Sensing and Mapping the Marine Environment 3

Monday 16th July 2007
Geological Society, Burlington House, London

The one-day symposium will bring together the special interests of the Remote Sensing and Photogrammetry Society (RSPSoc) and Challenger Society for Marine Science (CSMS).

Organiser:

Dr Samantha Lavender
Marine Institute / SEOES,
Portland Square A403,
University of Plymouth,
Plymouth,
PL4 8AA
Tel: 01752 232460
Fax: 01752 232406
E-mail: s.lavender@plymouth.ac.uk

Schedule

Time	Event	Comments
10:00	Registration	
10:30	Welcome	
10:40	Paper 1	New Approaches and Methods in Marine Geological Mapping. Christian Wilson (British Geological Survey)
11:00	Paper 2	The Landmap service and use of ASAR imagery for inter-tidal areas mapping. Kamie Kitmitto (University of Manchester)
11:20	Tea/Coffee	
11:40	Paper 3	Potential impacts of non-algal materials on water-leaving sun induced chlorophyll fluorescence signals in coastal waters. David McKee (University of Strathclyde)
12:20	Paper 4	A Novel Technique for Estimation of Primary Production directly from Earth Observation Data: An Inherent Optical Property Approach. Kathryn Barker (University of Plymouth / Plymouth Marine Laboratory)
12:40	Paper 5	The influence of seawater constituents on underwater light fields and their effects on primary production modelling. Leanne Ramage (University of Strathclyde)
13:00	Lunch	
14:00	Paper 6	An improved strategy for the determination of shelf seawater composition by inversion of in situ inherent optical property measurements. Ian Brown (University of Strathclyde)
14:20	Paper 7	Sea Surface Temperature from (A)ATSR and other EO datasets at the NEODC. Victoria Jay (NERC EO Data Centre)
14:40	Paper 8	GlobColour: Developing a European ocean colour service supporting global carbon-cycle research and operational oceanography. Yaswant Pradhan (University of Plymouth)
15:20	Summary	
15:30	End	

New Approaches and Methods in Marine Geological Mapping

Wilson CK[1], Stoker MS[1], Bradwell T[1], Spillard R[2] & Howe J[3.]

[1]British Geological Survey
[2]Maritime and Coastguard Agency
[3]SAMS

Much of the continental shelf around the United Kingdom is dominated by relic landforms created during past glaciations and subsequently submerged during sea level rise. Combining this with low rates of sedimentation and sediment transport mean that much of the offshore UK preserve a drowned glacial landscape with much greater detail than typically seen onshore. This landscape is still largely unexplored, unmapped and the record of processes it records uninterpreted. Only with advances in sonar technology and accurate positioning are the true scale and importance of these offshore environments beginning to be recognised.

The British Geological Survey in collaboration with Olex AS, the Maritime and Coastguard Agency and the Scottish Association for Marine Science are using the latest multibeam and collated echosounder databases to piece together the the meaning of the landforms uncovered with these techniques. Multibeam technology not only gives an extremely high resolution 3D surface but also, by means of backscatter, captures information on the physical properties of the seabed. The Olex database is an extremely novel approach to acquiring data, consisting of a collaborative network of mainly fishing vessels using standard echosounders and GPS equipment. The strength of the system is in the extent of the data and in the gridding algorithms used to process what is an inherently noisy dataset.

Integrating legacy and recently-collected data has allowed new insights into the extent and behaviour of the last British Ice Sheet as well as providing the foundation for more detailed mapping of the offshore geology.

A Novel Technique for Estimation of Primary Production directly from Earth Observation Data: An Inherent Optical Property Approach.

Kathryn Barker[1], Sam Lavender[1], Tim Smyth[2], Jim Aiken[2]

[1]School of Earth, Ocean and Environmental Sciences, University of Plymouth, UK.
contact: kathryn.barker@plymouth.ac.uk
[2]Plymouth Marine Laboratory, Plymouth, UK.

Phytoplankton primary production (PP) plays a major role in the uptake of oceanic carbon and is hence a key process for the carbon cycle. Determination of PP is therefore a major target of global earth observation (EO), and modeling is required to further improve these estimates. Traditionally PP models have always included some parameterisation of chlorophyll. However, chlorophyll retrieval can be complicated in case II regions, usually coastal areas, where the chlorophyll estimated from the satellite sensor can be impaired by other substances that vary independently of chlorophyll, namely Coloured Dissolved Organic Material (CDOM) and suspended sediments. The resulting overestimation of chlorophyll then perpetuates through to PP models, causing inaccuracies in the estimate. As the coastal zone accounts for around 30% of the global ocean, improvements in modeling PP in these optically complex waters are necessary.

Correct parameterisation of the effects of inherent optical properties (IOPs) on the in-water light field using satellite data offers a unique approach to PP modeling, and results of a new IOP-based spectral model are presented. Dependency on chlorophyll concentration estimates was removed by replacing the chlorophyll parameter with the absorption by phytoplankton, a_{ph}. EO data is used, through a radiative transfer model, to determine spectral absorption, $a(\lambda)$, and backscattering, $b_b(\lambda)$, from which scalar irradiance is calculated using a look up table (LUT). The new parameter, $a_{ph}(\lambda)$, is then derived from $a(\lambda)$. Given that $a(\lambda)$ and $b(\lambda)$ are estimated from model inversion rather than retrieval algorithms, the use of a_{ph} in the calculation of PP is subject to less potential for error.

The model, a triple integral of wavelength, depth and day length, was implemented to use satellite-derived Sea Surface Temperature, Photosynthetically Available Radiation and $a_{ph}(\lambda)$. A large LUT (approximately 4,000,000 PP values) was produced to alleviate the complications of such a computationally expensive model, but is capable of deriving PP through interpolation for a wide range of marine conditions. The model has currently been implemented using level 3 (9 km) SeaWiFS data (monthly, 1998-2004), but the advantages offered by MERIS include an increased number of spectral bands and overall sensor performance that should benefit the model. A basin mask, applied to the model output, delineates PP values for the Pacific Ocean, Atlantic Ocean, Mediterranean Sea, Southern Ocean, Artic Ocean and Indian Ocean, with both yearly and monthly production calculated for all basins. Model input and output are being subjected to systematic sensitivity analyses to establish the potential errors, from which error budgets will be eventually outlined. Validation will be done using some of the larger in situ PP datasets available such as the Bermuda Atlantic Time-Series Study (BATS). Finally, comparison to existing PP models utilising chlorophyll will provide a quantitative indication of model performance.

At present the results are at an early stage and while productivity patterns appear correct, global PP values were estimated at around 90 Gt C y^{-1}. This is tentatively supposed to be an overestimate, and investigation will focus on $a(\lambda)$, $b(\lambda)$ and especially $a_{ph}(\lambda)$ as inputs to the model together with the sensitivity of the PP estimate to these parameters. Results indicate the potential for this approach as a viable alternative to the use of satellite-derived chlorophyll concentrations, but further work is needed before final conclusions can be drawn regarding the suitability of IOPs in PP estimation from space.

The influence of seawater constituents on underwater light fields and their effects on primary production modelling.

Leanne Ramage
University of Strathclyde

The absorption and scattering characteristics of dissolved and particulate materials in seawater influence the attenuation of light as it penetrates into the water column. These effects are most prominent in coastal regions where light available for phytoplankton absorption may be limited by the presence of high concentrations of sediment and CDOM. This has a direct effect on primary productivity in shelf seas. Extensive data sets on the spectral quality of the underwater light field were obtained during recent research cruises to the Irish Sea and Bristol Channel. From these measurements, the impacts of suspended and dissolved materials on light availability for photosynthesis were examined. Through radiance transfer modelling, the in-situ measurements were combined with radiance transfer simulations to produce mathematical models of the underwater light field. Optical closure was achieved in several stations with varying concentrations of constituents (Chl 0.7 – 7mg m^{-3}, MSS 0 – 10 g m^{-3}, CDOM 0.09 – 0.28 m^{-1}). This provides a validation of the in-situ measurements and it enables a prediction of underwater light field characteristics as a function of seawater composition. The findings have been used to extend open ocean light field models to allow them to be used in shelf seas. They have also been used as drivers for models of phytoplankton primary productivity in optically complex coastal waters and to examine the significance of the light-harvesting strategies of different phytoplankton functional groups.

An improved strategy for the determination of shelf seawater composition by inversion of *in situ* inherent optical property measurements

Ian C. Brown
University of Strathclyde

Absorption, scattering and beam attenuation coefficients ($a(\lambda)$, $b(\lambda)$ and $c(\lambda)$, respectively) are collectively known as the inherent optical properties (IOPs) of seawater. The magnitude and spectral variation of inherent optical properties are determined by the composition and concentration of dissolved and suspended materials present in seawater. Measurement of inherent optical properties (IOPs) of seawater using an AC-9 dual-beam spectrophotometer has become routine on many oceanographic cruises. AC-9 data ($a_{AC9}(\lambda)$, $b_{AC9}(\lambda)$ and $c_{AC9}(\lambda)$) are frequently used in radiance transfer calculations of water leaving radiances, for use in remote sensing applications. There are at present, however, no generally accepted protocols for the inversion of *in situ* IOP spectra to obtain estimates of water composition. In general shelf seas contain four optically significant constituents: water, phytoplankton (measured as chlorophyll, *CHL*), mineral suspended solids (*MSS*) and coloured dissolved organic matter (*CDOM*). Shelf seas are optically complex, dynamic systems within which, a number of physical and biological processes occur. Water composition information may be used to identify, quantify and map these processes both spatially and temporally.

A model is presented to partition *in situ* IOP spectra between the aforementioned shelf seawater constituents using constituent-specific optical cross-sections. These partitioned IOP spectra are subsequently inverted, yielding estimates of optically significant constituent concentrations. The inversion of IOPs measured *in situ* enables the calculation of spatial and temporal variability in shelf seawater composition at greatly increased resolution when compared with traditional sample collection and analysis. On moorings, towed bodies and ferry-box systems, this data is greatly needed for validating remote sensing products and to provide information on shelf sea processes.

Sea Surface Temperature from (A)ATSR and other EO datasets at the NEODC

Victoria Jay, NERC Earth Observation Data Centre
v.l.jay@rl.ac.uk

The NERC Earth Observation Data Centre (NEODC) is the NERC designated data centre responsible for Earth Observation data. Datasets produced and used within NERC and the wider UK EO community are archived, catalogued and made available to registered users.

Recent work has produced an online, common-format archive of data products from the (A)ATSR (Along Track Scanning Radiometer) series of instruments. The (A)ATSR imaging radiometers on-board the ERS-1, ERS-2 and ENVISAT satellites were developed for exceptional sensitivity and stability of calibration, enabling sea surface temperature measurements to an accuracy of +/- 0.3K. The new common-format archive provides a complete set of high-quality SST and related data covering a 15-year period. The archive consists of some 80 Terabytes of data, available online to registered UK users alongside the NEODC's other data holdings.

NEODC's datasets include satellite (e.g. Envisat – MERIS, MIPAS and SCIAMACHY, LANDSAT) and airborne EO data (including the NERC Airborne Research and Survey Facility archive from 1982 to present). Most NEODC datasets are available for any bona fide research application, but some are restricted to authorised users only (e.g. NERC funded). Further details and a searchable catalogue of data holdings are available via the NEODC website http://www.neodc.rl.ac.uk.

GlobColour: a European Service for Ocean Colour

Yaswant Pradhan[1], Odile Fanton d'Andon[2], Samantha Lavender[1], Antoine Mangin[2] and Simon Pinnock[3]

(1) University of Plymouth
(2) ACRI-ST
(3) ESA

The GlobColour ESA Data User Element project aims to develop and demonstrate an EO-based service supporting global ocean carbon-cycle research by providing scientists with a long time-series of consistently calibrated global ocean colour information according to requirements as specified by the global ocean colour user community (represented by the user groups: IOCCG , IOCCP and the Met Office). GLOBColour will also put in place the capacity to continue the ocean colour service in the future by running a near-real time service in its third phase. The project started in November 2005 and had its first user workshop in December 2006.

A critical component of GlobColour is ocean colour data merging, as it provides a method for the rationalisation of space missions and data distribution. However, it requires critical preliminary steps and a demonstration of feasibility/usefulness of the merged data; therefore its acceptance depends very much on the quality of the first steps and overall process. To achieve this, GlobColour performed a comparative characterisation of the included ocean colour sensors (MERIS, MODIS-Aqua and SeaWiFS) including an analysis of the available retrieval algorithms and their compatibility between missions using Level-2 product match-ups. A review of existing data-merging methods that start from both radiance and derived bulk properties (such as surface chlorophyll concentration) also occurred and the final merging algorithm choice followed an algorithm inter-comparison and trade-off analysis on the Preliminary Products Set (four months of data), which was presented at the 2006 workshop. The project is currently producing a 10 year global ocean colour dataset at various temporal scales. A thorough validation of the products against in-situ measurements will be performed following well defined protocols, and software to handle the resulting diagnostic data set (DDS) subsets has been developed through BEAM.