data processing, for modelling and monitoring land surface processes, with special interest in numerical techniques for model inversion and data assimilation applied to remote sensing data. During 1995-1996 he was a visiting scientist at the NASA/Jet Propulsion Laboratory in Pasadena, California, USA. He has been involved in several European research networks, including the European Network for the development of Advanced Models to interpret Remote Sensing data over terrestrial environments (ENAMORS), and the European Radar-Optical Research Assemblage (ERA-ORA) network. He also participated in several EC research projects related to water management, such as RESMEDES (Remote Sensing and Mediterranean Desertification), FLAUBERT (Flood in Arid Units by Earth Remote Techniques), AIMWATER (Analysis, Investigation and Monitoring of Water resources) and DEMETER (DEMONstration of Earth observation TEchnologies in Routine irrigation advisory services). He is also PI of several ESA projects using ENVISAT/MERIS data and CHRIS/PROBA data.

Author of many publications in the field, including several book chapters, Prof. Moreno has served as Associate Editor for IEEE Transactions of Geoscience and Remote Sensing (1994-2000), and was a member of the European Space Agency Earth Sciences Advisory Committee (1998-2002), the Space Station Users Panel (SSUP) and other advisory committees (ESA, European Commission, European Science Foundation, Eumetsat, as well as member of several national and international societies, and scientific committees for many international conferences and workshops. He has participated actively in the design and development of several remote sensing experiments in preparation of future space missions, using airborne instruments such AVIRIS, CASI, HYMAP, ROSIS, DAIS, AHS, etc. He is also chairman of the SEOSAT/Ingenio Mission Advisory Group within the ESA GMES programme, and coordinated the proposal for the Fluorescence Explorer (FLEX), a candidate ESA Earth Explorer Mission, being currently chairman of the ESA-FLEX Mission Advisory Group. He is also member of the NASA HypSIRI International Science Group.

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1976 Ph.D. Faculty of Biology, University of Valencia, Spain.

Position: 2006- Chair Professor of Ecology (Lecturer on Microbial Ecology). University of Valencia; 1985-86 Head of Department Microbiology and Ecology (UVEG).

Projects: 2000-2002. ECOFRAME. Ecological quality and functioning of shallow lakes ecosystems with respect to the needs of the Europe. Water Framework Directive. (C.E., Env. Proj. EVK-1999-00261). PI España (Eutrofización): Dr. Eduardo Vicente. Coord. Intern. Dr. Brian Moss.

1993-94. Producción y descomposición en los ecosistemas acuáticos hipertróficos, basándose en la Albufera de Valencia como modelo. CAICYT, I+D - Conselleria de Educació i Ciència. Generalitat Valenciana. Investigadora responsable: Dra. Maria Rosa Miracle.

Maria Rosa Miracle

Position: Universidad de Valencia. Facultad de CC. Biológicas e Instituto Cavanilles de Biodiversidad y Biología Evolutiva. (UNESCO code: 241704-240106-250805-250808)

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Doctor en Biología. Facultad de Biología. Universidad de Barcelona. Noviembre 1974. Director: Dr. Ramón Margalef López. Calificación: Sobresaliente "cum laude"

Catedrática de Ecología. Facultad de Ciencias Biológicas. Universidad de Valencia, (since 1981-)

Director Dep.Microbiología y Ecología. Facultad de CC. Biológicas de la Universidad de Valencia, (since 2003-)

Projects: Modelización de la influencia de los pulsos de flujo hídrico en la oligotrofización de los lagos someros. La Albufera de Valencia, un caso de estudio. DGIYGP de I+D+I. (Referencia: CGL2009-12229) - Universidad de Valencia. 2010-2012. PI: Dr. María Rosa Miracle ECOFRAME. Ecological quality and functioning of shallow lake ecosystems with respect to the needs of the

European Water Framework Directive. C.E.. 1999-2002 PI: Dr. M. R. Miracle. Coord.: Brian Moss.

Shallow wetland lake functioning and restoration in a changing European environment. C.E. 1997- 2000.

PI Dr.M.R. Miracle. Coordinador Internacional: Brian Moss.

Ramón Peña-Martínez

Forest Engineer (Polytechnic University of Madrid, 1963) and was head of the Remote Sensing Unit in CEH-CEDEX. Having a strong background in limnology, he started using remote sensing in 1984, in the framework of the first national assessment of eutrophication in Spanish reservoirs.

Since then, his main interests have been the applications of remote sensing for inland water quality, as well as other remote sensing applications to water related issues (such as hydrologic modeling or water resources evaluation).

Remote sensing activities. With Landsat sensors (MSS, TM and ETM), he developed many survey projects and produced periodic reports for the Environment Ministry between 1987 and 1999, for the large-scale eutrophication monitoring in the reservoirs of Spanish river basins.

Also, he led some dedicated studies, such as the specific study of thermal pollution from power plants in rivers or the diffusion of suspended solids after dam flushing events, using the airborne sensor Daedalus ATM. More recently, other airborne sensors (CASI-2 and AHS) have been used for this and other purposes (basically the study of phytoplankton biomass and his dynamics)

Most recent projects. Since the launch of Envisat and Proba satellites, most of his activity has been centered in the application of this imagery for phytoplankton monitoring in inland waters.

He was the Principal Investigator of one MERIS ESA project (AO-594) two Chris ESA projects (AO-2830 and AO-3123), and of two Spanish-funded projects in this field. The results of these projects have been presented in different ESA workshops and in other remote sensing and limnology international meetings. Also applied imagery from other sensors, as SPOT, IRS, etc.

In 2007-2008 has participated as Spain team head, in the ESA Invitation to Tender (ITT) for “Development of MERIS Lake Water Algorithms” to develop a software processor as a plug-in module for the BEAM toolbox that can be used with MERIS data to estimate water quality parameters in inland waters.

University of Valencia (UVEG). Technical resources and facilities.

The University of Valencia (UV) have many investigators, facilities and instrumentation to run a program of sampling and observations on the most important water areas and inland water bodies what will be included in the image to acquire by the HICO sensor, coincident with the ISS announced pass. The University of Valencia team has also the necessary software and expertise to carry out HICO data processing, including all necessary radiometric corrections and atmospheric corrections needed for the retrievals (Guanter et al., 2005-2006-2008-2010).

The UV have advanced laboratories to analyse the samples through conventional techniques, HPL, etc. in order to evaluate the concentration of photosynthetic pigments in the water masses.

In the other side have field work equipment with both to navigate to find the sampling and observation points. Also have limnological probes and radiometers to take in situ info on water parameters and its optical properties. (Fig. 2)



Fig. 2.- Measurement set-up for above water spectrometer and fluorimeter set used in Spanish lakes (Ruiz-Verdú et al. 2007, Peña-Martínez, et al., 2003, 2004).

The UV would need to know the next acquisition programmed several days before the date to prepare the personal and equipment to field work, to provide information useful to program the sampling and observations as coincident support for the HICO imagery, and very important in developing models between the HICO data and the field data, in order to obtain tools to estimate the parameters and his very accurate validation process.

3. Output and deliverables

The first goal of this project will be is obtain several HICO images in order to develop validated models to estimate water parameters, especially photosynthetic pigments (Chlorophyll and Phycocyanin) with good fit between the data taken “in situ” from the water and the estimated data. The software developed in the framework of this project will be made available to the scientific community working with HICO data.

The second step is to produce thematic mapping of the limnological parameters in the water bodies, as a very useful tool to take decisions in the control and improve the water quality levels (EQR) in order to accomplish the requirements of the European Union Water Framework Directive.

Other objective should be in the future to coordinate with the HICO image acquisition plan, a Remote Sensing supported Program to monitor the Ecological Quality of Water in water bodies with high interest on its water quality and representing important ecological goal for the population.

Corresponding to the HICO confidence on the UV proposal, investigators involved in this project will prepare an Project Final Report and attend the next annual work meetings, to present to the user community the result of the works and his progress in the use of HICO data. In the resulting publications the usage of HICO data will be acknowledged.

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