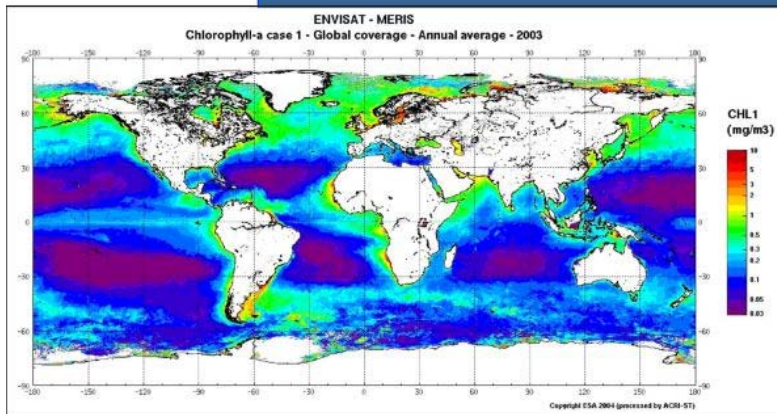


**ACRI-ST/LOV, UoP, NIVA, BC, DLR, ICESSE consortium**

**ESA DUE GlobColour**  
**Global Ocean Colour for Carbon Cycle Research**



	In Situ Range	Satellite Range
	2.40 - 2.496	-0.047 - 2.747
	2.36 - 3.005	-0.052 - 2.349
	3.08 - 3.675	0.098 - 3.299
	3.39 - 3.357	0.298 - 3.006
	0.938 - 0.095	0.187 - 3.186
	0.738 - 0.031	0.052 - 0.363
	0.794 - 0.192	0.641 - 19.930
	0.819 - 0.019	0.048 - 0.394
	0.682 - 0.042	0.057 - 0.171

SeaBASS

**Service Assessment Report**  
**Reference: GC-RS-UOP-SAR-01**  
**Version 1.1**  
**February 13, 2008**

## Document Signature Table

	Name	Function	Company	Signature	Date
<b>Author</b>	S. Lavender	Responsible for User Requirements follow-up	UoP		12 February 2008
<b>Verification</b>	A. Mangin	Scientific tasks controller	ACRI-ST		13 February 2008
<b>Approval</b>	S. Pinnock	ESA Project Manager	ESA		

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	Rosa Barciela (MetO)	1

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**GlobCOLOUR :**  
**An EO based service supporting**  
**global ocean carbon cycle research**  
**Service Assessment Report**

Ref: GC-RS-UOP-SAR-01  
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# 1 INTRODUCTION

## 1.1 Overview

This document is the Service Assessment Report for the GlobColour EO service. The aim is to document the validation of the FPS, end user opinions, cost benefit analysis and long-term sustainability conclusions.

## 1.2 Organisation of the document

**Section 2** documents the results of the consortium validation of the FPS while **Section 3** provides a summary of the feedback received by the end users through the user consultation meeting and an email survey. **Sections 4** then concludes by providing recommendations in terms of the cost benefit analysis and long-term sustainability.

## 1.3 Reference Document

No.	Title/Description	File Reference	Version
1	GlobCOLOUR Requirements Baseline	GC-RS-UOP-RB-01	27 February 2006
2	GlobCOLOUR Validation Report	GC-PL-NIVA-FVR-01	14 December 2007
3	Full Product Set	FPS-v1.1	November 2007
4	GlobColour/Medspiration Workshop - Session 4 - <a href="http://www.globcolour.info/workshops_2_forum_agenda.html">Data Merging benefits</a> for the users - Antoine Mangin / Stephane Maritorenna, <a href="http://www.globcolour.info/workshops_2_forum_agenda.html">http://www.globcolour.info/workshops_2_forum_agenda.html</a>	5_Mangin_Merging_Benefit_v1.0.ppt.ppt	November 2007

## Acronyms

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AD	Applicable Document
ADEOS	Advanced Earth Observation Satellite
AR	Acceptance Review
ATD	Acceptance Test Document
AATSR	Advanced Along Track Scanning Radiometer
AMESD	African Monitoring of the Environment for Sustainable Development
AVHRR	Advanced Very High Resolution Radiometer
BC	Brockmann Consult
BEAM	Basic ERS and Envisat (A)ATSR and MERIS Toolbox
BOUSSOLE	Bouée pour l'acquisition de Séries Optiques à Long Terme
CDOM	Coloured dissolved organic matter
CDR	Critical Design Review
CoP	Conference of the Parties
CF	Climate and Forecast
CFI	Customer-furnished item
CNES	Centre National d'Etudes Spatiales
COTS	Commercial Off-The-Shelf software
CZCS	Coastal Zone Color Scanner
DDF	Design Definition File
DDS	Diagnostic Data Set
DJF	Design Justification File
DLR	Deutsches Zentrum für Luft- und Raumfahrt
DPM	Detailed Processing Model
DRD	Document Requirement Definition
DUE	Data User Element of the ESA Earth Observation Envelope Programme II
ECSS	European Cooperation for Space Standardization
EEA	European Environment Agency
EO	Earth observation
EOSDIS	Earth Observing System Data and Information System
ESL	Expert Support Laboratories
FP	Final Presentation
FP6	EC Framework Programme 6
FPS	Full Product Set
FR	Full Resolution (300 m for MERIS)
FTP	File Transfer Protocol
FVR	Full Validation Report
GAC	Global Area Coverage (4 km sub-sampled SeaWiFS product)

GC-merging group	GlobColour merging group
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GOMOS	Global Ozone Monitoring by Occultation of Stars
ICESS	Institute for Computational and Earth Systems Science
IDDS	Initial Diagnostic Data Set
ITT	Invitation to tender
IOCCG	International Ocean Colour Coordinating Group
IOCCP	International Ocean Carbon Coordination Project
IOP	Inherent Optical Property
IODD	Input Output Data Definition
JPEG	Joint Picture Experts Group
JRC	Joint Research Center
KO	Project kick-off
LAC	Local Area Coverage (1 km SeaWiFS product)
LMD	Laboratoire de Météorologie Dynamique
LOV	Laboratoire Océanologique de Villefranche-sur-mer
MERIS	Medium Resolution Imaging Spectrometer
MERSEA	Marine Environment and Security for the European Area – Integrated Project of the EC Framework Programme 6
MetO	Met Office
MM5	Meteorological Mesoscale Model from NCAR University
MOBY	Marine Optical Buoy
MODIS	Moderate Resolution Imaging Spectrometer
netCDF	Network Common Data Format
NIVA	Norwegian Institute for Water Research
NOMAD	NASA Bio-Optical Marine Algorithm Data Set
NRT	Near-real time
OCTS	Ocean Color and Temperature Scanner
PC	Personal computer
PDF	Adobe portable document format
PDL	Parameters Data List
PDR	Preliminary Design Review
PLYMBODY	Plymouth Marine Bio-Optical Data Buoy
PM	Progress meeting
PMP	Project Management Plan
POLDER	Polarization and Directionality of the Earth's Reflectances
PP	Primary Production
PPS	Preliminary Product Set
PVAR	Preliminary Validation and Assessment Report

QR	Qualification Review
RB	Requirements Baseline document
RD	Reference Document
REASoN	NASA Research, Education and Applications Solution Network project
RID	Review Item Discrepancy
RMS	Root mean square
SAR	Service Assessment Report
SDP	Software Development Plan
SeaWiFS	Sea-Viewing Wide Field of View Sensor
SeaBASS	SeaWiFS Bio-Optical Archive and Storage System
SeaDAS	SeaWiFS Data Analysis System
SIMBIOS	Sensor Intercomparison for Marine Biological and Interdisciplinary Ocean Studies
SPR	Software Problem Report
SRR	System Requirements Review
SYS	GlobColour data processing system deliverable
TS	Technical Specification
UNFCCC	United Nations Framework Convention on Climate Change
UoP	University of Plymouth (UK)
VP	Validation Protocol
WFD	Water Framework Directive
WKS	Workshop
WWW	GlobColour web site deliverable

## 2 Overview of the Full Product Set

### 2.1 Validation Results for PPS

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#### 2.1.1 Open ocean water conclusions

The FPS has been validated with a global data set of field data (nLw's and Chl). The statistics for the nLw blue bands (412 and 443 nm) are improved compared to the individual sensors' data sets. At 490 nm nLw is by far the most homogeneous product among the 3 sensors, and so confidence in the merged product is higher for this waveband. The MODIS-A L555 is often smaller than the L555 for the two other sensors. For Chl, the statistics for the GSM Chl are a little better than those for the product from the weighted average. The time series of the chlorophyll anomalies, however, are closer to previously published data sets (i.e., Behrenfeld et al, 2006) for the weighted average chlorophyll.

Overall, the merged product has not degraded the situation as compared to the single sensors data sets. However, good results can result from compensating effects, in particular between MODIS-A and MERIS, and the FPS is often close to the SeaWiFS data set alone. Therefore, the FPS is definitely qualified and usable for e.g. assimilation into global models (there is a pixel-by-pixel error bar delivered with the GSM Chl)<sup>1</sup>. It is not yet qualified to perform temporal analysis over the period 1998-2007 i.e. it doesn't yet meet the standards for being qualified as a "climate quality data record". However, qualification of trends/cycles has already been initiated by the GlobColour team and first results shown at the second GlobColour User Workshop (see [RD6]).

#### 2.1.2 Coastal case 2 water conclusions

The best results are from the Ferrybox data set. Although not originally designed for Case II waters, the GlobColour GSM01 merging algorithm seems to be fairly robust when applied to coastal waters according to this validation. Therefore, GlobColour merged products have potential for investigating seasonal to inter-annual relative variability in the coastal zone. However, validation of merged case I products in coastal Case II waters presents the same limitations as with non-merged products, and therefore large errors. In addition, the GlobColour FPS was not designed for coastal waters i.e. has a relatively coarse resolution and the application of Case I techniques. Improvements also need a better in-situ dataset for coastal case II waters.

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<sup>1</sup> The quality of the data set is sufficient to meet the needs of operational users, but actual implementation would depend on negotiating suitable data access agreements with the data providers.

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## 2.2 Recommendations from the Validation Report

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- We need several in situ long-term time series, in order to add the temporal dimension to our statistical analyses (match ups).
  
- An international effort is still needed to standardize & improve the vicarious calibration methodologies. We are still not at the desired level of confidence to answer “climate questions” (see, e.g., Ohring et al., EOS Trans AGU, 88(11), 13 march 2007)
  
- Establish a collaborative frame between space Agencies (ESA, NASA and others), so that vicarious calibration and related issues (atmospheric corrections) can be standardized. This may need a specific body where these issues are discussed and the methods are implemented (see, e.g., The GHRSSST).
  
- Incorporate new approaches, for instance where the TOA level-1 observations of all instruments are processed the same way (same algorithm), which also means that they are all vicariously calibrated against the same standard. It might become obvious at some point that this approach is mandatory if one thinks to CDRs (“climate quality data records”).

## 3 User Assessment of the Full Product Set (FPS)

### 3.1 Phase 1 User Feedback Meetings

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#### 3.1.1 PM1, 03-04 January 2005

- Make MERIS level 3 available through sever so Level3 products are available to users prior to the GlobColour merged ones.
- IOCCG: Will discuss any issues raised at S Korean meeting next week and then give feedback by the 15 Jan 06.
- IOCCP: Approximately 150 scientists working with them. User contacts are Cyril Moulin (Remote Sensing / Modelling) and Dorothee Baker (Historical Data Sets).
- 

### 3.2 1<sup>st</sup> GlobColour Workshop

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The GlobColour PPS and project as a whole was presented to the combined GlobColour/Medspiration community at a meeting in Villefranche sur mer (France) on the 4th – 6th December 2006. In this section (previously Section 3.0 of the PVAR) is the collated feedback from the combined user community taken as notes by Samantha Lavender during the consultation meeting.

#### **Odile's presentation – Overall project organisation**

Janet Campbell (University of New Hampshire, USA) – request for more coastal DDS sites. [In offline discussions with Samantha Lavender it was agreed that she would be consulted further as one of the DDS sites (08) possibly covered her areas of interest, but this needed checking in terms of extent].

Medspiration – Have the same sites as Medspiration? They currently have over 200 sites primarily for data quality monitoring. It had previously been agreed that the GlobColour sites would also be Medspiration sites and this has occurred. There will be a meeting on the 5th February 2007 between GlobColour and Medspiration to discuss possible further collaboration between the projects on this area.

### **Sam's presentation – In situ database and characterisation**

Ian Robinson (Medspiration & National Centre for Oceanography, UK) – Have sub-pixel errors and the depth variation of chlorophyll concentration been considered in the in situ database and characterisation process? Both these issues are recognised and will be kept in mind during the FPS validation where an increased number of in-situ matchups will be available. The datasets currently being used (e.g. OBPG) often only have a single chlorophyll value rather than a depth profile or duplicate measurements so it is difficult to assess this issues. However, CV (spatial coefficient of variation) is used in assessing pixel variability in the macro (5x5) subset that is used in the match-up.

Janet Campbell (University of New Hampshire, USA) – Definition of median % difference? She currently uses RMS, but it's recognised that this overestimates the error and so she was interested in also using the median % difference that GlobColour has used as one of its key statistics.

Janet Campbell (University of New Hampshire, USA) – Which chlorophyll algorithm does GlobColour use? We use the standard algorithms as inputs, but these are converted to a "MERIS-like" algorithm in the merged averaged weighted product. However, conversions are provided in the Product Guide so that this can be converted to a "SeaWiFS-like" or "MODIS-like" product. For the GSM merged products the nLw's are inputs and the GSM inverse IOP model chlorophyll is the output.

### **David's presentation – Trade-off analysis**

The summary of the presentation was that:

- For phase 2 of GlobColour, the weighted average and GSM01 are recommended. This also means that 2 chlorophyll products will be available.
- Characterisation should be a permanent process throughout the project (regular updates when more data are available).

### **Gilbert's presentation – the GlobColour products**

Ian Robinson (Medspiration & National Centre for Oceanography, UK) – The chlorophyll and Kd products will not be accurate in coastal waters, how is GlobColour dealing with this? In turbid Case 2 waters the EL555 flag will flag these pixels and the GSM merging should be able to cope, at least partially, with the influence of CDOM. In GlobColour these potentially less accurate pixels are not removed, but flagged and given a larger error bar. Medspiration takes a different approach of removing less accurate data from its level-3 and level-4 products. A preview of the performance of the GlobColour products in Case 2 waters is given in Section 2.3.

### **Ralf's presentation – the GlobColour tools**

Ken Casey (NOAA, USA) – Has SeaDAS been taken into account when designing the GlobColour tools? No, but SeaDAS doesn't have the capability to read MERIS data and has the ability to extract points along a cruise track but not any statistical analysis. BEAM has been selected as the viewer for the GlobColour product. However, routines for reading GlobColour products will be made available on the GlobColour WWW site.

### **Comments/questions from presentation within the remainder of the meeting are listed below.**

Edward Armstrong (JPL, USA) – Is GlobColour's metadata compliant with climate metadata standards? Particular attention should be paid to ISO19115. GlobColour has followed the Medspiration netCDF format as a method for being compatible...

Samantha Lavender has taken on action to liaise with Edward Armstrong & Ken Casey so that GlobColour can take this onboard before producing the FPS. PPS product samples will be delivered for feedback.

Craig Donlon (Medspiration & Met Office, UK) - The level2P SST products contains MODIS (Aqua & Terra) chlorophyll and Kd as ancillary data for assessing diurnal warming. GlobColour is happy to provide ocean colour products for this purpose.

Jean Tournadre (IFREMER, France) – SST and chlorophyll are used in a mussel growth model by Francis Gohin.

Andre Morel (GlobColour & LOV, France) – presented several new products that could be produced including euphotic depth, Secchi depth and depth of the heated layer. The last one was of particular interest to the SST community. Also, the representative of the marine navy (Capitaine de Corvette, Remi Thomas) stated his high interest in the Secchi depth product.

Stephane Maritorena (GlobColour & ICES/UCSB, USA) – Within GlobColour the GSM merging accounts for nLw input uncertainties and is produced at 4.63km resolution, while in REASoN it is not weighted and at 9km resolution. A forward version is being implemented after merging so that the nLws can be regenerated and checked against the original nLws for quality control (residual monitoring).

Janet Campbell (University of New Hampshire, USA) – She summarised that 35% error is a myth and 50% is much more reasonable. If the errors in chlorophyll are binned into different chlorophyll levels then the errors are smallest in the region where most chlorophyll values are.

Veronique Garcon (LEGOS/CNES, France) – Presented research on the following merging techniques: Error Weighted Average; Objective Interpolation (OI); Wavelets. In the future wavelets may provide a good compromise between the other two: retains the structure, but can fill-in cloud gaps.

Frederick Melin (JRC, Italy) – Presented an approach similar to GSM as implemented within GlobColour. Melin et al. (Accepted) RSE includes an approach for aerosol merging.

Robert Frouin (Scripps Institution of Oceanography, USA) – the method for deriving PAR that has previously been implemented for SeaWiFS and MODIS has now been implemented for MERIS as part of GlobColour. Merging all three sensors would allow an account for diurnal variability, but this would require processing to start from level-1 and so at the moment just the MERIS PAR will be produced by GlobColour.

Rosalia Santoleri (CNR, Istituto di Scienze dell'Atmosfera e Del Clima, Italy) – Presented a case study of the Mediterranean Sea as part of MERSEA. Found that the standard chlorophyll products are overestimating chlorophyll and so has developed a local algorithm (MEDOC4). Would like single sensor co-located Rrs data from GlobColour for the Mediterranean; it would be helpful to have all the data in a single format.

Cyril Moulin (LSCE - CEA, France) – Presented the result of deriving phytoplankton functional types from the differences between nLw spectra and expected nLw spectra. Could be implemented as a future GlobColour product.

Rosa Barciela (Met Office, UK) – Have developed an assimilation scheme to take ocean colour data into their FOAM modelling system, by early 2008 it will be an operational system.

Needs from GlobColour:

- L2GAC chlorophyll with errors from the merged and individual sensor data
- Improved chlorophyll accuracy i.e. errors of less than 35%
- 4 km resolution data is sufficient for the current model resolutions
- SST & ocean colour products combined in a single file
- Validation so that large biases can be corrected for at the sensor level
- Long term provision of quality controlled and timely (1 day) data
- Shelf sea specific requirements – contact Martin Holt

Ken Casey – GlobColour should adhere to the GCOS Climate Modelling Principles. Possibility of including GlobColour products within the NOAA Long Term Stewardship & Reanalysis Facility (LTSRF) as there is a need for a joint reanalysis of ocean colour and SST products.

Odile (GlobColour & ACRI-ST, France) – Summary of main points:

- Ocean colour community is not structured as are the altimetry or SST ones.
- Community is also much larger and cannot be limited to oceanography modellers.
- Need for strong requirements/users federation (through IOCCG?) like GHRSSST for SST.
- Parallel architecture definition and setting up with SST world to favour synergies and information exchanges.
- GlobColour can interface with Medspiration to increase consistency of products delivery towards our common end users GlobColour could provide the met-ocean input to MARCOAST.
- There is a need for coordinated validation efforts within Europe.

Craig Donlon Medspiration & Met Office, UK) – There should be a strong link between GlobColour and Medspiration, with possibly an equivalent of GHRSSST for ocean colour. Future DUE project could be GlobSEASON which would utilise both datasets as inputs to predicting seasonal weather. Need for GlobColour to be engaged with its user community.

Helge Rebhan (ESA/ESTEC) – Sentinel-3 will be an altimeter plus visible/infra red imagery for ocean colour and SST. This must have coastal as well as open ocean applications because of the European user community. The ocean colour sensor (Ocean & Land Colour) must have an equivalent accuracy/precision to MERIS. Currently the specifications include 15 bands (includes a fluorescence band), 1-4km global resolution and 200m coastal resolution, and will be tilted so that sunglint will have a reduced impact. The current plan is that there will be two rather than one satellite so that it can truly have global coverage in 1-3 days. Launch in 2011/2012. Questions focused on the need for an improved accuracy of the NIR wavebands for atmospheric correction and crossing time; the current planned crossing time of 10:00 is not ideal for ocean colour.

Simon Pincock (ESA/ESRIN) – Meeting summary:

- Need to strengthen/broaden the ocean colour community.
- Synergies with Medspiration on DDS, formats and metadata.
- Need for an ocean colour equivalent of GHRSSST?
- New user requirements, e.g. PAR, Case 2, warming depth, Secchi disk, to be monitored and new (useful) products to be included as research provides suitable validated methods.
- Utility of GlobColour merged nLw for PFTs.
- Intercomparison with other merging methods.
- New dissemination methods (Google-Earth).
- Rigour, uniformity and honesty in error statistics – need to develop an operational & centralised quality control approach?
- Development of multi-disciplinary integrated (SST + OC + ...) data sets for model assimilation, seasonal forecasting, etc
- Need to prepare for a probable gap between ENVISAT and Sentinel-3 data supply, and how to manage the impact of this gap on the users.

## 3.3 Phase 2 User Feedback Meetings

### 3.3.1 PM5, 21 March 2007

- GlobColour products:
  - o John Siddorn (Met Office): Interested in sediment, CDM and Chlorophyll (Chl); algal bloom short term forecasts at 12km, 7km and 1 nautical mile model resolution. In the future IOPs; products from Sentinel 3? PAR would be used for validation rather than assimilation.
  - o Mathew Martin (Met Office): Interested in having swath data (level 2); via Marine Core Services and/or as a level 2P GHRSSST type products?
  - o Jim Gunson (Met Office) [from discussion session]: climatology of monthly Chl means. Interested in PFTs, Cloud Fraction (CF) and Aerosol Optical Thickness (AOT).
- BIODIVERSITY: GlobColour could start producing NRT data for them in July and the globally from January 2008
- MERSEA: 1/16 degree model resolution for North Atlantic.
- Definition of NRT: Marine Core Services, less than 1 day? Sentinel 3, 3hrs
- AOT– should have by-product caveat? Can do some work in phase 2 on validation as we can do sensor comparison and have the Aeronet *in-situ* data.

#### Discussion of Case 2/coastal waters.

- Ken: comment from US that MERIS is uncalibrated. Actually there is a different approach to validation, MERIS is vicariously validated. Address in NASA OCRT presentation. Odile also to send Ken information.
- POLDER: latest news about Polder/Parasol are that ocean colour products are now of good quality. Will not include at this time as the decision deadline has passed. Future inclusion of both POLDER datasets?
- Resolution/projection requirements:
  - o Cara: PC at 4.63km for fisheries. Therefore, need method of conversion as currently ISIN.
  - o John: Would also need to include other projections as PC is not always the best.
  - o Possible method of support: subscription service; example code e.g. C and IDL.
  - o 18 line problem with ISIN to PC conversion, caused by round off error and in legacy software. Maybe solved by GlobColour by using flux conservative rather than nearest neighbour interpolation.
- Cara: fisheries users are often using ArcGIS and so need an easy way for accessing /importing remote sensing data. Put data on OpenDap server so that is can be accessed by the NOAA tools/users? Will be a requirement for the marine core services.

## Discussion Session

Case 2 / coastal waters:

- 4.63km is not ideal.
- DDS can be any size and so interested users can ask for DDS sites rather than having to download global data.
- ESA are now routinely processing full resolution MERIS over Europe.
- Sentinel-3 will be systematically processing data at 300m resolution and then resampled to a coarser resolution.
- Coastal spin-off of GlobColour?

Links with GHRSSST:

- Have a proximity confidence flag that can be a subjective indicator of quality for the users.
- Create the equivalent of Level2P for ocean colour – level 2 with error information and ancillary data. Needs an iterative processing loop.
- Should be seen also in the context of the future Marine Core Service.
- Mechanism for GROC? Ocean colour equivalent of GHRSSST.
- GlobColour could do this experimentally for MERIS and MODIS.
- PODAAC to ingest GlobColour 10 year archive? Send to JPL as “real time backlog” for 10 year archive and then real time when phase 3 service begins.
- Could be helped if GlobColour became a RDAC.
- GHRSSST science team meeting in May, send representative?
- PODAAC interfaces with RDACs via FTP grab/put.
- CNES could also be an RDAC for POLDER and NASA for MODIS.
- Could give GlobColour POET interface for regional subsetting.

GHRSSST intercomparison:

- being performed by Ken on a limited basis
- could also include ocean colour merged datasets. In addition to GlobColour: LOV/Miami top of atmosphere approach; ReasonCAN; Fredrick Melin (Lwn), but not produced operationally?; MERSEA OI, experimental in North Atlantic (Claire Pottier); MARCOAST: regional blended analysis; Watson Gregg, climate model.

NOAA links:

- For fisheries cloud cover /holes is an issue. Modellers prefer the holes as they can then do the interpolation themselves.
- Have produced Primary Production using Behrenfeld and Falkowski model, available via NOAA Coastwatch site. Useful product for GlobColour, could use a widely recognised model rather than debating advantages of one versus another.
- IOOS links? OCPPOP? There is also a need for regional algorithms e.g. Chesapeake Bay. Coastwatch – Paul DiGiaccamo. Would only be interested in NRT.

### 3.3.2 PM6, 03-04 July 2007

- User requirement for CaCO<sub>3</sub> concentration for model validation - available for MODIS.
- User requirement exists for spatial sub-sets: 2<sup>nd</sup> GlobColour Workshop, ACRI will develop a WWW service with this capability.
- NRT service for DUE Biodiversity project: started in 2007 and reported at 2<sup>nd</sup> GlobColour Workshop.
- UEA user interest in 4-day composites for monitoring algal bloom development.

## 3.4 2<sup>nd</sup> GlobColour Workshop

The GlobColour FPS and project as a whole was presented to the combined GlobColour / Medspiration community at a meeting in Oslo (Norway) on the 20-22 November 2007. In this section the collated information / feedback from the combined user community taken as noted by Samantha Lavender during the consultation meeting.

### 3.4.1 Ken Casey (NOAA)

- NOAA are developing MERIS RR usage/operational processing.
- There is an interest in MERIS FR and raw L1A data.
- IOOS includes both Harmful Algal Blooms and Integrated Ecosystem Assessment. A coastal GlobColour is of interest – do coastal within GlobColour rather than “or”. There is also an interest from Coastwatch.
- Way Forward: Draft a Submission Agreement

### 3.4.2 MyOcean presented by Johnny Johannessen

- 3rd-4th Quarter 2008 kick-off
- Marine Core Service will only include Chl-a, not other products.
- However, it will provide a route for the continuity of GlobColour from 2009.

### 3.4.3 Discussion

- Ian Robinson – end users for colour are not modellers, want direct colour measurements
- Biodiversity - Need primary production; they also request to favour the spatial coverage against the accuracy. This in turn means that GlobColour should include an option to perform data kriging.
- Coastal zones:
  - o Global Case II Chl for assessing role of coastal zones in carbon flux
  - o Use of MERIS-FR for operational applications (including NRT Level-2 availability) – super sites around the world
  - o Carsten Brockmann – also CDOM and SPM plus other users / FR – case2 regional processor to be released in Dec (users own level-2 processor)
  - o IOOS/Coastwatch interested in FR

- Inclusion of PARASOL as 4th sensor (also possibility of including Indian sensors)
- Need for cloud-free analysed Chl product (DIVERSITY, all NRT surveillance services like e.g. monitoring of mesoscale eddies)
- Need for new products: primary prod, pCO<sub>2</sub>, PAR....Craig Donlon - Zhl
- Distribute ocean colour products to African users via ESA/DDS and Eumetcast?
- IFREMER – downstream services?
- African monitoring for sustainable development –MED/GL products of great interest near Indian ocean
- Connect to large marine ecosystems programmes in Africa

### 3.5 Post 2<sup>nd</sup> GlobColour Workshop Email Survey

After the November meeting an email survey was distributed to the end users with the following statements:

1. GlobColour has produced a 10 year set of merged products for MERIS, MODIS and SeaWiFS. The dataset contains an extensive list of products using various merging techniques (see Session 2, Odile Hembise's and Gilbert Barrot's presentations).
2. From the Phase 2 validation (see Session 2, David Antoine's and Dominique Durand's presentations) and an intercomparison of merged products (see Session 2, Stephane Maritorena's presentation) we believe that the results are as good as comparable products.
3. The products are available to download via the WWW and a near-real time (NRT) service is starting; the NRT service has been running for the DIVERSITY project (see Session 4, Philippe Gaspar's presentation).
4. A coastal water extension and additional products are under consideration (see Session 4 Samantha Lavender's presentation and the final summary presentation by Olivier Arino (and Simon Pinnock) in Session 5).

Comments were sought on the with respect to the original user requirements and any further comments. As per the 17<sup>th</sup> December 2007 the following comment has been returned:

#### 3.5.1 James Yoder, IOCCG

1. IOCCG Comments: Eric Thouvenot's presentation on behalf of IOCCG at the GlobColour meeting showed examples of how these products are being used, and will be used in the future for research and for societal benefit (e.g. as part of the GEO/CEOS implementation of the Global Climate Observing System (GCOS). I strongly endorse the summary of his presentation which made three important point: we still lack sufficiently long satellite time series to sort out differences between cycles and trends (i.e. some ocean cycles, e.g. the Pacific Decadal Oscillation, are longer than a decade); we need to sustain an international effort to make sure we can link one satellite data set to another to build the long time series that we need to distinguish change from cycles; and GlobColour is definitely a significant step in that perspective.

2. IOCCG Comment: IOCCG does not have an independent effort to evaluate products. As an individual, I am not familiar with Durand's work and background, but I certainly respect the opinions of David Antoine and Stephane Maritorena who are two of the best ocean color scientists in the world.

3. IOCCG comment: IOCCG supports efforts to make ocean color data and imagery easily available via the web and FTP, and we are very pleased to see the GlobColour products easily accessible.

4. IOCCG comment: I did not find details of what is being considered for a coastal water extension. IOCCG recognizes the importance of coastal water sensing and the difficulty of doing so as discussed in IOCCG Reports #3 and #5. A global coastal water product which included 300-m resolution MERIS data (when available) perhaps embedded within merged 1km MERIS, SeaWiFS and MODIS imagery would be a unique and useful data set for coastal research and applications and well received by the international community.

### **3.5.2 IOCCP, Cyril Moulin**

1. I must say that I am quite impressed by the work you have done so far within GlobColour. This 10-year dataset is going to be very useful for carbon studies and global modelling.

2. Yes, and the error bars are also very useful for modelers.

3. Great.

4. Sam's presentation suggests that phytoplankton type might become an additional product. This is interesting for carbon studies because the various types do not have the same efficiency with respect to carbon fixation and export. What are your plans for the future about these products?

### **3.5.3 Met Office, Rosa Barciela**

1. This meets Met Office requirements. It is interesting to see the difference in the chl product given by the different merging techniques, which suggests that the final product is perhaps (?) immature.

Potentially this can be confusing to the end-users who need to know the reasons behind those differences as well as which product is best.

2. It appears to be the case in most cases, which is reassuring.

3. NRT delivery, due to start in 2008, would be a good test for the timeliness and reliability of the merged product. The Met Office is in a unique position to test this aspect of GlobColour given the right funding is in place.

4. This will be an excellent follow-on to the project. The Met Office is also interested in this aspect, mainly for validation purposes

## 4 Analysis of the User Financial Costs & Benefits of a Service Continuation

### 4.1 Near real time service

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The near real time production started in Phase 2 for the BIODIVERSITY project and has been running well. In Phase 3 it will be run primarily for the GlobColour operational users i.e. the Met Office. However, operational users do need time and resources to change over to a new data stream and also confidence that this will be provided into the future. One delivery process for this is the Marine Core Services (MyOcean), which will probably start towards the end of 2008, but they are only interested in Chlorophyll at this time. This reflects the current state of the biological modelling assimilation that is still in its infancy.

### 4.2 Off-line service

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The FPS has been made available via the GlobColour WWW site as an FTP link. This has proved to be very popular (see in Annex 1 the log of user access), but has caused both the project and users difficulty in terms of the amount of data to be downloaded for the full global dataset. Solutions to this have been:

- Providing the whole data set on tape
- Offline sub-setting data on behalf of the users

Future scenarios also include:

- A WWW interface for on-line sub-setting
- Distribution of data via European and international data centres

The final scenario (of providing the FPS to data centres) also allows for the long term availability and archiving of the GlobColour FPS. The following data centres have currently expressed an interest on holding an archive of the GlobColour FPS:

- NEODC (UK): there have been preliminary discussions
- NOAA (US): Ken Casey has initiated discussion through a Submission Agreement.
- World Data Center for Marine Environmental Sciences (WDC-MARE): letter from Simon Pinnock (January 2008) giving authorization to archive and publish ESA data products in the framework of GlobColour.

An issue is that the underlying individual sensor level-2 data sets will not remain static; sensor reprocessing due to instrument understanding and software updates. Therefore, if the GlobColour FPS is to remain useful and used there must be provision for recreation of the merged products using updated individual sensor level-2 products. In addition, there is an interest in including further sensors, including Parasol that was considered at the start. For these reasons, we believe that an archiving centre should also stay close to the processing centre, which is hoped (but not guaranteed) to be the case within the deployment of MyOcean.

## 4.3 Potential extensions

The following extensions have been discussed at the workshop:

1. Coastal zones
  - a. Addition of global coastal 1km products such as Case 2 Chl, CDOM, etc - perhaps only based on MERIS products
  - b. Global Case 2 CHL, CDM, TSM, ... product for assessing role of coastal zones in carbon flux
  - c. Use of MERIS-FRS for operational applications (i.e. incl. NRT Level-2 availability)
  - d. NOAA IOOS (and CoastWatch) would like a coastal GlobColour (NASA & ICESS to be involved!)
  - e. AMESD users..? & LME's in Africa.
2. Assimilation of GlobColour products into models.
3. Inclusion of PARASOL as 4<sup>th</sup> sensor, + ISRO sensors
4. Need for cloud-free analysed Chl product (DIVERSITY, are there others?)
5. Need for new products: Primary productivity, pCO<sub>2</sub>, PAR, Secchi disk depth, heated layer depth, phytoplankton Functional Types ...
6. Support IOCCP Ocean CO<sub>2</sub> from Space workshop
7. Distribute ocean colour products to African users via ESA/DDS
8. Additional hardware and consumables for wider distribution of the GlobColour products and web access

### 4.3.1 Coastal zones

Further discussion has been launched by Simon Pinnock on Jan. 7, 2008, in an e-mail addressed to James Yoder, reported below:

"There were two "coastal" ideas raised at the GlobColour November meeting in Oslo:

1. To add global 1km Case 2 products to the existing GlobColour data set, to provide a better assessment of the contribution of Case 2 waters to the global oceanic carbon cycle. If this is a feasible and useful activity, then it might be possible to do this as a small extension to the existing GlobColour project.
2. To look into a new project demonstrating the capabilities of MERIS 300m resolution data over selected coastal sites around the globe. This is what Sam is referring to, I think. This would be too large and too far out of scope to be done as part of the existing GlobColour project, and would instead have to be an entirely new project, awarded by competitive Invitation to Tender in 2009 or later. There are a number of important questions to answer before we could start a new project, such as whether the Envisat ground segment could provide the necessary data, and whether there is a User and User Requirement that does not overlap with existing GMES activities. If we were to go ahead, it would be good to build in collaboration with, e.g. US scientists for the US coastal zones, African scientists for African coastal zones, etc.

Your feedback on both these ideas would be much appreciated."

The answer from Jim Yoder was received on January 7, 2008.

“I really like both ideas, and we should probably get comments from others at the upcoming IOCCG meeting. The additional spectral data at 1 km will be very useful for continental shelf and coastal waters. The 300-m project is very exciting, and I do believe it would be an excellent approach to engage scientists with expertise and in situ data for their local coastal waters. Other processing centers might be able to help with the processing and product generation, as well. I am sure that ESA would get a lot of credit and appreciation from the international community for this type of approach. The data would provide a unique view of regional and global coastal waters, and the data set would be extremely useful for the research and applications communities.”

There is an other need of 1km ocean colour derived products over Pan-European Seas related to European regulation (e.g. WFD), and EEA reporting requirements. These users are currently served in the context of MarCoast, such ocean colour products being delivered by the water quality assessment Services of Marcoast.

#### **4.3.2 Assimilation of GlobColour products into models**

Assimilation of global merged chlorophyll into FCOF's HADOCC model is strongly supported by the UK MetOffice.

#### **4.3.3 Inclusion of PARASOL as 4<sup>th</sup> sensor + ISRO sensors**

There is a definitive interest that would benefit all users to increase the number of sensors, and hence the spatial and temporal coverage. However, the characterization effort should not be underestimated prior to make them usable in a merged data set. Their availability should also be confirmed.

#### **4.3.4 Need for cloud-free analysed Chl product**

In addition to DIVERSITY, there is a large community of users that is interested by cloud-free analysed products, including:

- Several service providers of downstream services (e.g. Marcoast)
- Marine defence
- Oceanographic campaigns (e.g. eddies tracking, front and mesoscale structures identification)
- Fish

Proceeding with cloud-free analysed Chl product is an ultimate goal, that would harmonise the products supplied by the GlobColour service with the ocean colour products delivered by the MetOcean Data Service of Marcoast. The user community of such products is already paying to get the service (Marine defence, Oceanographic campaigns).

#### **4.3.5 Need for new products: Primary productivity, pCO<sub>2</sub>, PAR, Secchi disk depth, heated layer depth, phytoplankton Functional Types**

The interest to generate this type of products on a systematic basis lies in the fact that they are nowhere available. On the other hand, we could argue that they can be easily generated at user's place once GlobColour has provided the basic inputs. Further user feedback should be provided.

#### **4.3.6 Support IOCCP Ocean CO<sub>2</sub> from Space workshop**

IOCCP is strongly supporting GlobColour, as illustrated at the last UNFCCC CoP in Bali, 2007.

In the Reporting on Global Observing Systems for climate Change, DUE GlobColour is the only identified international source for archived ocean colour information [Appendix 4, p21, table 9].

#### **4.3.7 Distribute ocean colour products to African users via ESA/DDS**

The interest to distribute ocean colour products to African users was expressed during the workshop.

- Distribute ocean colour products to African users via ESA/DDS and Eumetcast, together with Medspiration products
- African monitoring for sustainable development –MED/GL products of great interest near Indian ocean
- Connect to large marine ecosystems programmes in Africa

This kind of demonstration could be organised in liaison with programmes like AMESD.

#### **4.3.8 Additional hardware and consumables for wider distribution of the GlobColour products and web access**

There is already a demonstrated need to ensure a wider distribution of the GlobColour products as demonstrated by the log of user access provided in Annex 1. The wider distribution means should be put in place together with an easier web access giving means to spatial sub-setting (an other user requirement expressed at PM6, 03-04 July 2007 and already put in place in a manual manner).

## 5 Annex 1 – Log of user access

During the period December 1, 2007, until January 10, 2008, 4236 products have been downloaded (about 60 Gb of data), consisting of 2234 FPS products and 2002 DDS products.

29 users from Japan, Poland, UK, Canada, Germany, Spain and United-States have retrieved data sets in addition to the data sets directly delivered to Russia (Vyacheslav Suslin), Germany (Nidia Martinez [nidia.martinez@zmaw.de](mailto:nidia.martinez@zmaw.de)), South Africa (Stewart Bernard [SBernard@csir.co.za](mailto:SBernard@csir.co.za)) and France (LOV), on specific user requests received at [service@globcolour.info](mailto:service@globcolour.info).

Here is the address IP of the connections:

122.169.14.109  
125.17.21.178  
129.247.240.244  
199.175.9.183  
77-102-160-36.cable.ubr27.newt.blueyonder.co.uk  
89.128.195.37  
97.89.114.6  
bcfire.gkss.de  
clione25.fish.hokudai.ac.jp  
d600david.obs-vlfr.fr  
dyndsl-091-096-113-113.ewe-ip-backbone.de  
eniac.atm.ox.ac.uk  
ex116.jamstec.go.jp  
gluglu.cmima.csic.es  
h12-98.pac.dfo-mpo.gc.ca  
malina.uqar.quebec.ca  
meris.who.edu  
monsun.ocean.univ.gda.pl  
nat-51-1.frascati.enea.it  
natpool4.AWI.DE  
ottgate.dfo-mpo.gc.ca  
pd5-1892904-pd.uopnet.plymouth.ac.uk  
peng-wireless.umeoce.maine.edu  
pool-71-112-20-238.stlwa.dsl-w.verizon.net  
sbelanger.uqar.quebec.ca  
spgpix.ucsd.edu  
sw-poseidon-1.ncmr.gr  
sybil.csd.plymouth.ac.uk  
twister.ocean.univ.gda.pl