GLOBCURRENT
TECHNICAL REQUIREMENTS BASELINE

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2.0	14 Feb 2014	Draft revision	Added a few REQ leads
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7.3	17 August 2014	RIDS revision	Changes to comply with ESA RIDS

Table of contents

Table of Illustrations:

Table of tables

1. Introduction

1.1. Purpose and scope

The purpose of this technical Requirements Baseline (RB) document is to capture the requirements that apply to the GlobCurrent project and to record how these requirements were derived so that each of them is traceable to a unique source. This document defines and updates the scope of the project following each System Requirements Review (SRR).

1.2. Document structure

This document is organized into the following sections:

- Section 1 (this section) outlines the scope and structure of the document
- Section 2 is an overview (background and vision) of the project
- Section 3 describes the Requirements Analysis Process used
- Section 4 provides an analysis of the sources of data to be used for the GlobCurrent System
- Section 5 provides the GlobCurrent Operations System requirements
- Section 6 provides a description of the different GlobCurrent products and the associated requirements.
- Section 7 provides a description of the Validation Requirements
- Section 8 provides the Communication and User Interface Requirements
- Section 9 provides the case study requirements
- Section 10 provides the NRT demonstration requirements
- Section 11 provides the schedule requirements
- Section 12 analyses the compliancy of the RB document Requirements with the SoW Requirements

1.3. Applicable Documents

[AD-1] Statement of Work for DUE GlobCurrent project (SoW), EOP-SM/2450, Issue 2, 26 March 2013

1.4. Reference documents

The following are the publications and web sites relevant to this document.

1.4.1. Publications

[RD-1] Bonjean F. and G.S.E. Lagerloef, 2002, Diagnostic Model and Analysis of the Surface Currents in the Tropical Pacific Ocean, *J. Phys. Ocean.*, 32, 2938-2954.

[RD-2] Larnicol, G., Guinehut, S., Rio, M.-H., Drevillon, M., Faugere, Y., and Nicolas, G. 2006, The global observed ocean products of the French Mercator project, in: Proceedings of the "15 years of progress in radar altimetry" ESA Symposium, ESA, Venice, 2006.

[RD-3] Madec G. 2008: "NEMO ocean engine". Note du Pole de modélisation, Institut Pierre-Simon Laplace (IPSL), France, No 27 ISSN No 1288-1619

[RD-4] Bradski, G. R. (1998) Computer vision face tracking for use in a perceptual user interface Proceedings of the Fourth IEEE Workshop on Applications of Computer Vision,

[RD-5] Rio, M. H., S. Guinehut, and G. Larnicol (2011), New CNES-CLS09 global mean dynamic topography computed from the combination of GRACE data, altimetry, and in situ measurements, J. Geophys. Res., 116, C07018, doi:10.1029/2010JC006505.

[RD-6] Rick Lumpkin; Semyon A. Grodsky; Luca Centurioni; Marie-Helene Rio; James A. Carton; Dongkyu Lee, Removing spurious low-frequency variability in drifter velocities, JTECH-D-12-00139

[RD-7] Rio, M-H, 2012: Use of altimeter and wind data to detect the anomalous loss of SVP-type drifter's drogue. Journal of Atmospheric and Oceanic Technology DOI:10.1175/JTECH-D-12-00008.1

[RD-8] Larnicol, G., Guinehut, S., Rio, M.-H., Drevillon, M., Faugere, Y., Nicolas, G., 2006: The global observed ocean products of the French Mercator project. Proceedings of the "15 years of progress in Radar altimetry" ESA symposium, Venice, March 2006

[RD-9] Hansen, M.W.; Collard, F.; Dagestad, K.; Johannessen, J.A.; Fabry, P.; Chapron, B., "Retrieval of Sea Surface Range Velocities From Envisat ASAR Doppler Centroid Measurements," Geoscience and Remote Sensing, IEEE Transactions on , vol.49, no.10, pp.3582,3592, Oct. 2011, doi: 10.1109/TGRS.2011.2153864

[RD-10] F. Collard, A. Mouche, B. Chapron, C. Danilo, and J. Johannessen, "Routine high resolution observation of selected major surface currents from space," in Proc. SEASAR Symp., SP-656, ESA, ESA-ESRIN, Frascati, Italy, 2008.

[RD-11] Rouault, M. J., A. Mouche, F. Collard, J. A. Johannessen, and B. Chapron (2010), Mapping the Agulhas Current from space: An assessment of ASAR surface current velocities, J. Geophys. Res., 115, C10026, doi:10.1029/2009JC006050.

[RD-12] Donlon C. J. et al., 2007: The Global Ocean Data Assimilation Project (GODAE) High Resolution Sea Surface Temperature Pilot Project (GHRSST-PP). Bull. Amer. Meteor. Soc., 88, 1197-1213.

[RD-13] Fangohr, Susanne, Elizabeth C. Kent, 2012: An estimate of structural uncertainty in quikscat wind vector retrievals. J. Appl. Meteor. Climatol., 51, 954–961, doi:10.1175/JAMC-D-11-0183.1

[RD-14] Stoffelen, A. (1998), Toward the true near-surface wind speed: Error modeling and calibration using triple collocation, J. Geophys. Res., 103(C4), 7755–7766, doi:10.1029/97JC03180.

1.4.2. Web sites

[WEB-1] GlobCurrent external web site	http://globcurrent.ifremer.fr
[WEB-2] GlobCurrent internal web site	http://globcurrent.nersc.no
[WEB-3] DUE web site	http://due.esrin.esa.int
[WEB-4] SD-DAC website	http://www.aoml.noaa.gov/phod/dac/index.php

1.5. Acronyms and abbreviations

AATSR	Advanced Along Track Scanning Radiometer (of ENVISAT)
ADB	Actions Data Base
AMSRE	Advanced Microwave Scanning Radiometer – E (of EoS Aqua)
AOI	Area Of Interest
AQUARIUS	Salinity mission (of NASA/CONAE)
AR	Acceptance Review
ARR	Acceptance Review Report
ASAR	Advanced Synthetic Aperture Radar (of ENVISAT)
ASCAT	Advanced SCATterometer (of MetOp)
ATBD	Algorithm Theoretical Basis Document
AVHRR	Advanced Very High Resolution Radiometer
CDL	Common Data Language (netCDF data text notation)
CDOP	C-band DOPpler shift model
CDR	Critical Design Review
CMOD	C-band model function (wind vector – radar cross section relationship)
CNES	Centre National d'Etudes Spatiales (French Space Agency)
DIR	Directory (of project participants)
DMSP	Defense Meteorological Satellite Program (of the USA)
DUE	Data User Element
ENVISAT	Environnent Satellite (http://envisat.esa.int)
ESA	European Space Agency
EO	Earth Observation
EU	European Union
EUMETSAT	EUropean Organisation for the Exploitation of METeorological SATellites
FAQ	Frequently Asked Questions
FR	Final Report
GOCI	Geostationary Ocean Color Imager
HRDDS	High Resolution Dynamic Diagnostic Data Sets
Hs	Significant Wave Height (also SWH)
ICD	Interface Description Document
ITT	Invitation To Tender
KO	Kick-Off
MR	Monthly Report
MTR	Mid-Term Review
MDB	Match-Up DataBase
MetOp	Meteorological Operational satellite A, B, or C (ESA and EUMETSAT)
MTF	Modulation Transfer Function
MMDB	Multi-sensor Match-up DataBases
NOP	Numerical Ocean Prediction
NWP	Numerical Weather Prediction

OSC	Ocean surface current
PAR	Preliminary analysis report
PM	Progress meeting
PMP	Project Management Plan
PMR	Passive Microwave Radiometry
QR	Qualification Review
QRR	Qualification Review Report
RA-2	Radar Altimeter 2 (of ENVISAT)
RB	Reference Baseline
RD	Reference Document
SAR	Synthetic Aperture RADAR
SAR	Scientific Assessment Report (of *SOS*)
SAP	Scientific Analysis Plan
SIAR	Scientific and Impact Assessment Report
SMOS	Soil Moisture and Ocean Salinity (mission)
SOS	Surface Ocean Salinity and Synergy (project)
SoW	Statement of Work
SPR	Software Problem Report
SR	Scientific Roadmap
SRR	System Requirements Review
SSH	Sea Surface Height
SSM/I	Special Sensor Microwave Imager (of DMSP)
SST	Sea Surface Temperature
STSE	Support to Science Element
SWH	Significant Wave Height
TBC	To Be Confirmed
TBD	To Be Determined
TDP	Technical Data Package
TDS	Test Data Set
TN	Technical Note (short report 10-50 pages)
TOA	Top of Atmosphere
TR	Technical Report (long report > 50 pages)
UCM	User Consultation Meeting
UM	User Manual
URD	User Requirements Document
URL	Universal Resource Locator
WP	Work Package
WSM	Wide Swath Mode (SAR)

2. Background and Vision

Satellite altimetry, arguably the most mature technique for mapping ocean currents, has permitted breakthroughs in our understanding the dynamics of large-scale (roughly >200-km) oceanic circulation and an unequalled view of eddy kinetic energy on a global scale. Still, the conventional coarse ground track spacing of an individual altimeter is known to limit cross-track resolution to several hundred km. Similarly, multiple altimeters yield gridded maps of sea surface height (SSH) that is limited to a resolution of about 100 km and 10 days. This so-called "altimetry gap" has prompted attempts to combine the lower resolution altimeter data with sequences of medium and higher resolution satellite and in situ observations.

Direct and indirect estimates of ocean surface current and higher level derived quantities such as frontal boundaries can indeed be derived using a variety of satellite sensors, including altimetry (both conventional and SAR mode), gravimetry, SAR imaging and Doppler properties, scatterometry, optical (VIS and TIR) and passive microwaves. Sparse in-situ current measurements from drifting and moored buoys, coastal HF-radar installations, Argo floats, gliders and ship observations can also complement these satellite measurements. Each of these satellite and in-situ based measurement techniques has specific strengths and limitations (e.g., resolution, coverage, accuracy, depth integration, cloud dependence, empirical based retrieval methods, etc). By development and use of systematic data merging and sensor synergy combined with advanced processing tools and simulation models, the complementary strength of each sensing technique can be optimized. Deficiencies are thereby reduced and the final estimate of the OSC is more consistent, regular and reliable. In turn, the use and uptake of satellite based OSC derived products will grow.

The GlobCurrent project is designed to re-map the world's ocean surface currents from a growing synergy of past and present observations and to conduct a series of user-led case studies that resolve high spatial and temporal variability and the underlying processes that govern surface current dynamics. An overview of the project architecture is given in Fig. 1. This includes data ingestion, formatting, quality control, and processing to L2 and L4 products (blue), a data management system for all data within the project (i.e. the input EO and in situ data, products, validation reports, etc; brown), validation (purple) coupled to user-led case studies (dark green), and a data delivery and communication system interfaced to users (light green).

GlobCurrent aims to exploit the widest possible range of EO capabilities and to deliver at its conclusion a nowcasting system with a more firmly established user group and easy internet access. References for such an operational service are SURCOUF and OSCAR [RD-1, RD-2]. These processing systems provide near real time global ocean surface velocity fields based on satellite observations of sea surface height, wind, and temperature (OSCAR's regional focus is the tropical Pacific Ocean). Both systems are subject to extensive validation and error analysis, and are applicable to ocean, climate, and basic research challenges. The SURCOUF and OSCAR user base derives from complementary national monitoring (e.g., NOAA CoastWatch) and climate prediction programs, broad research initiatives, naval operational ocean analysis

programs, and other civilian uses. Some of these users have also identified themselves within the GlobCurrent project.

The basis for ocean current analysis systems like SURCOUF and OSCAR is a linear combination of current components. Nevertheless, high resolution current analyses will require significant advances in processing tools and sensor synergy to allow the complementary strengths of ocean current sensors to be optimized. In the first year of the GlobCurrent project, global estimates of ocean surface current are provided at relatively large scales and low frequencies (e.g., those greater than about 20 days and 200 km), following in part the SURCOUF approach. Among these first GlobCurrent products to be produced are a global, three-hourly, two-level (0-m and 15-m) reanalysis for 2010-2012 that combines an estimate of the geostrophic and Ekman wind driven surface currents and provides users with estimates of data quality.

Subsequent GlobCurrent products target regional, high-resolution mesoscale current features and near real time services. Throughout the project, there is a distinction between separable current components distinguished in part by time and depth scales. The slowest components are considered to link interior and near-surface processes (and thus have a relatively large vertical scale, by analogy with foundation SST). Because some users will be looking toward assimilation, such a balanced and slow current may prove attractive for forecast initialization. Conventional altimetry, geoid models, passive microwave retrievals, and the notion of a current in geostrophic balance is the basis for such an analysis. Accommodation of high resolution (SAR) altimetry and consistency with patterns in infra-red and ocean colour imagery (particularly in coastal areas) may also be relevant.

One of the goals of this project is to resolve surface current variability on scales as small as one day and 25 km. Thus, subsequent GlobCurrent products increasingly focus on the fast current components that respond directly to a combination of wind, wave, and current forcing at the surface. Examples include the well known Ekman, Stokes drift, and wind drift components. Passive infrared and active microwave satellites are among the instruments that resolve these components. Higher time resolution products will also be delivered (hourly) that will include tidal current information coming from models.

An important objective of this project, as given by its users, is validation and estimation of data quality (e.g., errors and flags; Fig.1 purple), given observations that are independent of the analyses. Assessment of a GlobCurrent total surface current can be performed in part using assimilation systems (e.g., MyOcean) as a reference. However, because assimilation systems also depend on ocean models [RD-3] that have limited vertical resolution near the surface, they are not expected to be a reference for all the fast current variations that GlobCurrent aims to resolve. Global and regional observation-based and model-based surface currents are available at a spatial resolution of about 10 km, often as weekly analyses and daily forecasts. A complementary assessment of total current including fast variations is also possible using independent in situ observations (e.g., Argo and surface drifters), and high resolution remote sensing (e.g., satellite optical glitter and land-based high frequency radar). User led case studies (Fig.1 dark green) provide opportunities to pursue this objective at the GlobCurrent supersites (e.g., over the Orkney and Agulhas regions).

The last decade or two of EO has seen rapid growth in the measurement and interpretation of ocean surface current information. The arrival of the Sentinel era finds some techniques that are mature (e.g. altimetry, optical feature tracking), while new satellites (e.g. GOCE, Cryosat, SMOS) and techniques have emerged (e.g. SAR radial velocities, mean square slope from glitter patterns, improved geoid models) that promise additional capabilities to resolve ocean surface currents. This combination of established and newer techniques represents a rich infrastructure that can support a much greater provision of ocean services than it does now. Among numerous operational analyses and historical reanalyses of the ocean surface current (both global and local), GlobCurrent will seek to lead the exploitation of EO information.

3. Requirements Analysis Process

The user requirements in this document have been derived from two sources:

- The GlobCurrent Statement of Work (SoW), produced by ESA, contains a table with specific numbered requirements that shall be addressed by the GlobCurrent project. This table was obtained by analysing all the information collected in the GlobCurrent User Requirements document that was returned to ESA after the completion of the international User Consultation Meeting held in preparation for the ESA GlobCurrent project at IFREMER, Brest, France, on 7-9 March, 2012. This template document was developed to assist users and ESA in gathering specific information considered relevant to the specification of GlobCurrent user requirements. The aim was to obtain a consensus of requirements on various aspects of the project (e.g. common areas of geographical interest, driving requirements, format specification, spatial and temporal resolution, documentation requirements).
- A specific analysis of the targeted technical content of the GlobCurrent products for each phase of the project is described in the following sections.

The GlobCurrent requirements identified in this document are systematically checked against the list of GlobCurrent Statement of Work (SoW) requirements through a cross-check table (Annex A) that allows to quickly verifying that all SoW requirements will be covered in the GlobCurrent system to be built. The fulfillment of the GlobCurrent requirements baseline described in the present document will then be systematically checked during the GlobCurrent Qualification Reviews following the full set of tests described in the Acceptance Test Procedure Document (ATPD).

An overview of the GlobCurrent system is provided on Figure 1. The following sections provide the requirements of the different components of this overall system:

- Data operation (section 4; cf Figure 1; key elements in brown)
- Processing algorithms and products (section 5; blue)
- Validation (section 6; purple)
- Communication and user interface (section 7: light green)
- Use Case Study (section 8; dark green)

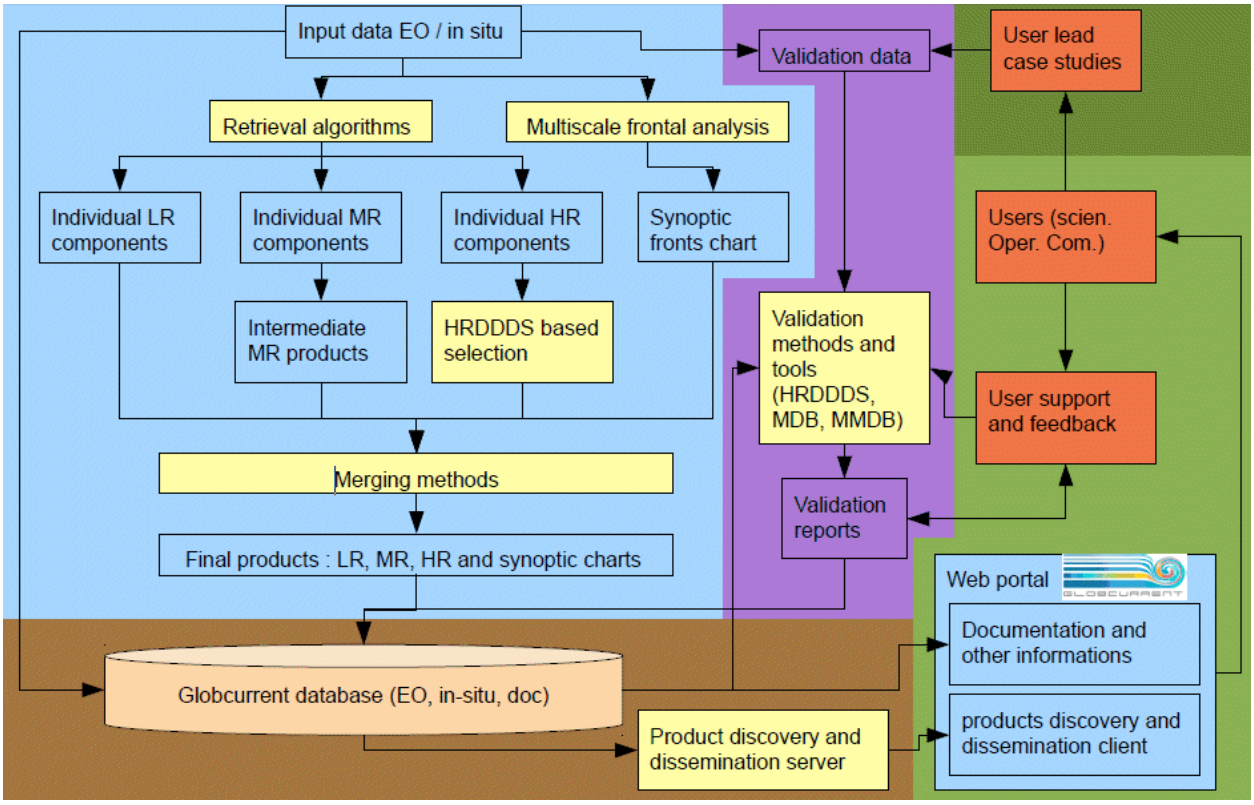

Figure 1: Simplified overview of significant components and their potential linkages within a *GlobCurrent* R&D demonstration system. The different coloured large boxes indicate the key subsystems of the project architecture. Arrows denote data flows within and between these key ingest, processing and product delivery sub-systems.

4. GlobCurrent Database

4.1. Sources of data to be used in the GlobCurrent system

4.1.1. Source of satellite data to be used in the GlobCurrent system

Satellite Observations: There are no satellite observing systems that provide direct observations of the ocean surface current, with the exception of the satellite SAR based interferometry and range Doppler shift measurements that detect signals that are directly related to the surface motion. In general, estimates of the surface current from satellites are retrieved by transformation of the satellite-measured quantities to the surface current based on a range of assumptions, feature tracking methods and empirical based retrieval algorithms. An overview of the satellite data that are avalaible for use in the GlobCurrent system is provided in Table 1 below.

Type	Platform	Instrument	Date
SAR	ERS-1 ERS-2	SAR	1991-07 ►2000-03 1995-04 ► 2011-07
	ENVISAT	**ASAR**	2002-03 ► 2012-04
	Radarsat-1 Radarsat-2	SAR	1995-11 ►2013-03 2007-12► 2014+
	Sentinel-1	SAR	
Scatterometry	**MetOp-A** MetOp-B	**ASCAT**	2006-10 ► 2014+ 2012-09 ►2018+
	QuickScat	SeaWinds	1999-06 ► 2009-11
Altimetry	ERS-1 **ERS-2**	RA	1991-07 ►2000-03 **1995-04 ► 2011-07**
	ENVISAT	**RA-2**	**2002-03 ► 2012-04**
	GFO	RA	1998-02 ► 2008-10
	TOPEX	NRA	1992-08 ► 2005-10
	JASON-1	**Poseidon-2**	**2001-12 ► 2013-07**
	JASON-2	**Poseidon-3**	**2008-06 ► 2015+**
	JASON-3		
	CRYOSAT-2	**SIRAL**	**2010-04 ► 2014+**
	SARAL	ALTIKA	2013-02 ► 2018+
	SENTINEL-3	SRAL	
Gravimetry	**GOCE**	**EGG**	**2010 ► 2013**
	GRACE	**SuperSTAR**	**2002-03 ► 2014+**
Infrared Radiometry	**MetOp-A** **MetOp-B**	**AVHRR-2**	2006-10 ► 2014+ 2012-09 ►2018+
	ERS-1 ERS-2	ATSR	1991-07 ►2000-03 1995-04 ► 2011-07
	ENVISAT	**AATSR**	2002-03 ► 2012-04
	EOS-Aqua EOS-Terra	MODIS	2002-05 ► 2014+ 1999-12 ► 2014+
	NOAA 14-19	AVHRR/2-3	1994-12 ► 2014+
	TRMM	VIRS	1997-11 ► 2014+
	MeteoSat 8-11	SEVIRI	2002-08 ► 2019+
	GOES 8-15	IMAGER	1995-04 ► 2011-07
Spectrometry	**ENVISAT**	**MERIS**	2002-03 ► 2012-04
	EOS-Aqua EOS-Terra	MODIS	2002-05 ► 2014+ 1999-12 ► 2014+
	Sentinel-3	OLCI	

	COMS	GOCI	2010-06 ► 2018+
C-band microwave radiometry	**Aqua-2**	**AMSR**	2002-05 ► 2014+
	GCOM-W1	AMSR-2	2012-05 ► 2017+
	Coriolis	WindSat	2003-01►
	DMSP	SSM/I	1987 ►
L-band microwave radiometry	**SMOS**	**MIRAS**	2009-11 ► 2014+
	SAC-D	Aquarius	2011-06 ► 2016+

Table 1:Satellite data available for GlobCurrent. Date ranges refer to the period during which a given platform was (or is expected to be) in orbit, thus corresponding to the broadest possible range of dates for an operating instrument on that platform.

GC-RB_1-DATA-REQ-1:	
The GlobCurrent project shall make use of the platform data listed in bold in Table 1for the purposes of constructing and validating the year-1 ocean current dataset, and either experiment with in year 1, or prepare for use in years 2 and 3, the platform data listed in normal type.	
Verification method	Inspection
Link to Sow	REQ-530, REQ-540, REQ-550, REQ-560, REQ-570, REQ-580, REQ-590, REQ-600, REQ-610,REQ-630, REQ-640,REQ-650, REQ-660

4.1.2. Source of in-situ data to be used in the GlobCurrent system

Type	Source	Date	Official Provider
Surface currents	HF Radar - Tsushima Strait - Aghulas Current - Iroise Sea - US West and East coast - Orkney area	 After 2003 After spring 2015 After 2005 (operational since November 2009) After 2009 After fall 2013	 Kyushu University University of Cape Town Ifremer/SHOM IOOS Brahan Project
	Drifting buoys	1993-2013	SD-DAC
	TAO moored buoys	2000-present	NDBC
	Argo buoys at the surface	2001-present	Coriolis IPRC

Table 2:In-Situ data available for GlobCurrent

GC-RB_1-DATA-REQ-2:
The GlobCurrent project shall make use of the source in-situ data listed in bold in Table 2 for

the purposes of constructing and validating the year-1 ocean current dataset and either experiment with in year 1, or prepare for use in years 2 and 3, the source data listed in normal type.	
Verification method	Inspection
Link to Sow	REQ-620,REQ-660,REQ-670,REQ-690

4.1.3. Source of analysis data to be used in the GlobCurrent system

Type	Source	Date	Official Provider
Sea surface height	**AVISO**	1993-2012	AVISO
Sea surface temperature	**GHRSST consortium**	All years	various
Surface vector wind	**ECMWF**	All years	ECMWF
Monthly mixed layer depth	**Ifremer**	Climatological	Ifremer

Table 3:Analysis data available for GlobCurrent

GC-RB_1-DATA-REQ-3:	
The GlobCurrent project shall make use of the source analysis data listed in bold in Table 3 for the purposes of constructing and/or validating the year-1 ocean current dataset and either experiment with in year 1, or prepare for use in years 2 and 3, the source data listed in normal type.	
Verification method	Inspection
Link to Sow	REQ-660

4.2. The GlobCurrent Products

The GlobCurrent analyses and interpretation framework, nomenclature and symbology technical note (TN-1, D-140) provides a detailed analysis and specification of the different surface current components.

All through the document, the following definitions will apply:

GC-RB_1-PROD-DEF-REQ-1: Current definition
The GlobCurrent measurements of Total Current will be given at a specified time (t), location (x,y) and measurement depth level (z). They will be provided as vector components of the form:

($\boldsymbol{u}[t,x,y,z]$, $\boldsymbol{v}[t,x,y,z]$) where $\boldsymbol{u}$ is a vector component which is positive when directed eastward (negative westward) and $\boldsymbol{v}$ is a vector component which is positive when directed northward (negative southward).	
Verification method	Inspection
Link to Sow	REQ-270

GC-RB_1-PROD-DEF-REQ-2: Product Level definition	
GlobCurrent shall use definition of the different product levels given below : L2 : swath or along track geophysical products L2p : intercalibrated L2 L3 : gridded product from a single instrument L4 : gridded product from multi-instruments sources It should be brought to attention that this in the specific case of the altimeter data, the above definition differs from the CNES definition that is classically used for the AVISO products (L2p is not used, and instead, L3 refer to intercalibrated along-track monomission products).	
Verification method	Inspection
Link to Sow	REQ-320

The GlobCurrent components and products and the running processes for their calculation are schematically described in Figure 2. The following color code has been used:

- Purple is for L2 input data
- Green is for L3-4 input data
- Red is for output products
- Brown color is for processing steps
- Blue color is for reference dataset (input data that don't need to be updated at each processing run: climatologies, mean fields)

The technical requirements associated with the development of the different products (the red boxes in Figure 2) are detailed in the following subsections (4.2.1 to 4.2.10.1). A synthesis of the retrieval algorithms and tools together with the final retrieved geosphysical information is given for each satellite sensor in Table 4.

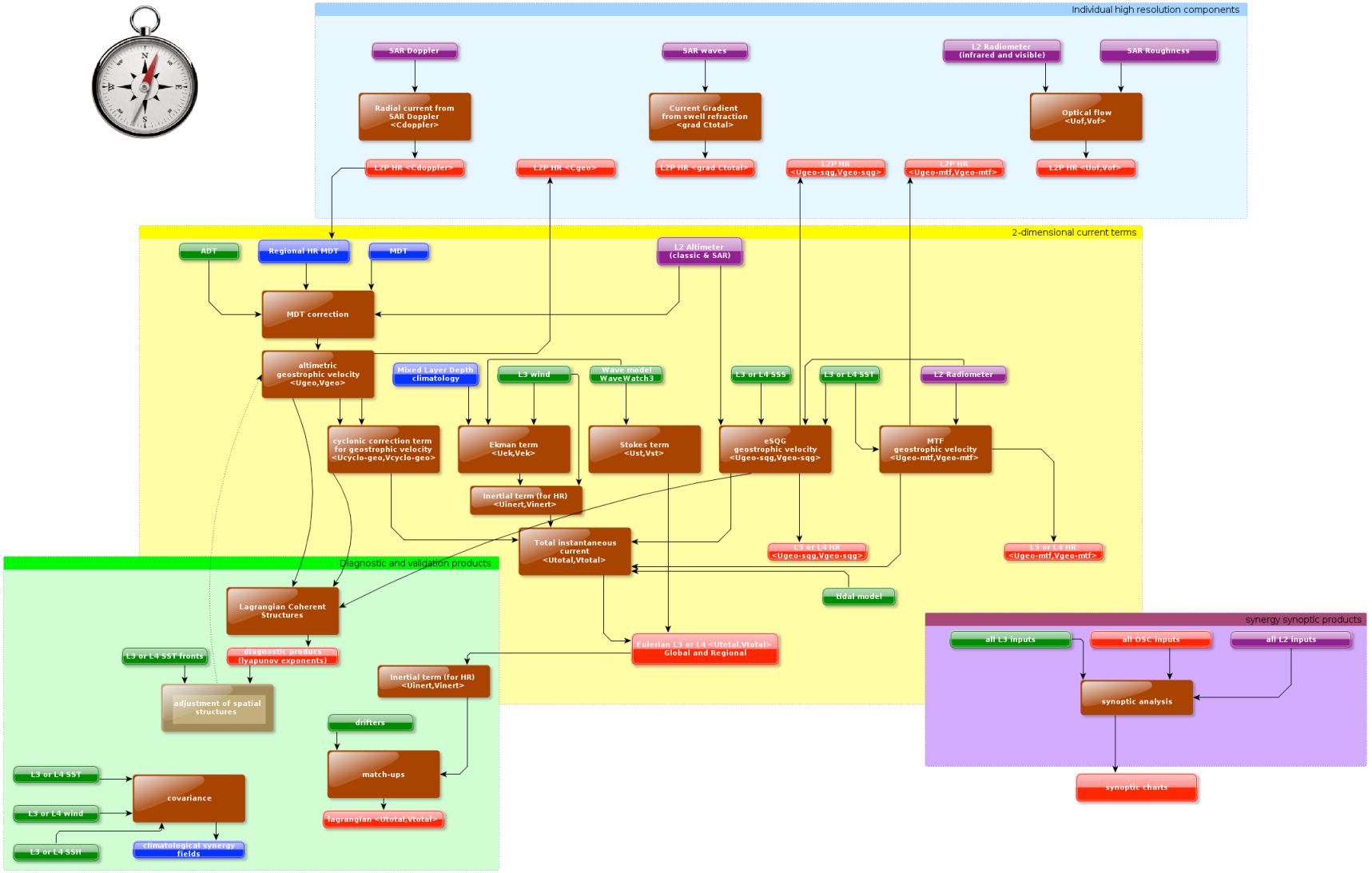

Figure 2: *Schematic illustrations of the running processes for the calculation of the GlobCurrent products*

Satellite sensor	Satellite observation	Retrieval algorithms and Tools	Final retrieved geophysical information
SAR	Surface roughness modulation	Swell retrieval algorithms and ray tracing	Surface current vorticity at 10km scale and temporal scales of 3-5 days. Depth ~ 10m
	Surface roughness pattern and roughness gradients	Wind retrieval algorithms (CMOD, CDOP)	Wind speed at spatial scales of 1 km and temporal scales of 3-5 days. Used to downscale scatterometers winds to estimate Ekman Current
		Radar imaging model	sub-meso scale Divergence and convergence zone of surface current
	Range Doppler anomaly shift	Surface motion in range direction after sea state correction (CDOP)	Surface current at the very surface (less than 50cm) snapshots at spatial resolution of ~10 km and temporal scale 3 - 10 days. Regional mean surface current at 10km scale.
Scatterometer	Surface roughness	Wind retrieval algorithm CMOD	Vector wind and wind stress curl at spatial scale of > 20 km and temporal scale of 12h/1day. Used to estimate Ekman Current.
Altimeter	Sea surface height	Mean sea surface and sea level anomaly	Geostrophic current at spatial scale of > 30 km and temporal scale of 5 to 10 days.
GOCE	Geoid	Mean dynamic topography	Mean geostrophic current at spatial scale of 100-200 km
Altimeter + GOCE	Sea surface height and geoid	Absolute dynamic topography	Absolute surface geostrophic current at spatial scale of 30 km. May even be finer (~10 km) with access to SARM altimetry data
IR radiometer	Sea surface temperature and fronts	(i) Surface quasi-geostrophic assumption; (ii) MCC method	Surface geostrophic current at spatial resolution of ~25km and temporal scale of about 1 to 10 days depending on clouds Feature tracking using MCC gives estimate of surface current at resolution lower that interrogation window
Spectrometer	Ocean color, chlorophyll A distribution and fronts Sun-glint	(i) Bio-optical retrieval algorithm BOREALIS (ii) MCC method (iii) Mean square slope (MSS)	Ocean color distribution associated with 3D mesoscale dynamics in the upper ocean. Feature tracking using MCC gives estimate of surface current MSS anomalies comparable to SAR based NRCS anomalies.
C-band microwave radiometer	Sea surface temperature and fronts	Surface quasi-geostrophic assumption;	Surface geostrophic current at spatial resolution of ~25 km and temporal scale of 1 day
L-band microwave radiometer	Sea surface salinity and fronts	Surface quasi-geostrophic assumption;	Surface geostrophic current at spatial resolution of ~100 km and temporal scale > 3-10 days

Table 4:. ***Overview of satellite sensors, observed quantities, retrieval algorithms and final derived variables.***

4.2.1. Products geographical and temporal coverage

GC-RB_1-PROD-REQ-1: Geographical coverage	
The GlobCurrent shall: Produce a baseline global coverage product for Year 1 Provide at least 5 regional AOI for Year 1 among : • Agulhas (strong current and natural laboratory) • Med sea (diurnal variability, SAR MDT, coastal) • Orkneys (strong tidal currents) validate SAR component • Black sea (enclosed playground basin, SAR MDT) • Norwegian Coastal Current Include at least 10 regional AOI for Year 2 among : • Agulhas (strong current and natural laboratory) • Iroise sea (strong tidal current) • Central equatorial atlantic • Med sea (diurnal variability, SAR MDT, coastal) • Orkneys (strong tidal currents) to validate HR SAR Doppler component • Black sea (enclosed playground basin, SAR MDT) • Gulf stream (stong western boundary clean signal in sst (winter) • Kuroshio (stong western boundary clean signal in sst (winter) • Loop current (potential availability of high drifters density) • Norwegian Coastal Current (coastal and availability of SAR/HF radar) • Sargasso sea (meso/submesoscale soup low current region) • Circumpolar (where the current bifurcates) • East autralian current (coastal) • China coastal current (availability of GOCI) *GlobCurrent* L2 products ***shall*** include coastal areas where appropriate.	
Verification method	Inspection
Link to Sow	REQ-10xi, REQ-20ii, REQ-20xv, REQ-230, REQ-240, REQ-330

GC-RB_1-PROD-REQ-2: Period coverage	
The GlobCurrent project shall: Provide a 3 years (2010-2012) global product for Year1 which correspond to the best years to have at the same time SMOS and AMSRE-E / ENVISAT /cryosat data) Produce a 10-year global historical output (2006-2014 data set addressing *GlobCurrent* Requirements for Year2	
Verification method	Inspection
Link to Sow	REQ-10xv, REQ-20xvi

4.2.2. Products spatial and temporal resolution

GC-RB_1-PROD-REQ-3: Spatial Resolution	
The targeted spatial resolution for the GlobCurrent products will differ from regional to global coverage. The target for global products is < 25km while GlobCurrent regional coverage L4 products ***shall*** be produced at the highest spatial resolution possible. The spatial resolution of gridded products will be set as the best resolution of all surface current components.	
Verification method	Inspection
Link to Sow	REQ-400

GC-RB_1-PROD-REQ-4: Temporal Resolution	
The targeted GlobCurrent L4 products temporal resolution is daily. GlobCurrent L4 products shall be produced at sub-daily intervals where feasible. In the case of use of tide information coming from tidal models, the temporal resolution of the total current shall be hourly. Temporal resolution of each component (see REQ-460) will be provided at the best temporal resolution	
Verification method	Inspection
Link to Sow	REQ-420

4.2.3. L2P HR <Cdoppler>

4.2.3.1. High resolution Doppler derived radial current snapshots

The observed line-of-sight SAR Doppler centroid anomaly (relative to satellite motion) is one of few direct estimates of the ocean surface current. From the SAR Doppler velocities, it is

necessary to remove a wave contribution from the Doppler centroid anomaly to obtain a measure of the sea surface current in the range direction. This latter methodology has been demonstrated in relatively strong (order of magnitude 1-2 m/s) current regimes such as the Equatorial Pacific current (Collard et al. 2008), the Agulhas current (Collard et al. 2008; Rouault et al. 2010) and the Gulf Stream, as well as in the weaker inflow (order of magnitude 40 cm/s) of Atlantic water to the Nordic Seas via the Norwegian Atlantic Current (Hansen et al. 2011)

GC-RB_1-SAR-REQ-1: Radial current estimation	
The GlobCurrent project (within the Year 1 phase) shall: Process the Doppler shift from ENVISAT ASAR wide swath over the AOI with sufficient coverage (ie Agulhas, Med Sea, Black Sea …) with the best possible sea state correction in order to retrieve radial component of surface current.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-530, REQ-560

4.2.3.2. Estimation of high resolution mean currents from SAR and buoys

Derivation of the mean current over regions with significant SAR coverage will be examined in GlobCurrent.

GC-RB_1-SAR-REQ-2: Mean current estimation	
The GlobCurrent project (within the V1 phase) shall: Construct a high resolution mean current analysis from reprocessed ENVISAT ASAR data with the best sea state correction (10m wind analysis and CDOP or model stokes drift), for the Agulhas region and compare this to MDT derived geostrophic currents following Johannessen et al. (2008).	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-530, REQ-560

GC-RB_1-SAR-REQ-3: Mean current estimation	
The GlobCurrent project (within the V2 phase) shall: Extend the construction of high resolution mean current analyses using SAR Doppler centroid anomaly data to include other regions of interest (e.g., the case study domains) for which there is a favourable imaging geometry (where current orientation is mostly in the line-of-sight direction). Comparison with corresponding mean currents based on drifting buoys shall address the different reference height to which the two estimates apply (e.g., allowing for a stonger signal of Stokes and wind drift in the SAR current estimate than that of drogued drifters).	
Verification method	Inspection
Link to Sow	REQ-20iii, REQ-530, REQ-560

GC-RB_1-SAR-REQ-4: Mean current estimation	
The GlobCurrent project (within the V3 phase) shall: Explore (by means of replacement and smoothing, if not by more sophisticated analysis methods) a set of regional modifications to MDT based on the high resolution mean current analyses that were constructed using SAR in previous years. This method of mean current estimation shall then become part of the main GlobCurrent processing chain.	
Verification method	Inspection
Link to Sow	REQ-30iii, REQ-530, REQ-560

4.2.4. L2P HR <Cgeo>

GC-RB_1-HRGEO-REQ-1: SAR altimetry	
The GlobCurrent project (within the V1 phase) shall provide Cryosat-2 across track currents over 3 regions (AoI) over a year (May 2012 - March 2013): Agulhas ; North West Med; Orkney The two SAR groups (isardSAT and CLS) will process 2 regions each and one in common. This common data set (Agulhas region) will allow accurate comparisons between both approaches. For both regions isardSAT shall concentrate on for V1: - Optimization of L1 processing for the benefit of ocean currents observations - Adaptation of the L2 to configuration chosen in L1 - Develop de-noising techniques for the derivation of the geostrophic component - Derivation of the geostrophic component CLS starts the processing from the L3 SLA products derived from the CNES SAR prototype (CPP products). The efforts are therefore focused on calculation of the geostrophic current.thanks to optimisation of the SLA filtering approach.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-570

GC-RB_1-HRGEO-REQ-2: SAR Altimetry	
The GlobCurrent project (within the V2 phase) will: -Process the remaining AOI by both teams. -Work on the improvement of the SAR altimetry currents in coastal strip thanks to L2 processing (MSS adapted to C2 coverage) and refinement of the current calculation. -Perform the same analysis as in V1 now revisiting what has been done in V1 and improving any configuration as needed, but also accounting for coastal regions. -Refine the validation with other data sources when possible Furthermore, in preparation for S3 we aim at adapting all configurations to Sentinel-3.	
Verification method	Inspection
Link to Sow	REQ-20iii, REQ570, REQ-540

GC-RB_1-HRGEO-REQ-3: SAR Altimetry	
The GlobCurrent project (within the V3 phase) shall: improve results as delivered in V1 and V2 adding data from the Sentinel-3 mission and cross-calibrating results of CryoSat and Sentinel-3 Provide absolute currents for Cryosat-2 associated with the regional MDT over the Agulhas region	
Verification method	Inspection
Link to Sow	REQ-30iii, REQ-570, REQ-540

4.2.5. L2P HR <Ugeo-mtf, Vgeo-mtf>

GC-RB_1-HRGEO-REQ-4: High resolution geostrophy	
Transfer function shall be estimated between SAR altimeter along track sea level anomaly spectral decomposition and intersected infrared SST. The transfer function will be variable in time and space and will be used to estimate geostrophic current at the resolution of the IR SST field.	
Verification method	Inspection
Link to Sow	REQ-20iii, REQ-30iii, RQ-660

4.2.6. L2P HR <Ugeo-esqg Vgeo-esqg>

GC-RB_1-HRGEO-REQ-5: High resolution geostrophy	
Geostrophic component of surface current daily at the best possible resolution shall be derived from surface density (estimated from IR SST and SSS) field to sea level height using a spectral decomposition, effective Brunt Waissala frequency and mixed layer depth (from in situ observations) using eSQG model described in the TN-1.	
Verification method	Inspection
Link to Sow	REQ-20iii, REQ-30iii, REQ-660

4.2.7. L2P HR <grad Ctotal>

GC-RB_1-HRSWELL-REQ-1: SAR swell parameters	
Field of surface current vorticity shall be estimated from the radius of curvature of swell propagation rays as retrieved from SAR data also used to estimate the SAR Doppler derived radial surface currents providing the presence of significant swell such as is usually the case in the Agulhas current region.	
Verification method	Inspection
Link to Sow	REQ-20iii, REQ-30iii, REQ-540, REQ-560

4.2.8. L2P HR <Uof, Vof>

Previous methods to detect regional ocean currents from visible and infrared Earth observation data have focused on the use of neighborhood-tracking methods. A popular example of this is the maximum cross correlation (MCC) approach. This is a simple but effective approach to detecting movement within a scene and performs well in regions with strong oceanic features, but requires good co-registration of the image data. The utility of this approach has recently been illustrated using data from the Korean Geostationary Ocean Color Imager (GOCI).

Feature space based methods appear applicable for detecting and tracking eddies in visible and infrared Earth observation data. Potential established approaches include the continuously adapting mean shift filter (Bradski, 1998). The open source openCV toolbox provides implementations of a number of the neighborhood-tracking and kernel-based tracking methods.

Data from the GOCI sensor provides a suitable test bed of high temporal resolution data that can be used to test novel visible spectrum approaches. AVHRR have a relatively high repeat rate for polar orbiting sensors due to large number in orbit. AVHRR series of sensors provides a suitable test bed for applying MCC methods to IR data. Some comparison metrics require consistently calibrated data; however, the relatively simple MCC method is robust to differences in calibration between different AVHRR sensors. However all methods require datasets with good navigation or else the geolocation of points has to be determined by comparison with known coastline features, restricting the ease of its implementation. The best available high-resolution AVHRR dataset with accurate navigation is that collected by the Dundee receiving station for NW European waters.

Conventional altimetry processing provides an estimate of the cross-track component of the velocity at the location of the sub-satellite track. However, near simultaneous thermal or optical imagery can provide strong guidance as to the 2-D direction of the flows at the altimeter crossing, and also delineate the current feature beyond the narrow confines sampled by the altimeter.

GC-RB_1-VIR-REQ-1: Visible and infrared approaches	
The GlobCurrent project (within the V1 phase) shall: - Implement and investigate the performance for two test regions of MCC as applied to visible spectrum GOCI data from the Korea Ocean Satellite Center, and also to AVHRR high-resolution data received by Dundee. - Evaluate the application of the method in the selected regions, using independent validation data, and provide a measure of uncertainty.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-660

GC-RB_1-VIR-REQ-2: Visible and infrared approaches	
The GlobCurrent project (within the V2 phase) shall: Implement and investigate the performance for Korean waters of established feature space based tracking methods for tracking eddies as applied to visible spectrum GOCI data, and making use of the openCV library. Evaluate the method in the area of GOCI coverage, using independent validation data, and provide a measure of uncertainty Implement ideas for projecting across-track altimeter currents along the directions inferred from 2-D thermal/visible imagery, and evaluate their accuracy.	
Verification method	Inspection
Link to Sow	REQ-20i, REQ-20iii, REQ-20iv, REQ-660

GC-RB_1-VIR-REQ-3: Visible and infrared approaches	
The GlobCurrent project (within the V3 phase) shall: Implement projection of geostrophic currents from single-pass altimetry along frontal directions derived from thermal/visible imagery, and evaluate their accuracy (for particular locations) by comparison with in situ current meters.	
Verification method	Inspection
Link to Sow	REQ-30iii, REQ-30iv, REQ-660

GC-RB_1-VIR-REQ-4: Geolocation	
We shall independently verify the quality of the GOCI geolocation for a subset of the GOCI dataset using independent datasets (e.g. high spatial resolution coastline datasets and fixed locations). The results of this will be presented in the relevant ATBD document.	
Verification method	Inspection
Link to Sow	REQ-470

4.2.9. Eulerian L3/L4 $<U_{TChs}, V_{TChs}>$, $<U_{TC15}, V_{TC15}>$

The Eulerian L4 $<U_{TChs}, V_{TChs}>$ $<U_{TC15}, V_{TC15}>$ products will be computed as the sum of different components:

$$U_{TChs}=U_{geo}+U_{ekman\_hs}+U_{inertial\_hs}+U_{tidal}$$
$$V_{TChs}=V_{geo}+V_{ekman\_hs}+V_{inertial\_hs}+V_{tidal}$$

$$U_{TC15}=U_{geo}+U_{ekman\_15}+U_{inertial\_15}+U_{tidal}$$
$$V_{TC15}=V_{geo}+V_{ekman\_15}+V_{inertial\_15}+V_{tidal}$$

Inertial current component will be estimated only where the diameter of inertial oscillations exceeds the target resolution of the L4 products.

GC-RB_1-L4-REQ-1: L4 product	
GlobCurrent L4 products shall be provided at different depths: surface (hs depth) and 15m (drifter depth) *GlobCurrent* L4 products shall contain the following components : Tidal (from model) Stokes drift (provided but not added to other components since it has a nul eulerian mean) Ekman drift Geostrophy from altimetry, eSQG and MTF. Inertial (due to Ekman) *GlobCurrent* L4 products shall contain ancillary data and Flags for interpretation purpose at least : Integrated wave parameters (surface depth) Neutral 10m Surface Wind Estimate of ABL stability Mixed layer depth (from ARGO) *GlobCurrent* L4 products ***shall*** be built from *GlobCurrent* L2P and L3 products. The source L2P/L3 product must be traced into the L4 and source L3 products will be provided within the L4 products as components. At V1, The GlobCurrent shall produce a baseline global coverage product based on the SURCOUF current products (Larnicol et al, 2005, Rio et al, in preparation) calculated as the sum of the geostrophic component and the Ekman component at two different depths (hs and 15m). In the subsequent versions, both the geostrophic and the Ekman components will be improved as described in sections 3.2.8.1 and 3.2.8.2. Also more components will be added to build the total current as described in sections 3.2.8.3 to 3.2.8.5.	
Verification method	Inspection
Link to Sow	**REQ-90, REQ-350, REQ-380, REQ-390, REQ-460**

4.2.9.1. Estimation of geostrophic currents

As suggested by observations and scaling arguments, flow in the ocean interior (away from the boundary layers) and away from the equator is to the first order in geostrophic balance, which means that the ocean surface velocity field can be readily obtained from the gradients of the sea level. Since the early nineties, altimeters have been providing global, accurate and repetitive measurements of the Sea Surface Height (SSH). The estimation of the geostrophic component of the surface current in GlobCurrent will thus be based on the use of all intercalibrated altimeter data available that has demonstrated its robustness in providing global synoptic geostrophic fields. Then, in specific area and conditions, this geostrophy field could be refined in time and

space using available microwave SST and SMOS SSS. In highly dynamical regions, such as western boundary currents, the advection of momentum may not be negligible and, centrifugal accelerations should also be taken into account for mesoscale vortices and meanders. In particular, direct ocean current observations have shown that the introduction of the centrifugal acceleration results in substantial differences in the estimate of sea level anomalies across Gulf Stream meanders.

GC-RB_1-GEO-REQ-1: Altimetry	
The GlobCurrent project (within the V1 phase) shall provide geostrophic surface currents derived applying the geostrophic approximation on Absolute Dynamic Topography (ADT) maps obtained by adding a Mean Dynamic Topography (MDT) and multimission maps of Sea Level Anomalies (SLA). - For the SLA, the latest version of the multimission maps from the SSALTO DUACS production chain (to be distributed on the AVISO website in April 2014). These are daily, global, ¼° maps. - For the MDT, the CNES-CLS13 MDT will be used. It is a global field (including the Mediterranean Sea) on a regular ¼° grid. As it is representative of the 1993-1999 period, it will first be readjusted to the SLA reference period (1993-2012) - Geostrophic currents will be derived from the absolute heights using a 9-point stencil method (Arbic et al, 2012). - At the equator, the altimeter velocity anomalies are calculated from the SLA using a β-plane approximation. The mean geostrophic velocities are directly obtained from the drifter observations. - Methods will be tested to incorporate centrifugal acceleration when deriving ocean velocities from altimetry products. For an axisymmetric eddy, the correction is proportional to the square of the initial solution and inversely proportional to the radial distance from the eddy center. In the general case, an iterative method will be assessed.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-550, REQ-560, REQ-570, REQ-590, REQ-660

GC-RB_1-GEO-REQ-2: Altimetry	
The GlobCurrent project (within the V2 phase) shall provide geostrophic surface currents derived applying the geostrophic approximation on Absolute Dynamic Topography (ADT) maps obtained by adding a Mean Dynamic Topography (MDT) and multimission maps of Sea Level Anomalies (SLA) for an extended, 10 year period. This may include the use of Jason3 and Sentinel-3 data. This will also include Altika data from 2013. This product corresponds to the AVISO product.	
Verification method	Inspection
Link to Sow	REQ-20i, REQ-20iii, REQ-540, REQ-550, REQ-560, REQ-570, REQ-590, REQ-660

GC-RB_1-GEO-REQ-3: Regional MDT	
The GlobCurrent project (within the V3 phase) shall: • Work on the calculation of a regional MDT (Agulhas) based on a new GOCE model (R5), drifters and ARGO floats • Work on the comparison/combination of the obtained MDT with SAR MDT • Provide absolute currents associated with the regional MDT over the Agulhas region	
Verification method	Inspection
Link to Sow	REQ-30i, REQ30-iii, REQ-30iv, REQ-540, REQ-550, REQ-560, REQ-570, REQ-590, REQ-660

GC-RB_1-GEO-REQ-4: eSQG	
Geostrophic component of surface current daily at 25km resolution shall be derived from surface density (estimated from microwave SST and SSS) field to sea level height using a spectral decomposition, effective Brunt Waissala frequency and mixed layer depth (from in situ observations) using eSQG model described in the TN-1. - For the SLA, the latest version of the multimission L2P from the SSALTO DUACS (or RADS or PODAAC) production chain shall be used.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-20i, REQ-20iii, REQ-30i, REQ30-iii, REQ-30iv

In recent years altimetric measurements of sea surface height (SSH) and measurements of sea surface temperature (SST) have provided a wealth of information about ocean circulation and atmosphere/ocean interactions. SSH is a depth integrated quantity depending on both the temperature/salinity structure of the water column and the depth independent barotropic contribution. SST is a purely surface parameter representing the temperature at the top of the ocean surface. Hence any relationship between SST and SSH is providing information on surface/subsurface coupling. Establishing the extent to which SST and SSH are related could lead to new techniques such as interpolation of SSH data with SST, improving eddy statistics, and providing new dynamical information about the coupling between the ocean surface and subsurface.

GC-RB_1-GEO-REQ-5: MTF	
Geostrophic component of surface current daily at 25km resolution shall be estimated using local (in time and space) transfer functions estimated between altimeter along track sea level anomaly spectral decomposition and intersected microwave SST and SMOS SSS. The transfer function are then applied to the microwave SST and SMOS SSS to retrieve geostrophic surface currents.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-20i, REQ-20iii, REQ-30i, REQ30-iii, REQ-30iv

Despite the successes of altimetric measurements, and of AVISO's multi-satellite gridded products in particular, increases in the resolution and fidelity of remotely sensed sea-surface height and surface current measurements are badly needed. The smoothing implicit in the creation of these maps—estimated to correspond to a filter half-power point at about 150 km wavelength—leads to an effective lower limit on the scales of eddies that can reasonably be resolved, as well as an attenuating effect on the amplitudes.

GC-RB_1-GEO-REQ-6: Geostrophy	
The GlobCurrent project (within the V2 phase) will assess and select the best sources of geostrophic surface currents (eg from altimetry eSQG and MTF) and provide geostrophic surface currents for an extended, 10 year period. This will also include Altika data from 2013.	
Verification method	Inspection
Link to Sow	REQ-20i, REQ-20iii, REQ-20v, REQ-30i, REQ30-iii, REQ-30iv, REQ-540, REQ-550, REQ-560, REQ-570, REQ-590, REQ-660

4.2.9.2. Estimation of Ekman currents from wind stress data

The GlobCurrent project will provide global, 1/4 degree resolution, 3-hourly maps of wind-driven upper ocean current components, i.e. Ekman currents. Estimates of Ekman currents contain uncertainties related to possible unconstrained variations of the vertical viscosity with depth, parameterizations for the surface drag coefficient, and knowledge about the mean motion of the underlying water.

GC-RB_1-EK-REQ-1: Ekman	
The global parameters needed to estimate the Ekman component shall include: surface winds (NWP and satellite-derived products), sea state information (NWP Hs and stokes and satellite-derived products), stability (from satellite SST and NWP surface air temperature), mixed layer depth (in situ low resolution estimates), GlobCurrent eulerian surface current without Ekman current. Comparisons with in situ velocities from drifter trajectories shall be performed to evaluate impact of the different uncertainties, and to test empirical and semi-empirical formulations.	
Verification method	Inspection
Link to Sow	REQ-10i, REQ-460

GC-RB_1-EK-REQ-2: Ekman	
The GlobCurrent project (within the V2 phase) shall: Work on the use of scatterometer winds versus ECMWF reanalysis Investigate the impact of Stokes drift on the estimation of the Ekman model parameters using drifter velocities Provide an improved Ekman model by taking into account those effects. Work on error estimation of the Ekman currents	
Verification method	Inspection
Link to Sow	REQ-20i, REQ-460, REQ-580

GC-RB_1-EK-REQ-3: Ekman	
The GlobCurrent project (within the V3 phase) will: Work on a specific Ekman model for the Mediterranean Sea Work on error estimation of the Ekman currents in the Mediterranean Sea	
Verification method	Inspection
Link to Sow	REQ-30i, REQ-460

4.2.9.3. Estimation of Stokes drift

GC-RB_1-STO-REQ-1: stokes drift	
Stokes drift will be computed at surface (hs depth) and 15m depth using WaveWatch3 model for the surface and wind sea wavelength dependant exponential decay for the depth. The same model input 10m wind will be used for the wind drift.	
Verification method	Inspection
Link to Sow	REQ-20v

4.2.9.4. Estimation of inertial oscillations

GC-RB_1-INERT-REQ-1: Inertial currents	
Inertial current component shall be estimated only where the diameter of inertial oscillations exceeds the target resolution of the L4 products.	
Verification method	Inspection
Link to Sow	REQ-20v

4.2.9.5. Estimation of tidal currents

GC-RB_1-TIDES-REQ-1: Tidal currents	
Tidal currents shall be estimated from model outputs at hourly resolution.	
Verification method	Inspection
Link to Sow	REQ-20v, REQ-430

4.2.10. Diagnostic Products

GC-RB_1-DIAG-REQ-1: Covariance analysis	
Covariance analysis shall be performed - Between microwave and IR SST and Globcurrent advected microwave previously observed SST. Advection period shall be controlled by the IR down to 5km - between HR fronts and deformation field : The deformation field from the Okubo Weiss indicator will be computed on any L2/L3/L4 Globcurrent products and compare to the HR frontal position.	
Verification method	Inspection
Link to Sow	

GC-RB_1-DIAG-REQ-2: Lagrangian coherent structure	
Rate of separation between virtual drifters estimated from Globcurrent product shall be compared to the separation rate from real drifters.	
Verification method	Inspection
Link to Sow	

4.2.10.1. Estimation of a validation dataset based on drifter velocities

GC-RB_1-DRF-REQ-1: Drifter validation dataset	
The GlobCurrent project (within the V1 phase) shall: • prepare a dataset of drifting buoy velocities based on the data provided by the SD-DAC (Surface Drifter Data Assembly Center) at http://www.aoml.noaa.gov/phod/dac/index.php Data are available until September 2012. Both drogued and undrogued data will be considered, and provided in two independent files. The methodology by Rio, 2012 shall be applied to provide an estimate of the wind slippage at each time step. An estimation of the Ekman currents at 15m depth shall be calculated and collocated along the drifter trajectories in case of drogued data An estimation of the Ekman currents at the surface shall be calculated and collocated along the drifter trajectories in case of undrogued data An estimation of the Stokes drift shall be calculated and collocated along the drifter trajectories The geostrophic component of the current as measured by altimetry shall be collocated along the drifter trajectories Wind stress values from the ERA INTERIM reanalysis shall be collocated along the drifter trajectories	
Verification method	Inspection
Link to Sow	REQ-690

GC-RB_1-DRF-REQ-2: Drifter validation dataset	
The GlobCurrent project (within the V2 phase) shall: • Update the dataset of drifting buoy velocities based on the data provided by the SD-DAC (Surface Drifter Data Assembly Center) at http://www.aoml.noaa.gov/phod/dac/index.php • Compare the datasets of Argo float surface velocities provided by Coriolis (ANDRO dataset) and IPRC (YOMAHA dataset) • Enrich the surface dataset with the surface velocities from Argo floats	
Verification method	Inspection
Link to Sow	REQ-690

GC-RB_1-DRF-REQ-3: Drifter validation dataset	
The GlobCurrent project (within the V3 phase) shall: • Update the dataset of drifting buoy velocities based on the data provided by the SD-DAC (Surface Drifter Data Assembly Center) at http://www.aoml.noaa.gov/phod/dac/index.php and the dataset of surface velocities from Argo floats	
Verification method	Inspection
Link to Sow	REQ-690

4.2.11. Synoptic charts

GC-RB_1-SYN-REQ-1: Frontal detection	
Globcurrent shall implement front detection methods (or collect existing outputs from other projects) to generate a front delineation database in homogeneous format from all possible HR datasets (SAR roughness, sun glitter, IR SST, ocean color).	
Verification method	Inspection
Link to Sow	

GC-RB_1-SYN-REQ-2: Synoptic charts	
Globcurrent analyst shall derive weekly synoptic charts of surface currents based on the multisensor front database and all available Globcurrent L2,L3 and L4 products with indication of the major currents path, the identification of eddies and persistent oceanic fronts for each case studies in WP5 and for a time period to be agreed with the end user leading the case study.	
Verification method	Inspection
Link to Sow	

5. GlobCurrent operation system

5.1. Overview

The GlobCurrent Operation System (GLOP) is in charge of ensuring the production and delivery of products and services to the GlobCurrent end users.

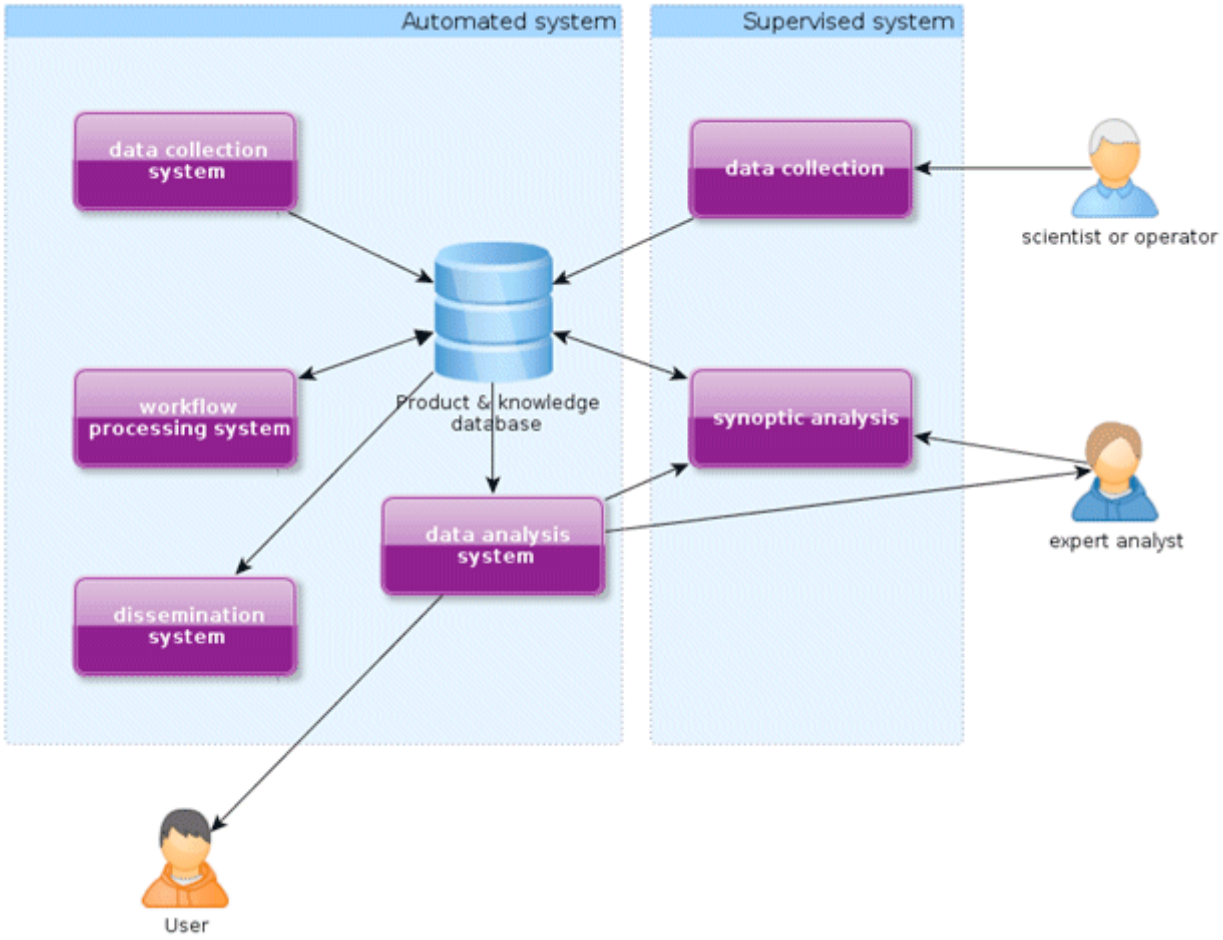

Figure 3: Overview of the GlobCurrent Operation system

GC-RB_1-GLOP-REQ-1:	
GlobCurrent shall provide an operation system (GLOP) able to ensure both automated operations and supervised operations for all computational tasks of GlobCurrent.	
Verification method	Test
Link to SoW	**REQ-10 v**: Develop and implement a data management system **REQ-20 viii**: Develop and implement a data management system **REQ-30 viii**: Evolve and improve data management system

Automated systems and operations don't require any human intervention but overall monitoring of the system and troubleshooting when errors are raised or detected. They include :

- the periodic **collection and ingestion** of new input data for the GlobCurrent system and registration into the GlobCurrent database.
- the generation, through a **workflow system**, of user products, diagnostic and validation information, quality and information reports
- the **dissemination** of data and information to users, through GlobCurrent portal and various dissemination protocols
- advanced tools for **data monitoring, analysis, combination and validation**, for GlobCurrent users but also operators of the GlobCurrent system

Supervised systems and operations require intervention of an operator or an expert at some stage to be fully completed, including :

- the **collection, formatting and ingestion** of input data that require man-to-man interaction with the provider (usually for validation or reference data)
- the generation of **advanced synoptic products** from multiple inputs, involving expert decision (similar to forecaster in meteorological offices)

5.2. Data collection system

The data collection system shall be able to automatically collect, ingest and register into GlobCurrent products various sources of input data in automated manner.

GC-RB_1-GLOP-REQ-2:	
The data collection shall be able to handle various kinds of deliveries : • FTP • OpenDAP • HTTP	
Verification method	Test
Link to SoW	**REQ-110:** The primary mechanism for *GlobCurrent* product delivery to users ***shall*** be ftp/sftp. **REQ-120:** The secondary mechanism for GlobCurrent product delivery to users shall be OpenDAP **REQ-130:** The tertiary mechanism for *GlobCurrent* product delivery to users ***shall*** be HTTP.

The collected data come in various forms and with various levels of contextual information. These data shall be homogenized and documented when being ingested and registered into

GlobCurrent database, so that they can be used, switched, or combined in a seamless manner by GlobCurrent processes and experts.

GC-RB_1-GLOP-REQ-3:	
The input data shall be registered into the GlobCurrent database, fulfilling the following requirements : • each input dataset (collection) shall be properly described and registered in a central catalogue • GlobCurrent shall provide a format model for each type of data (trajectory for in situ, along-track, swath, grid for satellite, climatological or model data). Each collected data shall be formatted to match the GlobCurrent data model at the ingestion step. • GlobCurrent shall provide a unique data repository for all input data. It should homogenize and make consistent the data organization. • Each incoming data file in the system shall be properly identified and indexed. • All data shall be available on disk to GlobCurrent partners through common protocols and access means	
Verification method	Inspection
Link to SoW	**REQ-50**: *GlobCurrent* ***shall*** provide a data management system for all data products within the project

The data collection and ingestion shall be done in an automated manner. This requires however monitoring by operators to ensure the system is running nominally.

GC-RB_1-GLOP-REQ-4:	
The GLOP shall provide the proper feedback mechanisms and reporting tools to the GlobCurrent system operators for data collection monitoring. Detected issues should be raised to users whenever relevant.	
Verification method	Inspection
Link to SoW	**REQ-220:** The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each product and service provided by the project on a daily basis. A time series of *GlobCurrent* Metrics for the processing system, the delivery system(s) and product performance ***shall*** be provided. *Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).*

5.3. Processing Workflow System

The GlobCurrent will develop and implement the necessary processing chains for the calculation of the GlobCurrent products described in section 5.2. When necessary, it could be based on existing facilities (for instance, tidal and wave models production, L3/L4 altimetry production,...)

The processing workflow system is designed to run all the processing tasks in GlobCurrent. The processing tasks include continuous (NRT like) processing tasks as well as processing of demonstration products or legacy datasets (reprocessings).

GC-RB_1-GLOP-REQ-5:	
The system shall therefore be able to perform automated processing in the following modes : • data driven : new incoming data triggers a specific processing chain • periodic (cron) : processing chains at triggered at a specific time frequency to generate periodic products (L4, reports, quality checks, …) • reprocessing : given a list of input data (data driven) or date/times (periodic), the system is able to run processing chains over the whole range of specified inputs, load balancing the processing on the available resources and reporting to the GLOP operators on progress and status (errors, etc...).	
Verification method	Test
Link to SoW	REQ-70 *GlobCurrent shall* provide a capability to re-process all data within the system using a consistent set of algorithms.] REQ30-xiv

GlobCurrent is a multi-partner project with a central processing system. As a consequence the GLOP shall offer the necessary flexibility and genericity to incorporate any new processing task provided at any stage of the project by a partner.

GC-RB_1-GLOP-REQ-6:	
The workflow system shall be able to integrate and deploy any processor provided by a GlobCurrent project member. In order to minimize integration effort it shall provide recommendation on processor design and interfaces (preferred language, input arguments, …).	
Verification method	Test/Inspection
Link to SoW	REQ-10 iv: Develop and implement necessary processing chains REQ-20 vii: Develop and implement necessary processing chains REQ-30 vii: Evolve and improve processing chains

The generation of GlobCurrent products may include several processing steps to compute different current components stacked into a final global or regional product, and a wide variety of possible inputs for each processing step.

GC-RB_1-GLOP-REQ-7:	
The workflow system shall be able to sequence and run any chain of successive processing steps, each one being implemented through a standalone processor.	
Verification method	Test
Link to SoW	REQ-10 iv: Develop and implement necessary processing chains REQ-20 vii: Develop and implement necessary processing chains REQ-30 vii: Evolve and improve processing chains

GC-RB_1-GLOP-REQ-8:	
The project shall provide recommendations to the project partners on the processor's input formatting and design so that input sources can be easily interchanged.	
Verification method	Inspection
Link to SoW	REQ-10 iv: Develop and implement necessary processing chains REQ-20 vii: Develop and implement necessary processing chains REQ-30 vii: Evolve and improve processing chains

Because of its incremental and experimental nature, the project will provide various successive versions of processors and products:

GC-RB_1-GLOP-REQ-9:	
The workflow system shall implement source control configuration of processors and processing chain configurations, and implement proper version track management. It shall be able to easily integrate new processors or configurations.	
Verification method	inspection
Link to SoW	**REQ-40** *GlobCurrent* software and systems ***shall*** be maintained under configuration control. **REQ-10 vii:** Implement version control for all aspects of the system

GC-RB_1-GLOP-REQ-10:	
The workflow system shall be able to run concurrently different versions of the processors and processing chains.	
Verification method	Test
Link to SoW	REQ-10 iv: Develop and implement necessary processing chains REQ-20 vii: Develop and implement necessary processing chains REQ-30 vii: Evolve and improve processing chains

The data processing shall be done in an automated manner. This requires however monitoring by operators to ensure the system is running nominally.

GC-RB_1-GLOP-REQ-11:	
The GLOP shall provide the proper feedback mechanisms and reporting tools to the GlobCurrent system operators for data processing monitoring. Detected issues should be raised to users whever relevant.	
Verification method	Inspection
Link to SoW	**REQ-220:** The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each product and service provided by the project on a daily basis. A time series of *GlobCurrent* Metrics for the processing system, the delivery system(s) and product performance ***shall*** be provided. *Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).*

5.4. Dissemination

The dissemination system delivers the products and information (quality, reports, indicators) generated by the project to the user community.

GC-RB_1-GLOP-REQ-12:	
A GlobCurrent dissemination system shall be implemented to disseminate data (products and higher level information) to the user community.	
Verification method	
Link to SoW	**REQ-10 vi**: Develop and implement a data delivery system for users **REQ-20 ix:** Evolve and improve data delivery system **REQ-30 ix:** Evolve and improve data delivery system

GC-RB_1-GLOP-REQ-13:	
The GlobCurrent dissemination system shall make the data available to any users without any restrictions or any cost. Preliminary (free) registration may required to track user profiles.	
Verification method	Inspection
Link to SoW	**REQ-480:** All products ***shall*** be freely and openly available to the user community without restriction.

A general requirement is therefore to aim at minimizing the uptake of GlobCurrent data by the user community by disseminating the data in an easy way, following common standards and practices.

GC-RB_1-GLOP-REQ-14:	
The GlobCurrent products shall be disseminated in widely used data formats. The preferred format for ocean community shall be NetCDF4, complying to standard recommendations such as Climate and Forecast (CF) for format and metadata.	
Verification method	Inspection
Link to SoW	**REQ-280:** All *GlobCurrent* products ***shall*** be provided in NetCDF v4 format, be fully self-describing and complaint with Climate Forecast (CF) metadata (see http://cf-pcmdi.llnl.gov). **REQ 310:** *GlobCurrent* ***shall*** provide all L2 input data products used in the project in a common NetCDF-v4 CF-Compliant "L2P" format. *Note: L2P refers to L2 pre-processed* **REQ-290:** GlobCurrent metadata shall be sufficiently detailed to implement end-to-end data management of all products and related parameters within the GlobCurrent project (including data search and discovery by users and sufficient information for users on data sources and any limitation to data use). *Note: the intention of this requirement is to ensure that metadata is able to properly capture such aspects as processing system identification, input data sets used within a file, contact points for data, licensing and version control etc.*

GlobCurrent is expected to serve different communities with different needs or requirements. It shall therefore be able to tailor the GlobCurrent information accordingly:

GC-RB_1-GLOP-REQ-15:	
The dissemination system shall be able to format GlobCurrent products to suitable format for a given application: in particular it shall be able to deliver relevant products in grib2 format.	
Verification method	Test
Link to SoW	**REQ-140:** *GlobCurrent* ***shall*** include a capability to deliver GRIB2 files to selected users using appropriate delivery mechanisms. **REQ-300**: *GlobCurrent* ***shall*** provide the capability to deliver data products in GRIB-2 format to example users at sea *Note: this requirement addresses the needs of operational/commercial systems requiring compressed NRT delivery of data to existing tools and systems*

Offshore operations have limited bandwidth and can't afford to download useless data (data out of the area of interest, full resolution numerical data vs image, …) and this aspect had to be taken into account in GlobCurrent data delivery mechanism.

GC-RB_1-GLOP-REQ-16:	
The GlobCurrent dissemination mechanism shall be able to subset data on demand for specific users. Other tailoring functions shall be added on user demand.	
Verification method	Test
Link to SoW	**REQ-100:** The *GlobCurrent* project ***shall*** provide appropriate and validated delivery options for EO products in support of users with low bandwidth data connections. *Note: The emphasis of this requirement is for users on board ships (including public yacht users) at sea and in developing regions.* **REQ-60:** Other tools shall be defined and implemented based on user requirements as required.

GC-RB_1-GLOP-REQ-17:	
The GlobCurrent dissemination mechanism shall be able to deliver data as images (GeoTiff, png,...).	
Verification method	Test
Link to SoW	**REQ-100:** The *GlobCurrent* project ***shall*** provide appropriate and validated delivery options for EO products in support of users with low bandwidth data connections. *Note: The emphasis of this requirement is for users on board ships (including public yacht users) at sea and in developing regions.*

GC-RB_1-GLOP-REQ-18:	
Other tailoring functions shall be added on user demand.	
Verification method	Test/Inspection
Link to SoW	**REQ-60:** Other tools shall be defined and implemented based on user requirements as required.

GC-RB_1-GLOP-REQ-19:	
The GlobCurrent dissemination mechanism shall be able to automatically perform these operations on a routine basis and make the tailored data available on a FTP repository or sent by email.	
Verification method	Test
Link to SoW	**REQ-100:** The *GlobCurrent* project ***shall*** provide appropriate and validated delivery options for EO products in support of users with low bandwidth data connections. *Note: The emphasis of this requirement is for users on board ships (including public yacht users) at sea and in developing regions.* **REQ-30 xvi.** Provide appropriate interfaces **REQ-30 xvii**. Provide other services requested by users within the scope of the GlobCurrent project.

The data dissemination shall be done in an automated manner. This require however monitoring by operators to ensure the system is running nominally and interaction with the users.

GC-RB_1-GLOP-REQ-20:	
The GLOP shall provide the proper feedback mechanisms and reporting tools to the GlobCurrent system operators for data dissemination monitoring. Detected issues should be raised to users whenever relevant, through RSS feed and email.	
Verification method	Inspection
Link to SoW	**REQ-220:** The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each product and service provided by the project on a daily basis. A time series of *GlobCurrent* Metrics for the processing system, the delivery system(s) and product performance ***shall*** be provided. *Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).* **REQ-160** - Registered users of the GlobCurrent Service shall be informed immediately of problems and outages if they subscribe to this service element.

GC-RB_1-GLOP-REQ-21:	
The users shall have a proper way to report issues with the data access to a help desk with fast reply to any reported issue.	
Verification method	Inspection
Link to SoW	**REQ-160** - Registered users of the GlobCurrent Service shall be informed immediately of problems and outages if they subscribe to this service element.

Fast uptake of the GlobCurrent products shall also include data discovery and visualisation tools. Access to GlobCurrent products first requires the proper tools for users to select the products and files relevant for their usage.

GC-RB_1-GLOP-REQ-22:	
The dissemination system shall provide a user-friendly discovery tool for GlobCurrent product collections (catalogue) and data (index of products).	
Verification method	Inspection
Link to SoW	**REQ-10x**. Provide a metadata browse catalogue of available EO products, **REQ-290:** GlobCurrent metadata shall be sufficiently detailed to implement end-to-end data management of all products and related parameters within the GlobCurrent project (including data search and discovery by users and sufficient information for users on data sources and any limitation to data use). *Note: the intention of this requirement is to ensure that metadata is able to properly capture such aspects as processing system identification, input data sets used within a file, contact points for data, licensing and version control etc.*

GC-RB_1-GLOP-REQ-23:	
The dissemination system shall provide a user-friendly visualisation tool to display and intercompare the GlobCurrent products.	
Verification method	Inspection
Link to SoW	**REQ-10xiii**. Provide on-line quick-look products

5.5. Data analysis system

Analysis of the data quality and production of synoptic OSC products will require tools to support data synergy through data intercomparison and combination tools.

GC-RB_1-GLOP-REQ-24:	
GlobCurrent shall provide tools to produce cross-sensor matchups (MDB : match-up databases), such as satellite to in situ matchups, or multi-sensor match-up databases (MMDB) over predefined sites (similar to the concept of HR-DDS sites defined in GHRSST). This may be based for instance on tools such as felyx (http://www.felyx.org).	
Verification method	Test
Link to SoW	**REQ-670**: A database of in-situ OSC validation data **shall** be collected, from a range of globally distributed validation sites, covering different ocean regimes and sampling different seasons. This data **shall** be used by the Contractor to perform validation of the data sets hosted on the web portal, and may be provided to other users if the in-situ data providers agree. **REQ-60** GlobCurrent shall provide tools for extracting time series of products over a given geographical location, as well as statistics of match-ups with in-situ and other (e.g., model output) data held by GlobCurrent.

GC-RB_1-GLOP-REQ-25:	
GlobCurrent shall provides tools to intercompare various sources of OSC (or ancillary) data, in particular to support decision making on supervised synoptic product generation. This may be based for instance on synergy tools such as Syntool.	
Verification method	Test
Link to SoW	

GC-RB_1-GLOP-REQ-26:	
GlobCurrent shall provide diagnostic and validation tools to assess the dynamic quality of the calculated currents and produce quality indicators and reports. Such diagnostic tools may for instance include production of Lagrangian Coherent Structures (such as Lyapunov exponents).	
Verification method	Test
Link to SoW	

5.6. Supervised data collection

Some data are produced manually by scientists. They include for instance qualified databases of ocean drifters (with drogue status) that are released by isolated contributors sporadically. They include also reference data such as mean dynamic topography or mixed layer depth.

GC-RB_1-GLOP-REQ-27:	
GlobCurrent project shall liaise with providers to get any relevant dataset that may not be readily available and format it to a usable form and content for GlobCurrent.	
Verification method	Inspection
Link to SoW	

5.7. Supervised product generation

GC-RB_1-GLOP-REQ-28:	
GlobCurrent project shall provide a system to deliver synoptic products from multiple sources of data. This process may be supervised through expert interaction.	
Verification method	Inspection
Link to SoW	

6. Validation of products and services to users

This section specifies the requirements for systematic validation of all GlobCurrent products and systems. We begin with a definition of individual satellite data processing levels: an L2 product is a georeferenced data file from an external source. An L2P product is the corresponding preprocessed data file, identical to the original L2 file, except that an estimate of bias error, error standard deviation, and at least one quality control flag is included. Flags permit masking of data values according to the application of interest. Errors and flags are known collectively as single sensor error statistics (SSES; Donlon et al. 2007). These can be assigned following construction of a lookup table based on comparison of a large collocation database (possibly subcategorized by likely error sources for each instrument). One caveat of this statistical approach is that the *in situ* dataset is also erroneous, which implies (for example) that a bias lookup table requires postulates of the relative error between the satellite and in situ observations (cf. Fangohr and Kent 2012). A simple postulate can always be made, and once created, the resulting lookup tables are easy to employ in processing.

GC-RB_1-VAL-REQ-1: Data collection	
The *GlobCurrent* system ***shall*** include a database of near contemporaneous *in situ* data for validation purposes including: HF-RADAR In-Situ Ocean Surface Current measurements Satellite measurements including lower level- 1 information Any other data required by *GlobCurrent* validation The in-situ OSC validation data shall be collected from a range of globally distributed validation sites covering different ocean regimes and sampling different seasons. These data should be provided to the GlobCurrent users (if the in-situ data providers agree).	
Verification method	Inspection
Link to Sow	REQ-670 REQ-690

GC-RB_1-VAL-REQ-2: L2 errors and flags	
GlobCurrent L2P products shall include uncertainty estimates and flags for every grid-point in the data file. Among the individual L2 current components that GlobCurrent will produce (i.e., from Fig. 2: Doppler line-of-sight, geostrophic, current gradient, and optical), none provide estimates of total current at 15-m depth. However, after smoothing over a few inertial timescales (or in an error-weighted mean sense for Doppler; cf. Hansen et al. 2011), the drifter data provide a common first-order reference for these L2P products. Differences can be computed directly, although by including a corresponding model estimate, a more accurate calculation of observational bias and standard deviation can be obtained (Stoffelen 1998). Comparison to HF radar, when available, should allow for refined error estimates of Doppler and current gradient estimates. Ekman current components may need to rely on error estimates of the model parameters (GC-RB_1-EK-REQ-2) and perhaps also on variance in the wind stress inputs (e.g., ECMWF versus scatterometer winds).	
Verification method	Inspection
Link to Sow	REQ-340 REQ-350

GC-RB_1-VAL-REQ-3: L4 errors and flags	
GlobCurrent L4 products shall include uncertainty estimates for every grid-point in the data file. Uncertainty estimates shall include those from the data and those from the analysis system. Eulerian (u and v component) and Lagrangian (FTLE or LCS) metrics will be employed for L4 validation. We will primarily use drifting buoys (usually drogued) as the ocean current reference because these and the SSES values obtained from them should be relatively consistent globally and over the decade 2002-2012 (about 13 million positions were collected since 1979). The remaining validation data (HF radar, moored buoys, ADCP, and gridded model output) should permit either a higher resolution validation, a better reference for a given current component, or an independent validation of errors, but with a reference error bias and standard deviation that may differ from that obtained relative to drifters.	
Verification method	Inspection
Link to Sow	REQ-10iii REQ-20vi REQ-30vi REQ-350 REQ-410

GC-RB_1-VAL-REQ-4: Intercomparison	
Validation shall be performed by: • Inter-comparison of Level-2 satellite OSC products with in-situ data (this Category-1 comparison is discussed in GC-RB_1-VAL-REQ-2 above) • Between different EO products (this Category-2 comparison shall address the complementary near-geostrophic current retrieval methods of altimetric and eSQG). In-situ data that has been used for calibration of a satellite OSC retrieval algorithm shall not be used to validate that retrieval. GlobCurrent L2 and L4 data products also shall be inter-compared to other existing products (e.g. OSCAR) on a regular (target daily) basis. The focus of this activity is on identifying differences between GlobCurrent and existing products at L4, so regular differences are performed at this level and where a diagnosis of differences would be enlightening, attribution of analysis method or L2 differences are explored. Existing products (like OSCAR) are *not* assumed to consist of independent data.	
Verification method	Inspection
Link to Sow	REQ-700 REQ-730

GC-RB_1-VAL-REQ-5: Long-term stability of the products	
Validation ***shall*** characterise the long-term stability of the satellite OSC data sets. The focus of this activity is on removing jumps in the OSC reanalysis that are caused by large changes in observational quality or coverage. Users shall be informed if such jumps are traced either to an unexpected impact, or to a problem with L2 observations or processing, of a given instrument or platform. Eulerian metrics shall be employed.	
Verification method	Inspection
Link to Sow	REQ-720

GC-RB_1-VAL-REQ-6: Product uncertainty validation	
Satellite OSC product uncertainty estimates ***shall*** be validated. This shall employ independent reference data for validation, such as the use of similar and independent buoy data (e.g., ARGO buoys and undrogued drifters).	
Verification method	Inspection
Link to Sow	REQ-710

GC-RB_1-VAL-REQ-7: Validation Reports	
Validation reports must be written and made available through the web portal. The metrics that are employed to characterize L2 and L4 data quality will be provided in a series of report updates that document the evolution of GlobCurrent products.	
Verification method	Inspection
Link to Sow	REQ-680

GC-RB_1-VAL-REQ-8: Product Validation	
The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each product. A time series of *GlobCurrent* Metrics for the product performance ***shall*** be provided. This activity shall automatically document standard (e.g., current component) metrics applied to each product and thereby highlight uncontrolled errors in the creation of GlobCurrent products that would be detrimental for user applications. Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).	
Verification method	Inspection
Link to Sow	REQ-220

GC-RB_1-VAL-REQ-9: System Validation	
The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each service A time series of *GlobCurrent* Metrics for the processing and delivery system(s) shall be provided. This activity shall identify uncontrolled failures in the provision of GlobCurrent services that would be inconvenient to users. Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).	
Verification method	Inspection
Link to Sow	REQ-10xiv REQ-220

GC-RB_1-VAL-REQ-10: Validation areas of interest	
Regions employed for validation will target the GlobCurrent areas of interest (i.e., year one will include 5 areas and global; years two and three will include 10 areas and global)	
Verification method	Inspection
Link to Sow	REQ-10xi REQ-20xv REQ-30ii

7. Communication and user interface system

The GlobCurrent communication with the user community at large will be based on: (i) the three annual UCMs; (ii) regular issuing of newletters directly to registered users and via the web portal; (iii) immediate information on service problems and outages; (iv) participation to relevant conferences and workshops; (v) open and easy way of users to provide feedback and updates on GlobCurrent products; (vi) updates of the URD; (vii) dedicated two-way communication with the PI of the user lead demonstration cases (see also section 7); (viii) quick responses to user request and offers to assist; (ix) provision of training material and dedicated courses; (x) performance of nowcasting and (xi) publication of GlobCurrent findings and results in international review journals.

7.1. Baseline support to users

GC-RB_1-COM-REQ-1	
Provision and updates of information on definition of GlobCurrent products, including their origin and applied retrieval methods, as well as how to access the products and use the web tools via the different communication lines identified above.	
Verification method	Test
Link to Sow	**REQ-10 viii:** Provide baseline support to users **REQ-20 xiii:** Provide baseline support to users **REQ-30 xii:** Provide baseline support to users

GC-RB_1-COM-REQ-2	
GlobCurrent ***shall*** provide maps of ocean current vectors for all products suitable for use on the *GlobCurrent* web portal and for download by users *Note: Versions of these maps may also provide a data product quick-look capability* *GlobCurrent* ***shall*** provide animations of products with dynamic visualisation capability similar to that used by the NOAA/GLERL Great Lakes Surface Currents Map project (http://www.glerl.noaa.gov/res/glcfs/currents/ and F. Viegas and M. Wattenberg (http://hint.fm)	
Verification method	Inspection
Link to SoW	REQ-10xiii, REQ-20xi, REQ-250, REQ-260

GC-RB_1-COM-REQ-3	
GlobCurrent ***shall*** provide tools for extracting time series of products over a given geographical location, as well as statistics of match-ups with in-situ and other (*e.g.,* model output) data held by *GlobCurrent*. Other tools ***shall*** be defined and implemented based on user requirements as required	
Verification method	Inspection
Link to Sow	REQ-60

GC-RB_1-COM-REQ-4
The *GlobCurrent* project ***shall*** develop and maintain tailored versions of EO product handbooks for each *GlobCurrent* product and service. Product handbooks ***shall*** include: (i) Glossary of terms, a table of acronyms (ii) Introduction and summary of product use in typical user applications (iii) Relevant background material describing the product, (iv) Description of the precise algorithms applied to generate the product with links to ATBD and other reference material, (v) A description of the Processing Model that explains how data were processed end-to-end for each *GlobCurrent* product. (vi) Range of product accuracy, precision and links to validation information and validation evidence, (vii) User guidance on the application of products by example application, (viii) A description of strengths and weakness of each data product, (ix) A comprehensive description of the derivation of uncertainties for each *GlobCurrent* Product and their validity. (x) An example of how to use uncertainty information provided with the product.

(xi)	Relevant scientific and engineering journal paper and report references,
(xii)	Detailed description of product format,
(xiii)	CDL dump of an example product,
(xiv)	Estimates of typical file sizes,
(xv)	Description of where and how to access/order products,
(xvi)	Contact points for each product,
(xvii)	Full visualisation (*e.g.,* images, line plots *etc.*) of an example product,
(xviii)	Example read software and links to actual software code available on the *GlobCurrent* web portal,
(xix)	A product FAQ tailored to *GlobCurrent* applications.
(xx)	A feedback form and contact details to submit feedback allowing users to report problems and request further information.
(xxi)	Any other material required by beginner users to successfully understand, read and apply the product.
(xxii)	Appendices detailing any web sites, software tools, read software *etc*.

GlobCurrent product handbooks ***shall*** be maintained and updated based on user feedback and product/service evolution for the duration of the *GlobCurrent* project.

Verification method	Inspection
Link to Sow	REQ-490

GC-RB_1-COM-REQ-5	
All project documents shall be available to the GlobCurrent users via the GlobCurrent Web Portal. All *GlobCurrent* documents ***shall*** accessible to the user community in an open and transparent manner. No restriction on public access to all *GlobCurrent* deliverable documents ***shall*** be allowed. This requirement excludes *GlobCurrent* project management reports to ESA.	
Verification method	Inspection
Link to Sow	REQ-510

7.2. Content and functionality of the GlobCurrent web portal

The aim of the web portal is to provide users with a resource to make full and easy use of the *GlobCurrent* data products and services facilitating their application.

GC-RB_1-COM-REQ-6:	
The *GlobCurrent* web Portal ***shall*** conform to the following specification: • Be operated in a robust manner with an availability[1] of >95%. • All data and information accessible via the portal ***shall*** by default be provided publicly and without restriction. • Include a blog. • All sources of data and information products ***shall*** be fully acknowledged. • Access to all data products hosted on the web portal ***shall*** require the user to enter their email address, which ***shall*** then be added to the *GlobCurrent* Directory (DIR) • Contain introductory information about the *GlobCurrent* project, including background, objectives, work plan and schedule, latest project news and news archive, dates/venues/registration link/presentations of all open meetings, list of *GlobCurrent* team members, contacts of the project manager and consortium partners. • Provide relevant links to related activities. • Include a list of *GlobCurrent* Champion users and pages providing User profiles of Key Champion Users and their applications. • A reference bibliography of relevant scientific papers and reports. • Description and links to sources all data used in the project. • Description and links to all satellite data sets used within the project including links to their ATBD and source processing systems. • Guides on how to access satellite data provided by the space agencies, and information on reprocessing activities. • An interactive geographical interface to visualise *GlobCurrent* data products. • Web-accessible tools to manipulate and work with *GlobCurrent* data. • FTP access to all *GlobCurrent* products. • Access to all public project documentation. • A password protected *GlobCurrent* project section containing project internal documentation, such as all draft document deliverables, RIDs, meeting minutes, actions database, monthly reports, project management plan, etc. Access to internal sections of the *GlobCurrent* web portal ***shall*** require registration. • Any other service or function required to implement the *GlobCurrent* project.	
Verification method	Inspection
Link to Sow	REQ-210, REQ-500, REQ-520

7.3. GlobCurrent results promotion

The mechanisms by which the GlobCurrent shall promote and disseminate the results of the project are detailed below.

GC-RB_1-COM-REQ-7: Directory and mailing list	
The GlobCurrent project will develop and maintain a directory and mailing list which shall contain contact details of: a) All members of the study team b) All participants to meetings. c) Users registering on the web portal.	
Verification method	Inspection
Link to Sow	REQ-170

GC-RB_1-COM-REQ-8: Peer-reviewed papers	
The GlobCurrent project will develop and submit scientific peer reviewed papers to appropriate international science journals. The publications shall acknowledge the support of the ESA DUE programme and use of ESA data.	
Verification method	Inspection
Link to Sow	

GC-RB_1-COM-REQ-9: Present results of the study	
The GlobCurrent project will present the study and results at relevant international events, including future ESA meetings and other international symposia during the lifetime of the project.	
Verification method	Inspection
Link to Sow	

GC-RB_1-COM-REQ-10: Promote results of the study	
The GlobCurrent project will actively promote the results of the study and distribute freely all data, reports and experimental output data to: a) User community. b) Other relevant scientific communities. The GlobCurrent project will produce and distribute on a regular basis newsletters (every 6 months) to communicate on the progress of the project and brochures (every year) before each User Consultation Meeting, to describe the different version of the Globcurrent system	
Verification method	Inspection
Link to Sow	

GC-RB_1-COM-REQ-11: Promote results of the study	
GlobCurrent ***shall*** use of social networking tools (e.g. Twitter, Facebook etc) as part of the project operational, outreach and communication service.	
Verification method	Inspection
Link to Sow	REQ-190

7.4. User Consultation Meeting

In addition, a user consultation meeting (UCM-1) shall be held at the end of the first year of the project.

The GlobCurrent team will present their v1 products and services.

The meeting will be over 2 and a half days and a report detailing the workshop discussions and feedback will be compiled and made available through the project website.

The meeting will be widely advertised and information on location, accommodation, travel, registration and timetable will be provided by the host organisation.

GC-RB_1-COM-REQ-12: User consultation meeting (UCM-1)	
The GlobCurrent project shall organise a User Consultation Meeting (UCM-1) within the first year of the project. It will have the following objectives: a) Exchange information on the results of the project with the user community. b) Outreach to other scientific users and researchers. c) Raise awareness of the utility of EO for ocean currents. d) Obtain feedback from users on the v1 products and services. e) Minutes of the workshop shall be produced and distributed in an electronic format.	
Verification method	Inspection
Link to Sow	

8. Case Study Requirements

The case studies will be selected in sequence with the first study kicked in at KO+9 months. Subsequent case studies will be timed to optimize access to new satellite data (e.g. Sentinel 1 and Sentinel 3) and new in-situ data. Each case study must be compliant with the specification provided in the Technical Proposal (DoW), including the provision of the Case Study Implementation Plan (CSIP) at least one month before the start of the study.

GC-RB_1-CASE-REQ-1:	
Provision of all GlobCurrent satellite products as well web-tools. On the case-by-case basis the GlobCurrent project team will be available to support and guide the case studies with respect to data handling, processing, collocation, visualization and interpretation.	
Verification method	Inspection
Link to Sow	**REQ-10 x:** Support case studies **REQ-20 xiv:** Support case studies **REQ-30 xiii:** Support case studies

9. GlobCurrent NRT demonstration service

GC-RB_1-DEMO-REQ-1:	
A Globcurrent analyst together with the steering team, will select a few cruises in agreement with end users (scientific cruise in the Agulhas/circumpolar current or commercial cargo ship from Shanghai to Cape Town, …) . Before cruise : the Globcurrent analyst and the end user will define the required surface current information needed in terms of depth, frequency, resolution, format, compression. During cruise : the Globcurrent analyst will provide synoptic charts, NRT gridded L2 and L4 products, email/telephone interpretation support. After cruise : the Globcurrent analyst will debrief with the end user on the value added and eventually economy made by using Globcurrent surface current information. The now-casting demonstration is aiming at helping a few selected users to start evaluating Globcurrent information for real ship routing (including discussion on the precise need, formatting, compression, delivery, interpretation assistance, and debrief) it should involved one sailing race, one research cruise, and a commercial vessels (CMA-CGM for instance) preferably over a overlapping period of a few month. This now-casting demonstration shall take place ideally within the second or third year of the project	
Verification method	
Link to Sow	**REQ-30x**

10. Requirements on the schedule

All V1 datasets are to be finalised and made available through the web portal three months before the first User Consultation Meeting (UCM-1). This will allow users to view and analyse any data prior to the workshop and allow them to provide feedback. The UCM-1 dates and location will be confirmed and advertised at least 10 months before the workshop is due to take place.

GC-RB_1-SCH-REQ-1: Workshop dates	
The dates and location of the UCM-1 will be finalised and advertised at least 10 months before the meeting is due to take place.	
Verification method	Inspection

GC-RB_1-SCH-REQ-2: providing datasets in advance	
The GlobCurrent project shall provide all v1 data products at least 3 months before the UCM-1.	
Verification method	Inspection

11. ANNEX A: Compliancy with the SoW Requirements Table

SoW REQ ID	*Type*	Requirement Description	*Trace/ Source*	*Validation*	*RB REQ ID*
[REQ-10]	System	Based on *GlobCurrent* TS-V1, ICD-V1 and DARD-V1, the V1 prototype system ***shall***: i. Perform R&D to develop and implement new algorithms and approaches to derivation of OSC measurements from EO data	URD/ ESA	INSP	**GC-RB_1-GEO-REQ-1** **GC-RB_1-EK-REQ-1** **GC-RB_1-VIR-REQ-1** **GC-RB_1-SAR-REQ-1** **GC-RB_1-SAR-REQ-2** **GC-RB_1-HRGEO-REQ-1** **GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5** **GC-RB_1-GEO-REQ-6**
		ii. Develop and implement new data merging strategies and methods		INSP	**GC-RB_1-GEO-REQ-1** **GC-RB_1-EK-REQ-1**
		iii. Produce new error and uncertainty estimations for OSC measurements		INSP	**GC-RB_1-VAL-REQ-3**
		iv.Develop and implement necessary processing chains			**GC-RB_1-GLOP-REQ-6** **GC-RB_1-GLOP-REQ-7** **GC-RB_1-GLOP-REQ-8** **GC-RB_1-GLOP-REQ-10**
		v.Develop and implement a data management system			**GC-RB_1-GLOP-REQ-1**
		vi. Develop and implement a data delivery system for users		TEST	**GC-RB_1-GLOP-REQ-12**
		vii. Implement version control for all aspects of the system			**GC-RB_1-GLOP-REQ-9**

		viii. Provide baseline support to users		TEST	**GC-RB_1-COM-REQ-1**
		ix. Produce new OSC products		INSP	**GC-RB_1-GEO-REQ-1** **GC-RB_1-EK-REQ-1** **GC-RB_1-GEO-REQ-6**
		x. Support Case Studies			**GC-RB_1-CASE-REQ-1**
		xi. Include at least 5 local AOI			**GC-RB_1-VAL-REQ-10** **GC-RB_1-PROD-REQ-1**
		xii. Provide a metadata browse catalogue of available EO products,			**GC-RB_1-GLOP-REQ-22**
		xiii. Provide on-line quick-look products			**GC-RB_1-GLOP-REQ-23** **GC-RB_1-COM-REQ-2**
		xiv. Provide metrics and other information describing the quality and availability of service for each product			**GC-RB_1-VAL-REQ-9**
		xv. Produce a 1-year output data set addressing *GlobCurrent* Requirements.		INSP	**GC-RB_1-PROD-REQ-2** **GC-RB_1-GEO-REQ-1** **GC-RB_1-EK-REQ-1**
[REQ-20]	System	Based on *GlobCurrent* TS-V2, ICD-V2 and DARD-V2, the V2 demonstration system ***shall***: i. Perform R&D leading to evolve and consolidate all aspects of the system	URD/ ESA	INSP	**GC-RB_1-GEO-REQ-2** **GC-RB_1-EK-REQ-2** **GC-RB_1-VIR-REQ-2** **GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5** **GC-RB_1-GEO-REQ-6**
		ii. Expand the portfolio of baseline global coverage products developed in REQ-10 to include the regional/local domain to support GlobCurrent Users and Case Studies			**GC-RB_1-PROD-REQ-1**

		iii. Evolve and improve algorithms and approaches to derivation of OSC measurements from EO data			**GC-RB_1-SAR-REQ-3** **GC-RB_1-HRGEO-REQ-2** **GC-RB_1-HRGEO-REQ-4** **GC-RB_1-HRGEO-REQ-5** **GC-RB_1-VIR-REQ-2** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5** **GC-RB_1-GEO-REQ-6**
		iv. Evolve and improve data merging strategies and methods			**GC-RB_1-VIR-REQ-2** **GC-RB_1-GEO-REQ-6**
		v. Produce new OSC products			**GC-RB_1-GEO-REQ-6** **GC-RB_1-STO-REQ-1** **GC-RB_1-INERT-REQ-1** **GC-RB_1-TIDES-REQ-1**
		vi. Produce new error and uncertainty estimations for OSC measurements			**GC-RB_1-VAL-REQ-3**
		vii. Develop and implement necessary processing chains			**GC-RB_1-GLOP-REQ-6** **GC-RB_1-GLOP-REQ-7** **GC-RB_1-GLOP-REQ-8** **GC-RB_1-GLOP-REQ-10**
		viii. Develop and implement a data management system			**GC-RB_1-GLOP-REQ-1**
		ix. Evolve and improve data delivery system			**GC-RB_1-GLOP-REQ-12**
		x. Provide a metadata browse and access catalogue of available products,			**GC-RB_1-GLOP-REQ-22**
		xi. Provide on-line quick-look products,			**GC-RB_1-COM-REQ-2**
		xii. Provide an easy means for users to contact the *GlobCurrent* project and			**GC-RB_1-COM-REQ-6**

		leave feedback or seek advice in a timely (TBD with users) manner.			
		xiii. Provide baseline support to users			**GC-RB_1-COM-REQ-1**
		xiv. Support Case Studies			**GC-RB_1-CASE-REQ-1**
		xv. Produce at least 10 AOI including 1 global AOI			**GC-RB_1-PROD-REQ-1** **GC-RB_1-VAL-REQ-10**
		xvi. Produce a 10-year historical output data set addressing *GlobCurrent* Requirements.			**GC-RB_1-PROD-REQ-2**
[REQ-30]	System	Based on *GlobCurrent* TS-V3, ICD-V3 and DARD-V3, the V3 production and re-analysis system ***shall***: i. Consolidate and evolve all aspects of the V2 system	URD/ ESA	INSP	**GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5**
		ii. Maintain V2 AOI activities			**GC-RB_1-VAL-REQ-10**
		iii. Evolve and improve algorithms and approaches to derivation of OSC measurements from EO data			**GC-RB_1-SAR-REQ-4** **GC-RB_1-HRGEO-REQ-3** **GC-RB_1-HRGEO-REQ-4** **GC-RB_1-HRGEO-REQ-5** **GC-RB_1-VIR-REQ-3** **GC-RB_1-GEO-REQ-3** **GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5**

		iv. Evolve and improve data merging strategies and methods			**GC-RB_1-VIR-REQ-3** **GC-RB_1-GEO-REQ-3**
		v. Produce new OSC products			**GC-RB_1-SAR-REQ-3** **GC-RB_1-HRGEO-REQ-3** **GC-RB_1-HRGEO-REQ-4** **GC-RB_1-VIR-REQ-3** **GC-RB_1-GEO-REQ-3** **GC-RB_1-GEO-REQ-4** **GC-RB_1-GEO-REQ-5**
		vi. Produce new error and uncertainty estimations for OSC measurements			**GC-RB_1-VAL-REQ-3**
		vii. Evolve and improve processing chains			**GC-RB_1-GLOP-REQ-6** **GC-RB_1-GLOP-REQ-7** **GC-RB_1-GLOP-REQ-8** **GC-RB_1-GLOP-REQ-10**
		viii. Evolve and improve data management system			**GC-RB_1-GLOP-REQ-1**
		ix. Evolve and improve data delivery system			**GC-RB_1-GLOP-REQ-12**
		x. Implement a near real-time service demonstration (e.g. a nowcasting demonstration) for all products and interfaces in collaboration with GlobCurrent Users and Case studies.			**GC-RB_1-DEMO-REQ-1**
		xi. Provide an easy means for users to contact the *GlobCurrent* project and leave feedback or seek advice in a timely (timing TBD with users) manner.			**GC-RB_1-COM-REQ-6**

		xii. Provide baseline support to users			**GC-RB_1-COM-REQ-1**
		xiii. Support Case Studies			**GC-RB_1-CASE-REQ-1**
		xiv. Perform a consistent re-analysis of the full data *GlobCurrent* set to provide a final data set.			**GC-RB_1-GLOP-REQ-5**
		From no later than KO+30 of the *GlobCurrent* project, a NRT demonstration service of EO data ***shall*** be provided. The NRT system ***shall***: *xv.* Be available as an open access service linked to the *GlobCurrent* web portal to encourage the widest possible use of EO data (i.e. academic, commercial and operational users) in support of their applications,			
		xvi. Provide appropriate NRT data access interfaces,			**GC-RB_1-GLOP-REQ-19**
		xvii. Provide other services requested by users within the scope of the *GlobCurrent* project. *Note: For this requirement NRT is defined as "made available to users within (TBC) of the last available data set required to complete an operation that satisfies user requirements"*			**GC-RB_1-GLOP-REQ-19**

		and will be different for L2 and L4 production.			
[REQ-40]	System	*GlobCurrent* software and systems ***shall*** be maintained under configuration control.	ESA	INSP	**GC-RB_1-GLOP-REQ-9**
[REQ-50]	System	*GlobCurrent* ***shall*** provide a data management system for all data products within the project.	URD	TEST	**GC-RB_1-GLOP-REQ-3**
[REQ-60]	System	*GlobCurrent* ***shall*** provide tools for extracting time series of products over a given geographical location, as well as statistics of match-ups with in-situ and other (*e.g.,* model output) data held by *GlobCurrent*. Other tools ***shall*** be defined and implemented based on user requirements as required.	ESA	INSP	**GC-RB_1-GLOP-REQ-16** **GC-RB_1-GLOP-REQ-18** **GC-RB_1-GLOP-REQ-24** **GC-RB_1-COM-REQ-3**
[REQ-70]	System	*GlobCurrent* ***shall*** provide a capability to re-process all data within the system using a consistent set of algorithms. *Note: the emphasis of this requirement is to produce a final data set at the end of the project.*	ESA	TEST	**GC-RB_1-GLOP-REQ-5**
[REQ-80]	System	*GlobCurrent* ***shall*** provide an open and easy way for users to provide feedback/updates and examples of their use of *GlobCurrent* Products.	ESA	INSP	**GC-RB_1-COM-REQ-6**
[REQ-90]	System	Multi-mission merged L3 and L4 analyses ***shall*** be implemented within the *GlobCurrent* project and be fully documented in appropriate	ESA	INSP	**GC-RB_1-L4-REQ-1**

		ATBD. *Note: the emphasis of GlobCurrent is to use native resolution L2 data products as a starting point.*			
[REQ-100]	System	The *GlobCurrent* project ***shall*** provide appropriate and validated delivery options for EO products in support of users with low bandwidth data connections. *Note: The emphasis of this requirement is for users on board ships (including public yacht users) at sea and in developing regions.*	ESA	TEST	**GC-RB_1-GLOP-REQ-16** **GC-RB_1-GLOP-REQ-17** **GC-RB_1-GLOP-REQ-19**
[REQ-110]	System	The primary mechanism for *GlobCurrent* product delivery to users ***shall*** be ftp/sftp.	URD	TEST	**GC-RB_1-GLOP-REQ-2**
[REQ-120]	System	The secondary mechanism for *GlobCurrent* product delivery to users ***shall*** be OpenDAP.	URD	TEST	**GC-RB_1-GLOP-REQ-2**
[REQ-130]	System	The tertiary mechanism for *GlobCurrent* product delivery to users ***shall*** be HTTP.	URD	TEST	**GC-RB_1-GLOP-REQ-2**
[REQ-140]	System	*GlobCurrent* ***shall*** include a capability to deliver GRIB2 files to selected users using appropriate delivery mechanisms.	URD / ESA	TEST	**GC-RB_1-GLOP-REQ-15**
[REQ-150]	System	*GlobCurrent* ***shall*** allow users to register with the system.	ESA	TEST	**GC-RB_1-COM-REQ-6**
[REQ-160]	System	Registered users of the *GlobCurrent* Service ***shall*** be informed immediately of problems and outages if they subscribe to this service	ESA	INSP	**GC-RB_1-GLOP-REQ-20** **GC-RB_1-GLOP-REQ-21**

		element.			
[REQ-170]	System	*GlobCurrent* ***shall*** inform registered users by email contact as the preferred form of feedback.	URD	INSP	**GC-RB_1-COM-REQ-7**
[REQ-180]	System	All *GlobCurrent* service availability and performance information ***shall*** be published on the *GlobCurrent* web portal.	URD	INSP	**GC-RB_1-COM-REQ-6**
[REQ-190]	System	*GlobCurrent* ***shall*** use of social networking tools (e.g. Twitter, Facebook etc) as part of the project operational, outreach and communication service.	URD	INSP	**GC-RB_1-COM-REQ-11**
[REQ-200]	System	*GlobCurrent* ***shall*** provide dedicated points of contact to assist users throughout the project.	URD	INSP	**GC-RB_1-COM-REQ-6**

[REQ-210]	System	The *GlobCurrent* project ***shall*** develop, operate and maintain a central web portal that ***shall*** provide a single entry point to all aspects of the project. The aim of the web portal is to provide users with a resource to make full and easy use of the *GlobCurrent* data products and services facilitating their application. An example of a typical web portal that is expected for *GlobCurrent* can be found at http://www.storm-surge.info The *GlobCurrent* web Portal ***shall*** conform to the following specification:	URD	INSP	**GC-RB_1-COM-REQ-6**
		• Be operated in a robust manner with an availability[2] of >95%.			

[2] Operational service availability is a measure of the average availability of a service over a period of time and it includes all sources of downtime (excluding the effects of non-recoverable failures). Operational availability (O_{av}) is the ratio of the system uptime (T_{up}) the potential time a system should have been available (T_{pot}): $O_{av} = T_{up/} T_{pot}$. O_{av} is the availability that a service user actually experiences. O_{av} is a function of time or operating cycle (i.e. the operating cycle is the overall time period for the service being measured and T_{up} is the total time the service was functioning during one operating cycle). When there is no specified logistic downtime or preventive maintenance, operational availability represents the Mean Availability of the service.

		• All data and information accessible via the portal ***shall*** by default be provided publicly and without restriction.			
		• Include an interactive blog.			
		• All sources of data and information products ***shall*** be fully acknowledged.			
		• Access to all data products hosted on the web portal ***shall*** require the user to enter their email address, which ***shall*** then be added to the *GlobCurrent* Directory (DIR)			
		• Contain introductory information about the *GlobCurrent* project, including background, objectives, work plan and schedule, latest project news and news archive, dates/venues/registration link/presentations of all open meetings, list of *GlobCurrent* team members, contacts of the project manager and consortium partners.			

		• Provide relevant links to related activities.			
		• Include a list of *GlobCurrent* Champion users and pages providing User profiles of Key Champion Users and their applications.			
		• A reference bibliography of relevant scientific papers and reports.			
		• Description and links to sources all data used in the project.			

		• Description and links to all satellite data sets used within the project including links to their ATBD and source processing systems.			
		• Guides on how to access satellite data provided by the space agencies, and information on reprocessing activities.			
		• An interactive geographical interface to visualise *GlobCurrent* data products.			
		• Web-accessible tools to manipulate and work with *GlobCurrent* data.			
		• FTP access to all *GlobCurrent* products.			
		• Access to all public project documentation.			

		• A password protected *GlobCurrent* project section containing project internal documentation, such as all draft document deliverables, RIDs, meeting minutes, actions database, monthly reports, project management plan, etc. Access to internal sections of the *GlobCurrent* web portal ***shall*** require registration.			
		• Any other service or function required to implement the *GlobCurrent* project			
[REQ-220]	System	The *GlobCurrent* Portal ***shall*** provide automated performance metrics for each product and service provided by the project on a daily basis. A time series of *GlobCurrent* Metrics for the processing system, the delivery system(s) and product performance ***shall*** be provided. *Note: the intention of this requirement is to provide users with an early warning of issues and problems and to help demonstrate the reliability of the system (as requested by many users).*	URD / ESA	TEST	**GC-RB_1-GLOP-REQ-4** **GC-RB_1-GLOP-REQ-20** **GC-RB_1-VAL-REQ-8** **GC-RB_1-VAL-REQ-9** **GC-RB_1-GLOP-REQ-11**
[REQ-230]	AOI	*GlobCurrent* ***shall*** provide regional products for specific areas of interest requested by Users. Regional AOI ***shall*** be chosen to maximise the user interest in *GlobCurrent* activities.	URD	INSP	**GC-RB_1-VAL-REQ-10** **GC-RB_1-PROD-REQ-1** **GC-RB_1-HRGEO-REQ-2** **GC-RB_1-HRGEO-REQ-3**

		Note: A limited number of regional products are foreseen to develop and test the GlobCurrent V1 prototype system prior to full implementation in the V2 demonstration and V3 NRT and re-analysis systems			
[REQ-240]	AOI	*GlobCurrent* ***shall*** provide global coverage products.	URD	INSP	**GC-RB_1-PROD-REQ-1**
[REQ-250]	Visualisation	*GlobCurrent* ***shall*** provide maps of ocean current vectors for all products suitable for use on the *GlobCurrent* web portal and for download by users *Note: Versions of these maps may also provide a data product quick-look capability*	URD	INSP	**GC-RB_1-COM-REQ-2**
[REQ-260]	Visualisation	*GlobCurrent* ***shall*** provide animations of products with dynamic visualisation capability similar to that used by the NOAA/GLERL Great Lakes Surface Currents Map project (http://www.glerl.noaa.gov/res/glcfs/currents/ and F. Viegas and M. Wattenberg (http://hint.fm)	ESA	INSP	**GC-RB_1-COM-REQ-2**
[REQ-270]	Product	*GlobCurrent* ***shall*** provide measurements of Total Current at a specified time (t), location (x,y) and measurement depth level (z) provided as vector components of the form: ($\boldsymbol{u}[t,x,y,z]$, $\boldsymbol{v}[t,x,y,z]$) where $\boldsymbol{u}$ is a vector component which is positive when directed eastward (negative westward) and $\boldsymbol{v}$ is a vector component which	URD	INSP	**GC-RB_1-PROD-DEF-REQ-1**

		is positive when directed northward (negative southward).			
[REQ-280]	Product	All *GlobCurrent* products ***shall*** be provided in NetCDF v4 format, be fully self-describing and complaint with Climate Forecast (CF) metadata (see http://cf-pcmdi.llnl.gov). *Note: Sufficient metadata **shall** be provided to allow a reasonable number (TBC) of freely available netCDF readers to read and display the data with no additional tools.*	URD	INSP	**GC-RB_1-GLOP-REQ-14**
[REQ-290]	Product	*GlobCurrent* metadata ***shall*** be sufficiently detailed to implement end-to-end data management of all products and related parameters within the *GlobCurrent* project (including data search and discovery by users and sufficient information for users on data sources and any limitation to data use). *Note: the intention of this requirement is to ensure that metadata is able to properly capture such aspects as processing system identification, input data sets used within a file, contact points for data, licensing and version control etc.*	ESA	INSP	**GC-RB_1-GLOP-REQ-14** **GC-RB_1-GLOP-REQ-22**
[REQ-300]	Product	*GlobCurrent* ***shall*** provide the capability to deliver data products in GRIB-2 format to example users at sea. *Note: this requirement addresses the needs of operational/commercial systems requiring compressed NRT delivery of data to existing tools and systems*	URD	INSP	**GC-RB_1-GLOP-REQ-15**

[REQ-310]	Product	*GlobCurrent* ***shall*** provide all L2 input data products used in the project in a common NetCDF-v4 CF-Compliant "L2P" format. *Note: L2P refers to L2 pre-processed.*	URD	INSP	**GC-RB_1-GLOP-REQ-14**
[REQ-320]	Product	All *GlobCurrent* L2 files ***shall*** maintain identical native grid or swath-grid specifications provided by the data provider. *Note: The intent of this requirement is to preserve the data in their native form (i.e. no interpolation) while reformatting to a common format L2P data file.*	ESA	INSP	**GC-RB_1-PROD-DEF-REQ-2**
[REQ-330]	Product	*GlobCurrent* L2 products ***shall*** include coastal areas where appropriate.			**GC-RB_1-PROD-REQ-1** **GC-RB_1-HRGEO-REQ-2** **GC-RB_1-HRGEO-REQ-3**
[REQ-340]	Product	All *GlobCurrent* L2 files ***shall*** provide uncertainty estimates with each measurement. *Note: it is acknowledged that this is a difficult requirement to meet in the case of L2 products and may only be possible using statistical techniques.*	URD	INSP	**GC-RB_1-VAL-REQ-2**
[REQ-350]	Product	All *GlobCurrent* products ***shall*** include ancillary data as "dynamic flags" (based on auxiliary data) to interpret the quality of OSC data as required by users to interpret and apply the product. *Note: many users require flags and uncertainty estimates attached to data values within products. Quality indicators and metrics (particularly to help define accuracy) are required to help users exploit uncertainty*	URD	INSP	**GC-RB_1-L4-REQ-1** **GC-RB_1-VAL-REQ-2** **GC-RB_1-VAL-REQ-3**

		information.			
[REQ-360]	Product	*GlobCurrent* L2 products ***shall*** be produced for a period of at least 10 years using archive data. *Note: this is foreseen in Project Phase-II and Phase III.*	URD	INSP	**GC-RB_1-PROD-REQ-2**
[REQ-370]	Product	*GlobCurrent* ***shall*** provide L2 satellite data in coastal areas. *Note: The emphasis is to fully exploit all available data to obtain meaningful OSC in coastal and shelf seas regions.*			**GC-RB_1-HRGEO-REQ-2** **GC-RB_1-HRGEO-REQ-3**
[REQ-380]	Product	*GlobCurrent* ***shall*** provide Level-4 analysis (L4) products derived from *GlobCurrent* L2P products	URD	INSP	**GC-RB_1-L4-REQ-1**
[REQ-390]	Product	*GlobCurrent* L4 products ***shall*** be built from *GlobCurrent* L2 products.			**GC-RB_1-L4-REQ-1**
[REQ-400]	Product	*GlobCurrent* regional coverage L4 products ***shall*** be produced at the highest spatial resolution possible (Target for global products is ≤25 km). *Note: This requirement refers to the analysis resolution rather than the product grid resolution. Regional products are expected to have a higher spatial resolution than global coverage products. Different satellite data products have different spatial resolutions and choices of the most effective resolution are*	URD	ANAL	**GC-RB_1-PROD-REQ-3**

		required.			
[REQ-410]	Product	*GlobCurrent* L4 products ***shall*** include uncertainty estimates for every grid-point in the data file. Uncertainty estimates ***shall*** include those from the data and those from the analysis system.	URD	INSP	**GC-RB_1-VAL-REQ-3**
[REQ-420]	Product	*GlobCurrent* L4 products ***shall*** be produced at the highest temporal resolution feasible (Target daily).	URD	INSP	**GC-RB_1-PROD-REQ-4**
[REQ-430]	Product	*GlobCurrent* L4 products ***shall*** be produced at sub-daily intervals where feasible.	URD	INSP	**GC-RB_1-EK-REQ-1** **GC-RB_1-TIDES-REQ-1**
[REQ-440]	Product	*GlobCurrent* L4 products ***shall*** include information on all L2P and other data used to derive the product within the data product file.			**GC-RB_1-L4-REQ-1**
[REQ-450]	Product	*GlobCurrent* L4 products ***shall*** be produced for a period of at least 10 years using archive data.	URD	INSP	**GC-RB_1-PROD-REQ-2**
[REQ-460]	Product	*GlobCurrent* products ***shall*** provide as separate variables, significant components of the current field (i.e., tidal, Ekman…) when appropriate. *Note: It is recognised that this may require the use of model outputs.*	URD	INSP	**GC-RB_1-L4-REQ-1** **GC-RB_1-EK-REQ-1** **GC-RB_1-EK-REQ-2** **GC-RB_1-EK-REQ-3**
[REQ-470]	Product	All *GlobCurrent* products ***shall*** include precise geo-location information.	URD	INSP	**GC-RB_1-VIR-REQ-4**

[REQ-480]	Products	All products ***shall*** be freely and openly available to the user community without restriction.	ESA	TEST	**GC-RB_1-GLOP-REQ-13**
[REQ-490]	Document	The *GlobCurrent* project ***shall*** develop and maintain tailored versions of EO product handbooks for each *GlobCurrent* product and service. Product handbooks ***shall*** include: (i) Glossary of terms, a table of acronyms	URD	INSP	**GC-RB_1-COM-REQ-4**
		(ii) Introduction and summary of product use in typical user applications			
		(iii) Relevant background material describing the product,			
		(iv) Description of the precise algorithms applied to generate the product with links to ATBD and other reference material,			
		(v) A description of the Processing Model that explains how data were processed end-to-end for each *GlobCurrent* product.			
		(vi) Range of product accuracy, precision and links to validation information and validation evidence,			
		(vii) User guidance on the application of products by example application,			

		(viii) A description of strengths and weakness of each data product,			
		(ix) A comprehensive description of the derivation of uncertainties for each *GlobCurrent* Product and their validity.			
		(x) An example of how to use uncertainty information provided with the product.			
		(xi) Relevant scientific and engineering journal paper and report references,			
		(xii)Detailed description of product format,			
		(xiii) CDL dump of an example product,			
		(xiv) Estimates of typical file sizes,			
		(xv) Description of where and how to access/order products,			
		(xvi) Contact points for each product,			

		(xvii) Full visualisation (*e.g.*, images, line plots *etc.*) of an example product, (xviii) Example read software and links to actual software code available on the *GlobCurrent* web portal, (xix) A product FAQ tailored to *GlobCurrent* applications. (xx) A feedback form and contact details to submit feedback allowing users to report problems and request further information. (xxi) Any other material required by beginner users to successfully understand, read and apply the product. (xxii) Appendices detailing any web sites, software tools, read software *etc.* *GlobCurrent* product handbooks ***shall*** be maintained and updated based on user feedback and product/service evolution for the duration of the *GlobCurrent* project.			
[REQ-500]	Document	All project documents ***shall*** be available to the *GlobCurrent* users via the *GlobCurrent* Web Portal.	ESA	INSP	**GC-RB_1-COM-REQ-6**
[REQ-510]	Documents	All *GlobCurrent* documents ***shall*** accessible to	ESA	INSP	**GC-RB_1-COM-REQ-5**

		the user community in an open and transparent manner. No restriction on public access to all *GlobCurrent* deliverable documents ***shall*** be allowed. This requirement excludes *GlobCurrent* project management reports to ESA.			
[REQ-520]	Document	A Frequently Asked Questions (FAQ) for the *GlobCurrent* project ***shall*** be published and maintained on the *GlobCurrent* Web Portal.	URD	INSP	**GC-RB_1-COM-REQ-6**
[REQ-530]	Data	The *GlobCurrent* project use of Sentinel-1 data if available	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-SAR-REQ-1** **GC-RB_1-SAR-REQ-2** **GC-RB_1-SAR-REQ-3** **GC-RB_1-SAR-REQ-4**
[REQ-540]	Data	The *GlobCurrent* project ***shall*** prepare to use Sentinel-3 data and ***shall*** use this data if available.	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-HRSWELL-REQ-1** **GC-RB_1-HRGEO-REQ-3** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-550]	Data	The *GlobCurrent* project ***shall*** use ERS data.	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-GEO-REQ-1** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-560]	Data	The *GlobCurrent* project ***shall*** use ENVISAT data.	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-SAR-REQ-1** **GC-RB_1-SAR-REQ-2** **GC-RB_1-SAR-REQ-3** **GC-RB_1-SAR-REQ-4** **GC-RB_1-HRSWELL-REQ-1** **GC-RB_1-GEO-REQ-1** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-570]	Data		ESA	INSP	**GC-RB_1-DATA-REQ-1**

		The *GlobCurrent* project ***shall*** use CryoSat data.			**GC-RB_1-HRGEO-REQ-1** **GC-RB_1-HRGEO-REQ-2** **GC-RB_1-HRGEO-REQ-3** **GC-RB_1-GEO-REQ-1** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-580]	Data	The *GlobCurrent* project ***shall*** use QuickScat data.	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-590]	Data	The *GlobCurrent* project ***shall*** use GOCE data.	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-GEO-REQ-1** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-600]	Data	The *GlobCurrent* project ***shall*** use SMOS data.	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-610]	Data	The *GlobCurrent* project ***shall*** use satellite sun-glitter data.	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-620]	Data	The *GlobCurrent* project ***shall*** use *In situ* HF-RADAR data.	ESA	INSP	**GC-RB_1-DATA-REQ-2**
[REQ-630]	Data	The *GlobCurrent* project ***shall*** use of MetOp data.	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-640]	Data	The *GlobCurrent* project ***shall*** use Coriolis WindSat data.	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-650]	Data	The *GlobCurrent* project ***shall*** use along-track altimeter data from all altimeters available. *Note the emphasis of GlobCurrent is to use native resolution L2 data products as much as possible as a starting point.*	ESA	INSP	**GC-RB_1-DATA-REQ-1**
[REQ-660]	Data	The *GlobCurrent* project ***shall*** make full use of	ESA	INSP	**GC-RB_1-DATA-REQ-1** **GC-RB_1-DATA-REQ-2**

		other relevant satellite and *in situ* data as required to fulfil the aim and objectives of the project.			**GC-RB_1-DATA-REQ-3** **GC-RB_1-HRGEO-REQ-4** **GC-RB_1-HRGEO-REQ-5** **GC-RB_1-VIR-REQ-1** **GC-RB_1-VIR-REQ-2** **GC-RB_1-VIR-REQ-3** **GC-RB_1-GEO-REQ-1** **GC-RB_1-GEO-REQ-2** **GC-RB_1-GEO-REQ-3**
[REQ-670]	Data	A database of in-situ OSC validation data ***shall*** be collected, from a range of globally distributed validation sites, covering different ocean regimes and sampling different seasons. This data ***shall*** be used by the Contractor to perform validation of the data sets hosted on the web portal, and may be provided to other users if the in-situ data providers agree.	ESA	INSP	**GC-RB_1-VAL-REQ-1** **GC-RB_1-DATA-REQ-2** **GC-RB_1-GLOP-REQ-24**
[REQ-680]	Validation	A validation report ***shall*** be published on the Web Portal and regularly updated for each *GlobCurrent* product.	URD	INSP	**GC-RB_1-VAL-REQ-7**
[REQ-690]	Validation	The *GlobCurrent* system ***shall*** include a database of near contemporaneous *in situ* data for validation purposes including: • HF-RADAR	ESA	INSP	**GC-RB_1-DATA-REQ-2** **GC-RB_1-VAL-REQ-1**
		• *In situ* OSC measurements			**GC-RB_1-DATA-REQ-2** **GC-RB_1-DRF-REQ-1** **GC-RB_1-DRF-REQ-2** **GC-RB_1-DRF-REQ-3** **GC-RB_1-VAL-REQ-1** **GC-RB_1-DATA-REQ-2**
		• Satellite measurements including lower level- 1 information			**GC-RB_1-VAL-REQ-1**

		• Any other data required by *GlobCurrent* validation			**GC-RB_1-VAL-REQ-1**
[REQ-700]	Validation	Validation ***shall*** be performed by: • Inter-comparison of Level-2 satellite OSC products with in-situ data (Category-1) and	ESA	INSP	**GC-RB_1-VAL-REQ-4**
		• Between different EO products (Category-2). In-situ data that has been used for calibration of a satellite OSC retrieval algorithm ***shall*** not be used to validate that retrieval.			**GC-RB_1-VAL-REQ-4**
[REQ-710]	Validation	Satellite OSC product uncertainty estimates ***shall*** be validated.	ESA	INSP	**GC-RB_1-VAL-REQ-6**
[REQ-720]	Validation	Validation ***shall*** characterise the long-term stability of the satellite OSC data sets.	ESA	INSP	**GC-RB_1-VAL-REQ-5**
[REQ-730]	Validation	GlobCurrent L2 and L4 data products ***shall*** be inter-compared to other existing products (e.g. OSCAR) on a regular (target daily) basis	ESA	INSP	**GC-RB_1-GEO-REQ-1** **GC-RB_1-EK-REQ-1** **GC-RB_1-VAL-REQ-4**