

GlobColour: A European Service for Ocean Colour supporting Global Carbon-Cycle Research and Operational Oceanography

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ABSTRACT

The aim of GlobColour is to develop and demonstrate an earth observation 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 a community represented by the specific user groups. It has produced a 10-year datasets that has been validated within the consortium and has been made freely available via the WWW for potential users to download. Current activities include the continuation of the dataset in near-real time and the development of new products.

INTRODUCTION

In 2005, the International Ocean Colour Coordinating Group (IOCCG) convened a working group to examine the state of the art in ocean colour data merging, which showed that the research techniques had matured sufficiently for creating long multi-sensor datasets (IOCCG, 2006). As a result, ESA initiated the Data User Element (DUE) GlobColour project (<http://www.globcolour.info/>) to develop a earth observation (EO) based dataset to support global carbon cycle research. The aim was to satisfy the scientific requirement for a long (10+ year) time-series of consistently calibrated global ocean colour information with the best possible spatial coverage. This was to be achieved by merging together data from suitable sensors: SeaWiFS on GeoEye's Orbview-2 mission, MODIS on NASA's Aqua mission and MERIS on ESA's ENVISAT mission.

In setting up the GlobColour project, three user organisations were invited to help. Their roles are to specify the detailed user requirements, act as a channel to the broader end user community and to provide feedback / assessment of the results. The International Ocean Carbon Coordination Project (IOCCP) based at UNESCO in Paris provides direct access to the carbon cycle modelling community's requirements and to the modellers themselves who will use the final products. The UK Met Office's National Centre for Ocean Forecasting (NCOF) in Exeter, UK, provides an understanding of the requirements of oceanography users, and the IOCCG bring their understanding of the global user needs and valuable advice on best practice within the ocean colour science community.

PROJECT OUTLINE

The three year project kicked-off in November 2005 with the first year being a feasibility demonstration phase that was successfully concluded at a user consultation workshop in December 2006. Error statistics and inter-sensor biases were quantified by comparison with in-situ measurements from moored optical buoys and ship based campaigns. The second year was dedicated to the production of the 10-year time series. In total, more than 25 Tb of input (level 2 – L2) data were ingested and 14 Tb of intermediate and output products created, with 4 Tb of data distributed to the user community. Quality control (QC) is provided through the Diagnostic Data Sets (DDS), which are extracted sub-areas covering locations of in-situ data collection or interesting oceanographic phenomena. The Full Product Set (FPS) is made freely available via the GlobColour WWW site and includes global merged ocean colour products in the 1997-2006 time period.

The products include daily, 8-day and monthly data sets at 4.6 km resolution for, chlorophyll-a concentration, normalised water-leaving radiances (412, 443, 490, 510, 531, 555 and 620 nm, 670, 681 and 709 nm), diffuse attenuation coefficient, coloured dissolved and detrital organic materials, total suspended matter or particulate backscattering coefficient, turbidity index, cloud fraction and quality indicators. Error statistics from the initial sensor characterisation are used as an input to the merging methods and propagate through the merging process to provide error estimates within the output merged products. These error estimates are a key component of GlobColour as they are invaluable to the users; particularly the modellers who need them in order to assimilate the ocean colour data into ocean simulations (GlobColour, 2007a).

During 2007, an intensive phase of validation was undertaken to assess the quality of the data set and also provide an inter-comparisons between different merged datasets. Both the final products and the quality assessment were presented at a second user consultation in November 2007 (presentations from both the first and second workshops are available on the GlobColour WWW site). In 2008, the project continues to merge MERIS and MODIS ocean colour data, with a global daily delivery in near-real time (NRT) to primarily support operational oceanography.

PROCESSING

A pre-processing is applied to each sensor, just after extraction of the L2, which involves any required conversions (e.g. reflectance into normalised water leaving radiance for MERIS) and the application of a cross calibration look-up table (LUT) determined through the cross-characterisation exercise. The data is then spatially binned onto a global integerised sinusoidal (ISIN) grid by employing a flux-conserving algorithm, merged and then temporally binned.

Three different merging methods were prototyped: simple averaging, error-weighted averaging and an advanced retrieval based on fitting an in-water bio-optical model to the merged set of observed normalised water-leaving radiances. This third technique is also being utilised by the NASA Ocean Color Time-Series Project, and is termed GSM because it originates from the Garver & Siegel (1997) bio-optical model (Maritorena &

Siegel, 2005). Two different families of merging strategies were chosen and are currently implemented: merging of bio-optical properties – the weighted approach is used where cross-characterisation information is available; application of bio-optical models for calculating ocean-colour products (GSM method).

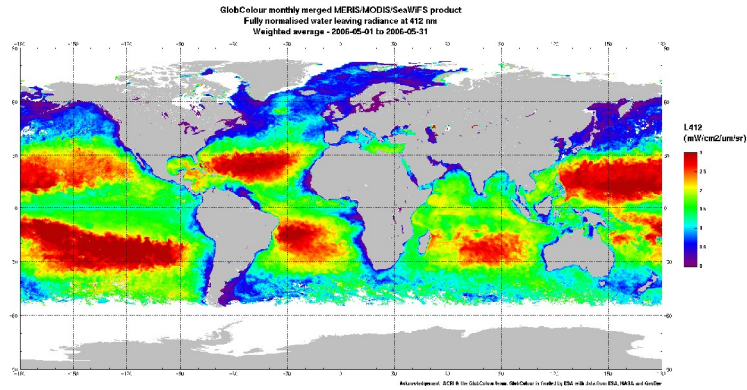
Figure 1 shows four example products. The L412 composite (Figure 1a) has the lowest values corresponding to coastal seas where the influence of Coloured Dissolved Organic Matter (CDOM) is important e.g. the Baltic. The composite also shows the oligotrophic gyres (low values), equatorial zones (moderate values) and coastal upwellings (high values). The L555 composite (Figure 1b) shows a homogeneous distribution, which would be expected at this wavelength that is close to the ocean reflectance “hinge point” (Clarke *et al.*, 1970). Areas with high values include the North Atlantic where coccolithophore blooms are known to occur and turbid coastal waters such as the North Sea. The CHL1 distribution derived by a weighted average of the OC4 MERIS equivalent algorithm (Morel *et al.*, 2007) applied to all the sensors (Figure 1c) doesn't exhibit any obvious artefacts apart from coastal waters where the application of global empirical algorithms is known to be more problematic. CHL1 derived from the GSM method (Figure 1d) primarily has differences (lower values) in the regions of high chlorophyll concentration (e.g. coastal upwellings) which is inherent to the GSM model.

DISCUSSION

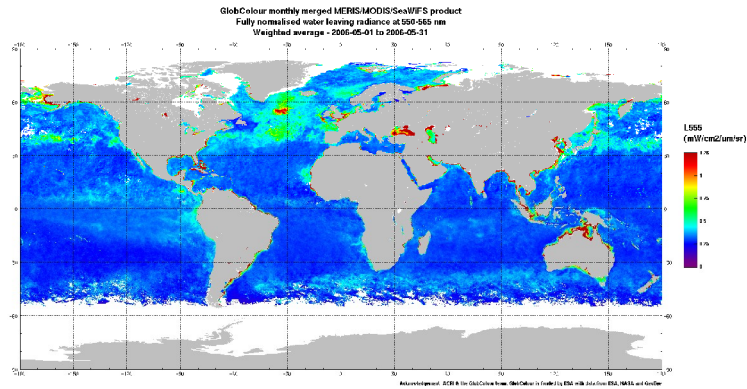
A critical component for GlobColour was the ocean colour data merging as it provides a method for the rationalisation of space missions and data distribution. However, it also requires critical preliminary steps (cross-characterisation) and a demonstration of feasibility/usefulness of the merged data. The long-term test of the dataset will be its use by the global user community and the ability to continue its creation (and need for reprocessing as the input data sets change themselves) into the future. At present, it will be an input to the European Community funded Marine Core Service through the Ocean Colour Thematic Assembly Centre (OC TAC) that aims to provide a suite of services to support Europe's decision makers.

Current activities include the operation of the service in NRT and the development of new products. Products of potential interest include the Photosynthetically Available Radiation (PAR), primary productivity, Secchi depth, heated layer depth and phytoplankton functional types. Interest has also been expressed in terms of coastal products at 1km resolution. These will be investigated during 2008 with a third user workshop in November.

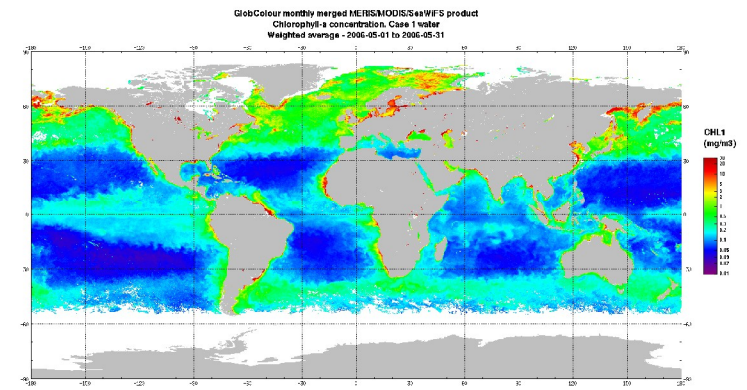
(a)



(b)



(c)



(d)

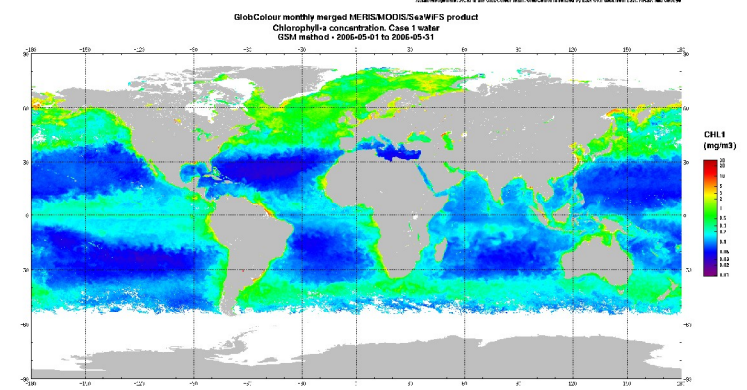


Figure 1: GlobColour May 2006 composite for (a) L412, (b) L555, (c) CHL1 (weighted average) and (d) CHL1 (GSM).

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