ABSTRACTS

Automated Processing of Underwater Digital In-Line Holograms

Nick Burns, Aberdeen University. (n.burns@abdn.ac.uk)

Digital holography offers a high-resolution solution to sampling marine environments, allowing particulates to be captured in-situ, thereby providing images of undamaged particles. Analysis of the holograms presents a challenge for automated data extraction, as this involves the use of focal-plane detection, which often suffers inaccuracies depending on hologram speckle and particle attributes. In this paper we introduce an automated focusing and data extraction procedure, which relies on spatial-domain data from reconstructions performed at regular intervals through the hologram volume, and detects particles via edge sharpness-quantification techniques designed to reduce the impact of speckle.

Assessment of a Computational Grid for the Replay of Digitally-Recorded Holograms

Jindrich J. Nebrensky and Peter R. Hobson School of Engineering and Design, Brunel University (j.nebrensky@brunel.ac.uk)

To speed up the replay of a digital hologram of particles in water we have used the EGEE computational Grid, with each node independently reconstructing a small number of image slices that are all sent to one Storage Element which then holds the entire volume for further analysis.Although most of the sample volume is generated up to 20 times faster on the Grid, there are some stragglers which cause the reconstruction rate to slow, and a significant proportion of jobs get lost completely, leaving blocks missing from the sample volume. We propose some strategies to ameliorate this data loss.

Deconvoluting inherent optical property measurements in shelf seas

Ian C. Brown, A Cunningham & D. McKee, University of Strathclyde. (i.c.browm@strath.ac.uk)

The magnitude and spectral variation of shelf seawater inherent optical properties (IOPs) are determined by the concentration and composition of shelf seawater constituents. In situ absorption and scattering coefficients (a(λ) and b(λ)) are routinely measured using WETLabs AC9 dual-beam spectrophotometer instruments. Proposed strategies for partitioning in situ absorption measurements between optically significant constituents include matrix inversion and constrained, non-linear regression methods. A mechanistic deconvolution procedure has been developed to partition both in situ absorption and scattering coefficient measurements between constituents. Constituent concentration estimates are subsequently obtained from partitioned IOPs, using specific IOPs. A comparison of the mechanistic and matrix inversion procedures is presented

Ocean colour data in case II waters: a different approach in support of ecosystem models

Violeta Sanjuan. National Oceanography Centre Southampton. (vsc@noc.soton.ac.uk)
David McKee. University of Strathclyde.

Generation of modelled remote sensing reflectance spectra is a key step in the implementation of coupling bio-optical models in ecosystem models. Specific inherent optical properties (SIOPs) play a critical role in this process. Understanding natural variability in SIOPs is therefore vital. We propose to review the manner in which SIOPs are determined from inherent optical properties (IOPs) taking into account the effect of measurement uncertainties and comparing traditional approaches with regression analyses. We will then examine the propagation of these uncertainties and their impact on the calculation of remote sensing reflectance using a radiative transfer model (Hydrolight).

Spectral variability of the particulate backscattering ratio revealed by regression analysis.

David McKee, Alex Cunningham, Ian Brown, Leanne Ramage
Physics Department, University of Strathclyde (david.mckee@strath.ac.uk)

The particulate backscattering ratio plays an important role in determining the distribution of photons in the underwater light field and the generation of remote sensing reflectance signals. Until recently, relatively few measurements of in situ spectral backscattering were available and, in accordance with Mie theory results using Junge particle size distributions, the spectral dependency of the backscattering ratio was often assumed to be flat. It has recently been claimed that an extensive study of in situ measurements of particle backscattering ratio shows no significant wavelength dependency and very strong variability in magnitude (Whitmire et al 2007). We will present backscattering data from the Bristol Channel including an analysis of measurement uncertainties. It will be shown using regression analysis that the true natural variability of the backscattering ratio is considerably lower than previous studies have suggested and that there is, in fact, significant spectral variability in the particulate backscattering ratio for these waters.

Tidal Amplification of Submarine Light

D.G.Bowers Bangor University (oss063@bangor.ac.uk)
J.M.Brubaker Virginia Institute of Marine Science

Light is generally observed to decay exponentially with depth in the sea. In a tidal sea, the gain of light at low tide will be greater than the loss of light at high tide. There will thus be a net amplification of the light reaching the sea bed, compared to the situation with no tide but other conditions being equal. The amplification factor is increased or diminished depending on the phase of the tide and the day length. Analytical and numerical solutions for the tidal amplification factor are compared to observations in the Menai Strait, North Wales. The agreement between theory and observations is good, and the size of the amplification is surprisingly large, up to an order of magnitude in physically realistic conditions. Tidal amplification of submarine light is therefore a significant, and hitherto unidentified, factor in the ecology of light-limited algal growth.

UV light penetration of the oceans: measurements and modelling using a coupled atmospheric in-water radiative transfer approach

Tim Smyth Plymouth Marine Laboratory (tjsm@pml.ac.uk)

A hydrological radiative transfer (RT) model has been developed which uses as input the measured visible range Inherent Optical Properties of the water column to determine the downwelling irradiance in the UV (range 300 - 400 nm). This model was then coupled to an atmospheric UV RT model. Both the atmospheric and hydrological RT models are validated using data obtained from a research cruise in the sub-tropical North Atlantic. The atmospheric model gave agreement within 20% of the in-situ measurements; the hydrological RT gave best agreement for the wavelengths 325 and 340 nm. Mechanisms, such as the photobleaching of Coloured Dissolved Organic Matter and the further coupling of RT to photochemical models, are discussed.

Modelling Underwater Light Fields in Shelf Seas

Leanne Ramage, Physics Department, University of Strathclyde (l.ramage@strath.ac.uk)

Absorption and scattering by dissolved and particulate materials in shelf seas influence the attenuation of light in the water column. These effects are most pronounced in coastal regions where the light available for phytoplankton absorption may be limited by the presence of sediment and coloured dissolved organic matter. Quantification of the underwater light field is therefore a key element in primary production modelling. A forward

model has been devised for optically complex shelf seas which allows prediction of the underwater light field from constituent concentrations and specific inherent optical properties. This model was applied to the Irish Sea where an extensive data set and a regionally tuned ocean colour algorithm were available.

The influence of wind-driven variations in suspended particulate matter on the subsurface light climate in Western Australian coastal waters.

F. I. Verspecht_ School of Ocean Sciences, University of Wales Bangor; C. B. Pattiaratchiy School of Environmental Systems Engineering, University of Western Australia. (f.verspecht@bangor.ac.uk)

Field data obtained from a study of shallow, high-light, oligotrophic, wind-dominated coastal waters off south-western Australia revealed re- suspension trends during storms and sea breezes as to the inuence of wind on acoustic backscatter. Echo level (EL) was derived from acoustic backscatter and used to approximate suspended particulate matter (SPM) in the water column. Wind events ultimately controlled particulate matter resuspension. This conclusion is based on (1) elevated EL during periods of high wind-generated turbulence and bed shear stress, (2) positive time-lagged correlations between wind speed and EL at three field sites with different exposures to wave action, and (3) significant negative correlations between wind speed and depth-differentiated echo level (d(EL)/dz) at all sites. The wind speed required to achieve homogenously mixed SPM (where d(EL)/dz was equivalent to zero) was calculated for each site. Diurnal sea breezes produced a similar response in EL to a small storm event. However, due to the frequency, EL was consistently higher in summer relative to winter, indicating that the SPM was almost constantly retained in suspension. In winter, subsequent to the passage of a storm, calmer conditions returned that allowed the SPM to settle out of the water column, requiring _32 hours to reach pre-storm levels. The effect of changes in EL on the subsurface light climate were quantifed using the light attenuation coefficient (kd) that was approximated from in situ measures of photosynthetically active radiation (PAR). A close coupling between wind-driven resuspension and a reduction in surface light reaching the sea bed was revealed through strong positive correlations between wind speed, EL and kd. In the absence of riverine inputs, and with low pelagic chlorophyll a concentrations (_1 mg m□3) due to oligotrophy, SPM was the main factor contributing to the extinction of light through the water column. In situ near-bed dissolved oxygen concentrations were reduced in accord with elevated wind speeds, EL and kd, highlighting a possible biophysical mechanism between phytoplankton and resuspension events.

Spatial variability in remote sensing spectra from optically complex waters

Claire Neil, University of Strathclyde (claire.neil@strath.ac.uk)

Standard remote sensing algorithms for the derivation of water composition perform poorly in optically complex coastal waters. The ability to identify optical water types from normalised water leaving radiance (nLw) spectra could be used to guide the development of improved algorithms. An analysis and visualisation tool was developed to identify optical waters types from clusters in nLw ratio plots. This was used to classify optical water types by characteristic spectral shape, and to relate these water types to specific locations in MODIS images of the Irish Sea and Bristol Channel. Two of the optical water types identified correspond to those proposed by McKee et al, (2007) based on inherent optical properties, but other clusters indicate that a more flexible classification scheme is required for this geographical region.

MERIS CalVal matchup database

Kathryn Barker and Sam Lavender, ARGANS Ltd. (KBarker@argans.co.uk)

ARGANS Limited is a subcontractor to ESA, for the ongoing MERIS Calibration and Validation activity. A growing database of in situ normalised water leaving radiance is being populated, to emulate the NASA SIMBIOS database. Wide-ranging European research institutes have been contacted and expressions of interest have been received, and contact will be extended worldwide to increase the range of in situ data received. Data received so far is undergoing formatting for data conversion, normalisation and traceability, and will be made available to the MERIS Quality Working Group, for validation and calibration, via the Brockmann Consult CalVal Portal.

AlgaRisk: predicting harmful and nuisance algal blooms using EO data and ecosystem forecasts

Peter Miller and Jamie Shutler, Plymouth Marine Laboratory; John Siddorn and Martin Holt, Met Office, Exeter; Roger Proctor Proudman Oceanographic Laboratory, (pim@pml.ac.uk)

AlgaRisk is an innovative effort to apply an operational ocean ecosystem forecast to the problem of predicting harmful algal blooms (HABs) around the UK coast, incorporating validation against Earth observation (EO) data and in situ samples. The Met Office runs a series of nested operational marine models giving forecasts of the marine environment: the Medium-Resolution Continental Shelf (MRCS) model gives 7 km resolution 3-D predictions of the NW European continental shelf of the physical state, depth-resolved light conditions, biochemistry and biology including plankton biomass. The model is run operationally with a five day forecast. The model complements the EO data in providing a number of additional parameters at the surface and within the water column, and fill in gaps where satellite coverage is limited (for instance due to cloud cover). It also provided flow fields to allow users to determine where existing blooms will advect. A pilot project was run in association with the UK Environment Agency (EA) Southwest over the summer of 2007 to assess the feasibility of forecasting exceptional algal blooms in coastal waters. This combined EO observations, coupled physics-ecosystem model and meteorological forecasts in a rules-based (fuzzy logic) system to predict the probability of blooms occurring 1-2 days ahead in 10 defined coastal regions. A high probability resulted in increased monitoring of beaches by EA to validate the forecasts. This pilot has demonstrated that a practical forecasting scheme can be implemented, and AlgaRisk willl provide a nuisance bloom warning pre-operational service for the 2008 season for EA Southwest and one other region. Future work will consider requirements for transition to an operational UK-wide service for Defra/EA in support of the European Bathing Waters directive; discrimination of certain HABs from nuisance blooms; and application for blooms affecting shellfish harvesting areas for the Foods Standards Agency.