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Dear Colleagues,

I am very pleased to welcome you at the MERIS User Workshop taking place from Monday 10 November to Thursday 13 November at ESA’s ESRIN centre in Frascati.

Envisat’s MERIS instrument currently returns a wealth of data on Earth’s oceans, land and clouds to more than 350 scientific teams worldwide. The workshop shall be a valuable opportunity to get first-hand information on its latest results, and learn more about the calibration and validation results for ESA standard products.

The objectives of this three-day User Workshop are to:

- inform you about the most recent status of the instrument calibration, processing algorithms and the quality of the products derived from them
- gain understanding of the Envisat user services and MERIS data distribution activities and constraints
- provide a forum for investigators to present their latest results from ongoing research
- discuss the use of MERIS products across the fields of ocean colour, land applications and atmospheric science
- demonstrate the scientific capabilities of MERIS measurements and how they compare with other optical sensor data
- get your feedback on the usefulness of available data analysis tools
- train users in the programming of the BEAM toolbox software
- formulate recommendations for the development of new algorithms and products in the future
- generate a sense of community among MERIS investigators

The final programme of this workshop includes a number of oral presentations, poster sessions, hands-on software demonstrations, round table discussions, and thematic working sessions.

Your active participation provides you with the opportunity of meeting your colleagues in a stimulating environment geared towards shaping the future of the successful exploitation of the MERIS mission.

Peter Regner (ESA/ESRIN)
Workshop Organiser
Session 1: Status of Envisat, Data Distribution, Calibration, Processing, Validation
Envisat/MERIS Mission Status

Henri Laur (1)

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Abstract

After a successful launch in March 2002 and an intensive 9-months commissioning phase, the Envisat mission entered into operations in early 2003 with a gradual release of numerous types of products. Most of the mission services are now routine, and further improvements are foreseen in the near future (e.g. on-line ordering) in order to meet the growing user expectations.

All Envisat instruments are operating nominally, with very stable performances observed from all of them, and in particular with the MERIS instrument. Some anomalies were encountered with few instruments and have been solved satisfactorily. Thanks to the introduction of the Artemis data relay satellite for Envisat data transmission during Summer 2003, data recovery, in particular for MERIS Full Resolution, has notably improved.

Despite the problems encountered with the irregular throughput of the data distribution during the Commissioning Phase, the calibration/validation teams provided excellent results and relevant recommendations, leading to the release of MERIS Level 2 products in June 2003. The validation effort will continue during the mission lifetime. Events like the Envisat Validation Workshop in December 2002 confirmed the enthusiasm of the Earth Science community for the performances and capabilities of the data provided by all Envisat instruments, with particular satisfaction concerning the MERIS instrument.

The presentation will cover the above points and provide some preliminary results of the Envisat mission.
Envisat User Services and MERIS Data Distribution

Simon Jutz (1)

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Abstract

The overall acquisition strategy for MERIS Full Resolution mode, including the Regional Background Mission will be presented and acquisition plots since Envisat Launch will be shown. The instrument utilization in MERIS Full Resolution mode constrained by data recovery limitations will be discussed including an outlook of future changes. User Access to MERIS data will be explained and the new Online ordering system for MERIS data will be presented.
MERIS Calibration

Steven Delwart (1)

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Abstract

The calibration results from the first year of operation of the MEdium Resolution Imaging Spectrometer (MERIS) will be presented, including in-flight verification and radiometric, spectral and geometric characterisation of the instrument. Radiometric calibration using the on-board diffuser will be discussed and comparison with vicarious calibration results over desert sites or well-characterized marine sites will be presented. The image quality will be assessed, and improvements resulting from the in-flight characterisation will be presented.
MERIS Level 1b and Level 2 Processing

Dr Ludovic Bourg (1)

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Abstract

An overview of the MERIS data processing and products will be provided. A schematic description of the MERIS instrument will be given as an introduction to the Level 1b processing. The main Level 1b processing steps will be described in relation with the most significant instrument features, the Level 1b products and annotations will be introduced. The general structure of Level 2 processing will be described, introducing the main processing branches: the common processing steps yielding to pixel classification according to surface type (cloud, water and land), the water vapour retrieval which apply above all surfaces and the water, land and cloud processing branches. Each processing branch will then be described individually together with the associated products.
The MERIS Cal/Val Program and the Level 2 Products Quality

Dr Carsten Brockmann (1), and Philippe Goryl (2)

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Abstract

In March 2002, the European Space Agency launched Envisat, an advanced polar-orbiting Earth observation satellite which provides measurements of the atmosphere, ocean, land, and ice. The Envisat satellite has an ambitious and innovative payload that will ensure the continuity of the data measurements of the ESA ERS satellites. Envisat data supports earth science research and allows monitoring of the evolution of environmental and climatic changes. Furthermore, the data will facilitate the development of operational and commercial applications. The presentation will give an overview of the Meris data quality, calibration and validation program. The data acquisition, data processing and data distribution will be presented as well.
Session 2: Atmospheric Products Validation
Validation of MERIS Atmospheric Products: an Overview

Prof. Jurgen Fischer (1), Dr Rene Preusker(1), Mr Peter Albert(1)

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Abstract

Since its launch onboard ENVISAT in March 2002, the Medium Resolution Imaging Spectrometer MERIS gives insight into the properties and dynamics of the Earth’s atmosphere with unprecedented accuracy and resolution. There has been successfully developed, tested and validated algorithms for the remote sensing of columnar water vapour and cloud top pressure from MERIS measurements. Both properties play important roles in the Earth-Atmosphere energy budget and are key variables in the local and global energy transport and exchange.

The atmospheric water vapour has been derived within an accuracy of 0.11 g/cm2 when compared with estimates from ground based microwave measurements. The cloud top pressure is derived from measurements in the oxygen A-band. The achieved accuracy depends on the measuring conditions ranging from 20 hPa for single cloud layers to 100 hPa for multi layer clouds.
Validation of MERIS Water Vapour Measurements

Mr Peter Albert (1), Dr Ralf Bennartz(2), Prof. Jürgen Fischer(1), and Dr Rene Preusker(1)

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(2) University of Wisconsin-Madison, 1225 W Dayton St., Madison, WI 53706, United States

Abstract

This paper describes the current status of validation activities with regard to measurements of atmospheric water vapour by the MERIS instruments. A first comparison of MERIS measurements of integrated water vapour over cloud free land surfaces with radio soundings over central Europe showed a high agreement with a root mean deviation of 0.2 cm precipitable water vapour and a bias of -0.03 cm. Further validations shown in this paper include a comparison to measurements of the Microwave Water Radiometer at the ARM-SGP site and a validation of MERIS measurements of integrated water vapour above cloud tops. Comparisons to measurements of the Moderate Resolution Imaging Spectroradiometer MODIS onboard the TERRA platform are also shown.
Cross-validation of MERIS’s Water Vapor and InSAR Wet Delay Observations

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Abstract

During ERS-1 and ERS-2 missions, the application of synthetic aperture radar interferometry (InSAR) became known as a very important method for topographic mapping and high accuracy surface displacement measurements. Further investigations, however, showed that expected accuracy couldn’t be achieved. It appeared that radiowave propagation through the atmosphere causes significant distortion to the observed signal and obscures effects of topography and/or deformations. Even though in the case of InSAR observations the atmosphere represents the unwanted component of signal, given knowledge of the earth surface behavior, one can obtain very accurate information on the state of atmosphere at the time of measurements.

Similar to GPS atmospheric measurements, InSAR observes radiowave path delays. These path delays can be related to the amount of water vapor in atmosphere. As a result InSAR observations can provide high-resolution (~20 m) atmospheric integrated precipitable water vapor maps.

Due to the location of MERIS and ASAR (advanced synthetic aperture radar) on board of the ENVISAT, their acquisitions are collocated both in time and space. In this work we compare MERIS water vapor products and the integrated precipitable water vapor as observed with ASAR. Here we pay special attention to the cloud free areas, since in these areas both instruments have an optimum performance. Since a radar signal penetrates through clouds and precipitation, it gives a possibility of total water vapor column observations regardless of weather conditions. Therefore, differences in the water vapor products over cloudy areas are also studied.
CWave’03: Validation of MERIS Near IR Water Vapour Retrievals Using MWR and GPS

Professor Jan-Peter Muller(1), Mr Peter Albert(2), Prof. Paul Cross(1), and Mr Zhenhong Li(1)

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Abstract

The CWAVE’03 (Clouds, Water Vapour Experiment) is a joint experiment between two EU-FP5 projects: CLOUDMAP and CLOUDNET involving several university and government research groups interested in atmospheric instrumentation and Cloud Resolving Models around the UK which took place in and around the CCLRC Chilbolton Radar Observatory between 14 June and 11 July 2003. A small network of 4 GPS receivers was set-up for 10 days (2 in place for several years and 2 in place temporarily), and a ground-based 3-frequency microwave radiometer (MWR) collected observations continuously. In this paper, the GPS and MWR measurements are used to validate MERIS Near IR water vapour products produced by the Freie Universität Berlin (FUB) and ESA ESRIN. A previous comparison of MERIS Near IR PWV (from FUB) with collocated radiosondes distributed across Europe showed a standard deviation of 2.6 mm, whilst a comparison with near real-time GPS PWV retrievals from the GeoForschungsZentrum Potsdam (GFZ) showed a standard deviation of 1.4 mm. Scale factors significantly different from unity were found in both comparisons along with positive zero-point offsets [Li et al., in preparation]. MERIS Near IR water vapour products (from FUB) were also compared to NASA MODIS Near IR water vapour products (collection 3) at UCL. These results indicated that FUB MERIS water vapour retrievals were drier than the official NASA MODIS near IR products for the experimental period [Li et al., 2003].
Inter-comparison of MERIS, MODIS and MISR Cloud Top Heights

Dr Catherine Naud (1), Dr Bryan Baum (2), Dr Ralf Bennartz (3), Prof. Juergen Fischer (4), Dr Richard Frey (3), Dr Paul Menzel (3), Prof. Jan-Peter Muller (1), Dr Rene Preusker (4), and Dr Hong Zhang (3)

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Abstract

The last three years has seen the launch of new experimental polar orbiters with TERRA in December 1999 and ENVISAT in March 2002. These new satellites include instruments for observing clouds and retrievals of cloud properties are operationally performed. The objective of this paper is to assess the accuracy of three very different cloud top height retrieval techniques derived from two satellite platforms. Onboard TERRA, two new instruments are operationally retrieving cloud top heights: the Multi-angle Imaging SpectroRadiometer (MISR) and the MODerate resolution Imaging Spectrometer (MODIS). MISR is composed of 9 pushbroom cameras observing the Earth in 3 visible and one near infrared channels, from 9 different view angles. Cloud top heights (CTHs) are retrieved using a (purely geometrical) stereo-matching technique developed at UCL. MODIS is a whiskbroom imager with 36 channels from the visible to the CO2 absorption band at 15mm and retrieves cloud top heights using the CO2-slicing technique. Onboard ENVISAT, The MEedium Resolution Imaging Spectrometer (MERIS) observes the Earth with 15 channels in the visible and near-infrared. Cloud top heights are estimated using the Oxygen A-band absorption lines. Differences in cloud top heights between the three instruments have been analysed and an independent 35GHz radar measurement is used here to provide reference CTHs. This comparison was conducted over the Atmospheric Radiation Measurement (ARM) Southern Great Plains (SGP) site, where clouds are operationally monitored with a wide range of ground based instruments. The radar profiles were also used to derive additional information on the cloud vertical distribution. Preliminary results show that MERIS O2-A band retrievals cannot provide cloud top heights when clouds have an optical depth less than 5 as expected, but the technique performs very well for low water clouds, with a difference of less than 200m with the radar retrieval. Other cases show thin ice clouds which can not be retrieved with the O2-A band technique, but show that MODIS CO2-slicing technique experience problem at the edge of thin ice clouds.
MERIS Cloud Masks: Exploration and Visualisation of MERIS Spectra

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Abstract

In this work we present a cloud mask for MERIS, developed as part of the EU NAOC project, which can discriminate between optically thick and thin clouds. The method is based on the expert selection of a small labelled data set of cloudy and cloud free pixels in MERIS observations taken over the ocean, guided by meteorological knowledge. This rather small labelled data set is augmented by a much large unlabelled data set randomly extracted from a large number of MERIS scenes over the ocean. This unlabelled data set is used to characterise the structure of the MERIS spectra that are observed, using a pattern recognition method called the generative topographic mapping. The generative topographic mapping constructs a density model for the 15 dimensional (i.e. the MERIS bands) data in a lower (typically 2) dimensional latent space, which allows visualisation and understanding of the structure and distribution of the data. The lower dimensional structure is then used to define a non-linear projection, which retains information, but permits the construction of simpler classification models, something that will be especially important in future hyper-spectral instruments. We show the results of our cloud classification on several MERIS scenes and contrast our cloud mask with the standard MERIS cloud mask.
Session 3: MERIS Water Products Validation
The MERIS Water Products

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Abstract

The MERIS water products consist in marine reflectances at 13 wavelengths, 9 in the visible and 4 in the infrared, aerosol epsilon and optical thickness at 865, and a certain number of geophysical products derived from the information contained in the marine reflectances, such as chlorophyll pigment indices, total suspended matter content, and yellow substance concentration. The detailed meaning of the various products will be reviewed, as well as the measures taken to validate them. In addition, quality flags are associated with the products. The pertinence of these quality flags, which are crucial for the correct exploitation of the products, will be presented. In addition, the significance of the various scientific flags (turbidity, absorbing waters, absorbing aerosols, etc…), also part of the MERIS will be detailed. Finally the state of the art for the atmospheric correction in coastal zones will be presented as well as current limitations inherent to the physics of the problem.
Validation of MERIS Case 1 Water Products

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Abstract

Validation results are presented, concerning Case 1 waters MERIS products, and which have been obtained from three oceanic sites where optical characteristics are contrasted. The first site was an oceanographic cruise carried out off the South African coasts (Benguela current), where chlorophyll concentration can reach very high values. The second site is the BOUSSOLE site, which is in the Western Mediterranean sea and is regularly visited for several years now and where an optical mooring should be deployed. The range of chlorophyll concentrations there is from about 0.05 to 2 mg/m³. The third site is the MOBY site, located in the Hawaii archipelago, and which has been developed and maintained by the NOAA and the NASA for more than 10 years now. This site, where conditions remain oligotrophic throughout the year, is equipped with a special type of optical buoy. The validation results obtained at these three sites, in terms of the water-leaving reflectance in the visible, are presented. They are extremely encouraging and suggest that no major calibration problem or drift occurred since MERIS was launched.
Validation of MERIS Coastal Products

Dr Roland Doerffer (1)

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Abstract

With a spatial resolution of 300 m, a revisit period of 2 - 3 days and 15 spectral bands MERIS is well designed for the production of coastal water products. In order to provide products, which can be applied in many areas worldwide, a product model has been selected, which consists of optical components rather then concentrations of water constituents. This optical component model will briefly be explained. However, presently the components are converted into concentrations by simple conversion factors, which have been derived from measurements in the North Sea.

The accuracy and reliability of coastal water products depend on a number of factors, including the composition of substances, their concentrations, variability of their optical properties and also on surface effects, such as sun glint and foam. The consequence is that it is not possible to produce a unique error figure for a scene. In contrast, the accuracy may vary pixel by pixel.

The validation of these products has been performed by a number of groups which form the MAVT (MERIS AATSR Validation Team). Most of the groups have participated in workshops for cross calibration of instruments and round robin analysis of test samples. Different strategies have been applied to the field work. The validation comprises the comparison of the water leaving radiance reflectance in order to check the accuracy of atmospheric correction, which is extremely important for the success of the retrieval of concentrations. Furthermore, the concentrations have been compared with that derived from water samples. The results of these comparisons are different and depend on many factors, such as the existence of sun glint and foam and the validity of the optical model for the area of comparison. Very important is to consider the flags, which are included in the product and which indicate possible problems or the application of special procedures in the atmospheric correction. Furthermore, validation strategies, such as the comparison of transects or the statistics of pixels / samples over a certain area or time, are preferable in many coastal waters with complex and patchy hydrography over direct comparisons of matchups.
MERIS Validation in the Northwest Mediterranean and Mascarene Ridge (Indian Ocean)

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(2) Centre d’Estudis Avançats de Blanes (CEAB), Accès Cala S. Francesco 14, 17300 Blanes, Girona, Spain

Abstract

This paper evaluates the quality of MERIS reflectance and chlorophyll (Level 2) data for several data processing stages during the commissioning phase of ENVISAT, after the launch in spring 2002. This is achieved by comparing in situ data and MERIS Level 2 data from the north west of Spain between May to October 2002 and from the Mascarene Ridge in June and July 2002. A time series of measurements of phytoplankton pigments and water-leaving reflectance using Satlantic profiling and surface sensors were obtained at times of MERIS overpasses at a station in the north west Mediterranean, close to Blanes (41° 39.15’N, 2° 52.62’E). 11 match-ups were obtained in this region (6 for MERIS reflectance, Satlantic water-leaving reflectance and phytoplankton pigments, 1 for MERIS reflectance and Satlantic water-leaving reflectance only, and 4 for MERIS reflectance and phytoplankton pigments only). 4 match-ups were also obtained during a cruise which circumnavigated the Mascarene Ridge region of the Indian Ocean (MERIS and water-leaving reflectance (Satlantic) only). MERIS reflectance is compared with in situ water-leaving reflectance for two stages of processing; February/March 2003 and August 2003. Comparisons are also made between satellite and in situ phytoplankton pigments.
Intercomparisons of MERIS and SeaWiFS Ocean Products

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Abstract

The objectives of the work presented in the paper are to evaluate the differences between the SeaWiFS and MERIS ocean products. A preliminary study had been conducted a year ago that showed over clear waters very promising agreement between the MERIS and the SeaWiFS retrieved chlorophyll concentration; likewise, agreement concerning the water leaving reflectances was very promising. But, on the contrary, agreement concerning the 865nm aerosol optical thickness had shown to be poor. Since last year, thanks to the calibration and validation activities that were conducted, the MERIS processing has improved (both in the pixel classification, the atmospheric corrections, and in the ocean processing). This paper will therefore present the current status of the differences between MERIS and SeaWiFS ocean products, and present the differences from last year’s status. The comparisons will be based on Level 2 products, but also on regional Level 3 products from both instruments.
An Evaluation of the Accuracy of MERIS Radiometric and Geophysical Products for a Northern Adriatic Coastal Site

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Abstract

An evaluation of MERIS radiometric and geophysical products is made using in situ data taken at the Acqua Alta Oceanographic Tower in the northern Adriatic Sea from May 2002 to May 2003. The analysis is restricted to satellite and in situ data taken within 1 hour difference to minimize the effects of the spatial and temporal non-homogeneity of atmosphere and sea around the measurement site. The comparison analysis between satellite and in situ normalized water leaving radiances for 28 match ups exhibits spectrally averaged mean differences of 2.3% in keeping with match-ups analysis of SeaWiFS and MODIS data for the same site. When the analysis is restricted to MERIS Case 2 flagged data (i.e., as turbid waters), the comparison over 12 match-ups shows spectrally averaged mean differences of 14.6%. Differently when the analysis is restricted to MERIS Case 1 data, the comparison over 16 match-ups shows spectrally averaged mean differences of -6.4%. These systematic biases of satellite data versus in situ measurements suggest different accuracies in the atmospheric correction of data taken over turbid and non-turbid waters. Recurrent negative water leaving radiances at 670 nm over Case 1 water (approximately 1 over 3 of the considered match-ups), suggest an overcorrection of the atmospheric effects. The comparison between in situ and MERIS derived aerosol optical thickness at 865 nm shows a general overestimate of 30% for the satellite derived data, and it does not exhibit any significant difference between Case 1 and Case 2 waters. The overestimate could be attributed to inaccuracy in the absolute calibration coefficient of the specific near infrared channel or to the adoption of a non-appropriate aerosol model for the atmospheric correction. The comparison between MERIS derived pigment concentrations (i.e., Algal 1 product) and total chlorophyll a computed from in situ radiometric data by applying a regional band ratio algorithm, or alternatively determined from in situ samples analyzed through High Performance Liquid Chromatography, shows an overestimate of a factor 2 for the satellite product values regardless of the water type. This result could be mostly justified by the application of an ocean color algorithm not suitable for the northern Adriatic Sea coastal waters. The comparison over 5 match-ups for total suspended matter and absorption coefficients by yellow substance plus non-pigmented particles exhibit mean differences of -45% and 310% with standard deviations of 15% and 240%, respectively.
Validation of MERIS Ocean Color Algorithms in the Mediterranean Sea

Dr Salvatore Marullo (1), Fabrizio D’Ortenzio (2), Maurizio Ribera D’Alcalà (2), Maria Ragni (2), Rosalia Santoleri (3), and Vincenzo Vellucci (1)

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Abstract

The major aim of this work is to evaluate the capabilities of several ocean color algorithms to correctly estimate chlorophyll-a concentration in the Mediterranean Sea. A data set containing 85 in situ chlorophyll-a profiles and optical measurements of in water and above water radiances was used to validate the ocean color algorithms in the Mediterranean Sea. In situ chlorophyll-a measurements were performed during several cruises carried out in the Mediterranean Sea through the years 1999-2002 on board the R/V Urania of the National Research Council (CNR). Optical measurements were done using: 1) Satlantic SPMR (SeaWiFS Profiling Multichannel Radiometer) 2) SIMBAD radiometer 3) SIMBADA radiometer SIMBAD and SIMBADA data were then processed at LOA (Laboratoire d’Optique Atmospherique) of the University of Lille. The algorithms evaluated were OC4v4, the algorithm proposed for MERIS (ATBD 2.9) and two Mediterranean algorithms recently proposed by D’Ortenzio et al. (2002) and Bricaud et al. (2002). As already found by D’Ortenzio et al. (2002), OC4v4 tends to overestimate chlorophyll concentrations in the Mediterranean Sea and the error appears to be correlated with chlorophyll-a concentration, by exhibiting marked differences at low values (16% for concentrations greater 0.3 mg/m3, 57% for concentrations between 0.06 mg/m3 and 0.3 mg/m3 and 167% for concentrations less than 0.06 mg/m3 ). For the others three algorithms the error is not correlated with the measured chlorophyll. Excluding the algorithm proposed by D’Ortenzio et al. (Mean Bias Error = -3%) all the others tend to overestimate chlorophyll concentrations (11% for Bricaud et al., 23% for MERIS and 63% for OC4v4). The observed discrepancy between in situ measurements and global ocean colour algorithms, and the better performance of the Mediterranean algorithms confirms that the Mediterranean waters contain optical relevant components, which can alter its color respect to the mean global ocean characteristics and can be important in terms of the Mediterranean ecosystem.
MERIS Imagery of Belgian Coastal Waters

Dr Kevin Ruddick (1), Mrs Vera De Cauwer(1), Mrs Bouchra Nechad(3), and Dr Youngje Park(1)

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Abstract

Optical remote sensing can provide maps of chlorophyll-a (CHL) and suspended particulate matter (SPM) concentration in coastal waters as support for applications such as eutrophication monitoring and sediment transport analysis. CHL quantification for water with high loads of coloured dissolved organic matter or organic detritus requires careful choice and calibration of algorithm and can be subject to high uncertainty especially for low CHL. SPM quantification is generally reliable in high sediment coastal waters, though is only recently becoming a standard product for ocean colour sensors. This presentation will review the state-of-the-art of algorithms for estimating CHL and SPM from remote sensing reflectance spectra in turbid coastal waters and will demonstrate applications to MERIS imagery of Belgian coastal waters from 2003. Product accuracy will be assessed and compared to application needs and to products from other ocean colour sensors, including SeaWiFS and MODIS.
MERIS Validation Activities at Lake Constance

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Abstract

Lake Constance is the only inland water test site of the MERIS & AATSR Validation Team (MAVT). It was chosen for validating MERIS products for case II waters because development of remote sensing algorithms has a long tradition at this lake and hence the optical properties are well-studied. In particular, two MERIS-adapted regional algorithms were developed within the German project MAPP, based on neural network and principal components inversion. Several validation campaigns have been performed in 2002 and 2003. Optical and biochemical in-situ data were collected from ship, additional airborne data from the imaging spectrometers ROSIS and HYMAP are available for one day. A comparison between MERIS derived concentrations of water constituents and in-situ measured values will be presented, and a preliminary assessment of error sources will be given.
Session 4: MERIS Land Products Validation
First Results of ESA’s MERIS for Land and Environmental Applications

Mr. Michael Rast (1), M Bouvet (1), Steven Delwart (1), Philippe Goryl (2), Jean-Paul Huot (1), and Peter Regner (2)

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Abstract

Following the successful launch of the Medium Resolution Imaging Spectrometer onboard Envisat and the completion of the Commissioning Phase, first results of the MERIS validation activities are pointing towards a large exploitation potential, which goes beyond the original mission objectives, providing a European remote sensing capability for observing marine biology and the secondary objectives directed to the understanding of atmospheric parameters in addition to land surface parameters, in particular vegetation processes.

MERIS has a high spectral and radiometric resolution and a dual spatial resolution, within a global mission covering open ocean and coastal zone waters. The global mission of MERIS has a major contribution to scientific projects which seek to understand the role of the oceans and ocean productivity in the climate system. In addition to its main objectives MERIS data already now show a large potential for applications in the area of vegetation monitoring, hydrology, land use and specifically in the observation of natural hazards. The torrential floods in Germany during Summer 2002 and the volcanic activities of Mount Etna are prominent examples, which also render the data of MERIS as valuable asset for the International Charter on Space and Major Disasters. In that context MERIS data are being used owing to their accuracy, spectral and spatial performance and high level of calibration. The establishment of these products is supported by a user-friendly data analysis and image processing software package called the MERIS Toolbox. The paper is intended to give an overview of the current MERIS data products in the Envisat Ground Segment and to show first results after launch.
Validation of MERIS Products over Land

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Abstract

Over land, the aerosol remote sensing is based on the observation of Dense Dark Vegetation and this concept is applied on MERIS with a spectral index (ARVI) to detect the DDV and the use of the bands at 442 nm and 670 nm to characterize the aerosols. The aerosol size distribution is assumed to be the Junge one while the aerosol refractive index is set to 1.45. The aerosol product consists on the aerosol optical thickness at 865 nm and on the spectral dependence of the aerosol path radiance. The validation exercise is mostly based on the use of ground based optical measurements based on the AERONET network. A classical validation of the aerosol product is conducted using the extinction measurements. A deeper validation is done in order to investigate the different assumptions used in the aerosol remote sensing module by: (i) using the ground based measurements to validate the DDV reflectance model. Atmospheric correction will be done, including the aerosols, to derive DDV reflectances for comparison to standard values. (ii) using the ground based measurements to validate the choice of the Junge size distribution by comparing the simulated radiances with this model to the measurements in the principal plane. It is shown that the DDV cover is sufficient in summer but not in winter where an extension of the concept of DDV is mandatory in order to enable an operational aerosol characterisation. A linear relationship between ARVI and reflectance of the extended DDV in the red allows using such grey targets for the retrieval of aerosol optical properties (aerosol optical thickness at 550 nm and Angström coefficient) throughout the year without loss of accuracy.
MERIS Global Vegetation Index: Evaluation and Performance

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Abstract

The paper overviews the evaluation and the performance of the Medium Resolution Imaging Spectrometer (MERIS) Global Vegetation Index (MGVI) algorithm which is implemented in the MERIS ground segment as one of the Land Surface Product, also called the Top Of Atmosphere Vegetation Index (TOAVI). In fact, MGVI value represents the Fraction of Absorbed Photosynthetically Active Radiation (FAPAR) which acts at once as an integrated indicator of the state of the plant canopy and can be retrieved by remote sensing techniques with acceptable accuracy. This has motivated the hypothesis that the FAPAR variable can be used to quantify the presence of vegetation with good reliability on a global scale, a variable of major importance for a variety of research and applied issues. The presented analyses are conducted by inter-comparing first the MGVI products to similar one derived from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) that are generated at the European Commission Joint Research Center (EC-JRC). These evaluations between MERIS and SeaWiFS derived products are made using data acquired over regions in few places over the Earth during the year 2002 by both instruments and show acceptable agreement. Finally, we analyze time series of FAPAR during year 2003 over Europe to demonstrate its capabilities for vegetation monitoring useful in land application.
The SPARC Campaign for Validation of MERIS Biophysical Retrievals

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Abstract


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The validation of the retrievals of biophysical products derived from optical remote sensing systems is always a difficult activity, because it requires the simultaneous measurements of a complete set of parameters about atmospheric status to check atmospheric correction procedures, surface radiometric data for vicarious calibration and testing of radiometric corrections, plus the set of ground measurements of biophysical parameters of interest (LAI, chlorophyll, biomass, etc.) all in coincidence with satellite overpasses. Ideally, coincidence of several satellite and airborne sensors is optimal for intercomparison of different retrievals. The operation of aircrafts and a large number of ground instruments becomes expensive, and such intensive campaign activities are only possible with the combined support from a number of parallel initiatives.

In the context of an ENVISAT-AO project where some routine systematic measurements are carried out over the study area in La Mancha, Spain, in coincidence with time series of satellite overpasses (MERIS, ASAR and other satellite sensors), an intensive campaign was carried out in July 2003. One of the objectives of the campaign was to provide a complete validation dataset in coincidence with one of the MERIS overpasses, for which MERIS Full Resolution data was requested over the study area.

The SPARC campaign (SPECTRA Barrax Campaign) had as a main objective to collect a dataset to serve as reference in future scientific and technical studies in preparation of the ESA Earth Explorer Core Mission SPECTRA. However, since part of planning for SPECTRA is based on the assessment of limits on current remote sensing systems, the campaign was planned to be carried out in coincidence with a MERIS overpass, not only to validate MERIS data and MERIS-based retrievals, but also to check the capabilities of MERIS versus more complex hyperspectral/multangular optical systems. The SPARC campaign was supported by ESA, with additional support from several EU and national projects.

The main campaign activities were carried out in coincidence with three consecutive days of CHRIS/PROBA overpasses. In order to serve the purposes of the campaign and to make possible comparisons with MERIS data, CHRIS was programmed in a full spectral resolution model (62 bands), providing 5 different view angles for each overpass with 34 m spatial resolution. During the campaign, airborne acquisitions were carried out by using HYMAP (126 spectral channels, 5 m resolution) and ROSIS (115 spectral channels, 1 m resolution) sensors. The high resolution airborne -HYMAP and ROSIS- and satellite -CHRIS- data provided similar spectral information as MERIS, and then are ideal for validation of MERIS data.

In coincidence with ENVISAT / PROBA and aircraft overpasses, detailed information about atmospheric status (radiosoundings, ground-based aerosols lidar, high-spectral-resolution direct/global surface radiance measurements, sunphotometer measurements), were collected. Surface radiometric properties were characterised by using several ground radiometers (GER, ASD) over calibration and reference targets. A complete set of vegetation biophysical parameters were collected: LAI, chlorophyll, fCover, leaf biomass, leaf water content, canopy structural parameters (canopy height, leaf size) and relevant information about phenology of each type of crop. Fields used for ground sampling were large enough to be identifiable in MERIS FR data, while the high spatial resolution imagery (HYMAP, ROSIS, CHRIS) helps for scaling purposes.

The MERIS data acquired during the SPARC campaign have been geometrically and atmospherically corrected, and several retrieval methods have been tested to get vegetation biophysical parameters from the MERIS data. In this paper a full description of the SPARC campaign aspects relevant for MERIS will be presented, and preliminary results from the MERIS data acquired during the SPARC campaign will be discussed.
Session 5: Coastal and Inland Waters
Detection of Algae-blooms in the Baltic Sea with MERIS Data

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Abstract

Satellite remote sensing is an effective tool for the regular observation of the ecological state of the environment. The availability of MERIS reflectances in the visible and near-infrared parts of the spectrum gives now the useful opportunity of regular observation the water quality in coastal waters. Therefore the development and validation of appropriate interpretation algorithms is necessary. A special case-2 interpretation algorithm, developed for the Baltic Sea, will be presented. The Algorithm is basing on atmospheric corrected MERIS reflectances, and estimates the concentrations of Phytoplankton, inorganic Sediments and Yellow Substance. The algorithm - a model based inversion/regression technique using Principal Component Analysis as an information extraction tool- will be introduced and demonstrated on a number of examples in the Baltic Sea.
CHL-mapping in Dutch Coastal Waters Using MERIS

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Abstract

The EC-funded REVAMP project aims to provide an atlas of CHL-maps of the North Sea to end-users. This atlas will be based on MERIS images of 2003. We will present an overview of the status, activities and some results of REVAMP.

For the whole range of North Sea watertypes the REVAMP project has concluded from a comparative workshop that analytical algorithms for CHL retrieval are preferable. Especially algorithms based on complete forward models (hydrolight), which are inverted using look-up tables or artificial neural networks perform well.

Part of the REVAMP work is carried out, as a case study, in the Dutch North Sea. In the Dutch coastal waters inherent optical properties were measured for some years, which allowed to set-up and calibrate suitable optical models. During cruises reflectance spectra were measured (also in 2002 and 2003) which enabled the validation of MERIS observed spectra and CHL-products.

This presentation will show some examples of CHL-maps (for the Dutch coastal waters) based on MERIS images using a relatively simple analytical algorithm and will discuss their quality and potential impact on North Sea eutrophication management.
Validation of Chlorophyll Fluorescence in Coastal Waters Derived from MERIS

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Abstract

MERIS on Envisat provides images of above-atmosphere spectral radiance in bands at 665, 681 and 709 nm. These bands were included in the baseline spectral band set to allow detection of the fluorescence signal from surface chlorophyll in sea water, stimulated by ambient sun and sky light. We present images of fluorescence as derived from the level 1 MERIS data that show significant patterns in coastal waters of western Canada. We compare the signal levels of the fluorescence with measurements of extracted chlorophyll from research cruises during 2002 and 2003, with satellite estimates of chlorophyll from the blue to green ratio observed by MERIS, MODIS and Seawifs, and with fluorescence measurements made by MODIS. We show that the fluorescence signal is consistent between MERIS and MODIS, and that relation between fluorescence and chlorophyll concentration in surface waters is consistent with a simple model accounting for absorption of stimulating and emitted radiation by chlorophyll pigments. Considerable scatter is observed, suggesting variable fluorescence efficiency and effects of coloured dissolved organic matter.
Use of MERIS Data within the ESA GSE COASTWATCH Service: a Demonstration Case

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Abstract

Coastwatch is an ESA project funded in the frame of the first stage of GMES Services Element (GSE) (17065/03/I-LG). Coastwatch is the GMES service element focusing on environmental management and monitoring of coastal areas. The aim of Coastwatch is to provide services to help better monitoring and assessment in the frame of environmental policy of the coastal zone. Monitoring of water quality is one key element of such a Coastwatch service where we experiment advanced techniques such as remote sensing of ocean colour, making use of the enhanced European capability through the MERIS mission on board the ESA ENVISAT. The objective is to demonstrate the capability of water quality monitoring over coastal areas. Besides this primary objective, the activity provides useful feedback to the still on-going validation activities of MERIS in various coastal areas by comparing the MERIS products with in-situ observations available at the various users sites. Thanks to its wide coverage and involvement of several major users, we provide a global view of local performances of MERIS.

The Water Framework Directive which is the main driver policy of COASTWATCH WFD service distinguishes four types of monitoring: 1. Surveillance monitoring: to provide assessment of long term changes in natural conditions, resulting from anthropogenic activity, to supplement and validate impact assessment and to design better monitoring systems in the future. 2. Operational monitoring: to identify the status of these bodies being at risk of failing to meet their environmental objectives, to assess any changes in the status of these bodies, to identify the impact on these bodies. 3. Investigative monitoring: to ascertain the magnitude and impact of accidental pollutions. 4. Protected areas monitoring: to control and monitor protected marine areas at the appropriate frequency and appropriate quality elements.

This introduction session will be followed by demonstration cases of the Coastwatch monitoring capability in each four types. The commonality between each case study is that it makes extensive use of the WFD service of Coastwatch, and more specifically of - Level 3 Sea Surface Temperature products - Geophysical level 3 Water Colour products such as Chlorophyll, Photo- synthetically Active Radiation and Suspended sediment. - Tailored products for environment monitoring and regulation survey (primary production, sea waters clarity) derived from the above.

Demonstration cases

Protected areas monitoring: Whales numbering in the Mediterranean (Summer 2003)

Investigative monitoring: Optical Remote Sensing of the Chinese Freighter Accident on 31 May 2003 in the Baltic Sea

Surveillance monitoring: Support to the GAUSS campaign in the North Sea (July-August 2003)

Surveillance monitoring: Emiliana huxleyi blooms in the Barents Sea in July 2003
Operational Coastal Water Quality Monitoring: Are Space Borne Products an Alternative to In-situ Measurements - Where Are We Now?

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Abstract

C. Brockmann, S. Dury, R. Duin, Mark Slater, G. Hesselmann, Hakvoort, K. Stelzer, R. Jordans

Water quality monitoring is an essential part of the monitoring programmes of the North Sea countries, required by international regulations such as the EU water framework directive or the HELCOM agreement. Because of budget constraints cost effective alternatives to the very expensive ship cruises are urgently needed. The potential usage of water quality products from the space borne instruments MERIS, MODIS and SeaWiFS is presently assessed in close collaboration with the monitoring agencies in the Netherlands and Germany in the framework of the EU project OROMA and the ESA Coastwatch initiative. Standard products from these instruments are compared with in-situ data, taken by the monitoring agencies, and airborne measurements. Local inherent optical properties are available for the Dutch waters, which are used to improve the water quality products, and which results in a convincing comparison with in-situ data. This has been shown with SeaWiFS data on a statistical evaluation of a 2-year time series. MERIS products are compared on a case study basis because of the short period of data availability. However, the objective is also to prove the quality of the products on a sound statistical basis. The first reactions of the monitoring agencies are very positive.
Mapping of Photosynthetic Pigments in Spanish Reservoirs

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Abstract

We present the preliminary results of the first stage of Project AO-594, which comprises the development and calibration of algorithms for photosynthetic pigment mapping in Spanish reservoirs. In the years 2001-2002, an extensive field campaign was carried out in 36 reservoirs and lakes in order to obtain a database of Rrs spectra (400-1000 nm), photosynthetic pigments concentration and phytoplankton composition. The sampled water bodies cover a wide range of environmental conditions, trophic levels and phytoplankton communities. 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 Rrs spectra. We found a very good linear relationship for chlorophyll a, (R2=0.919) using the ratio between bands 9 and 7. Similar results are found using band 8 instead of 7. However, the model derived for the whole range of concentrations (0-500 mg m-3) fails for low values (<15 mg m-3). Possible solutions include the use of non-linear models or the use of two different models depending on the ratio values. The ratio between bands 9 and 6 for cyanobacteria detection (the latter being centred at 620 nm) shows a good correlation (R2=0.723) with phycocyanin concentration measured fluorometrically, and an even better correlation (R2=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 algorithms accurate enough for bloom monitoring.

This paper also discusses the problems found with the L2 MERIS reflectance imagery that we have tried to use for model calibration. We present the results of the study conducted in six reservoirs in Northeast Spain. On a date that coincided with a MERIS image (June 19th, 2003) we collected pigment concentration and reflectance data measured from a boat and 10 m resolution imagery for the 15 MERIS bands acquired with an airborne CASI-2 sensor. This three-level data has enabled us to calculate a new set of reflectance MERIS bands from the L1B imagery and compare them with the L2 imagery. The comparison could be useful for modifying the current atmospheric correction algorithms applied to L2 data generation that, as we have observed, frequently fail in inland waters.
Water Quality Monitoring of Lake Garda Using Multi-temporal MERIS Data

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Abstract

The successful launch of MERIS in March 2002, gave a great opportunity to understand the changes of water colour with high temporal and spatial resolutions. In this study, potentials of MERIS sensor were investigated to describe variations of optically active substances of Lake Garda, from June to September, 2003. Lake Garda is located in the Italian sub-alpine lake district, where several other lakes and rivers give the region more than the 50% of all Italian freshwater resources. With an area of 368 km2 and a water volume of 49 km3, Lake Garda represents a greatly valuable renewable resource, because the multiple uses of its waters (e.g., drinkable, irrigation, energy, tourism). Moreover, the size of Lake Garda seems large enough to be monitored using MERIS. The dataset analysed in this paper includes 7 MERIS images acquired in Full Resolution (FR) mode over the entire lake area. During three of those 7 overpasses, a large amount of lake-truth observations were performed on the Lake Garda, to the aim of image-data processing (mainly atmospheric correction) and validating products (i.e. concentration maps of chlorophyll, Secchi disk depth, etc.). In particular, during the overpasses a boat equipped with a flow-trough system measured fluorescence and turbidity, along a 50 kilometres horizontal transect which increased the spatial resolution of the lake-truth, providing a suitable dataset for products validation. During the cruises, the boat stopped at regular intervals in 10 stations to collect water samples for subsequent laboratory analyses. At the same time the Apparent Optical Properties (AOPs) of Lake Garda were also measured. Moreover, on 22nd July 2003 the Inherent Optical Properties (IOPs) along vertical profiles were also collected in four stations, in coincidence with the MERIS overpass. Those data were used to optimise an analytical bio-optical model used to derive the concentrations of water quality parameters from MERIS imagery. Each image was geolocated and corrected by the atmospheric effects using a radiative transfer code and measured values of aerosol optical thickness. Considering the air/water effects and inverting the subsurface irradiance reflectance estimated from MERIS, the principal waters parameters were finally mapped all over the lake for the whole summer season. Some of those results were evaluated using the concentrations measured in situ.
Ecosystem Monitoring of the Fresh Water Lake IJsselmeer

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Abstract

The IJsselmeer is the largest fresh water lake in the Netherlands with a surface area of 1300 km² and an average depth of 4.4 meter. Due to high nutrient loadings in this lake and bottom processes serious eutrophication problems occurred in the past. Some of those remain till the present day. In some periods a strong growth of cyanobacteria (Microcystis) occurs that causes ecological and economical damage. Understanding and monitoring of three algal groups (green algae, cyanobacteria, and diatoms) is therefore of major concern to the water authorities.

Over the last years a large investment has been made to provide all the necessary in-situ measurement and algorithms for interpretation of the SeaWiFS and MERIS images of Lake IJsselmeer. Data sets were collected of the Specific Inherent Optical Properties of algal blooms at the IJsselmeer, together with field spectra on R(0-) from PR-650 and other standard water quality parameters. A detailed water quality (DBS) model was adapted and prepared for inter-comparison with RS and in-situ measurements.

From the combination of SeaWiFS images, DBS model output, maps of monthly mean CHL were made and compared with local measurements. The project results indicated that this integration has great potential. The remote sensing and model results showed a remarkable consistency in the evolution of CHL patterns in Lake IJsselmeer for the year 1999.

MERIS has the potential to map CHL with improved accuracy and with greater detail. Moreover it is able to resolve additional important parameters (Cyano-phycocyanine) and CDOM. We will present the first MERIS results of lake IJssel and discuss their quality and prospect for monitoring of water quality in large inland fresh water lakes.
Aerosol Retrieval and Atmospheric Correction for MERIS Data over Lakes

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Abstract

One of the objectives of the ENVISAT project AO-164 on "Environmental Research in the Eastern Alps" is the development of algorithms for water quality retrievals in alpine and peri-alpine lakes from MERIS data. For inversion of MERIS measurements the at-surface reflectance is required. Therefore it is necessary to correct for atmospheric effects. The main errors for these corrections result from uncertainties about the content and characteristics of atmospheric aerosol. For operational use in water quality monitoring it is desirable to estimate the optical depth and reflectance properties from the MERIS data. In addition, the retrieved aerosol information per se is of interest for atmospheric research. In order to study and test algorithms for aerosol retrieval from MERIS data and for atmospheric correction, we carried out several field campaigns in summer 2003 at Lake Garda, Italy (45°50'N, 10°40'E, 50 m a.s.l.) and Mondsee, Austria (47°50'N, 13°22'E, 450 m a.s.l.), parallel to MERIS overflights. The atmospheric transmittance was measured at four wavelengths (368, 412, 500 and 862 nm) with a Precision Filter Radiometer (PFR) deployed at the lake shore. Reflectance spectra were measured above the water surface in the range 400 - 900 nm with a FieldSpec spectroradiometer. Different atmospheric conditions were observed on these days, with daily mean aerosol optical depth (AOD) at 550 nm varying between 0.11 and 0.33 and the Ångström alpha coefficient between 1.54 and 1.87. On some days strong increase of AOD was observed around noon at the measurement site on the north shore of Lake Garda (e.g. AOD at 500 nm from 0.08 to 0.30), due to advection of turbid air from the south. This change was caused by a strong spatial gradient in the aerosol loading, emphasizing the need for spatially distributed input data for atmospheric correction of MERIS images. Various test runs of the atmospheric correction of MERIS data were carried out, based on the 6S radiative transfer code. First results show good agreement between in situ and MERIS derived surface reflectance over the lakes. Further validation of atmospheric correction, as well as of the algorithm for aerosol retrieval are planned as soon as further MERIS data have been delivered.
Session 6: Land Cover Monitoring
Monitoring Landcover Changes of the Niger Inland Delta (Mali) by Means of Envisat MERIS Data

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Abstract

The inland delta of the river Niger is one of the most fragile ecosystems in the Sahelian zone of Africa. The extent of annual flooding of the vast plains during the months of September to December depends on water levels of the main rivers Niger and Bani. The interaction among pre-flood, flood and post-flood conditions strongly affect land use patterns in and around the delta. Human impact is mainly driven by irrigated rice cropping, rainfed agriculture, grazing and browsing of hers and flocks as well as by fuelwood consumption. Assessing and mapping dynamics of land use are made possible by the systematic application of remote sensing and image analysis. Operational missions of earth observation contribute to the establishment of multi-seasonal and multi-annual monitoring schemes. Under ESA-Announcements of Opportunity (AOs) two projects have been set up to evaluate the reliability of ERS-SAR, ENVISAT-ASAR and ENVISAT-MERIS data for supporting research on the dynamics of land use change in the delta. Actually the project under the ESA ENVISAT AO, which aims to apply high spectral resolution imaging spectrometry for monitoring spatio-temporal patterns of land use and land cover change in Sub Saharan wetlands with special regard to the inland deltas of the Niger (Mali) and the Okavango (Botswana) Rivers, has been started. First steps of investigations focus on data selection and visualization as well as on visual and digital classification of multi-seasonal MERIS imagery of the Inland Delta of the Niger river.
Deriving Landcover Information over Siberia Using MERIS and MODIS Data

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Abstract

Estimating the extent of various land cover types at regional and global scales is an important source of information required by a variety of applications. Although techniques for classifying remotely sensed data have been presented and discussed for many years, it is only recently that classification analysis over such large areas has been possible. The generation of the kilometre resolution IGBP and UMD global landcover maps (based upon AVHRR data) indicate an early advance in this area.

We may now be approaching the next evolutionary step in large-scale land cover mapping. The availability of globally acquired data from satellite-borne medium resolution optical sensors has increased dramatically with the recent launch of the Terra, Aqua, ENVISAT and SPOT5 platforms. However, a critical factor is that the spatial, spectral and radiometric resolution of these 'next generation' sensors are, in many geographic areas, far more suited to identifying certain land cover classes when compared to previous sensors. In particular, this is true over the Siberia region were many land features are sub-kilometre in size with similar spectral properties. Previous land cover results for this area, for example the IGBP and Global LandCover2000 maps, have been limited in their accuracy because of this.

The main focus of this paper is upon deriving land cover information over the Siberia region using data from the MERIS sensor. Classification of the data at the sensors full resolution (300m) allowed many more land cover features to be identified compared to a classification based upon the reduced resolution mode (1km). However, the limited wavelength range of the MERIS spectral bands hindered the ability to discriminate some of the vegetation classes. The accuracy of the thematic result was reduced in comparison to a classification derived using MODIS data for the same area (spatial resolution of 500m). This was primarily due to the addition of the MODIS short-wave IR bands which tended to increase the feature-space separability of these vegetation classes. The implications of these results are discussed further in the paper and suggestions for future use of these data sources are also made.
Use of MERIS Data for Land Cover Mapping in the Netherlands

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Abstract

The Medium Resolution Imaging Spectrometer (MERIS) is a payload component of Envisat-1. MERIS is operated over land with a standard 15 band setting acquiring images in the VIS and NIR part of the electromagnetic spectrum. Data are acquired at 300 m (full resolution) and 1200 m (reduced resolution) spatial resolution over land, thus vegetation can be monitored at regional to global scales. Major value of MERIS for land applications lies in the provision of (calibrated) data with a spatial resolution intermediate to that of NOAA-AVHRR or SPOT-VEGETATION and Landsat-TM or SPOT-HRV data. This paper describes the results of a preliminary study towards the use of MERIS for land cover mapping in the Netherlands. Full resolution level 1b data of February 18th 2003 and March 16th 2003 and reduced resolution level 1b data from March 22th 2003 were used in this study. The Dutch land use database LGN was used as a reference by aggregating the database from 25 m to 300 m and 1200 m, respectively. First, quality and information content of the used MERIS images were explored. Subsequently, the feasibility of the data for land cover classifications was studied. Results were also compared to results obtained with other sensors, like MODIS, VEGETATION and AVHRR. Results show that the merit of MERIS lies primarily in the improved spatial resolution of the full resolution mode (300 m) when compared to the mentioned low-resolution sensors. Due to a lack of spectral bands in the SWIR part of the spectrum, MERIS does not yield improved spectral information for land cover mapping and monitoring.
Baltic Region Land Information Database through Use of MERIS

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Abstract

The Baltic Sea Region is a drainage basin shared by 14 countries. It covers around 1.8 million km2 with a total population about 85 million. Homogenous geographical information for the whole region is required for a number of applications e.g. calculations of nutrient load into the Baltic Sea. Integrated datasets for the area exists through previous projects such as MapBSR (http://www.mapbsr.nls.fi), BALANS (http://www.lantmateriet.se) and GLC2000 (http://www.gvm.sai.jrc.it/glc2000). Metria has been involved in the production of two of these existing datasets: the BALANS dataset which is a land cover database with 150 meters resolution created from IRS 1C/1D WiFS-data and the GLC2000 dataset based on SPOT VGT.

The aim of this project is to see if it is possible to enhance the existing land cover databases through the use of Envisat MERIS data. MERIS-data for a test area in Sweden is evaluated and compared to similar sensors (SPOT-VGT and IRS-WiFS). The evaluation includes the geometric accuracy and the resulting land cover classification is compared both to previous classifications and a more detailed classification based on Landsat TM.

Metria is also performing a study to see if MERIS-data can be used for mapping vegetation cover of arable land. The Swedish Meteorological and Hydrological Institute (SMHI) models the diffuse P load from agricultural lands into river basins. Surface runoff is an important factor that determines the amount of material eroded, which is critical for the losses of particulate-P from agricultural fields. Calculations of surface runoff and sediment transport are based on equations that consider the land cover. Both surface runoff and sediment transports are higher from bare soils, compared to soils covered with a vegetative layer, especially when the soil is frozen. This makes vegetation cover one of the most critical model variables and available information today is based on agricultural crop statistics for large regions. More site-specific information would increase the accuracy and usefulness of the model considerably. Metria will examine the possibilities to use MERIS-data and regularly (every month) create information about vegetation cover of the arable land.
Monitoring Snow Cover in Alpine Regions through the Integration of MERIS and AATSR Envisat Satellite Observations

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Abstract

The ENVISAT mission with a suite of high performance sensors offers some opportunities for mapping snow cover at regional and catchment scale. The geometric resolution of MERIS data and the spectral resolution of AATSR data are suitable for these purposes. A new approach, developed in the framework of the GLASNOWMAP project (ESA-DUP2) for monitoring snow cover in Alpine regions, based on the combined use of MERIS and AATSR observations, and topographic information, is proposed. As MERIS spectral bands are not completely proper for the discrimination of snow from clouds - due to the lack of short wave infrared channels -, a multisource classification scheme has been developed to combine the results obtained by the classification of MERIS data with the information on cloud distribution as derived from AATSR data; the integration is performed with the aid of snow elevation distribution as derived from the Digital Elevation Model. A supervised fuzzy statistical classifier (Wang 1990) has been chosen to perform classification of MERIS images, being particularly suited for the representation of land cover class mixture. The classifier bases estimates of the distribution of pixels in multispectral space on the concept of the probability measure of fuzzy events to produce an output of the proportions of individual components. A cloud normalized index has been defined to extract clouds from AATSR images previously registered and resampled on MERIS images. The results of MERIS and AATSR processing are integrated to extrapolate snow over the cloud covered areas exploiting statistical parameters computed on cloud free areas. The Alpine region is selected as test area to demonstrate the potential and limitations of the novel approach. In particular, the attention is focused on three regions of Northern Italy (Valle d’Aosta, Piemonte, Lombardia). The first results obtained by the application of this new method to Earth Observation data will be presented and analysed.
Session 7: Vegetation Monitoring
MTCI: a New MERIS Terrestrial Chlorophyll Index

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Abstract

The long wavelength edge of the major chlorophyll absorption feature in the spectrum of a vegetation canopy moves to longer wavelengths with an increase in chlorophyll content. The position of this red-edge has been used successfully to estimate, by remote sensing, the chlorophyll content of vegetation canopies.

Techniques used to estimate this red-edge position (REP) have been designed for use on small volumes of continuous spectral data rather than the large volumes of discontinuous spectral data recorded by contemporary satellite spectrometers. Also, each technique produces a different value of REP from the same spectral data and REP values are relatively insensitive to chlorophyll content at high values of chlorophyll content.

This paper reports on the design and preliminary evaluation of a surrogate REP index for use with spectral data recorded at the standard band settings of the Medium Resolution Imaging Spectrometer (MERIS). This index, termed the MERIS terrestrial chlorophyll index (MTCI) was evaluated using model spectra, field spectra and MERIS data. It was easy to calculate (and so can be automated), was correlated strongly with REP but unlike REP was sensitive to high values of chlorophyll content. Further evaluation of the MTCI was proposed.
Assessing Vegetation Classification Using Multiple MERIS Scenes

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Abstract

MERIS imagery of the Canadian prairies acquired over the 2003 growing season is used to assess a red-edge vegetation classification algorithm. The spectral red-edge classification technique (VClass) models the chlorophyll absorption feature in the red to near-infrared region of the reflectance spectrum as outlined in Miller, et al. (1990) and uses the fitted parameters with an unsupervised classification algorithm to produce a classification map. This technique has proven to be effective for species differentiation in forested scenes and detecting vegetation stress, Zarco-Tejada and Miller (1999) and Belanger et al. (1995).

However, physiological changes due to stress and growth stage affect the chlorophyll red-edge and may influence the classification results when comparing scenes from different times of year. This study uses multiple MERIS full-resolution image products acquired over the growing season to address these issues and assess the performance of this algorithm.
On the Possibility to Retrieve Land Vegetation Fluorescence from MERIS

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Abstract

J. Moreno, L. Alonso, I. Moya, M.P. Stoll, S. Delwart

Ocean applications of MERIS data already include the possibility to retrieve water chlorophyll fluorescence. The standard set of MERIS spectral bands already include a band around 681.25 nm optimised for the retrieval of water chlorophyll fluorescence. Radiometric sensitivity of MERIS bands is already adapted to make possible such water chlorophyll fluorescence measurements. Fluorescence emission from land vegetation chlorophyll cannot be detected in the same way as for water chlorophyll, because over land the background reflectance dominates the signal, and fluorescence spectral features are masked by the dominant reflectance signatures. However, there are other techniques that can be used to get land vegetation fluorescence. Some of these techniques make use of specific very narrow spectral bands (Fraunhofer lines) which are not available in MERIS, but other method that has been demonstrated successful in retrieving vegetation fluorescence over land is by using the oxygen absorption band around 760 nm, in particular a spectral configuration similar to MERIS bands 10 (753 nm, oxygen absorption reference) and 11 (760 nm, oxygen absorption R-branch). The measurements in these two bands allow to get land vegetation fluorescence provided some assumptions (same reflectance and fluorescence emission in the two spectral bands), and provided also a proper atmospheric correction of the data, or using in-scene non-fluorescent targets as reference. This technique of using the O2 absorption bands to get land vegetation fluorescence has been demonstrated in field experiments, over agricultural areas and boreal forest targets. An airborne simulator is currently under development by using the same principle, and proposals for future satellite systems have been suggested by using optimised spectral configurations. In this paper, we review algorithms applicable to the standard MERIS spectral sets of bands, and apply such algorithms to actual MERIS FR and RR data over agricultural areas. Moreover, since the standard set of MERIS bands is not fully optimal for the purpose of getting land vegetation fluorescence, we have used actual MERIS data from spectral calibration campaigns with a different set of spectral bands covering the O2 absorption bands with much higher spectral resolution than in the MERIS standard configuration. Results from such analysis are reported in this paper, and required radiometric levels of the signal and perspectives for optimisations in spectral configurations are discussed. Fluorescence maps derived from MERIS data can serve to get spatial patterns of fluorescence over large vegetated areas, something never available before. This information is essential to map actual vegetation photosynthesis activity and then CO2 assimilation by terrestrial plants. Although MERIS cannot be used to get land vegetation fluorescence in an operational basis, the analysis of MERIS data allows to set limits on the retrieval capabilities according to different spectral configurations, accounting for effects due to varying surface pressure in O2 absorption and angular effects. Moreover, the analysis of MERIS data allow to set precise requirements for sensor improvements in a future satellite mission specifically dedicated for the purpose of measuring land vegetation fluorescence from space.
Artificial Neural Networks for Estimating Biophysical Products from MERIS

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Abstract

Remote sensing estimates of vegetation characteristics are required by climate and ecosystem models as forcing variables, or for validation and assimilation purposes. The high revisit frequency of the MERIS instrument allows inferring the spatial and temporal variability of the biogeophysical and biogeochemical processes that govern biosphere-atmosphere interactions. The underlying principles of a new algorithm proposed to derive level 2 products from MERIS observations, at full and reduced spatial resolutions, is presented. The considered biophysical products are: the fraction of absorbed photosynthetically active radiation (fAPAR), the fraction of vegetation cover (fCover), the leaf area index (LAI), and the canopy chlorophyll content (LAI_{e}Cab). The retrieval algorithm is based on neural network techniques that allow providing accurate estimates while being computationally efficient to process operationally large amounts of data. The implementation of the artificial neural networks relies on a training database made of radiative transfer simulations of top of canopy reflectances. The latter is regionalized, i.e. based on biome type and realistic biophysical variable distributions derived from the CYTTARES database. Moreover, the estimation algorithm explicitly takes into account actual MERIS observation geometry. Besides the considered biophysical products, it will concurrently provide their estimation uncertainty.
Session 8: New Methods
A Method for Atmospheric Correction Based on Spectral and Spatial Observation

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Abstract

The signal recorded by the sensor contains information relative both to the atmosphere and the surface. Atmospheric correction is therefore necessary to extract the surface reflectance required within biophysical algorithms used to estimate canopy characteristics. Aerosol characteristics are the most difficult to evaluate because they vary rapidly with time and space. The objective of this study is to develop an autonomous aerosol correction method exploiting the information content in the image of the satellite considered. The spectral variation of the radiance signal, when enough sampled by the sensor, generally allows decoupling aerosol effects from that of the surface because of the very different spectral features exhibited. We thus propose to use 13 over the 15 MERIS bands to estimate the aerosol optical thickness (AOT) assuming continental aerosol type from MERIS Level2 signal. For this purpose, a dedicated neural network was trained to retrieve the AOT from the top of atmosphere signal recorded in 13 MERIS bands. The training database was made of Radiative Transfer Model simulations, SMAC coupled to SAIL and PROSPECT. Results demonstrate the pertinence of the method, with a 0.042 Root Mean Square Error associated to the estimation of the AOT, inducing a RMSE on the estimated top of canopy reflectance better than 0.005. In addition, assuming that the aerosol vary typically over scales of few tenths of kilometers, while the surface varies at shorter distances, allows to smooth the AOT values for all pixels of an image. The method was applied to actual MERIS data over AERONET sites for its validation.
Automatic Clustering and Classification of MERIS TOA Spectra

Prof. Sylvie Thiria (1), Prof. Fouad Badran (1), Dr. Michel Crepon (1), Dr. Cyril Moulin (2), and Prof. Awa Niang (3)

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Abstract

The Kohonen map with PRSOM was used to analyze several time sequences of MERIS images. These images were observed on the Mediterranean Sea. We processed the normalized reflectance of full TOA spectrum by first using a 20X20 Kohonen map and then we aggregated these 400 classes into 50 classes by using the PRSOM algorithm. The classifier was trained on a one year (2002-2003) Mediterranean MERIS images using a temporal homogeneity. (2 images/month). We have developed an automatic labeling procedure based on the MERIS LUT used to invert the TOA signal. The labeling procedure allows us to identify five different aerosol type (Coastal, Maritime, Tropospheric Dust, Oceanic) and their corresponding optical thickness. We analyzed several events of Sahara dust coming from the Sahara, crossing the Mediterranean Sea and invading North of the Mediterranean. These events are in agreement with the winds displayed by the corresponding meteorological maps. The classification procedure can be extended to automatically detect case-1 and case 2 waters.
Atmospheric Correction of MERIS Imagery above Case-2 Waters

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Abstract

To retrieve surface reflectances from remotely sensed images one needs to remove the effects of the atmosphere. Removing the contributions that result from scattering and absorption in the atmosphere and from reflection at the sea surface from the measured Top-of-Atmosphere (TOA) radiances is called atmospheric correction. In this work we propose an atmospheric correction algorithm designed for Medium Resolution Imaging Spectrometer (MERIS) data above case-2 waters based on inverse modeling of radiative transfer calculations by using artificial neural network techniques. As forward model we used a radiative transfer code based on the matrix-operator method to simulate azimuthally resolved upward radiances in the MERIS channels just above the sea surface and at TOA. The simulations performed for a mixture of maritime and continental aerosol types, above an ocean characterized by varying concentrations of water constituents, typically found in European coastal waters. The simulated dataset is used to train the inverse model, which consists of a Multi-Layer-Perceptron (MLP) with one hidden layer. As input to the MLP we use beside the sun and observing geometry, the spectral information of all MERIS bands at TOA, except MERIS band 11, which is affected by the oxygen absorption and MERIS band 15, which is influenced by water vapor absorption. The presented correction scheme is implemented as a direct inversion of spectral top-of-atmosphere radiances into spectral remote sensing reflectances at mean sea level, with additional output of the aerosol optical thickness at 4 wavelengths for validation purpose. In this work we apply the inversion algorithm to a set of MERIS Level 1b data tracks of the year 2003 covering the North and Baltic Sea region. A validation is performed with in situ sunphotometer measurements of the Aerosol Robotic Network (AERONET) from Helgoland island.
A Technique for Aerosol Retrieval over Land from MERIS Data

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Abstract

The study of the role played by atmospheric aerosols in topics such as radiative forcing of climate, environmental pollution or atmospheric chemistry is becoming more and more decisive. High resolution hyperspectral capabilities of the most recently launched sensors makes possible an accurate global knowledge of different aerosol features, not available until now. Respecting the atmospheric correction of modern airborne sensors data in the solar spectrum, eliminating the aerosol perturbation on the useful ground reflected signal is a challenging matter that is in continuos evolution. Thus, there is a need of newer techniques that can extract aerosol information from satellite data.

In this paper we want to present an aerosol retrieval algorithm specifically designed for the hyperspectral ENVISAT MERIS sensor, even though its solid principles make it works for any hyperspectral sensor with little modifications. The final objective of the algorithm is to obtain physical knowledge on the total atmospheric aerosol content, as well as the concentration percentage of four reference aerosol species. An important aspect of the algorithm is that it can be applied to any land zone, mix of vegetation and soil, so it is not focused on the restrictive consideration of dark pixels, like other equivalent aerosol retrieval algorithms do.

The fundamental basis lie on a multiple parameter inversion for heterogeneous clusters of various pixels in the image, considering invariant the atmosphere above them for numerical stabilization reasons. Reflectance in the surface level for each pixel is modelled as a linear combination of two typical vegetation and soil spectra. Atmospheric contribution to the top of atmosphere signal (TOA hereinafter) is evaluated with the 6S radiative transfer code. In this contribution the information relative to gaseous abundances and its vertical profiles is fixed, whilst four parameters are left free for aerosol characterization. These are the aerosol optical depth in 550nm and the percentage of the four aerosol species implemented in the 6S code (dust-like, water soluble, oceanic and soot types). The difference between this simulated TOA reflectance and the real satellite obtained one is implemented in the corresponding figure of merit, which is minimized by means of the Nelder-Mead Simplex method. As a result, proportions of the two surface endmembers are retrieved for each pixel, and the sought aerosols parameters for the clusters.

In order to validate the algorithm it has been check with MODTRAN4 MERIS simulated TOA spectra, retrieving both atmospheric and surface parameters in good agreement with forward conditions. Inversions performed on real MERIS images also show high consistency in results, although a final version of the algorithm is still under development. The inclusion of directional effects in surface reflection and adjacency effects is considered matter for future investigation.
Use of the 709 nm Band of MERIS to Detect Red Tide and Other Conditions in Coastal Areas

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Abstract

Water-leaving radiance with a strong spectral peak at about 705 nm has been noted as a signature of dense surface phytoplankton in “red tide” conditions. In shallow water, a peak near this wavelength can also indicate the presence of benthic vegetation. MERIS on Envisat provides a band at 709 nm which can be used to detect this signature. We present images and spectra derived from MERIS data round Vancouver Island on the west coast of Canada, showing examples of the peak in the productive waters on the continental shelf, where it appears characteristic of small areas of high surface biomass. In other cases, the peak occurs in shallow waters, and we interpret it as being due to bottom vegetation. ESA has accepted an AO proposal in which the spectral bands of MERIS should be changed for a brief period to give continuous coverage of the spectral range 640 to 723.5 nm at about 10 nm resolution. This would allow a fuller evaluation of spectral signatures in this region, including the chlorophyll red edge on land.
Demonstration and Field Experimentation of MERIS Images for Fishing Support *

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Abstract

In the frame of AO project n° 768, EADS SDE has studied the benefits brought by ocean color data for ocean surface monitoring. Targeted applications are fishing industry and fish stock assessment, aquaculture, scientific and defense applications. Geographic area of interest for this study is Indian ocean and coastal waters (Madagascar, South Africa, Seychelles, Reunion).

Before 2000, a processing chain was operated with SST (derived from ATSR, AMSR and AVHRR data sets), SSA (Topex/Poseidon and Jason). It was foreseen to extract additional and complementary information through the use of ENVISAT MERIS imagery.

For this purpose we have processed reduced resolution MERIS data sets and built multi-layered products, combining sea surface temperature maps and chlorophyl concentration maps. These composite maps allow to extract high level information such as fishing potential. We demonstrate also that poor calibrated data can be useful in some operational scenarios: for instance when the purpose is to identify the boundaries between clear waters and high concentration waters (preferred areas for tuna farms).

The field experiment of this scientific study has been performed in partnership with potential end users (fishing company). We show some results and sample products.

* Demo
Demonstration of the MERISDOC Software *

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Abstract

The MERISDOC software (MERIS Diagnostic and Operating Center) is an IDL based tool that has been developed to manipulate, visualize and analyse MERIS data. This software presents lots of various functionalities: production of child products, production of RGB images, a comparison tool allowing the user to compare results of the MERIS processing when using different configurations, a general visualizing tool, a reporting tool building HTML reports showing all MERIS fields, a data below ship track tool, etc.. This tool is applicable for all MERIS resolutions, and for L0, L1b, and L2 data. It may either be used through a GUI interface, or from the IDL command line. A practical demonstration of the tool will be performed during the MERIS workshop.
Demonstration of BEAM – A Tutorial for Making Best Usage of VISAT *

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Abstract

The Basic ERS & Envisat (A)ATSR and Meris Toolbox (BEAM) is a collection of executable tools and an application programming interface (API) which has been developed to facilitate the utilisation, viewing and processing of MERIS, (A)ATSR and ASAR data. BEAM is available for all common platforms and in source code. It can be downloaded free of charge from the Envisat home page (http://envisat.esa.int/services/beam).

VISAT is BEAM's VISualization, Analysing and processing Tool. Basic functions, e.g. such as image display, color palettes manipulation, using the bit-masks, statistical analysis, export and import, as well as advanced tools, e.g. such as co-registration of MERIS and AATSR products or the the generation of Level 3 products, will be demonstrated in form of an interactive tutorial.

A CD is given to the participants of the workshop which includes a new version of BEAM and sample products. All lessons of the tutorial can be reconstructed with the sample products.

Tutorial will be given twice during the workshop: Wednesday morning and Wednesday afternoon.

* Demo
Poster and Demo Session
Ongoing and Planned MERIS Exploitation Projects: Globcarbon, Contrail, Desertification, Globcover, GMES

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Abstract

The development of the application is driven by user requirements. The establishment of a long-term relationship with champion users, where the benefits of the projects are clearly demonstrated, would allow a close partnership to be formed that could be used to promote the product. These champion users should preferably be federated through large scientific programmes (e.g. IGBP) or through large environmental conventions (e.g. UNCCD).

The MERIS ongoing and planned exploitation projects are as follows:

GLOBCARBON: multi-instrument, multi-geophysical global products service generation to serve the global carbon community under the leadership of IGBP.

CONTRAIL: validation of condensation trails and their derived cirrus retrieval from infrared sensors in order to support the impact of air traffic on the environment within a partnership with EUROCONTROL.

DESERTIFICATION: in support of the Thematic Programme Network 1 of the UNCCD a desertification project is going to be run over Asia making full use MERIS data.

GLOBCOVER: in response to UNEP for a consistent recurrent Global Land Cover product, MERIS FR data will be used together with VEGETATION data to improve the GLC2000 product in partnership with the EC JRC.

GMES Service Element (ROSES, COASTWATCH) are serving Users in the field of marine environment for coastal pollution and algae bloom.
Coastwatch WFD Service - Demonstration Cases of Use of MERIS Data

Dr. Odile Fanton d’Andon(1), Mangin Antoine(1), Marcel Babin(1), Simon Belanger(1), Mrs Padmini Dalpadado(2), Christophe De Dreuille(3), Alexandre Gannier(4), Philippe Garnesson(1), Patrick Houdry(3), Anne Littaye(4), Fred Roufii(1), Mr Helge Sagen(2), Klaus Strubing(5), Kees Van Ruiten(6), and Stephanie Vrac(7)

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Abstract

Coastwatch is an ESA project funded in the frame of the first stage of GMES Services Element (GSE) (17065/03/I-LG). Coastwatch is the GMES service element focusing on environmental management and monitoring of coastal areas. The poster presents illustrative cases of monitoring of water quality based on the WFD service of Coastwatch, including: - Level 3 Sea Surface Temperature products - Geophysical level 3 Water Colour products such as Chlorophyll, Photo-synthetically Active Radiation and Suspended sediment - Tailored products for environment monitoring and regulation survey (primary production, sea waters clarity) derived from the above.

Protected areas monitoring: Whales distribution in the Mediterranean In 2002, a study highlighted a relationship between the primary production and the summer distribution of fin whales (observed by a boat survey) in the north-western Mediterranean Sea. A predictive model was studied in calculating a Potential Grouping Index. This model calculates an index by integrating primary production data over different temporal scales, since the beginning of March until the date of the ship surveying at sea. The primary production was estimated from ocean colour data (SeaWifs and MERIS), chlorophyll and PAR data and AVHRR/NOAA data, with a relevant model, Behrenfeld and Falkowski (1997). In order to take into account the environmental changes and the likely whales movements, the model includes a revaluing of the index every 8 days, with a start, beginning of March 2003, of the time integration of primary production. A field campaign has been carried out in July - August 2003 in the Northwestern Mediterranean Sea by the GREC laboratory (Groupe de Recherche sur les Cétacés, Antibes) in order to evaluate the value of the model to predict areas favourable to fin whale presence. The technological and scientific support in satellite imagery (MERIS, AVHRR, and SeaWifs NRT) has been ensured by the ACRI company in the frame of Coastwatch. Preliminary results as transmitted by the ship in NRT have confirmed the relevance of the use of such data for the purpose of the mission. The complete statistical assessment will be presented at the workshop. This exercise has been the opportunity to test the operational capability of the Coastwatch service in the frame of a protected areas monitoring.

Investigative monitoring: Optical Remote Sensing of the Chinese Freighter Accident on 31 May 2003 in the Baltic Sea Saturday 31 of May, the Chinese freighter “Fu Shan Hai” sank to 68 m depth in the Bornholms-gat, Baltic Sea, and caused an oil spill. For details about the accident, see ESA’s web site at http://earth.esa.int/ew/planning/pl_swedenoil-jun03.htm. Although the optical remote sensing of ocean colour is generally not used to detect oil spills, we are extracting here spatio-temporal information from MERIS imagery as a preliminary attempt to demonstrate the use of MERIS as a potential complementary tool to other means of investigation (e.g. SAR). A combination of MERIS data with AATSR/AVHRR and ASAR could help to identify oil spills and other polluted areas, which has to be investigated in detail. This monitoring has demonstrated the capability to set up an immediate monitoring capability, including timely delivery of products, regular iterations between user (BSH), scientific expert (GKSS), and service team (ACRI-ST), all performed in a very short time frame. If, on the one hand, analysis of water colour changes appeared to be highly complex, especially due to atmospheric effects which must be corrected for, but without correcting the sunglint influence, on the other hand, the analysis that has been performed on the series of raw images seems very promising in the capability to detect oil spill when it falls in the sunglint patch (i.e. direct sun ray specular reflected toward the sensor) as the surface becomes smooth by the slick. Even though the weather conditions may reduce the true availability, the availability of quasi one image per day on the area also appears to be a strong advantage to perform a regular monitoring. The detection of small scales structures is definitely possible using the MERIS Full Resolution
products, and this would be of great interest to monitor coastal pollution. Although commonly agreed to stop the specific systematic monitoring of the area for the time being, it is kept in mind that the main load was about 60 thousand tons of fertiliser, which might favour changes in he water colour and/or algae blooms in the next coming weeks, and the monitoring will be immediately reactivated in case of alert raised by BSH.

Surveillance monitoring: Support to the GAUSS campaign in the North Sea (July-August 2003) The Coastwatch WFD service has provided support to the summer Gauss campaign in the North Sea (July 28 until August 15, 2003) by supplying in NRT Ocean colour derived products (Chl-a, TSM, Transparency) and SST. The preliminary results obtained on board have shown a very good agreement between the measured in situ Secchi depth and the transparency derived from MERIS, both showing a surprisingly high value (about 16 to 18 meters depth) compared to the other years. The complete comparison analysis between in situ and Earth Observation data will be presented at the workshop. Besides the contribution to MERIS validation, this exercise has been the opportunity to test the relevance of the Coastwatch WFD service as a contribution to a monitoring system in the frame of the WFD surveillance monitoring.

Surveillance monitoring: Emiliana huxleyi blooms in the Barents Sea in July 2003 The milky turquoise colored nature observed in a series of satellite images during July-September 2003 from the Barents Sea reflects most probably the blooming of the Emiliana huxleyi. Emiliana huxleyi is a microscopic alga (2-10 micrometer), not visible to the naked eye. Due to its calcium carbonate skeleton, large concentrations of this alga appear as milky turquoise patches in the ocean. Since 1965, Institute of Marine Research conducts cruises annually (August-September) to monitor 0-group fish. In the recent years (2001-2003), scientists have observed Emiliana huxleyi blooms covering large areas of the open waters of the Barents Sea. The algae are not commonly found in the Barents Sea, though it is not so uncommon in Norwegian fjords. During 2001-2003, temperatures in the Barents Sea have been exceptionally high, probably due to the increase in inflow of Atlantic water from the Norwegian Sea into the Barents Sea. It seems that the Emilania huxleyi has the capacity to expand in large numbers, in such water conditions and thus be regarded as an indicator of changing climatic conditions (change) in the Barents Sea.
SISCAL: Satellite-based Information System on Coastal Areas and Lakes

Dr Frank Fell (1), Dov Ganor (2), Tibor Gideon (2), Barak Herut (2), Saleem Nimre (2), Thomas Schröder (3), Alon Zask (4), and Tinglu Zhang (3)

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Abstract

SISCAL aims at providing water-quality related data products in Near-Real-Time from satellite data, tailored to individual end users needs and integrated into a specific GIS. The SISCAL project is now into its final year and a prototype service is already operational and accessible under http://www.siscal.net.

In the frame of SISCAL, it is intended to integrate MERIS and AATSR data. The corresponding AO has been submitted to ESA and access to 216 MERIS and AATSR scenes in Near-Real-Time has been granted.
Integrated Watershed Modeling

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Abstract

Integrated systems that bring together EO data, local measurements and modeling tools, are a fundamental instrument to help decision making in watershed and land use management. The BASINS system (EPA http://www.epa.gov/OST/BASINS/) follows this philosophy, merging data from local measurement with modeling tools (HSPF, SWAT, PLOAD, QUAL2E). However, remote sensed data is still used in a very static way (usually to define land cover, see corine land cover project). This approach is being replaced with operational methods that use EO data (such as land surface temperature, vegetation state, soil moisture, surface roughness) for both inputs and validation. The development of integrated watershed models that dynamically interact with remote sensed data opens interesting prospective to the validation and improvement of such models. This paper describes the possible data contribution of remote sensing to the needs associated with state of the art watershed models, including well know systems (such as SWAT or HSPF) and a system still under development (MOHID LAND). Application of such models is shown at two pilot sites, which were selected under EU projects, TempQsim and Interreg II B - ICRW.
Deriving Surface Albedo from Coupled MERIS and MODIS Products

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Abstract

MERIS Level 2 surface reflectance products are now available to the scientific community. We demonstrate the production of MERIS-derived surface albedo and Nadir BRDF-adjusted reflectances by coupling the MERIS data with MODIS BRDF products. Initial efforts rely on the specification of surface anisotropy as provided by the global MODIS BRDF product for a first guess of the shape of the BRDF and then make use of all of the coincidently available, atmospherically-corrected, cloud-cleared, MERIS observations to generate MERIS-derived BRDF and surface reflectance and albedo quantities for each location. Comparisons between MODIS (aerosol-corrected) and MERIS (not-yet aerosol-corrected) surface values from April and May 2003 will also be presented for case studies in Spain and California as well as preliminary comparisons with field data from the Desert Rock Surfrad/BSRN site.
NorSatVal - a New High-latitude Marine and Terrestrial Validation Network

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Abstract

A group of Northern European environmental research institutes using remote sensing data have taken an initiative towards several research facilities in Northern Fennoskandia to form a network of satellite validation and application centres in the Nordkalotten region, named NorSatVal.

The main aim of the initiative is to build up validation sites with intercalibrated instrumentation for spectral imaging satellite instruments, covering a broad variety of typical boreal/sub-arctic surface types, both terrestrial and marine/aquatic.

To optimise satellite measurements for the conditions at high latitudes (particular atmospheric conditions, extensive snow cover, and low sun for most of the year, vast boreal forests and sub-arctic mountain regions), one part of the project concentrates on the adaptation of existing satellite measurement algorithms, which are generally designed for very different solar illumination, atmospheric and land cover conditions of densely populated areas at middle and low latitudes.

The new validation network will be tested in a series of pilot validation exercises using data from operational satellite instruments such as MERIS and MODIS. The validation measurements will be performed not only from ground validation sites but also from airplanes and research vessels. It is envisaged that the interaction between validation and algorithm development will result in regionally optimised satellite measurements of several key parameters of the sea surface layer, lakes and land surfaces. These parameters are extensively used in global change monitoring, which is of increasing importance for the region, as well as monitoring of quality and local changes of the environment, e.g., land cover changes due to use of natural resources by man. They may also find applications in flooding control and water reservoir monitoring for hydropower industry.

We shall give an overview over the planned network, the instrumentation, parameters envisaged, and the state of realisation.
Retrieval of the Aerosol Optical Depth from MERIS and Ground-based Radiometers

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Abstract

Optical properties of aerosols vary with region and seasons. Thus, radiative simulations, which are used for the atmospheric correction of remotely sensed imagery of ocean surfaces, have to be based on a regional climatology. Furthermore data of aerosol optical properties is used for the global radiative budget and atmospheric pollution, caused by biomass buning and by traffic.

Data for the atmospheric correction of ocean color satellite is provided mainly by ground-based measurements sites, which are located near the coast, like the sun-photometer network AERONET. This coastal data is collected with a high temporal frequency, but has only little spatial information. In contrast, ocean color satellite sensors provide a high spatial information, but the data is limited generally to one sequence per day. The retrieval of the aerosol optical properties using SeaWiFS data from 1997-2003 demonstrated that they are not appropriate for the purpose of an aerosol climatology in the coastal area of the German Bight. This is due to the few aerosol models used, which don’t include the urban/industrial aerosol model. In particular, the SeaWiFS aerosol retrieval algorithm includes aerosol with an Angstrom coefficient for the spectral range 510-865nm not higher than 1.5. MERIS aerosol retrieval algorithm is based on a much broader range of aerosol types, including the desert dust and the absorbing urban aerosols.

MERIS data are compared firstly with the sun-photometer data from AERONET site Helgoland Island and secondly with the data from handheld radiometer Simbada of cruises in the German Bight. Helgoland Island is situated in the middle of the German Bight, which belongs to turbid case 2 coastal waters. It was of interest to investigate, if the aerosol correction procedure for turbid water will provide sufficient accurate results. The match-up data is discussed, showing the improvement of the aerosol information retrieved from the MERIS sensor, when compared with SeaWiFS or MODIS data. The evaluation of this data has been performed with the help of the MERIS Toolbox developed by Brockmann Consult.
The Potential of Red Edge Index Derived from ENVISAT MERIS Data in East Africa

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Abstract

The state of vegetation is represented in its spectral signature, especially in the red and near infrared region of the electromagnetic spectrum, characterized by a low reflectance in the red and a high reflectance in the near infrared. In this region between 670 nm and 780 nm the point of the steepest rise of reflectance of green vegetation is referred to as red edge. The derivation of red edge index from remote sensing data and its use for the analysis of vegetation properties has been already discussed on simulated MERIS data sets. MERIS with its spectral high resolution of 15 bands and the narrow band setting in the red and near infrared spectra seems particularly suitable for using the red edge index. A first application of this index on real ENVISAT MERIS data is performed in the Mount Kenya region, in East Africa. The region is characterized by a high population density, climatic variability and a strong ecological gradient from the rain fed slopes of the extinct volcano towards the arid savannahs of the Laikipia plateau. As a result the land use varies from agro-forest and small scale farms to large scale farming and rangelands and savannahs. In this test area the potential to detect the state of the land cover is investigated using the red edge index derived from the ENVISAT MERIS data. The advantages and restrictions in deriving a land cover and land use classification based on the index are discussed. For ecosystem monitoring the red edge index seems a promising parameter.
Validation of MERIS Biophysical Products Estimated by Artificial Neural Networks

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Abstract

An artificial neural network algorithm has been developed for deriving level 2 products from MERIS observations, at full and reduced spatial resolutions: the fraction of absorbed photosynthetically active radiation (fAPAR), the fraction of vegetation cover (fCover), the leaf area index (LAI), and the canopy chlorophyll content (LAI\(_{eCab}\)). The neural networks have been trained on a database made of radiative transfer model simulations. Moreover, this training database is biome type dependent insofar as it has been generated with realistic distributions of the biophysical variables derived from CYTTARES. The validation of these products is presented. It relies on estimations processed on atmospherically corrected MERIS images acquired on specifically selected sites. First, the spatial and temporal consistency of the estimated biophysical variables are investigated. Then, their reliability is appraised by comparison with other existing products, mainly MODIS-LAI/fAPAR and MERIS-MGVI.
HiProGen - a System to Generate High Level Products

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Abstract

The High level Product Generation (HiProGen) system was developed by an industrial consortium of Infoterra Ltd. of the UK and VTT of Finland under a TRP contract with ESA. The HiProGen project has created a demonstration system that can automatically convert low level Earth Observation data to geocoded, geophysical composites and wide area mosaic products. The system demonstrates the follows features:

- automatic generation of Level 3 products from lower level Earth Observation data (specifically MERIS Level 1 and 2, ASAR Level 1 Wide and Global Monitoring and Level 1 ATSR-2 / AATSR);

- output of Level 3 products in a range of projections and data formats;

- a flexible architecture which allows easy extension of the system to generate new and improved Level 3 products;

- an expandable and portable system which can be distributed across several platforms to increase production capacity.

Five example (non-validated) terrestrial geophysical products are generated by the system as weekly and monthly global composites. These are broadband Albedo, Global Vegetation Index, fraction of Photosynthetically Active Radiation, Leaf Area Index and Net Primary Productivity. In addition the system can generate regional ASAR mosaics and weekly/monthly composites of MERIS Level 2 algal_1 and algal_2 pigment concentrations. Example products will be shown.

To ease integration of new algorithms into the HiProGen production environment, software 'wrappers' are used to control different types of processing (e.g. Java, C/C++ executables and IDL batch procedures). Taking advantage of this flexibility, version 2.0 of the Basic ERS & Envisat (A)ATSR and MERIS toolbox (BEAM) was embedded into the HiProGen system and used to create algal_1 and algal_2 binned data products. A modified version of BEAM 2.0 is used to create higher resolution, resampled composites of these products incorporating a flux conserving algorithm developed by NASA.
Neural Algorithms for Ocean Color (NAOC) Project: Demonstration with MERIS Data *

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Abstract

NAOC "Neural Network Algorithms for Ocean Colour" is an EU project funded in the frame of the 5th framework programme, energy, environment and sustainable development (EVK2 2000 00651). The aim of NAOC is to provide advanced algorithms for better exploiting the information embedded in new multi-spectral ocean color satellite observations: - provide information on aerosol type and on water type, which are used for atmospheric correction and ocean constituent retrieval - provide improved algorithms for atmospheric correction that is crucial for obtaining accurate ocean product owing to the large percentage of the signal due to the atmosphere. - improve ocean constituent retrieval by taking into account the full spectrum range of the new multi-spectral ocean color sensor such as MERIS. ENVISAT cat 1 AO 1533 has allowed NAOC team to use MERIS data as a contribution to NAOC algorithms validation by comparing the MERIS nominal chain to the several neural networks derived in the frame of the project. A dedicated computing tool (demonstrator) has been derived to accept new competitive algorithms to be put to the test for inversion of MERIS data. In particular, new algorithms from FUB and GKSS for atmospheric corrections and ocean constituent retrievals in case 1 and case 2 waters have been integrated in this demonstrator and tested with MERIS scenes. The results of this exercise and the demonstrator itself will be presented during the workshop. In addition NAOC was the opportunity to set up successfully a neural network for SeaWifs data classification based on Probabilistic Self-Organizing Map (PRSOM). Present training with MERIS data should allow to obtain and to present some results at the MERIS workshop.

* Demo
MERIS SPM Mapping over the Belgian Waters - Hydro-optical Model Calibration

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Abstract

A hydro-optical algorithm based on reflectance at 555nm has proved effective for suspended particulate matter concentrations (SPM) retrieval from SeaWiFS over the Belgian coastal (case II) waters in Southern North Sea. The extra spectral resolution of MERIS offers the possibility of improvements, though necessitates algorithm recalibration.

This study presents the calibration of the hydro-optical model used to derive SPM from MERIS- reflectance over the Belgian coastal waters. The model is based simply on reflectance at one suitably-chosen band. Regression analysis is carried out on MERIS data and measurements of SPM taken over our region of interest. Sensitivity of the method to errors is studied. Comparison with the multiband neural network-based standard MERIS product and with the SeaWiFS derived SPM completes this study.
Development of an Integrated System for Coastal Waters

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Abstract

This paper describes some of the needs and problems associated to the assessment of coastal and estuarine problems (sediment transport and eutrophication). The development of an integrated system including EO data, local measurements with special emphasis on modeling tools, is presented as a solution for studying and helping decision making on the subject. Two pilot sites for the implementation and the present development status of the integrated system are depicted. This framework was already presented in a recent AO specific for Portugal, which is still under evaluation.
Determination of Fine Particulate Matter from MERIS and SeaWiFS Aerosol Data

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Abstract

Suspended fine particles in the air are a key element for the monitoring of air quality and thus are defined very precisely: one speaks of PM10 and PM2.5 for Particulate Matter smaller than 10 micron et 2.5 micron in diameter. As for epidemiological studies dealing with gases, air quality ground networks bring most of the information concerning particles exposure. Nevertheless, whether their sampling is representative is still a matter of debate, the spatial coverage is sometimes very sparse, measurement accuracy is weak for PM2.5 as several methods are currently used, and background exposure is badly known. The project aims at providing an estimation of the background exposure to fine particles and this for multi-year time series on a regional scale using SeaWiFS and MERIS data.

These maps are correlated with ground based measurements of PM in an attempt to calibrate PM maps derived from satellite sensors within the Euro-region centred on North of France including Belgium and South-East England. Several key issues are addressed in this study:

- Consolidation of the SeaWiFS and MERIS aerosol product over land
- Validation of the aerosol product with comparison to CIMEL sun-photometers
- Conversion from aerosol product to Particulate Matter: validation of the aerosol Size Distribution and sensitivity to ambient relative humidity
- Sensitivity to the aerosol vertical distribution
MERIS Temporal Synthesis

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Abstract

A MERIS synthesis has been computed using reduced resolution data from the months of March and April 2003 and covering the whole world. GAEL Consultant has processed 1242 segments, representing more than 600 GB, acquired by the Kiruna station or coming from other stations and relayed by the Artemis satellite. For each new segment, a new synthesis of five bands is computed leading to a total of 9936 GB (~10 TB) generated data. Among the various projections, the Plate Carrée has been chosen and input data have been orthorectified using the grid of tie-points provided in auxiliary data. Results have shown an excellent accuracy in on-ground location. Two algorithms (“Radiance minimum” and “NDVI maximum”) have been tested to compare pixels from a new MERIS segment with the corresponding pixel computed in the previous synthesis. Two other algorithms have been tested to replace the synthesis pixel (“Replacement”) or to compute a sliding mean involving the previous values (“Mean”). After having analysed the radiometry distribution of the synthesis produced, post-processing is presented as far as refined regional enhancements. Results have been shown on a large poster at the Paris Bourget Air show on 16-22 June 2003 and are now available on ESA Web map server. This study demonstrates that MERIS synthesis provide valuable Information to monitor the whole Earth over time.
New Methodologies in the XTH Region of Chile to Determine Phytoplankton Blooms

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Abstract

Since 1972 HAB has become a growing problem in Chile, the leading country in the production of salmon fish. The exploitation of marine resources is one of the main economical activities for which the implementation of new technologies to improve the prediction of HAB (Harmful Algae Blooms) has been considered. It is of rapid growing interest for the fish farming industry and for the shellfish extractors, mainly in the Xth Region of the country.

For the first time ocean colour data is being used to monitor phytoplankton bloom events, in particular related to HAB, in Chile.

This is the first project to exploit ENVISAT data in the frame of the Earth Observation program in the country. Although this is a pilot project with scientific application the usefulness of the technique is being demonstrated for the aquaculture industry.

The combination of MERIS and AATSR remotely sensed data brings to this area the possibility to study the ocean from the space and to demonstrate how the prediction of development of phytoplankton blooms can be performed and confirms the presence of toxic species, using ancillary data from in situ water samples.

Through the study of photosynthetic phytoplankton pigments it is possible to identify four divisions of algae: chlorophyceae, cianophyceae, diatoms plus dinoflagelates and criptophyceae, as the fluorescence excitation spectrum for each group has a typical fluorescence fingerprint. Under this concept the instrument Fluoroprobe was developed and in used in this project. Water temperature, the concentration of dissolved organic matter and transparency are also determined in the water column in five areas in the region.

Remotely sensed data have demonstrated the influence of mesoscale events and open ocean circulation in the Gulf of Ancud. Two areas located in the North and South of the big island of Chiloé have been identified mainly affected by the open phenomena.

Preliminary results obtained using the Fluoroprobe demonstrated that diatoms and dinoflagelates are dominant algae divisions in the area. This group includes many species of phytoplankton responsible of the harmful algal blooms in the region, as Gymnodinium spp, determined during April 2003 and Alexandrium catenella determined during the austral summer of 2002.

There is a clear pattern in the general distribution of chlorophyll from the North to the South in the coastal area of Chiloé Island, where the concentration is higher in the southern region. The vertical profiles of pigments and temperature show homogeneous distribution in the water column, in correspondence to the winter time. In some cases maximum values of chlorophyll have been found.
Monitoring Landcover Changes in Subsaharian Wetlands - The Niger Inland Delta

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Abstract

Aim of the work The use of the MERIS data takes place in the context of an extensive project which is dedicated to the monitoring of landuse and landcover changes in the Niger inland delta of the Republic of Mali Western Africa. The inland delta of the Bani-Niger river system has ever been favoured by local people due to its comparatively rich watersupply. Today, a growing population causes increasing pressure on landuse for agricultural purposes and resources consumption. This excessive use of natural resources leads to progressive degradation of soils and erodes the income base of wider population parts.

As a basis for future decisions regarding kind and range of using agricultural resources, in particular soil and water, the dynamics of landuse have to be examined. This work is concerned in particular with the suitability of MERIS data for such a monitoring.

First a sketchy characterisation of the water regime and the prevailing forms of vegetation takes place, generally for the Sahel-region and particularly for the inland delta, whereby the focus is directed toward their temporal variability. Subsequently takes place a short description of the MERIS and after that the workflow is described in principle.

Water regime As a transition region between the northerly arid Saharan zone and the semi humid Sudan zone in the south the Sahelian vegetation is characterized by its extremely scarce watersupply. Annual rainfall rarely exceeds 300-400 mm. Those temporally and spatially highly variable precipitation fall almost exclusively in summer months from Mid-June to Mid September. According to that "rainy season" of 3 to 4 months faces a dry season continuing 8 to 9 months. The high variability of the anyway small precipitation causes thereby in some years a partial or complete loss of the "rainy season". This leads into dry phases of several years like that from 1984 to 86.

The water regime at the Niger inland delta is characterized by another kind of water "source". Yet it is dominated by this. The summer precipitation around the southerly mountainous source areas of river Bani and river Niger leads to a rise of the river levels. This rising occurs temporally delayed, so that the flood reaches the southern edge of the inland delta in mid October and fades away at the beginning of January at the northern end. In consequence are wide ranges of the extremely flat delta inundated outside the rainy seasons.

The extent of this flooding correlates thereby with the amount of precipitation in the source mountains. Cause of the uncertain rainfalls only the more deeply lain areas are flooded each year. In particular the inundation at the boundary regions of the delta should be regarded therefore as non periodic and /or episodic. During the flood period swales fill with water and form so-called Mare.

From this only short de scripted behaviour of the inland delta's water regime the following three periodical changes are derived:

1) a seasonal variation between rainy and dry season 2) a seasonal variation between flooding and drainage phase 3) a variation counting several years between dry phases and years with sufficiently precipitation

The latter cycle expresses itself thereby primarily in variable amplitudes of the two first cycles, whereby however the high spatial variability of the precipitation does not permit causal linkage of the two first cycles. In particular it may happen that also in years with small summer precipitation in the delta a sufficient flooding occurs, due to high rainfalls around the rivers source areas.

Vegetation Due to its limited offer, water represents the restricting factor for the vegetation at Sahel. Therefore three vegetation cycles running parallel to the "water cycles" can be designated, which follow the water offer with a certain temporal delay. This delay may vary from few days (sprout of grasses) up to several months (die from trees due to lack of water). In connection with the all year around high temperatures the expanded dry-season leads to a development of Combretaceen-savannah as characteristic form of Sahelian vegetation. According to [1] that vegetation is divided into three layers:

a) 40 to 80 cm high gras-layer with annual grasses and herbs b) 50 to 300 cm high bush-layer c) a very open tree layer, consisting of 3 to 6 m high single trees.
While bushes and trees cover only a small part of the earth's surface (up to 25%) the grass-layer outweighs with a coverage up to 80% according to [2]. During the dry-season most of the annual grasses drop, so that the earth's surface appears to a large extent without any vegetation. The remaining bushes and trees train no complete vegetation cover during this period of the year.

Within the range of the inland delta the comparatively rich water offer causes a wider development of trees and bushes. Beside natural vegetation cover far parts of the delta are agriculturally used. Irrigated agriculture results in a closed vegetation cover at present flooding, while outside of this period wide ranges lie vegetation less fallow. Annual and perennial grasses prevail within the bank ranges of the Mare. These serve often as pasturelands for nomadic cattle breeder, while the Mare itself are used as watering places.

working area The investigation extends to the area of the inland delta itself and the plateau of Bandiagara, neighboured east. It is limited by the four corner points (15°37N; 4°40W), (15°27N; 3°03W), (13°49N; 5°03W), (13°38N; 3°26W).

Characteristic of the MERIS data At full resolution mode the MEdium Resolution Imaging Spectrometer supplies data with a spatial resolution of 300 m in nadir range. The instrument measures thereby the reflected solar radiation in 15 bands within the visible and close infrared range (390 - 1040 nm). A covering of the entire earth's surface within 3 days is made possible by a swath with of 1150 km. Owing to the individually programmable spectral resolution also very specific reflection spectra can be registered for the first time in history of earth observation. This allows also the detection of narrow reflection features such as chlorophyll absorption. New promising opportunities for vegetation analysis are given by this. Band ratios from infrared and red channel permit the computation of vegetation indices. The analysis of water colours permits conclusions on the condition of different open water surfaces (rivers, Mare). Therefore can several bands at the spectral range of 400 - 520 nm be programmed used data For the analysis of annual dynamics was a time series consisting of 4 data records composed. Data were acquired at following dates:  


While the August data shows the situation at the end of rainy season, the data record from October falls into the beginning of the flood period. With the December record the end of flooding can be analysed and the April data documents the dry season. An fifth data record may be added from May/June 2003 With this supplementary data the situation at the beginning of the rainy season could be analysed.

Classification The approach uses the method of linear unmixing in combination with the "mixture tuned matched filtering" procedure, allowing a classification at Subpixel level. This is urgently required due to the small spatial resolution of MERIS data. Past analyses and knowledge from a field research at February/March this year show that the following 8 essential object categories are to be expected:

a) open water surfaces b) flooded surfaces c) damp soils d) dry soils e) trees / forest, bushes f) grass land g) agriculture land h) antropogene objects (roads, settlements)

In context of a first classification step the separate analysis of the 4 data records took place. Subsequently, a linkage of all 4 separate classification results and the inclusion of additional a priori information should improve the reliability of the classification results.

references


Remote Sensing of Virally Induced Mass Mortality of Cyanobacteria

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Abstract

We develop a remote sensing tool to investigate drastic changes in the contribution of cyanobacteria to the phytoplankton community of shallow, eutrophic lakes. Viruses can be controlling agents in the growth of cyanobacterial populations. Sometimes, the balance between virus and host is disturbed, resulting in loss of photosynthetic pigments and increased transparancy. A remote sensing tool for the monitoring of cyanobacterial populations could track the circumstances under which such events of mass lysis occur in nature.

The pigment phycocyanin is present in almost all cyanobacteria and few other species. All phytoplankton species have chlorophyll a. Absorption of light by phycocyanin is highest at 615 nm and can be detected by the 620 nm band of MERIS on ENVISAT. The pigment ratio phycocyanin : chlorophyll a is related to the share of cyanobacteria in the phytoplankton. A sudden decrease of this ratio can indicate mass mortality of cyanobacteria. Additional optical changes can reveal the viral nature of such a cyanobacterial mortality.
RealCup - Near Real Time Customized Products *

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Abstract

Current Ground Segments are based on a “push” mode wherein the overall acquired data are pre-processed and archived as standard products before being proposed and distributed to end-users. This approach suffers from several disadvantages, including the processing and transfer of large amounts of unnecessary data resulting in network congestion and poor bandwidth utilization. The user service facility becomes a bottlenecked and user response time lag due to sequential processing. This paper presents an alternative “pull” approach wherein only data relevant to orders emanating from the end-user are processed and transferred. The data are collected and processed as soon as feasible in the acquisition chain and potentially during their acquisition. This technique disconnects the dissemination from the archiving activity, enabling performances never yet been attained. This new approach has been implemented as the RealCup demonstrator that is currently running for ENVISAT-1 MERIS data distribution. RealCup has already shown impressive performance capabilities, delivering ortho-rectified images from 5 to 40 seconds next their acquisition. Thanks to its open architecture, RealCup supports orders from several interfaces that may operate simultaneously. A dedicated Web interface as well as a MASS interface have already been developed. It is foreseen to append new interfaces including SOAP and CORBA components enabling orders emanating from computer programs. On the processing side, RealCup has been designed to support several data sources. Using a JPEG2000 based compressor and an HTTP fast viewer, RealCup optimizes again the bandwidth enabling the end-user to pre-visualize the resulting image at any resolution independently from its size, and to refine his/her area of interest and compression ratio before downloading it. RealCup has is being used in the framework of EOLES consortium for the management and assessment of flood disasters using MERIS data. A Cat-1 project has been agreed with ESA for the utilization of MERIS measurement until august 2004.

* Demo
Upscaling Hyperspectral Imagery for Biodiversity Assessment in Coastal Wetlands

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Abstract

The coastal wetlands of the Netherlands are remnant natural ecosystems offering nutrient cycling capacity for maintaining water quality, wildlife habitat, and tourism. Management, especially in response to activities such as grazing and tourism, require information on vegetation, which provides food and habitat for wildlife.

The main aim is to map the distribution of, and change in, species composition, structure, and concentration of foliar chemical properties of coastal wetland vegetation, using ASAR imagery concurrently acquired with the MERIS imagery. Secondly, to "scale up" results obtained from detailed point based models, and relate the foliar chemical properties to wildlife populations (wildfowl and lagomorphs). Thirdly to investigate any relationship between plants and vegetation succession and water pollution across the Wadden Zee.
Integration of Optical (Spot and Envisat MERIS) and Radar SAR Data (ERS-1 and 2 and Envisat) for Urban Characterisation and Monitoring in Northern Algeria

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Abstract

The aim of this communication is to present some preliminary results of part of the project submitted and accepted at the « third Announcement of Opportunity for ERS Data (AO3) and the ENVISAT CAL/VAL Projects ». This communication presents satellite images analysis and interpretation methodologies using different multisources satellite data such as optical ones (Landsat TM, SPOT and Envisat MERIS), SAR and ASAR radar data (ERS-1/2 and ENVISAT) investigating different fusion techniques and classification techniques. The methodology is applied for the characterisation and the monitoring of state surface concerning an urban and coastal environment of a area in northern Algeria (the town of Algiers and it surroundings) and we present the problem which is the study of the management of the space of the Grand Algiers with all the problems of great towns such as urban, agricultural and environmental ones.

This region was already studied and is always under study in our laboratory using optical (Landsat TM and SPOT) and SAR radar data (ERS-1) and we already presented the results obtained with the support of the European Space Agency but ENVISAT (ASAR and MERIS) data were not used in previous studies of the urban areas in our laboratory. ASAR imagery can be used to define urban features, roadway network and built structures. MERIS has a spectral resolution capable of delineating land uses and covers and patterns of environmental degradation, and vegetation. The radar reflectances data at the highest resolution can be used to formulate decision rules for categorizing pixels unclassified by MERIS analysis alone. Precise registration, fusion and integrative analysis of MERIS with ASAR is necessary for providing valuable collateral information to resolve the complex spectral signals of urban features.

This research proposes to develop the methodology to specify, monitor and understand the urban landscape. We will characterize urban areas using ASAR, and classify land cover using ASAR and MERIS. The proposed integration of MERIS and ASAR will yield higher spatial resolution land cover classification and aggregate cover estimates, associated roadway features, and more detailed information on the types of surface states. This study comprise the development of methodology and techniques using a Northern Algeria area representative of the diversity of urban land covers, uses and features will be selected. We believe that precise registration with ASAR data will be a valuable collateral information source to resolve the complex spectral signals of the urban features. Both radar reflectance and interferometric characteristics can be used to formulate decision rules for categorizing pixels unclassified by the MERIS analysis.

Carrying out the project will allow us to see which level the new data of ENVISAT satellite (optical Meris and ASAR radar data) will allow us a better interpretation of images of urban areas. Our wish is to achieve good results as objective as possible and for this goal the choice of scenes parameters is very important.
MERIS IPWV Validation: a Multisensor Experimental Campaign in Central Italy

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Abstract

This paper reports the results of an experimental campaign carried out in the Central Italy, considering also part of the Tyrrhenian Sea. Integrated precipitable water vapour (IPWV) estimates obtained from measurements of multiple sensors were produced for a period of about one year, with the purpose of validating the corresponding MERIS estimates. Ground-based sensors were available at the following test sites: - Elba Island equipped with a dual channel microwave radiometer (23.8 and 31.4 GHz), a GPS receiver and a meteorological station; - Perugia with a GPS receiver and a meteorological station; - L’Aquila with a GPS receiver and a meteorological station; - Pomezia with a dual channel microwave radiometer (23.8 and 31.7 GHz) and a radiosonde launching station. In addition, the IPWV outputs of the PSU/NCAR mesoscale numerical prediction model MM5 V2.12 were produced and collected for reference at each of the four test sites. To assess the MERIS performances over a land background, we present local comparisons of MERIS water vapour estimates performed at each test site considering the available ground-based instrumentation and the outputs of the MM5 model. In order to evaluate the performances also over a sea background, we make comparisons based on IPWV maps of extended areas produced, on the one side, by MERIS and, on the other side, by geostatistical interpolation of the measurements (performed over land) of the Italian network of GPS receivers and the measurements (performed over sea) of the satellite-based Special Sensor Microwave Imager Radiometer. Considering the Tyrrhenian area, a further element of comparison comes from IPWV measurements of ENVISAT Microwave Radiometer (MWR).

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Abstract

The provision of quick, objective and homogeneous information about the phenomena of natural disasters which occur frequently and affect large areas in Hungary such as flood, waterlog and drought are very imperative at regional scale. The effectiveness of a regional, cost-effective satellite based monitoring model can be increased by enhancing the quality (temporal, spatial or spectral) of satellite data. This paper shows the main results of the ESA-FÖMI Prodex-ENVISAT R&D project (ESA Contract no. 14525/00/NL/SFe(IC), ESA EO CAT-1) aiming at the application development of ENVISAT satellite data for regional remote sensing based flood/waterlog and drought monitoring (2000-2003).

The effectiveness of remote sensing based techniques has been proved by the implementation of the operational satellite based National Crop Monitoring and Production Forecast Program (CROPMON 1997-) at FÖMI RSC. In the fundamental CROPMON that has been operational for the 7th years in 2003, FÖMI RSC provides county and country level crop production forecast to Ministry of Agriculture and Rural Development (MARD) by a strict calendar across the season based on remote sensing, measuring the areas and expected yields of the 8 main crops.

Other related monitoring programs (waterlog and impact monitoring 1998-1999, experimental flood and drought monitoring 2000) were also carried out on CROPMON basis. Further extension of the already developed methodologies was proposed for rapid, regional monitoring of the spatial extent and temporal changes of flood/waterlog and drought affected areas involving the new ESA ENVISAT satellite data. The new generation sensors on board ENVISAT (MERIS, ASAR) can increase the effectiveness of remote sensing based rapid, large area flood/waterlog and drought/crop monitoring. The processing and comparative analysis of currently available, operational satellite data (NOAA AVHRR, SPOT VEGETATION, IRS-1C/1D WIFS, Landsat and ERS SAR) were carried out on a regional (2-3 counties) test area to accomplish the model setting, extension, testing (data from 1998-2000) tasks and the semi-operational (data from 2001) phase of the project. The category system of the WIFS based regional waterlog map could be further refined since the degrees of wet soils and wet vegetation could be identified and differentiated more effectively using the lower spatial but higher spectral resolution SPOT VEGETATION images. These data were also successfully tested for regional drought and flood monitoring (2000-2002).

Further extension of the model has been carried out with real time monitoring tasks since 2002. The Gemenc Forest flood was monitored in August 2002 and inundated areas were evaluated using high resolution Landsat TM and IRS LISS image time series data. Drought monitoring was also carried out with the comparative analysis of SPOT VEGETATION time series data. It indicated that the area extension and the intensity of drought was smaller in June 2002 than in June 2000, when serious drought occurred in Hungary.

The use of weather independent radar data for flood/waterlog monitoring has been tested on historical datasets from 1998-2001. Multitemporal radar data (ERS-2 SAR scenes) was used successfully in the monitoring of the flood of river Tisza in 2001. The comparison with high resolution optical/infrared data (Landsat TM, IRS-1C LISS) showed good agreement between the flood inundation maps. With the integration of low and medium resolution optical/infrared data (IRS WIFS, SPOT VEGETATION) and high resolution radar data (ERS-2 SAR) a new multisensor dataset can be produced which is very effective tool in waterlog monitoring compared to the original datasets capabilities. Further extension of the model has been carried out for operational waterlog and drought monitoring using NOAA AVHRR, SPOT VEGETATION, IRS WIFS and Landsat images (data from 2003). The first results of the experimental processing and utilization of ESA ENVISAT MERIS data (from 2003) for drought monitoring will be presented and compared with the results obtained from other satellite data sets.
Synergy of MERIS/ASAR for Observing Marine Film Slicks and Small Scale Processes

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Abstract

In the last few years synergy between imaging sensors, such as SeaWiFS and ERS SAR, has revealed that multi-sensor observations are highly beneficial when analyzing and interpreting marine phenomena. But this synergy has also raised pertinent questions. One of these questions is: “Are the current algorithms for the chlorophyll concentration retrieval sufficiently accurate when film slicks are present on the sea surface?” To answer this question it is necessary to assess a considerable amount of data coincident in time and space, and test if the existing algorithms are dealing with the effect of surface film slicks correctly. ESA is at a privilege situation to answer that question because ENVISAT is the first civilian satellite equipped with an Advanced Synthetic Aperture Radar (ASAR) and an ocean colour sensor (MERIS) with partly overlapping footprints.

We present a series of MERIS observations of small scale processes that had not been observed before by ocean colour sensors such as SeaWiFS. These include: short-period internal waves, ship-wakes, slicks, upwelling fronts and filaments. Surface signatures of short-period internal waves were identified on a series of MERIS Full Resolution images off the Iberian Peninsula. It is well known that internal solitary waves are frequently observed in high-resolution Synthetic Aperture Radar (SAR). However, until now satellite sensors with high temporal resolution (wide field-of-view and near-daily global coverage) such as SeaWiFS, were unable to observe small scale ocean processes such as this. Possible mechanisms to explain the observations will be presented based on our knowledge of the SAR signatures of those features.

The effect of surface-active film slicks in MERIS imagery is discussed. The sensor measures optical radiance formed by light reflected from the surface and from underwater layers. The two components give different contributions depending on the surface wave spectra, optical characteristics of sea water, optical wavelength and geometry of observation. Possibilities of characterization of film slicks from variability the sea surface radiation in different spectral bands are analysed.
The European CYCLOPES project (Carbon cYcle and Change in Land Observational Products from an Ensemble of Satellites) aims at estimating and comparing the biophysical variables (LAI, fAPAR, fcover, albedo) that are used for forecast and climate studies. In this project, these biophysical products are derived from various large swath sensors, which are associated to a medium spatial resolution (such as the MERIS sensor onboard ENVISAT). A radiative transfer model is inverted using neural networks techniques. The algorithm must be then trained and tested over a dedicated database, named CYTTARES (CYclopes Training and Testing Algorithm Reference Ensemble of Sites), which is described here.

Such database represents the whole range of variation of the vegetation types at the Earth surface (1-km resolution). The selection of the sites is made by using a global biome classification named ECOCLIMAP (218 biome classes, 1-km resolution). The sites (11*11 km) are selected by considering the world geographical repartition, the intra-site biome homogeneity, the intra-site elevation variation and the already investigated sites (such as AERONET, FLUXNET or VALERI). A complete year is required and will be implemented in order to cover all the growth stages. We will focus on the year 2003 which is unique because of the maximum number of available sensors, such as AATSR/ENVISAT, AVHRR/NOAA, GLI/ADEOS2, MERIS/ENVISAT, MODIS/TERRA/AQUA, SEVIRI/MSG, POLDER/ADEOS2, WIFS/SEAWIFS, VEGETATION/SPOT4/SPOT5. The CYTTARES database will be accessible on the web in order to calibrate other algorithms and to inter-compare different products. The objective is not only to describe the complete CYTTARES sites location, but also to detail the various steps of the methodology which enable to select these representative sites, and to observe the corresponding distribution of the LAI values.
Development of Algorithms for the Exploitation of MERIS Data over Land

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Abstract

This paper presents an overview of a study that aims at developing and validating algorithms and associated processing line prototypes for the exploitation of the Full Resolution MERIS data acquired over terrestrial surfaces. It specially focuses on the aerosol correction scheme and on the generation of vegetation bio–chemical and –physical parameters from the existing MERIS standard products. The concerned vegetation products are the Leaf Area Index (LAI), the chlorophyll content and the fraction of vegetation cover. These products will be generated at Full Resolution. This study responds to the ESA contract no 16545/02/I-LG.

The project is split into three major steps to obtain the vegetation products: 1) the establishment of the theoretical algorithms, 2) the development of the processing lines in the BEAM environment in order to promote the generated MERIS products for land applications, 3) the validation of the products based on different approaches (comparison between MERIS and ground measurements, comparison between MERIS products and products derived from other sensors, evaluation of the spatio–temporal coherence of the MERIS products) Obvously, the vegetation products must be generated from Top Of Canopy reflectances. However, the reflectances provided in the MERIS level 2 land products are Top Of Aerosol, i.e. they are only corrected of the atmospheric molecular and gaseous contributions and not of the aerosol effect. Consequently, a definition and an implementation of an aerosol correction scheme for the removal of aerosol scattering contributions over land has been proposed in the frame of this study before the generation of the vegetation products. The selected algorithm for the correction scheme is based on a simultaneously estimation of the aerosol properties (Aerosol Optical Thickness and Angstrom coefficient) and correction of the atmospheric effects. This algorithm named BAER has been developed previously in the case of SeaWIFS data [1] and is adapted here in the case of MERIS. The main adaptations concern the application of the 8-channel BAER algorithm to the MERIS bands, the modification of the algorithm to start with L2 MERIS products, i.e. with TOA Aerosol reflectances, the study of the BAER assumption and principles (mixing model, soil properties definition, etc.), the strategy for the AOT assessment at Full Resolution, … The algorithm to derive the vegetation products is based on a modelling inversion method using a Neural Network Technique. This technique needs a training database on which the network is calibrated. This database named CYTTARES is established on actual MERIS data in order to integrate a large variety of biome types and temporal vegetation changes. Due to the unavailability of the required large MERIS dataset at the beginning of the project, a first version of the training data set has been simulated with the help of radiative transfer models. Preliminary results will be derived over AERONET sites where aerosol measurements are available.

State in Aerosol Remote Sensing for Atmospheric Correction of MERIS Land Surface Products

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Abstract

A retrieval algorithm has been developed for the determination of aerosol optical thickness over land surface using nadir observations from multi-spectral radiometers like SeaWiFS, and MERIS. The algorithm determines the aerosol reflectance, considering Rayleigh scattering and surface reflectance. The surface spectral reflectance is estimated by a mixing model between spectra of green vegetation and bare soil using the NDVI. This way has a broader applicability to land surface types (most surfaces in Europe) than the restriction to DDV areas, however it doesn’t cover snow and very bright bare soils, like desert regions. The algorithm is able to determine the aerosol optical thickness within 20% for short wave channels of the instruments. Presently MERIS L1 data in reduced resolution can be used. It is planned to extend the application to L2 Rayleigh corrected reflectances and full resolution data too.
A new MERIS spectral calibration method is proposed exploiting the synergy between MERIS and SCIAMACHY ENVISAT instruments. In the O2 calibration mode MERIS is measuring atmospheric radiances in the 750-785 nm spectral range in order to verify the instrument ability to reproduce position and shape of O2 band-A absorption features. The same spectral range is covered by SCIAMACHY. The proposed method is based on the assumption that the two instruments are sensing the same atmosphere and, hence, detected spectral features are approximately the same.

When operated in this mode the MERIS slit functions are characterized by a FWHM of 1.2 nm, while for SCIAMACHY the spectral resolution is 0.3 nm for the same range.

Results indicate that this simple method can efficiently detect MERIS wavelength shift with respect to SCIAMACHY to an accuracy of 0.01 nm. Detailed analysis of results will be presented.