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TUTORIAL ON REMOTE SENSING FOR CAPACITY BUILDING

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1. INTRODUCTION

Since 1992 The Pan Ocean Remote Sensing Conference Association (PORSEC), has sponsored capacity building in association with its bi-annual conferences in several different countries, where the use of remotely sensed data for operations and research in meteorology and oceanography was not yet well developed. The goal was to enhance scientific and technical capacity in this field in several PORSEC member countries. This was the vision of the founder Prof. H. Sugimori of Chiba University, Japan. Prof. José Stuardo of the University of Concepcion, Chile, included a short course tutorial before the conference in 2004, and more have followed.

Over the past 14 years and the last 7 PORSEC's, the tutorial has been held in Brazil, Chile, China, India, Indonesia, South Korea and Taiwan. The courses have focused on existing instruments in space and methods of analysis and presentation. The work of student participants included some practical familiarization with various types of remote sensing data and software. The early Advanced Very High Resolution Radiometer, AVHRR, for observing Sea Surface Temperature has found much practical use in finding ocean-fronts, useful for fisheries. The direct read-out of the infrared data has made this convenient. A staple at all the conferences has been instruction in using passive and active microwave data such as from radiometers observing atmospheric moisture, clouds and precipitation and scatterometers measuring surface winds over the ocean. Instruments used in this instruction have been the Special Sensor Microwave Imager, Scanning Special Sensor Microwave/Imager, SSM/I, and especially the U.S. SEASAT scatterometer and the

European scatterometers on the European Remote Sensing Satellites, ERS1 and ERS2, and the Advanced Microwave Instrument, AMI on the operational meteorological satellite, METOP. Ocean color has been discussed in the course over the years with emphasis on discovery of phytoplankton blooms in coastal areas. Theoretical background, instrument details and the products produced from each instrument have all been discussed and examples given of how the data can be used in operational settings and for research. A bit more esoteric, the Synthetic Aperture Radar data from the ESA satellites have also been discussed. Special features have been a major lecture on proper writing and presentation of results, and calibration exercises with field data. These aspects of technical work, we consider especially important in a tutorial of this sort.

Each course has received about 30 students many from the country where the conference was taking place, but we have always made an effort to include as many students as finances would allow from other nations, typically half a dozen or more. Support for students to come to the course has been obtained from government agencies in the US, Canada, Europe and students' home country agencies as well as from local institutions. Most of our students have been graduate students, since a certain level of background instruction is necessary to benefit from the remote sensing information, but we have also included young professionals and advanced undergraduate students, who wanted to expand their expertise.

We believe that this effort has been effective as evident by those of our "graduates" who have subsequently participated in later PORSEC's and who have found a cohort of colleagues for future interactions. We consider these aspects of developing a network of colleagues, in addition to the interactions with well-known and experienced scientists, to be major benefits of this program in the ever advancing field of remote sensing in Earth sciences.

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2. EXPERIENCE FROM THE 2016 TUTORIAL

The capacity-building tutorial was hosted in 2016 by the Earth Observation Laboratory at the Universidade Federal do Ceará, Instituto de Ciências do Mar (UFC-LABOMAR) in association with the 13th biennial Pan Ocean Remote Sensing Conference (PORSEC), held in Fortaleza, Brazil, Nov. 8 and 11. LABOMAR's downtown Fortaleza campus provided an excellent location for the tutorial held from Nov. 3 to 7. The conference theme was: 'Enabling Earth Observations in Support of Global, Coastal, Ocean and Climate Change Research and Monitoring'.

The 2016 tutorial was attended by students and early career scientists from 5 countries, with specialties in oceanography, meteorology and geology. Nine international lecturers gave practical and theoretical lessons on various types of remote sensing data, and where to access data and applications for use in research and operations. The 2016 tutorial included 4 international students from Turkey (1), Belgium (1), India (1), and Russia (1) and 11 students from different universities and institutes from all over Brazil (Table 1). Nine (60%) of the students were women. The participants included post-graduate fellows, doctoral students, young scientists, and exceptional undergraduate and Master's students. All of the students were encouraged to participate in the main PORSEC.

Table 1. Participants of the 2016 PORSEC Capacity Building Tutorial.

Student	Country
Bulent Acma	Turkey
Barbara Barros Carlos	Brazil
Fransmagno do Nascimento Matos	Brazil
Lucas Ferreira Correa	Brazil
Raul Fritz	Brazil
Svetlana Karimova	Belgium
Patrícia Marroig	Brazil
Stefanny Matos	Brazil
Ankita Misra	India
Lea Nunes Teixeira	Brazil
Laymara Sampaio	Brazil
Meiry Skamoto	Brazil
Yuriy Titchenko	Russia
Erik Zarko Solha	Brazil
Monique Vinhas	Brazil

The lecturers were enthusiastic volunteers, who gave overviews on different topics and examples from their own research as follows:

- Milton Kampel (fundamentals of visible remote sensing)
- João Lorenzzetti (fundamentals of thermal and microwave remote sensing)
- Cara Wilson (fisheries applications)
- Jim Gower (ocean color)
- Gad Levy (data assimilation)
- Abderrahim Bentamy (satellite wind data)
- Ana Paula Morais Krelling (Statistical data analysis)
- Stefano Vignudelli (satellite altimetry)
- Leonid Mitnik (SAR data)

We find that the lecture rooms need to have individual desktop computers for all participants (Figure 1), to accommodate today's sophistication and technological advances common in remote sensing data analysis.



Figure 1. In top panel Prof Lorenzzetti is lecturing on microwave remote sensing; in bottom left panel, Cara Wilson discusses NOAA's data base and accessibility, and bottom right, Abderrahim Bentamy is talking about air-sea interaction and scatterometry for wind measurements over the ocean.

3. NETWORKING BENEFITS

The tutorials provide an important opportunity for students to develop their professional network. Many of these connections happen in the free time over meals and during outings—and during the times when students work on their individual and team projects and help each other. In Figure 2 we illustrate some of these special opportunities that presented themselves in 2016.



Figure 2. In the top panel: Students and lecturers shared lunch each day in a local restaurant in Fortaleza, in the foreground to the right our hosts Gerlado Antonio Ferreira and Ana Paula Morais Krelling of LABOMAR. In the bottom panel the group went on a beach excursion between the tutorial and main conference.

4. LEARNING OUTCOME OF THE TUTORIAL

The tutorials have often included a session on writing scientific reports in English and presenting the work to colleagues. We were very fortunate to have an editor-in-chief of the International Journal of Remote Sensing, Arthur Cracknell, present this session at several earlier tutorials, but could not do the same in 2016. However, it appears students are gaining in their proficiency with

English and scientific presentation, so they did quite well—some have had prior experiences, travelling and interning at foreign Universities, yet we still feel that this is an important aspect of the remote sensing tutorials that should be emphasized, since the work continues to be very international and many data sets depend on international collaborators.

The tutorials from 2008 to 2014 had field components, which received very positive feedback from the students. In China 2008, Taiwan 2010 and India 2012 we made ocean color observations from ships of opportunity and research vessels (Figure 3). A photometer was brought to illustrate surface measurements of solar radiation on a beach in Indonesia in 2014.



Figure 3. Students spent the field portion of the 2010 tutorial in Taiwan onboard the National Taiwan Ocean University's research vessel learning about techniques for calibrating ocean color sensors.

In 2016 the students presented their work on the last day (Figure 4) and produced a summary slide for their colleagues. We present two of those in Figure 5.

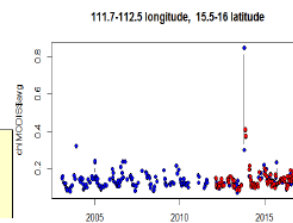
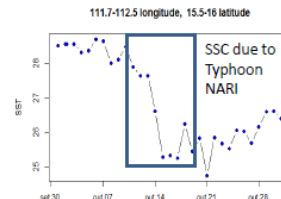
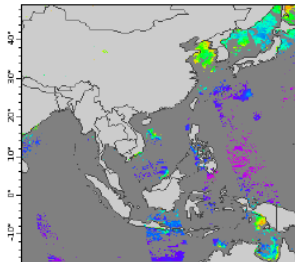
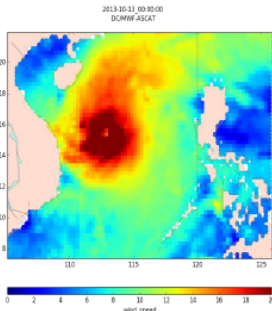


Figure 4. Two students presenting their work, Svetlana Karimova (left) and Lucas Ferreira Correa (right).

The end of the course was celebrated with certificates of completion after the student presentation as seen in Figure 6.

Enhancement of Chlorophyll- a concentration by typhoon – NARI

Ankita Misra
CSIR-Senior Research Fellow
Indian Institute of Technology- Bombay, India



Data Used :

- DC > MWF ASCAT
- GHRSSST Global 1-km Sea Surface Temperature (G1SST)
- Chlorophyll-a, Aqua MODIS, NPP, L3SM1, Global, 4km, Science Quality (1 Day Composite)

Observations :

- Sea Surface Cooling after the passage of typhoon- NARI.
- The satellite derived Chl-a estimations suggest an increase in chlorophyll concentration, which is due to the typhoon induced upwelling of nutrients.



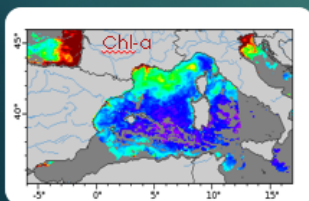
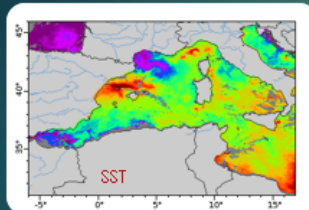
Combined SST and Chl-a frontal density



► Svetlana Karimova, University of Liege

Purpose: A method for a co-analysis of SST and Chl-a fronts is proposed.

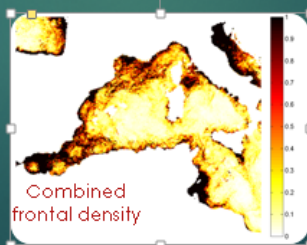
Datasets: daily fields of Aqua MODIS SST and Chl-a



Algorithm: $CFD = 1/n \sum SG_i \cdot CG_i$

where

- CFD – timely averaged combined frontal density,
- SG – numerical gradient of SST,
- CG – numerical gradient of Chl-a,
- i – time point



Possible applications:

- highlighting the areas with especially sharp contrasts of water properties;
- assessing the match between SST and Chl-a fronts;
- better visualization of mesoscale circulation features (e.g. eddies), etc.

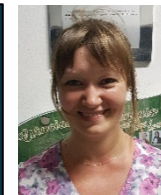


Figure 5. Top slide shows Ankita Misra's observations of chlorophyll in the South China Sea after a typhoon. The bottom slide shows Svetlana Karimova's summary of her analysis of fronts in the Mediterranean Sea.



Figure 6. Final ceremony of the tutorial of PORSEC 2016, where certificates were given to the student participants (11 are in the picture) with most of the lecturers and organizers of the tutorial—(10 are in the picture). (photo Yuri Titchenko)

5. SUMMARY AND CONCLUSIONS

We believe that this effort has been effective in that some of our “graduates” have also participated in later PORSEC’s, gained some “hands-on” experience, and have found a cohort of colleagues for future interactions.

The aspect of developing a network of colleagues we consider to be one of the most important benefits of the accomplishments of this program --- in addition to the interactions with well-known and experienced scientists in the ever advancing field of remote sensing in Earth sciences.

A project of the PORSEC Association is to continue relationships with some of the students as mentors, often by assisting with production of publications via Special Issue of selected papers from the conferences in the International Journal of Remote Sensing, and “inspired by” issues in Environmental Research Letters.

The capacity building tutorials focusing on a fast developing field such as remote sensing of various aspects of planet Earth, especially its oceans and atmosphere, have been very rewarding to teachers and students alike. We feel it serves a special purpose in that universities have not always had the expertise or resources to develop comprehensive courses in remote sensing from satellites, and we want the next generation of researchers to be aware of the tremendous opportunities that remotely sensed data from satellites provide for comprehensive insights about the Earth’s physical and biological system.

Our wish would be to extend the tutorial by a few days and include more hands-on tests and calibrations of the variables inferred from remote sensing by satellites. The field component has been a very successful

component of past tutorials but we did not manage to include it in 2016.

6. FINANCIAL SUPPORT

The host-institutions provide most of the funding and support the venue for the classes. Additional funds for tuition, travel and subsistence have been obtained from instructors’ institutions and from international and national bodies, such as the Scientific Committee for Oceanic Research (SCOR), United Nations, UNESCO (in early days). Other funding organizations include: from the USA: the National Aeronautical and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA), the Office of Naval Research Global (ONRG), the National Science Foundation; from Europe: the European Space Agency, ESA, the French National Space Agency (CNES); from Asia: The Japan Aerospace and Exploration Agency (JAXA), the Indian National Centre for Ocean Information Services (INCOIS), the Chinese Academy of Science (CAS), and others.

7. ACKNOWLEDGEMENTS

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