EARSeL



June 2012 No. 90

NEWSLETTER



European Association of Remote Sensing Laboratories

The Newsletter is a forum for the exchange of news and views amongst the members of the Association. The opinions expressed in the Newsletter do not necessarily reflect the views of the editors, the EARSeL Bureau or the other members of the Association.

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Front Cover: Windmills in Mykonos. Courtesy: Nicola Masini.



EARSeL Newsletter

ISSN 0257-0521 Bulletin of the European Association of Remote Sensing Laboratories, http://www.earsel.org September 2011 – Number 87

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Published by:

Institute of Methodologies for Environmental Analysis (IMAA) Italian National Research Council (CNR)

Printed by:

Form Innovation Shahed Hirtenweg 8 30163 Hannover, Germany



Members receive the Newsletter as part of the annual membership fee. For non-members, the annual rates (four issues) are as follows:

Within Europe	80€
Outside Europe	88€
Personal subscription from members	30€

EARSeL annual membership fee

Individual observer	330€
Laboratory/Company with fewer	
than 10 researchers	330€
Laboratory/Company with 10	
or more members	500€

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Editorial

Dear members,

The 32nd EARSeL Symposium "Advances in Geosciences" was held in Mykonos, with enormous success including high participation and numerous presentations made by young scientists. The symposium was accompanied by two workshops: 1st Workshop on *Temporal Analysis of Satellite Images* and the 4th Workshop on *Geological Applications*. In addition, a special session dedicated to the Proba-V mission was jointly organized by the Symposium and the Workshop on Temporal Analysis.

We would like to thank everyone for their contributions, presentations and participation. For those who didn't manage to attend the Symposium, you'll have the opportunity to see what went on by reading the report from the Symposium organisers. Moreover, a number of presentations are already available for download from the programme page of the symposium web-site (http://www.earsel.org/symposia/2012-symposium-Mykonos/). We also recommend that you to do not miss the Symposium Proceedings, which will be distributed on CD to all members and will also be available on our homepage (http://www.earsel.org/?target=publications/proceedings/symposia).

In the EARSeL Council meeting a new EARSeL Bureau was elected, with Dr. Ioannis Manakos as the Chairman; see the article starting on page 10.

Finally, we welcome Konstantinos Perakis, Professor of Remote Sensing and Statistical Applications, and his co-worker Athanasios Moysiadis, University of Thessaly, as new members of the EARSeL Newsletter Editorial Board.

Forthcoming EARSeL workshops:

- EARSeL's Prague Workshop on 4D Radar Applications for Young Researchers, 26 28 June 2012, Czech Technical University in Prague, Czech Republic
- 3rd Workshop on Remote Sensing for Archaeology and Cultural Heritage Management, 19 -22 September, 2012, Ghent, Belgium.

Best Wishes for a relaxing and pleasant summer.

Sincerely, The Editorial Team



News from EARSeL

The Symposium 2012

The 32nd European Association of Remote Sensing Laboratories (EARSeL) Symposium was held in Mykonos Island in Greece, on 21 - 25 May 2012, at the "Myconian Imperial Hotel". This year's Symposium was jointly organised by EARSeL and the Department of Planning and Regional Development of the University of Thessaly, under the auspices of the Hellenic Ministry of the Environment, Energy and Climate Change and the Municipality of Mykonos.

The 32^{nd} EARSeL Symposium entitled "Advances in Geosciences" was accompanied by the "1st Workshop on Temporal Analysis of Satellite Images" and the "4th Workshop on Geological Applications", on 23 – 25 May. Both the Symposium and the Workshops were aimed at keeping participants up to date with the latest advances in Geosciences applicable to various disciplines. Moreover, the main goal is to present outstanding research within a unique forum that encourages strong collaborations between experts from around the world. There were 240 participants coming from four continents of the world with more than 20 scientific sessions within both the Symposium and Workshops.

The Symposium venue, the "Myconian Imperial Hotel", provided high standard facilities and amenities for both the symposium's requirements and the participants' accommodation; there were three rooms for the sessions as well as a room for the EARSeL meetings. The social events included an Icebreaker on Monday evening and a Symposium dinner on Wednesday evening, which took place at the same premises. An excursion at the sacred Delos Island was organised for the Friday.



The premises of the 32nd EARSeL Symposium



The opening and the closing sessions of the 32nd EARSeL Symposium

The agenda of the Symposium included 18 scientific sessions and an interactive poster session. There were both oral and poster presentations for the following sessions: Hydrology, Thermal Remote Sensing, Ocean and Climate Change, Disaster Monitoring and Response, Coastal Zones, Land Use/Land Cover, Forest Fires, Cultural and Natural Heritage, Developing Countries, Change Detection, Imaging Spectroscopy, Instruments and Methods, Radar Remote Sensing, 3D Remote Sensing, Education and Training, Land Ice and Snow, Urban Remote Sensing and Forestry and Natural Environment. A special session dedicated to Proba-V mission was jointly organised by the Symposium and the Workshop on Temporal Analysis.

As keynote presentations, the past and future activities as well as the contribution of international organisations to Remote Sensing and related Geosciences were presented:

- Professor Orhan Altan, President of the International Society for Photogrammetry and Remote Sensing (ISPRS), gave a presentation about the history and contribution of ISPRS through the years. Professor Chen Jun, the Secretary General of ISPRS gave a presentation titled "Global land cover mapping at fine resolution".
- Dr. Maurice Borgeaud, Head of the EO Science, Applications and Future Technologies Department at the European Space Agency (ESA) outlined the ESA Earth observation programme, its achievements and perspectives whereas
- Dr. György Büttner (European Environmental Agency) talked about the GMES Initial Operations Land Services 2011-2013: status and perspectives for Europe.
- Professor Giorgos Mountrakis from the College of Environmental Science and Forestry, State University of New York, Syracuse, USA gave an interesting presentation entitled "Developing Confidence Metrics for Remote Sensing Applications".
- Professor Changling Wang from the Center for Earth Observation and Digital Earth and the International Society for Digital Earth (ISDE) discussed The Digital Earth initiative and the cooperation with EARSeL.



Orhan Altan and Maurice Borgeaud, two of the invited speakers.

A step further towards the foundation of "The International Remote Sensing Academy" (IRSA), an idea initiated by Dr Rainer Reuter, was made at a special meeting with the participation of ISPRS and ESA on Monday. News on this joint institution will be published in the September issue of the EARSeL Newsletter.

There was strong interest and participation within the 1st Workshop on Temporal Analysis of Satellite Images, chaired by Professor Yifang Ban, with 85 participants and sessions that ran from Wednesday afternoon until Friday. There were thematic sessions related to temporal analysis using Remote Sens-



ing techniques (Agriculture, Climate, Urban, Change Detection with Optical Data, Change Detection with SAR Data, Forest, Vegetation Stress & Drought, Vegetation Dynamics, Hazards and Risks, Coastal Zones and Aquatic Environment). Keynote speakers included:

- Professor Lorenzo Bruzzone, Head of the Remote Sensing Laboratory, University of Trento, Italy;
- Dr. Yves-Louis Desnos, Head of the Research and Development Section & Senior Advisor Science, Applications and Future Technologies Department, ESA-ESRIN;
- Dr. Thuy Le Toan, Centre d'Etudes Spatiales de la Biosphere (CESBIO), CNRS-CNES- Université Paul Sabatier;
- Professor Paolo Gamba, Head of the Remote Sensing Group, University of Pavia, Italy and Editor-in-Chief of the IEEE Geoscience & Remote Sensing Letter

The 4th Workshop on Geological Applications, chaired by Professor Konstantinos Nikolakopoulos on Thursday and Friday, attracted participants not only from a number of thematic sessions related to Remote Sensing in Geology, but also by the two tutorials related to commercial remote sensing software and radar Interferometry (see the article starting on page 10).

In all, we hope that the 32nd EARSeL Symposium was a very fruitful and successful EARSeL event, with the strong support and help of the EARSeL's Bureau, the EARSeL's secretariat and members of the Organising committee from the University of Thessaly.

For future reference, the detailed programme of the 32nd EARSeL Symposium will remain available at http://www.conferences.earsel.org/program/show/32 and the abstract book will be available on the 32nd EARSeL Symposium website: http://www.earsel.org/symposia/2012-symposium-Mykonos.

Hope to see you in forthcoming EARSeL events, more specifically at the 33rd EARSeL Symposium in Matera, Italy and keep support EARSeL's ideas and vision in the years to come.

Konstantinos Perakis Professor of Remote Sensing and Statistical Applications University of Thessaly Local Organiser of the 32nd EARSeL Symposium perakis@uth.gr Athanasios Moysiadis

Member of the Organising Committee of the 32nd EARSeL Symposium Surveying Engineer, M.Sc, PhD. Cand. University of Thessaly moysiadis@uth.gr



Best poster award at Symposium 2012

At the Annual Symposium, the Bureau members Lena Halounova and Rainer Reuter visited the interactive poster session with the aim was of encouraging young scientists.

The prize was awarded to Dr. Andrzej Z. Kotarba from the Earth Observation Group at Centrum Badan Kosmicznych PAN in Warsaw, Poland, for his poster entitled Increase in Spatial Resolution by Superimposing a Time-Series of IFOVs (MODIS Case on Cloud Cover) which is an excellent contribution in the field of Satellite Image Processing.

Congratulations!

Increase in Spatial Resolution by Superimposing a Time-Series of IFOVs (MODIS Case on Cloud Cover)

Andrzej Z. Kotarba, Earth Observation Group at Centrum Badan Kosmicznych PAN, Warsaw, Poland *Abstract*

Spatial resolution of a satellite image is defined by the angular size of an instantaneous field of view (IFOV). Spectral response is being averaged over IFOV during single satellite pass, thus objects of subpixel scale cannot be resolved. It is extremely unlikely, that scheme of IFOVs' projection on ground will be exactly repeated during a second and following passes: ground-projected IFOVs will be shifted and only partially overlaid. This means that each time the radiometric "input" into IFOV's value will be different.

In this research the value of common part of superimposed IFOVs was exploited in order to increase the imagery spatial resolution. To demonstrate the technique MODIS Level 2 data set on cloud cover was used. The Terra and Aqua cloud masks of native 1 km/pixel resolution at nadir, were analysed. Data covered one month of observation, meaning each location on the Earth was covered with at least 124 IFOVs, none of each repeated the footprint exactly. The final resolution of mean monthly cloud cover data was one hundred time higher (100 m/pixel), than input data.

The proposed method was found to be useful for cloud cover studies over complex topography, but can be also applied to any other timely-averaged satellite data (satellite climatology) or to pseudo-stable or stable land cover (especial on a planetary bodies with solid surface but no atmosphere).





1st Workshop on Temporal Analysis of Satellite Images

The 1st Workshop on Temporal Analysis of Satellite Images of the EARSeL's Special Interest Group "Temporal Analysis of Satellite Images" took place on 23-25 May 2012 in Mykonos Island in conjunction with the 32nd EARSeL Symposium.

There were thematic sessions related to temporal analysis using Remote Sensing techniques (Agriculture, Climate, Urban, Change Detection with Optical Data, Change Detection with SAR Data, Forest, Vegetation Stress & Drought, Vegetation Dynamics, Hazards and Risks, Coastal Zones and Aquatic Environment) with the contribution of 85 presentations. The presence of Professor Lorenzo Bruzzone, Dr. Yves-Louis Desnos, Dr. Thuy Le Toan, Professor Paolo Gamba, keynote speakers of the 1st Workshop on Temporal Analysis of Satellite Images, strongly supported the event.

Website: http://www.earsel.org/SIG/timeseries/workshops.php

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4th Workshop on Remote Sensing and Geology

The 4th Workshop of the EARSeL Special Interest Group on Geological Applications, entitled *Remote Sensing and Geology*, took place on 24-25 May 2012 in Mykonos Island in conjunction with the 32nd EARSeL Symposium.

Scientists from eleven countries presented 30 papers. 22 oral presentations and eight poster presentations divided into 7 different topics including: Hydrology-Hydrogeology, Remote Sensing and GIS applications in Geology, Geohazards, Geological Mapping, Tectonic Geology, Hyperspectral Remote Sensing and Mine Monitoring.

Tutorials were organized on *3D Geological Mapping* and *Interferometry*.

Internet: http://www.earsel.org/SIG/Geology/

Konstantinos Nikolakopoulos University of Patras, Greece knikolakop@upatras.gr



Bureau elections

At the end of May 2012, in Mykonos, the EARSeL Council elected the new EARSeL Bureau for the forthcoming two years. Dr Samantha Lavender, the National Representative of the UK, is the new Treasurer. Dr Rosa Lasaponara, former Treasurer and Newsletter Editor, is elected at the position of

the Secretary General. Dr Lena Halounova, National Representative of the Czech Republic, is reelected Vice-Chairman. Dr Ioannis Manakos, former Secretary General and Co-Chairman of the SIG Land Use & Land Cover, is the newly elected Chairman.

The present Bureau is committed to a) act following the Statutes and the tradition that is being built all these years through the activities and vision of its members, b) cooperate with a spirit of goodwill and trust towards all EARSeL members for the common benefit, c) present and represent EARSeL with responsibility and effectiveness to non-EARSeL Organizations and at every occasion outside the 'EARSeL family', d) promote EARSeL's networking and dissemination activities, such as the SIG Workshops, the e-Proceedings, the Book series, and other training events, and e) cooperate with the Council members for developing strategies that will keep EARSeL attractive and up-to-date for its members and the new ones to join in.

Following this, the main focal points are initially identified as:

- i. Existing cooperation and contacts shall be strengthened, while others initiated, preferably with European Organizations, like ESA, JRC or UNESCO, and other non European ones, situated in Africa, Asia, America or Australia. Focus should be given to Organizations serving big Consortia of States around the European borders: Environmental issues and science do not recognize human delineated administrative borders.
- ii. The cooperation of EARSeL members shall be promoted further than the science per se, and the role of the Association shall be enhanced as a catalyst towards forming of consortia for common project development attracting European and National funds for coordinated and integrated remote sensing applications throughout Europe.
- iii. The promotion and development of new strategies for networking and disseminating members' knowledge to the wider public, promoting research results and practices to serve public and local authorities in everyday life.



The new EARSeL Bureau. From left to right: Samantha Lavender, Rosa Lasaponara, Lena Halounova, Ioannis Manakos



Being elected from the members, willing to act for the members, reflecting members' will, the Bureau strongly welcomes any ideas, comments, and suggestions that may assist the Association to serve its objectives and role (as defined in the Statutes):

- to encourage European research and to promote concerted efforts in all disciplines of remote sensing,
- > to facilitate exchange of knowledge between Member Laboratories,
- > to identify priorities for research activities, and
- > to foster cooperation between Member Laboratories.

Please feel free to communicate any of your contributions/ interventions at secretariat@earsel.org . Please note that the Association abstains from all political activity.

Honoured to be of service, Staying at your disposal, On behalf of the Bureau, Ioannis Manakos EARSeL Chairman ioannis.manakos@earsel.org

Amended statutes approved

The amendments to the EARSeL statutes, approved by General Assembly in its meeting in Prague on 01 June 2011, have been accepted by the Tribunal d'Instance in Strasbourg, France, on 20 April 2012. They are available for download on the EARSeL homepage (http://www.earsel.org) in English and French.

New members since 06/2011

Greek Biotope Wetland Centre The Goulandris Natural History Museum Inventory of Natural Resources 14th kilometre Thessaloniki-Mihaniona 57001 Thermi, Thessaloniki, Greece EARSeL representative: Dr. Eleni Fitoka

Facultad de Informática Universidad Politécnica de Madrid Campus de Montegancedo S/N 28660 Boadilla del Monte, Madrid Spain EARSeL representatives: Dr. Julio Gutiérrez-Rios,

Dr. Angel Esteban-Orobio

Informatics & Telematics Institute Centre for Research & Technology – Hellas 6th km Xarilaou – Thermi P.O.Box 60361 57001 Thessaloniki, Greece EARSeL representative: Dr. Ioannis Manakos

Laboratorio di Oceanologia Sperimentale ed Ecologia Marina Università degli Studi della Tuscia (UNITUS) Molo Vespucci – Porto di Civitavecchia 00053 Civitavecchia (RM), Italy EARSeL representative: Prof. Dr. Marco Marcelli

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Cancellations since 06/2011

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Statistical Geomatics and GIS Dpt. Statistical Office of the Republic of Slovenia Vozarski pot 12 1000 Ljubljana Slovenia EARSeL Representative: Dr. Igor Kuzma

GAF AG Arnulfstr. 197 80634 Munich, Germany **EARSeL** Representatives: Dr. Rupert Haydn, Dr. J. Zeeb



News from other organisations

Eurisy Conference on Renewable Energy



In a one-day conference to be held in Graz, Austria, on 11 September 2012, Eurisy in cooperation with the Austrian Research Promotion Agency and the Internationalisierungscenter Steiermark will address the topic *Renewable Energy: the added value of satellite solutions for SMEs*. Participants will learn about operational satellite applications for use in the renewable energy sector, through good practice examples from SMEs who are already using them.

Read more on the Internet.

Annual meetings of international partner societies

The International Society of Photogrammetry and Remote Sensing (ISPRS) will organise its XXII Congress 2012 in Melbourne, Australia, on 25 August to 1 September.

The African Association of Remote Sensing of the Environment (AARSE) will hold its 9th Conference on 29 October - 2 November 2012 in Eljadida, Morocco.

The Latin American Sociedad de Especialistas Latinoamericanos en Percepcion Remota (SELPER) will organise the Symposium 2012 on 19-23 November in Cayenne, French Guiana.

AARS, the Asian Association on Remote Sensing, will meet for the 33rd ACRS Conference on 26-30 November in Pattaya, Thailand.

4th National Remote Sensing and GIS Symposium (4. UZAL-CBS) in Turkey

The initiator of this biannual symposium series (UZAL-CBS), Prof. Dr. Derya Maktav from the Geomatics Engineering Department of the Istanbul Technical University (ITU), is also the National Representative of Turkey on EARSeL Council. The main goal of the symposium series is an information exchange between Turkish scientists, decision makers and students from various disciplines including remote sensing, GIS and the integration of these very popular and useful technologies. They inform participants about applications, projects, books, papers, etc. of different scientific groups, NGOs and governmental institutions. Another goal is to encourage the participants to collaborate on remote sensing and GIS.

The 1st National Remote Sensing and GIS Symposium was held in Istanbul on 27-29 November, 2006. The symposium was hosted by the Geomatics Engineering Department of the ITU. After this very successful meeting, the next symposium was organized at the Geodesy and Photogrammetry Department, Kayseri Erciyes University on 13-15 October, 2008 (co-chair Prof. Dr. Erkan Beşdok). The Third National Remote Sensing and GIS Symposium was jointly organized by the ITU, Gebze Institute of Technology (GYTE) and Chamber of Surveying Engineers (TMMOB-HKMO) (co-chair Prof. Dr. Taşkın Kavzoğlu) on 11-13 October, 2010 in Kocaeli where 90 oral and 20 poster papers were presented. There were 250 registered participants and the papers were peer reviewed by the scientific committee with poster and oral awards being made. Dr. Rainer Reuter, former EARSeL chairman, also participated in the meeting as an invited speaker.

On 16-19 October 2012, the 4th Symposium will be hosted by the Department of the Geodesy and Photogrammetry Engineering of the Bülent Ecevit University in Zonguldak, Turkey (co-chair Ass. Prof. Hüseyin Topan). Dr. Ioannis Manakos (EARSeL chairman), Dr. Rosa Lasaponara (EARSeL General Secretary) and Prof. Mag. Dr. Wolfgang Sulzer (Karl Franzens University, Austria) will be keynote speakers of the meeting.

Derya Maktav

Read more on the Internet: http://jeodezi.karaelmas.edu.tr/fukal/uzalcbs2012/ (in Turkish language).



EuroSDR/ ISPRS: Test on pattern recognition in remote sensing

The European Spatial Data Research Network (EuroSDR; http://www.eurosdr.net/start/) and the International Society for Photogrammetry and Remote Sensing (ISPRS; http://www.isprs.org/) will perform an empirical 'Test on Pattern Recognition in Remote Sensing', in the following called EuroSDR-ISPRS-Test. The goal of the test is to assess the potential of recent classification and interpretation techniques in the context of remote sensing image analysis. The data will be open for every-one who wants to participate in the test.

This letter is to invite interested colleagues to provide data sets for this test. A data set consists of remote sensing image and corresponding reference information, i. e. information about the land cover of the individual pixels. In addition, a brief description of the land cover classes and image data set should be provided. A more detailed description of the required formats is made available upon request. The data sets are meant to be collected on the EuroSDR server and made freely accessible to the research community.

On condition that an adequate number of data sets can be provided to perform a sound test, participants will be asked to make the data available approximately in July 2012.

Read more on the internet: http://www.ipb.uni-bonn.de/isprs/icwg_III_VII/EuroSDR_ISPRS_test.html

Feedback from the EARSeL Linked Projects

Geoland2 Scientific Soundness Review

EARSeL is an active partner of the geoland2 consortium. It is responsible for the interaction amongst the consortium members and independent Remote Sensing science specialists throughout Europe. Part of its activities comprises the compilation of Third Party Scientific Soundness Reviews (SSR) on Products and Processing Chains developed within the consortium. As such, the following SSRs have been performed by distinguished Members of the Association:

- "Change detection for Urban atlas" review by the Geomatics/Remote Sensing Group, Geography Department, Ruhr-University Bochum.
- "Change Detection & Validation of High Resolution (HR) layers" review by the Institute for Photogrammetry and Geoinformation (IPI), Leibniz University Hannover.
- "HR layer grassland and relevant change detection procedure" review by the Remote Sensing Research Group, Department of Geography, Bonn University.
- "HR layer Forest product 'forest crown cover density'" review by the Remote Sensing Laboratory, Institute for Forest Resources Management, Swedish University of Agricultural Sciences.
- "HR layer wetland and relevant change detection procedure" review by the joint team of the Department of Geoinformation in Environmental Management, Mediterranean Agronomic Institute of Chania, International Centre for Advanced Mediterranean Agronomic Studies, and the Greek Biotope Wetland Centre, The Goulandris Natural History Museum, Inventory of Natural Resources.

The review procedure was iterative and took place during the last months between the aforementioned assigned teams and the respective Developers' teams inside the consortium. At the moment that the review procedure had reached an adequately mature level, visits to the production sites and discussions between the reviewers and the developers / implementers guaranteed best and deep understanding of the established production chains for both sides (reviewers and reviewed teams). The reviews are conducted based on the experience and expertise of the reviewers, and the international literature (addressed and cited within the review sheet), in a qualitative (descriptive texts) and quantitative way (quality grading levels). They focused on the following points:



- Provision of a solution on real user needs
- > Evaluation of the level of user uptake and relevance for policy making
- > Analysis of the state of the art of the developed methodology/approach against existing ones
- Identification of alternatives and possible problems and potential bottlenecks
- The comprehensive description of the applied methodologies, their correlation with other Core Mapping Service products, and their exposure towards the scientific society (in the form of peer reviewed publication(s))
- The interoperability and interconnections of data processing and delivery systems, keeping in mind the level of standardization achieved
- > The interfaces for operational service provision
- > The flexibility of the methodology/ approach to adopt to future developments
- The correlation and preservation of the know-how and momentum of previous GMES activities
- Recommendations

The reviews have been delivered and finalized. They identified only minor issues, which were discussed with and tackled by the Developers. A final meeting will take place on the 12 - 13 June 2012 in Thessaloniki, at the premises of the Centre for Research and Technology Hellas, where all reviewers and developers will convene to discuss all issues and recommendations. Following their submission, the results will be available for public use on the Web server of the project soon.



100% Crown Cover Density 10% Crown Cover Density

Example of the geoland2 Forest Crown Cover Density product: East of Munich, from the demo site EU-05 Alpine Transect, produced from IRS-LISS III of 7th September 2006. Left: Antrix Corporation Limited 2006. Distribution by Euromap GmbH, Germany, all rights reserved. Provided under EC/ESA GSC-DA. Right: geoland2 project / GAF AG

Acknowledgement: My thanks to Steffen Kuntz, Astrium - Infoterra GmbH, Markus Probeck, GAF AG, and Rainer Reuter, former EARSeL Chairman, for reviewing the text.

Ioannis Manakos, EARSeL Chairman Co-Chairman of the EARSeL SIG Land Use& Land Cover imanakos@iti.gr



4th Workshop on Remote Sensing and Geology Proceedings preprint

EnGeoMAP - a geological mapping tool applied to the EnMAP mission

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Abstract. Hyperspectral imaging spectroscopy offers a broad range of spatial applications that are primarily based on the foregoing identification of surface cover materials. In this context the future hyperspectral sensor EnMAP will provide a new standard of highly qualitative imaging spectroscopy data from space that allows a spatiotemporal monitoring of surface materials. The high SNR of EnMAP offers the possibility to differentiate and to identify minerals that are showing characteristic absorption features as a 30m x 30m spatial mixture in the visible, the near infrared and the short wave infrared range (0.4 -2.5 μ m). For this purpose spectral mixture analysis (SMA) approaches are traditionally used. However, these approaches lack in transferability, repeatability and inclusion of sensor characteristics. Additionally, they rely on image based and randomly detected endmembers as well as on in-situ or laboratory spectra that are not spatially stable in case of an image based extraction and assumed to be spectrally pure. In this work, a new framework is proposed that addresses these limitations considering the EnMAP sensor characteristics. It is named as EnMAP Geological Mapper – EnGeoMAP. It consists of several new and adapted approaches to identify spectrally homogeneous regions. In parallel, minerals are identified and semi-quantified by a sensor related and knowledge based fitting approach. Supplementary outputs are abundance, classification, homogeneity and uncertainty maps. First results show that the proposed approach offers 100% repeatability and gains an identification error for minerals of about 2 % on average for different studies.

1. Introduction

Remote sensing of soils and geology often relies on approaches that directly identify minerals within hyperspectral images. To achieve this, unknown image spectra are statistically compared with known library or in-situ spectra. Field samples are often additionally analysed by X-Ray diffractometry (XRD) and by fluorescence spectroscopy (XRF) for identification and quantification. Based on geochemical and spectroscopic analyses the absorptions of different minerals are identified or modelled and defined as diagnostic spectral features. These features are to some extent unique for each mineral. Additionally, analysed minerals are assumed to be pure or spectral impacts of insignificant fractions of elements on mineral compounds are neglected. However, minerals often form partial solid solutions, e.g. pyroxenes. Rocks that are built by rock forming minerals might be unique in texture and spatial distribution according to their geological and petrological evolution. Hence, in-situ, airborne and spaceborne acquired spectra show rather unique region related mineral mixtures than pure minerals. This makes it more difficult to identify observed minerals and their fraction within one pixel. Since mineral identifications are frequently conducted in mountainous regions shadows aggravate any kind of identification due to the decrease of reflected incident radiation. Contemporary, hyperspectral sensors may considerable differ in their sensing principle, spectral and spatial resolution. This leads to sensor specific scaling phenomena between the sensors and in-situ or laboratory spectroscopy.

In the frame of the EnMAP project (1) an approach was developed – named as EnMAP Geological Mapper (EnGeoMAP) – that aims on the reduction of the previously described signal impacts. The core algorithm of the EnGeoMAP is similar to the broadly accepted Tetracorder (2). However, it dynamically and iteratively utilises properties of the inspected acquisition and its sensor. Characteristics such as sensing geometry, spatial and spectral resolution and terrain are considered. It consists of a multistep algorithm and enables soil and geological applications such as mineral mapping, alteration zone detection, mine waste characterisation and much more. Additionally, quality flags for each inspected pixel are given. These can be incorporated in further analyses, e.g. classifications, or in suc-



ceeding iterations. The approach was tested in the Makhtesh Ramon of the Negev Desert in Israel. Here geology has been studied for decades. One artificial EnMAP scene was synthesised on the basis of one real hyperspectral airborne scene to objectively evaluate the EnGeoMAP identification results of a spaceborne hyperspectral acquisition.

2. Material and Methods

The Makhtesh Ramon of the Negev desert in Israel (Figure 1) was selected as case study region. The Makhtesh consists of different mineral compounds that are known and useful for testing geologically related remote sensing algorithms (3). In preparation to the EnMAP mission an atmospherically corrected hyperspectral AISA DUAL (4) scene was used as basis to simulate an EnMAP scene with the EnMAP-End-to-End-Simulator – EETES (5). This scene was acquired on the 15.03.2004 at 30.4° North / 34.5° East incorporating a sun azimuth of 210° and a sun elevation of 54°.



Figure 1: Case study region Makhtesh Ramon here figured as hill shaded 3D false colour composite that is grey overlayed by the extent of the hyperspectral AISA DUAL acquisition (RGB = Landsat TM (GSD 30 m) mineral ratios 5/7 (clays), 5/4 (ferrous iron) and 3/1 (iron oxides); 3D = ASTER DEM (is a product of METI and NASA, GSD 15 m))

During the EETES simulation many sensor parameters from the manufacturer were considered, such as the orbit parameters, Point Spread Function (PSF) for each detector, spectral and radiometric responses. In consequence, the simulated EnMAP scene consisted of 244 bands ranging from 400 – 2500 nm and incorporating a ground sampling distance (GSD) of 30 m. In this work we focused on the spectral range from 2 to 2.5 microns of the Short Wave Infrared (SWIR) that includes most significant diagnostic spectral features of minerals.

In addition, missing illumination caused by shadow casting objects such as mountains can be nearly linearly continuum normalised (compare Figure 2 that shows an average deviation from linearity of about 0.8 %) only in the SWIR range.

Due to inadequate research on the impact of shadow and its removal approaches on mineral identification techniques, the scene was not corrected for shadows. However, the analysis of shadowed regions implies a reduction of the identification accuracy since the Signal-to-Noise-Ratio (SNR) is significantly lower than in directly illuminated regions. Although this effect is broadly accepted, most geological mappers (6) do not fully consider the relationship between SNR and identification accuracy. Most of them directly compare known library spectra with unknown spectra directly assessed from the image as endmembers (7). In this work, we rely on the USGS spectral library (8) and the feature descriptions of the Tetracorder (2). However, this algorithm can be considered as a



knowledge-based expert system to directly identify spectra of hyperspectral acquisitions. The Tetracorder has proven its applicability in the past, but provides only limited capabilities to analyse mineral compounds by modelling abundances of exclusive features (2). However, this algorithm and other widely used (6) only consider the spectral characteristics of the sensor but not the spatial impact of the GSD and the PSF on the distribution and the abundances of spectra.



Figure 2: Deviation of the ratio between diffusive and total radiation from linearity

In this work we propose a sensor related approach that fully incorporates sensor characteristics such as the Spectral Response Function (SRF) and the PSF. With increasing sensor GSD the likelihood for having spectrally pure material in one pixel decreases. To avoid confusion, the material compound of each pixel is here considered as a mixture and spectrally homogeneous regions are considered as flat fields composed of basic mixtures. This definition is independent on the sensor and the acquisition geometry. Furthermore, it was assumed that in spectrally homogeneous regions (flat fields) pixels are linear mixtures also incorporating adjacent pixels within the effective range of the PSF for this detector and wavelength. The relevant range used for this work was 99 % of the PSF's volume. Additionally, it was assumed that the PSF of different detectors are similar shaped and per scene constant. In this case each pixel of a flat field is an isotropic mixture of itself and its neighbourhood. Nonlinear effects in flat fields only exist if BRDF effects occur and, hence, the spatial extent of inspected neighbourhood should be rather narrow.

The EnGeoMAP consists of three modules – the FeatureLUT, the Basic Mixture identification and the Mixture analysis that are sketched in Figure 3 and described in more detail in the following.



Figure 3: Workflow and relation of the modules of EnGeoMAP

Module 1 – FeatureLUT

The Look-Up-Table (LUT) of the EnGeoMAP named as FeatureLUT consists of more than 100 mineral spectra and their feature and fitting descriptions. It is similar to the Tetracorder (2) but extended with additional entries for chemical formulas, mineralisation type, alteration type etc. To use the library and the feature descriptions with different sensors, all criteria and spectra were resampled to 1 nm resolution. In cases that spectra and criteria had a lower spectral resolution than 1 nm, Hermite Splines were used for interpolation. After resampling to 1 nm, a re-usable FeatureLUT was created that is still sensor independent. This sensor independent FeatureLUT is then resampled to the sensor. The spectral resampling is performed by spectral deconvolution (9). Knowledge based fitting thresholds are also adapted in the process of resampling. This is necessary because predefined thresholds (as in Tetracorder) depend on incorporated sensors leading to misidentifications of spectra acquired by sensors with a higher spectral and spatial resolution and a better SNR. After resampling the Fea-



tureLUT is sensor dependent, re-usable for this sensor unless its characteristics have changed and serves as a basis for next processing steps of the EnGeoMAP.

Module 2 – Basic Mixture identification

This module consists of 3 steps – the flatfield detection, the mineral identification (core of the EnGeoMAP) and a Bounded Value Least Squares (BVLS) unmixing.

The flatfield detection is based on the assumption that in spectrally homogeneous regions mixtures are related to the PSF. In this process a moving window of an adapted size that relates to the 99 % volume threshold of the mean sensor PSF is used to locally compute the uncentred Pearson correlation coefficient between the spectrum of the centre pixel of the window and the spectra of all the neighbours within this window. To suppress albedo effects, the continuum of each spectrum is removed by normalising with its Delaunay approximated convex hull. In the process of continuum removal concave curve shapes are preserved that correspond to absorptions. If all fits pass a predefined fitting threshold (by default 0.99), the pixel is binary marked as flat field pixel. This is performed for all pixels in the scene and results are stored in a binary map where all flat field pixels are marked.

After detecting flat field locations the mineral identification is carried out. For this, each spectrum of the flat field is fitted towards all library spectra of the FeatureLUT within their specific diagnostic features. All fits that pass the sensor adapted thresholds, similar to Tetracorder, are stored in a local pixel related list. After this, a BVLS unmixing is performed for this pixel that excludes all identified spectra that do not pass an unmixing threshold (by default 5 %, but SNR dependent) to remove outliers that were too noisy and not significantly abundant. All remaining, identified spectra are stored in a global list and all identification results for this pixel are rejected. Then, the next pixel of the flat field is considered and the global list is updated. This is performed until all pixels of the flat field were inspected. Consequently, a global list of matching spectra was created that is directly used in the next step.

Module 3 – Mixture analysis

In this step all pixels are linearly unmixed on the basis of the global list by the BVLS. Again, outliers are removed by applying an abundance related threshold (also 5 % minimum abundance by default, but SNR dependent). After this, the image is synthesised by using previously estimated abundances of identified mineral spectra.

This allows the generation of a model image that is directly comparable with the continuum removed real image. Consequently, each pixel gets an individual model error that helps to distinguish regions where spectra were accurately identified from problematic regions such as shadow regions. Additionally, a next iteration can be applied starting with module 2 to exclude these areas in advance.

As result, each individual pixel provides wavelength dependent information of mineral abundances, error budget and flat field potential. This is then directly applicable in a next step such as spatial pattern analyses for hydrothermal alteration mapping.

3. Results

The potential of the EnGeoMAP is here exemplarily demonstrated for the analysis of one hyperspectral, synthesised EnMAP scene. The evaluation of the results is based on the assumption that only a correct identification of diagnostic features and a correct estimation of abundances of minerals provide low deviations between modelled and real image spectra. The bands that encompass dominating minerals absorption features should be spatially and spectrally equivalent. This condition was mostly fulfilled for given examples (Figure 4).

For the 2.2 μ m band shown in fig. 4 a deviation between the model and the real image of about 0.5 % was achieved that is close to the overall accuracy of 0.8 % on average for all bands. However, the accuracy of EnGeoMAP is decreased up to 20 times for the whole spectral range in low SNR regions. Comparing the



mean ratio of the diffusive to total radiation within the spectral range between 2 and 2.5 μ m (about 10 %) with the accuracy decreasing rate (about 20 times) for low SNR regions as in shadows clearly shows a strong relationship between the accuracy and the SNR. This is also shown in fig. 5 for 3 plots representing 3 different extreme SNR scenarios (Plot 1 – average SNR, Plot 2 – low SNR, Plot 3 – high SNR).



Figure 4: Inversed colour composite for the 2.2 um band (Clay) of the real image (top) and the model image (bottom)





Considering only the results for these extreme regions reveals the range of potential uncertainties in assessing mineral contents, although the assessment is superimposed by the evaluation of non-relevant spectral regions. It was exemplarily shown in Figure 6 that depicts the maximum error along the spectral dimension for each analysed pixel and its likelihood for a low albedo.



Figure 6: Upper two quartiles of shadow and dark material abundances (top) and error budget for this scene (bottom, maximum 16% and minimum 0%) having a common spatial correlation of 88% on average.

In any case analyses in low SNR regions as in shadows should be spatially and error budget related marked to avoid relying on average error budgets for the whole scene. A positive side effect is the



potential of having weights for succeeding analyses such as classifications as given in Figure 7 that illustrates abundance dominating minerals.



Figure 7: False coloured RGB abundance composite of dominating minerals (Red – Carbonates, Blue – Epidote, Green – Clay minerals)

Overall, EnGeoMAP achieves an identification accuracy of about 99 % on average and of about 98 % on average for the maximum error budgets along the spectral dimension.

Uncertainties in the BVLS unmixing and in the identification of minerals in low SNR regions still remain so that pixel based error budgets can be used to exclude erroneous analyses from further processing such as classification.

4. Conclusions

EnGeoMAP achieved for this region a very high identification accuracy. It is completely unsupervised, 100 % repeatable since no random statistics are used, platform independent and will be freely available as soon as it will be implemented in the free EnMAP software named as EnMAP box. Additionally, spectral and spatially homogeneity maps are provided that might be useful for other processing such as segmentation. Currently, more hyperspectral scenes are acquired in Southern Africa, Mongolia and Spain that will be used to verify and further improve the proposed EnGeoMAP approach.

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EARSeL eProceedings

New Publications in Vol. 11(1), 2012



Chlorophyll determination in Silver Birch and Scots Pine foliage from heavy metal polluted regions using spectral reflectance data

Lucie Kupková, Markéta Potůčková, Kateřina Zachová, Zuzana Lhotáková, Veronika Kopačková, and Jana Albrechtová

Abstract

Read full paper online: http://www.eproceedings.org

The foliage chlorophyll content can be used as one of the indicators of tree stress caused by adverses oil conditions with heavy metal contamination being the major stress factor. Linear regression models showing the relation between spectral indexes derived from spectroscopic measurements of Norway Spruce foliage and its chlorophyll content were successfully applied in previous studies. Silver Birch (*Betulapendula* Roth), a pioneer tree species, and Scots Pine (*Pinus sylvestris* L.) used for revegetation after mining activities are typical tree species in the mine reclamation area of the Sokolov Basin (West Bohemia, Czech Republic). In August 2010 hyperspectral images with a resolution of 5 x 5 m² were acquired with the HyMap sensor. In four selected areas with a different level of soil contamination samples of Silver Birch leaves and Scots Pine needles were collected during the field campaign. Spectral reflectance curves of samples were measured in a laboratory with an ASD Field Spec3 spectrometer using the contact probe.

The goal of this study is to prove the correlation between spectral reflectance data and the chlorophyll content determined spectrophotometrically in the laboratory using different spectral indices (*MCARI*, *TCARI* / *OSAVI*, *mNDVI*₇₀₅, *ANMB*₆₅₀₋₇₂₅) and to find a mathematical description of this relation. The suitability of different indices for application on coniferous foliage of pine and broad leaved birch is discussed. Although the relations between different indices and the chlorophyll content show similar trends, the *ANMB*₆₅₀₋₇₂₅ index revealed the best results regarding the statistical significance. While the sought relation between spectral indices and the chlorophyll content showed to be statistically significant in the case of Scots Pine, it was rather weak and thus not applicable in the case of Silver Birch. The present work is a part of a study aiming to create a methodology for chlorophyll determination in Silver Birch and Scots Pine from available hyperspectral data

Accuracy assessment of ALS-derived stem volume and biomass maps

Markus Hollaus, Lothar Eysn, Christoph Bauerhansl, Florian Riccabona, Bernhard Maier, Andreas Jochem, and Frederic Petrini-Monteferri

Abstract

Read full paper online: http://www.eproceedings.org

As an active remote sensing system airborne laser scanning (ALS) is well suited to achieve normalized digital surface models (nDSMs) by subtracting digital terrain models (DTMs) from digital surface models (DSMs). The nDSM represents object heights and is an important data source for the derivation of various forest parameters such as tree height, stem volume or biomass. The validation of the derived results as well as the comparison of the results from different study areas is often a challenging task due to different sampling designs and accuracies of forest inventory data being used as ground truth data.

In this study we use 17 fully callipered samples, covering an area of 4.55 ha in total, to assess the accuracies of stem volume and biomass maps for different Austrian test sites. For the callipered samples all trees with a diameter at breast height \geq 10.5 cm were measured. For the calibration of the stem volume and biomass models available national forest inventory (NFI) as well as local forest in-



ventory (LFI) data are used, which are both based on angle count sampling plots. This verification approach guarantees firstly the independency of calibration and validation data and secondly it allows accuracy analyses for different reference units. For the study area Montafon the relative differences of stem volume and biomass range between -20.0% and 57.4% and between -16.3% and 56.2% respectively for twelve coniferous dominated sample areas with ~ 0.25 ha each. For a reference unit with an area of \sim 3.0 ha the relative differences decrease to 15.7% and 19.3% for stem volume and biomass respectively. For the study area Tyrol deciduous and coniferous models were applied. The calculated relative differences of stem volume and biomass vary between -25.8% and -10.3% and -18.5% and 3.1% respectively for the two coniferous dominated sample areas with an area of \sim 0.38 ha each. For the two deciduous dominated sample areas with an area of \sim 0.38 ha, both the relative difference of stem volume and biomass vary between -10.0% and 0.6% and -3.3% and 1.1% respectively. The average relative differences for all sample areas of the Tyrol study area with a total area of \sim 1.5 ha is -1.2% and -1.9% for the stem volume and the biomass, respectively. As the estimations of the stem volume and biomass maps are based on federal state wide data sets (ALS and NFI) the findings of this study are of high practical relevance for integrating ALS derived forest parameters into operational forest inventories.

Bronze age economies and landscape resources in the Kargaly steppe (Orenburg, Russia). Remote sensing and palynological data for ancient landscape resources modelling

Carlos Fernández Freire, Antonio Uriarte González, Juan Manuel Vicent García, and Mª Isabel Martínez Navarrete

Abstract

Read full paper online: http://www.eproceedings.org

We present the methodological and technical issues of a research on ancient vegetation modelling in the Russian steppes combining remote sensing and palynological data. This research is framed in an international project developed by Russian and Spanish archaeologists from the Russian Academy of Sciences and the Spanish National Research Council (CSIC) and centred on the study of the Bronze Age mining complex of Kargaly (Orenburg, Russia).

One of the research guidelines focused on potential landscape resources for copper metallurgy and subsistence activities, such as the availability of wood fuel or pasture and arable land. A palaeobotanical research has been carried out in order to explore such questions, including the use of remote sensing data for providing environmental calibrative criteria that help interpreting palynological data. Combining current pollen rain data and remote sensing products (obtained by digital processing of Landsat and ASTER imagery), we have developed a model to improve our understanding of the paleopalynological record.



New books

Dr. Claudia Künzer, chairman of the Special Interest Group on Thermal Remote Sensing, and her colleague Fabrice G. Renaud from Cranfield University, Bedfordshire, UK, are authors of a new book published by Springer entitled **The Mekong Delta System**.

This book presents a unique collection of state-of-theart contributions by international experts from different scientific disciplines about the characteristics and pressing water-related challenges of the Mekong Delta in Vietnam.

The Mekong Delta belongs to an area that is expect to face large challenges linked to environmental change and climate change induced by sea level rise. The Delta acts as the "rice bowl" of Southeast Asia and is home to over 17 Million people, who need to cope with ecologic as well as socio-economic changes linked to the rapid economic development of the country. Annual floods, severe droughts, salt water intrusion, degrading water quality, tropical cyclones, hydrologic changes due to hydropower projects in the upstream of the Mekong, coastal erosion, and the loss of biodiversity are some of the problems in the region. Heterogeneous resource management responsibilities,



and the fact that the Mekong – and thus also the Delta – is influenced by six countries aggravate the situation. Integrated water resources management and fostered cooperation and information exchange are pressing needs for the sustainable development of the Delta.



HIGH RESOLUTION OPTICAL SATELLITE IMAGERY lan Dowman Karsten Jacobsen Gottfried Konecny & Rainer Sandau



A new book entitled **High Resolution Optical Satellite Imagery** is available from Whittles Publishing. Authors are Ian Dowman, Karsten Jacobsen, Gottfried Konecny and Rainer Sandau.

The book is a comprehensive guide to the characteristics and use of high resolution optical images from satellite-borne sensors, concentrating on sensors designed for mapping. It considers in detail the SPOT series of satellites and sensors with a ground sampling distance (GSD) of less than 15 m, operational since SPOT 1 and particularly the commercial sensors launched since 1999 with GSD of less than 1 m.

Topics covered are the fundamentals of mapping and the key features in the design of sensors and methods of data storage and transmission, including data compression and sensor calibration. Results from tests show the accuracy which can be obtained, and the generation of digital elevations models, are included, as well as image processing and data fusion. Finally, future missions and the issues which face further development are discussed.



Forthcoming EARSeL Conferences

Prague Workshop on Radar Applications for Young Researchers



Scope:

The 1st Youth Prague Workshop will be organized as an in-depth discussion and knowledge sharing exercise based on detailed presentations of participants' projects. Each oral speaker will have 45 minutes to present his/her theme, objectives, method and problems. The presentations will be followed by common discussion between the session participants and a facilitator. The school programme will have two parallel sessions all days.

3rd Workshop on Advances in Remote Sensing for Archaeology and Cultural Heritage Management

19-22 September 2012, Ghent, Belgium

More info



Scope and Topics:

After the overview provided by the Rome meeting in 2008, the Gent workshop will be focusing on strategic issues. It will include not only knowledge improvement, but also the contribution of remote sensing to the sustainable management of cultural resources; not only within Europe, but with a strong focus on the emerging and developing countries of Asia, Africa and Latin America.

The cultural and practical interconnections between environment, culture and territory are the framework of the third EARSeL Workshop in Gent. The organising committee selected some priority themes:

- fields of application such as:
 - o the use of remote sensing for risk management, cultural and natural heritage,
 - the interconnections between the environment, climatic change and the dynamics of human habitation,
 - \circ an awareness of material and immaterial witnesses of ancient civilizations;
- methodologies such as the development of ad hoc semi-automatic and automatic approached for extracting cultural information, integration and fusion of passive and active remotely sensed data, remote sensing and geospatial analysis for preventive archaeology, palaeoenvironmental investigation and risk management;
- cooperation strategies for the creation of a permanent platform for data and knowledge sharing.



1st Course on Radar Remote Sensing applications for the study and observation of archaeological sites

17 – 18 September 2012, Ghent, Belgium

In the framework of the 3rd EARSeL Workshop on *Advances in Remote Sensing for Archaeology and Cultural Heritage Management*, a training course will take place on Radar Remote Sensing techniques and examples of end user applications of polarimetry within the archaeological field.

Programme:

17 September, Theory session / Course introduction:

- > theoretical principles of SAR (Synthetic Aperture Radar) and fundamentals of radar;
- Radar polarimetry, basic concepts and typical applications.

18 September, Practical session:

with the aim to present, visualize and interpret polarimetric products for archaeological case studies.

Further details provided at the end of this article.

Requirements:

Participants are asked to bring a personal laptop for the practical sessions. Software needed for the course can be downloaded and installed from the following link: Polarimetric SAR Data Processing and Educational Tool PolSARpro: http://earth.esa.int/polsarpro/ (please download the latest version). You will need to fill in a registration form before downloading the



software for free. Please read carefully the system requirement information on the ESA website;

- Exercises will be distributed at the beginning of the practical training course;
- A basic knowledge of optical data processing as well as a basic use of ENVI and ERDAS Imagine

Official language: English.

Location: University of Gent

Participants: up to 20 participants.

Participants will be selected on the basis of their experience. The registration form must be submitted **before 20 May, 2012** for the attention of:

- > Jolanda Patruno, e-mail: jolanda.patruno@uniroma1.it
- Nicole Dore, e-mail: nicole.dore@uniroma1.it
- Rosa Lasaponara, e-mail: lasaponara@imaa.cnr.it
- Rudi Goossens, e-mail: Rudi.Goossens@ugent.be

Admitted participants will be informed in due time (before 15 June, 2012).

A certificate of participation will be issued by ESA and the University of Ghent.

Costs: the course is free for participants. Course materials will be provided by ESA. Participants are expected (have to) cover all other expenses related to their participation (travel cost, accommodation, subsistence etc).

Teachers:

- Prof. Laurent Ferro-Famil (IETR Universitè Rennes 1, France)
- Nicole Dore ("Sapienza" University of Rome c/o ESA, Italy)
- Jolanda Patruno ("Sapienza" University of Rome c/o ESA, Italy)

	Monday, 17 September 2012	Tuesday, 18 September 2012
8:30-9:00	Registration	Exercise distribution
9:00-9:30	Course introduction	
9:30-10:00	SAD intro (L. Forro E.)	SAR Polarimetry (L.Ferro F.)
10:00-10:30	SAR IIITIO (L.FEITO F.)	
10:30-10:50	Coffee break	Coffee break
10:50-11:30		SAR Polarimetry and optical Re-
11:30-12:00	SAR Polarimetry (L.Ferro F.)	mote sensing application in Ar-
12:00-12:30		chaeology (J. Patruno)
12:30-13:00		
13:00-13:30	Lunch	Lunch
13:30-14:00		
14:00-14:30		
14:30-15:00	SAR Polarimetry (L.Ferro F.)	Interactive Evergica (N. Dara)
15:00-15:30		interactive exercise (N. Dore)
15:30-16:00	Coffee break	
16:00-16:30		Coffee break
16:30-17:00	Presentation PolSARPro (J. Patru-	
17:00-17:30	no)	Interactive Exercise (N. Dore)
17:30-18:00		
18:00-18:30	Discussion	Closing session



Other Conferences

- 14-23 July, 2012: COSPAR 2012: 39th Scientific Assembly of the Committee on Space Research. Mysore, India
- 22-27 July, 2012: IEEE International Geoscience and Remote Sensing Symposium. München, Germany.
- 25 August 1 September, 2012: ISPRS Congress 2012.
 Melbourne, Australia
- 3-5 September, 2012: 1st EAGE/GRSG Remote Sensing Workshop 2012. Paris, France.
- 11-14 September, 2012: ForestSAT 2012.Corvallis, Oregon, United States
- 12-14 September, 2012: Remote Sensing and Photogrammetry Society Annual Conference. Greenwich, London, United Kingdom
- 24-27 September, 2012: SPIE Remote Sensing 2012.Edinburgh, United Kingdom.
- 8-12 October, 2012: 21st Ocean Optics Conference.
 Glasgow, United Kingdom.
- 15-18October, 2012: 10th Seminar on Remote Sensing and GIS Applications in Forestry. Curitiba, Parana, Brazil.
- 29 October 2 November, 2012: 9th International Conference of the African Association of Remote Sensing of the Environment (AARSE).
 Eljadida, Morocco
- 19-23 November, 2012: XV Symposium SELPER. Cayenne, France
- 26-30 November, 2012: 33rd Asian Conference on Remote Sensing (ACRS 2012). Pattaya City, Thailand.
- 16-18 December, 2012: Computer Vision in Remote Sensing. Xiamen, China.



Summer Schools and Advanced Courses

5th EUFAR FP7-EUROSPEC Training Course for Airborne Research.
 18 - 28 July 2012, Albacete, Spain. Application due date is **30 April 2012**

Climate Change in the Marine Realm.

10 - 24 September 2012, Alfred Wegener Institute for Polar and Marine Research, List/Sylt, and University of Bremen. Application due date is not indicated (5 March 2012)

- EARSeL's Prague Workshop on 4D Radar Applications for Young Researchers.
 26 28 June 2012, Czech Technical University in Prague, Czech Republic. Abstract submission due date is 30 March 2012
- CliChaMoR Summer School 2012 on *Climate Change in Mountain Regions*.
 25 June 6 July 2012, Centre for Geoinformatics, Salzburg University, Austria. Registration due date is **15 May 2012**
- 6th ESA Earth Observation Summer School on *Earth System Monitoring and Modelling*.
 30 July 6 August 2012, ESA-ESRIN, Frascati, Italy. Registration due date is **30 January 2012**
- 4th International Summer School on *Radar/SAR*.
 13 20 July 2012, Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR, Bonn, Germany. Registration due date is 18 March 2012



Back cover – Photos from the 32nd Symposium in Mykonos, 21 – 24 May, 2012. Courtesy: Gottfried Konecny.





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