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The Antares Observation Network

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The ANTARES Observation Network

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ABSTRACT

The ANTARES network seeks to understand the variability of the coastal environment on a continental scale and the local, regional, and global factors and processes that modulate this variability. The target are coastal zones of South America and the Caribbean Sea. The initial approach includes developing time series of *in situ* and satellite-based environmental observations in coastal and oceanic regions. The network is constituted by experts that seek to exchange ideas, develop an infrastructure for mutual logistical and knowledge support, and link *in situ* time series of observations located around the Americas with real-time and historical satellite-derived time series of relevant products. A major objective is to generate information that will be distributed publicly and openly in the service of coastal ocean research, resource management, science-based policy making and education in the Americas. As a first stage, the network has linked oceanographic time series located in Argentina, Brazil, Chile and Venezuela. The group has also developed an online tool to examine satellite data collected with sensors such as NASA's MODIS. Specifically, continental-scale high-resolution (1 km) maps of chlorophyll and sea surface temperature are generated and served daily over the web according to specifications of users within the ANTARES network. Other satellite-derived variables will be added as support for the network is solidified. ANTARES makes data available and offers simple analysis tools that anyone can use with the ultimate goal of improving coastal assessments, management and policies.

Keywords: coastal, ocean, time series, remote sensing, ocean color, bio-optics, sea surface temperature, ANTARES

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1. INTRODUCTION

ANTARES is an integrated network of *in situ* and remote sensing stations focused on detecting long-term changes in marine waters around South America that grew out of consensus by scientists in the region. In November 2002, a multi-sponsored international training course on remote-sensing applications was held at the University of Concepción, Chile. Discussions during the course led to the formation of a South-American network for ocean bio-optics, through which the participants would share resources and intellectual property, achieve all the benefits of collaboration including capacity building, and produce results that applied at the continental scale. Subsequently, the foundational meeting of the network took place at the National Institute of Fisheries Research (INIDEP, Mar del Plata, Argentina), with the support of the International Ocean-Colour Coordinating Group (IOCCG) and the Partnership for the Observation of the Global Oceans (POGO), where the basis of the network were established.

The main research goal of the ANTARES network is to promote observations of the coastal ecosystems of South America and the Caribbean Sea at various scales ranging from time-series observations at fixed points in the ocean to large-scale, and spatially-extensive observations through remote sensing. Such long-term sustained observations will serve the overall goal of detecting and understanding long-term variability in the coastal ecosystems, and evaluating the impact of climate change and human activities on coastal ecosystems at local and regional scales. The list of institutions that currently participate in the ANTARES network is shown in table 1.

Table 1. List of participating institutions in the ANTARES network

Fundación La Salle de Ciencias Naturales	FLASA	Venezuela
Universidad Simón Bolívar	USB	Venezuela
Fundação Universidade Federal de Rio Grande	FURG	Brazil
Instituto Oceanográfico da Universidade de São Paulo	IOUSP	Brazil
Instituto Nacional de Pesquisas Espaciais	INPE	Brazil
Universidad de Concepción	UdeC	Chile
Instituto Nacional de Investigación y Desarrollo Pesquero	INIDEP	Argentina
Estación de Fotobiología Playa Unión	EFPU	Argentina
Instituto de Astronomía y Física del Espacio	IAFE	Argentina
Bedford Institute of Oceanography	BIO	Canada
Dalhousie University	Dal	Canada
Institute for Marine Remote Sensing, University of South Florida	ImaRS/USF	USA
Scripps Institution of Oceanography	SIO	USA

To achieve the overall goal of the network enhancement and standardization of the measurements performed at a number of existing coastal time-series stations around South America was proposed. This would allow the creation of a common database which could be used to assess whether change was occurring simultaneously in coastal and shelf waters across large continental scales, and to validate and improve the algorithms used to retrieve oceanographic information by remote sensing, such as: chlorophyll-a concentration (Chla) and sea surface temperature (SST). The ultimate goal of the integrated database of field measurements as well as satellite images from the whole coastal zone around South America and the Caribbean Sea is to facilitate the study of changes in these ecosystems. At the same time, this database should be accessible to the general public for educational and management purposes, contributing to the social and economical development of the countries involved.

As a first step to achieve these goals, a project called “Coastal Ecosystems of the South American Region (CESAR): An integrated satellite data management and distribution system” financed by the Inter American Institute (IAI), which involved the creation of an interactive database of the existing satellite images of ocean color was developed. This allowed the first gathering of satellite images of different coastal areas around South America in a common and accessible interface, since the images are processed and stored following a common protocol.

The results of this first phase of the ANTARES network will be presented in Section 3.

2. INITIAL APPROACH

The network is built on ongoing initiatives in different countries in the Americas both in the remote sensing area (Table 2) and *in situ* observations (Table 3). From the start, this project has been conceived as a highly integrated one. The strategy is to foster and sustain the human and technological capacity across South America to enable application of satellite remote sensing for the scientific assessment of change in the coastal marine ecosystem. For this purpose we envisage two components, which will be intrinsically connected, and which will grow from mutual feed-back. The strategy for observation is a judicious mix of remote sensing and *in situ* observations: remote sensing provides the only window for synoptic scale observation of ocean ecosystems. In the ANTARES network project we propose to link ocean-color and other remote sensing observations with a carefully selected set of *in situ* time series stations. The field observations will be used to improve ocean-color algorithms and to test and validate the performance of satellite sensors. The remotely sensed data in turn will serve to interpolate the *in situ* observations in time, and to extrapolate them over larger spatial scales.

Table 2. List of ANTARES Remote Sensing Centers

Name of Centers	Country	Institution	Responsible Researcher
CARIACO	Venezuela	USB	Eduardo Klein
	USA	USF	Frank Müller-Karger
Concepción	Chile	UdeC	Osvaldo Ulloa
Laboratorio de Teledetección	Argentina	IAFE	Domingo A. Gagliardini
INPE	Brazil	INPE	Ana I. Dogliotti Milton Kampel

Table 3. List of ANTARES Time Series Stations

Name of station	Location	Country	Institution	Responsible
CARIACO	10° 30' N 64° 47' W	Venezuela	EDIMAR*	Ramón Varela
		USA	USF	Frank Müller-Karger
COPAS-Concepción EGI	36° 31' S - 73° 08' W	Chile	UdeC/COPAS	Rubén Escribano
	43° 20' S - 65° W	Argentina	EFPU	Walter Helbling Elena Barbieri
EPEA	38° 28' S 57° 41' W	Argentina	INIDEP	Rubén Negri Vivian Lutz
Ubatuba	23° 44' S 45° 00' W	Brazil	IOUSP	Salvador Gaeta
			INPE	Milton Kampel

* Estación de Investigaciones Marinas de Margarita (Fundación La Salle)

3. THE “CESAR” PROJECT

The “Coastal Ecosystems of the South American Region (CESAR): An integrated satellite data management and distribution system” project (IAI) focused on developing a set of real-time applications that use Moderate Resolution Imaging Spectroradiometer (MODIS) imagery collected by the NASA Aqua satellite.

3.1 Objectives

The objective of the project was to develop a set of applications that help integrate the knowledge generated by NASA and the MODIS Instrument Team into resource management and general education programs. The target environments were coastal zone and oceanic environments of the continent of South America and the Caribbean Sea. The objective included developing a simple and accessible web-based application and analysis tool to distribute satellite data and make it useful for scientists, educators, the general public, resource managers and policy makers. Specifically, the objective was to minimize the technical knowledge about satellite data formats, specialized remote sensing background, etc., that has traditionally limited the use of satellite data to a small and select group of people. The tools would ultimately allow the general public to learn about coastal and ocean resources and about technologies available to study processes on Earth that operate over large scales.

3.2 Approach

The CESAR project constitutes the first concrete product of the ANTARES network. The program is particularly suited to providing customized products in near real-time. We use standard data formats, such as HDF, where possible, as these are compatible with the DODS strategy. DODS is the product of the Virtual Ocean Distributed Oceanographic Data System (VO-DODS) project, funded by the U.S. National Oceanographic Partnership Program (NOPP). It provides a transparent means to deliver spatial data to remote users based on queries that define a geographical window for specific geophysical data. The strategy will incorporate mechanisms to nurture long-term relationship with stakeholders (scientists, educators, costal managers and the media), as a primary source of input regarding product design and the application’s performance.

Currently the applications include only MODIS data. However, the applications will continue to be developed to fuse EOS MODIS with ancillary satellite data, meteorological analyses, and oceanographic observations generated by *in situ* observing systems in real-time decision-support applications. These applications will be based on the best available science and will be tested using short-term evaluations of satellite-observable water quality indicators. The ANTARES team will seek feedback from members of the education, resource management, and science communities to continue to develop the tools.

3.4 Outcomes of “CESAR” project

3.4.1 ANTARES web portal and local web sites

A fundamental step to implement the satellite data distribution system was the development of the ANTARES web portal (<http://antares.ws>). A home portal exists at ImaRS (USF, USA), where the images are daily downloaded processed and incorporated into the ANTARES web page. Then, local ‘mirror’ sites are developed by each one of the member countries, to accommodate local information, not only from satellite but also from the field stations. General information on the mission and objectives of the network, as well as on the members (institutions and researchers), projects and workshops carried out, can be found on these web sites. The brief on the main portal is in the three official languages of the network (English, Spanish and Portuguese); local web pages are written in the native language. The main aim of the ANTARES web portal is to link all the data servers from each member country and the various participating institutions through a common interface. The interface serves the data in a variety of ways that insulate the user from the complications of data file formats, sensor characteristics, etc. In this sense, links to educational tutorials on remote sensing subjects have been incorporated, as well as explanations on the meaning of technical specifications such as the warning ‘flags’ display with the satellite data. We expect to advance in making the web-pages as user-friendly as possible for the general public. To accomplish this task we will require the input, comments, and criticism from the users.

3.4.2 Implementation of the satellite data distribution system

The application developed permits the customer to view and analyze separate MODIS data streams for specific regions defined around South America in high resolution, 1 km (Figure 1). The project took advantage of the recent efforts at the NASA Goddard Space Flight Center SeaWiFS Project to process the entire global MODIS data set to unmapped, high resolution (1 km pixels) standard products, i.e., normalized water-leaving radiance, the diffuse attenuation coefficients (K₄₉₀), chlorophyll concentration (Chla), Sea surface temperature (SST) and atmospheric correction parameters (Eps₇₈ and Angstrom₅₃₁).

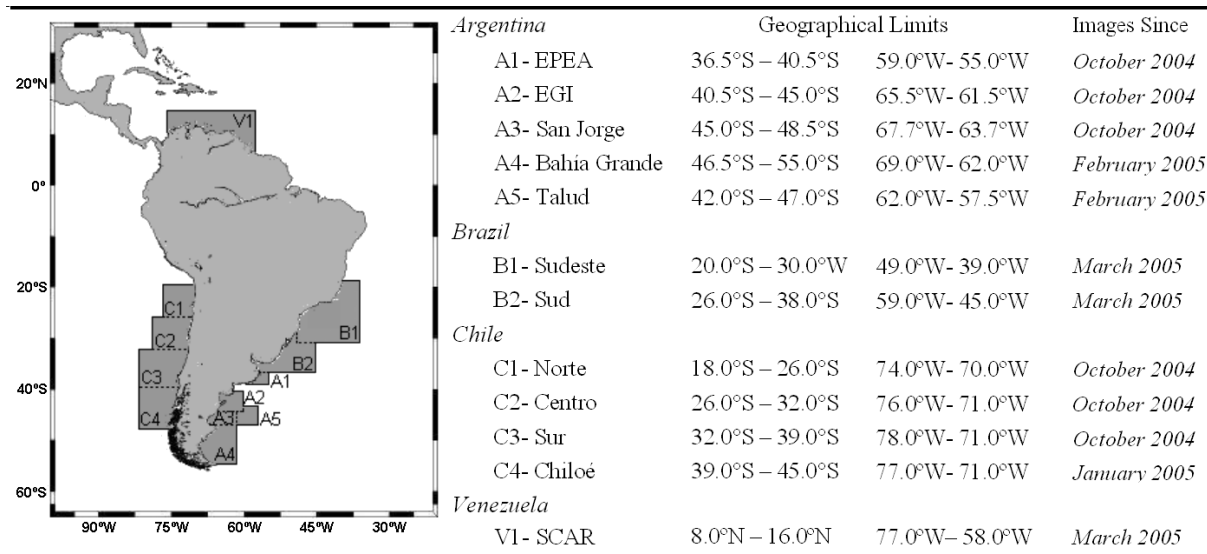


Figure 1. Specific regions defined by ANTARES where MODIS data can be obtained and the starting date of acquisition for each.

The University of South Florida established with NASA Goddard Space Flight Center SeaWiFS Project a subscription for all MODIS Level 2 data granules covering the Atlantic and Pacific Ocean from about 60 degrees south to about 30 degrees north. Subsets of the original MODIS data granules are obtained for each of the regions specified (Figure 1) and mapped to a cylindrical projection. Hierarchical Data Format (HDF) file for each mapped region which includes all NASA MODIS standard products are generated. The images (HDF files) are placed on a server at USF and files can be retrieved from each local ANTARES web site. In total, each file produced represents approximately 5 (five) megabytes, and USF generated approximately 10 files per day for the CESAR-ANTARES network over a one year period. It is anticipated that the number of files will grow as people start using the data and as new members join the ANTARES network.

3.4.3 Data extraction

Thumbnails of daily images of MODIS Chla and SST data products can be seen and selected for each region previously defined. The starting acquisition date for each region can be found in Figure 1. The ANTARES web service offers different options to obtain the satellite product desired. One option is to work online with the highest resolution image. The data extraction tool developed offers the capability to query the satellite data by clicking on an image or by inputting specific latitude and longitude positions from which data are desired. The system collects and returns a table to the local user over the internet, which includes chlorophyll, sea surface temperature, and various quality control parameters or “flags”. Other possibility is to view the HDF file’s attributes via the DODS server. The DODS Dataset Access Form, that can be access through the “DODS view” option, displays the HDF file contents from the dataset selected. This form allows selecting the desired variables amongst the MODIS standard products and the specific information for each variable is also available, e.g. the slope and intercept to be applied to retrieve the product, the units, the projection category and name, the latitude and longitude limits of the subset, etc. Once the desired variables are selected the data can be acquired in different formats, like ASCII and DODS binary object. The other option is to download directly the full HDF file (all the standard products) via ftp through the “ftp (DODS file)” option.

4. FUTURE ACTIVITIES

The ANTARES network will grow along several closely intertwined paths. One path will continue developing the internet web services tools, i.e. applications to extract spatially, over a desired transect, and also temporally, for a user-defined period of time on a selected point, the variable of interest. Also other satellite-derived variables will be added to the existing ones, like wind and wave observations and the same strategy is planned to be addressed to other existing sensors like MERIS and follow-on missions. Local websites will be further improved with data and product descriptions, tutorials in three languages (Spanish, Portuguese and English). The incorporation of a mechanism to collect the feedback from the end-users of the web-pages is envisaged, like on-line forms to obtain end-users opinions and questions. Another path is to maintain and strengthen the *in situ* time series that will allow validation of the satellite data. Effort will be focused to enhance and standardize the measurements performed at the existing local time-series stations around South America in order to create a common database and the inclusion of new time-series stations are expected so as to gain understanding on a continental-scale scope. Another step to follow is to integrate remote sensing data with field data, *in situ* versus satellite-derived graphs of variables like Chla and SST will be posted on a regular basis on the local web sites, in order to make a direct comparison is possible and showing the degree of accuracy and quality of the remotely sensed estimates at the different sites. Finally, both of these paths will be closely linked with each other and fed into an education and outreach path. ANTARES website will be used to communicate sampling protocols, results, and also educational tools developed in part through this one-year project.

5. CONCLUSIONS

ANTARES is an integrated network of *in situ* and remote sensing stations focused on detecting long-term changes in marine waters around South America that grew out of consensus by scientists in the region. Through the CESAR project, sponsored by the IAI, one short-term objective of the ANTARES network has been achieved, namely to develop a simple and accessible web-based application and analysis tool to distribute satellite data and make it useful for scientists, educators, the general public, resource managers and policy makers. Thus, through the ANTARES web portal (<http://antares.ws>) we provide a simple interface to historical, as well as new daily satellite data for the coasts and oceans surrounding large proportion of the South American sub-continent.

The outcome of this first one-year project demonstrates the feasibility, desirability, and utility of a scientific information system on the coastal ecosystems of the South American region. It will also serve as a communication vehicle for integration of various existing *in situ* time-series stations dispersed around the periphery of the continent that requires a synoptic framework for common interpretation of otherwise disparate and independent datasets.

This project has contributed significantly to solidify the observational network of institutions and countries. The project required close coordination and handshake to link the satellite data to each country's web sites, to be delivered to the public through interfaces that are similar in each country but each translated to the local language. The interfaces follow a set of technical and aesthetic standards that had to be developed, and continue to be developed, in close coordination. Follow-up activities are currently underway showing the commitment of the group to continue the joint effort that proved to be for common and public benefit by sharing expertise and knowledge and by deploying widely a tool that makes local ocean satellite data accessible to effectively anyone with an Internet connection in South America.

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