Horizon 2020

Call: H2020-EINFRA-2015-1

Topic: EINFRA-9-2015

Type of action: RIA

Proposal number: 676557

Proposal acronym: VeriBlue

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How to fill in the forms

The administrative forms must be filled in for each proposal using the templates available in the submission system. Some data fields in the administrative forms are pre-filled based on the previous steps in the submission wizard.

Proposal ID **676557** *Acronym* **VeriBlue**

1 - General information

Topic EINFRA-9-2015 Type of action RIA

Call identifier H2020-EINFRA-2015-1 Acronym VeriBlue

Proposal title* Virtual Environment for Research and Innovation for Blue Planet

Note that for technical reasons, the following characters are not accepted in the Proposal Title and will be removed: < > " &

Duration in months *36*

Fixed keyword 1 *Computer sciences, information science and bioinformatics* Add

Free keywords *Container, collaboration, remote processing*

Abstract

We aim to develop a VRE for the use cases of the Blue Planet initiative, the GEO Marine Task, using novel technologies for containerisation, sharing and collaboration functionality and use of semantic, usage and comment/rating metadata to assist and advice users on other possibilities for what they are trying to do. Other technical aspects of the VRE rely on commonplace, well-tested and easily-integrated solutions. The networking aspects of the project are aimed towards bringing together the community around the VRE, and enhancing the communities capabilities, both technically and in a human capacity sense. The JRAs guide the development of the VRE, holding it to the Blue Planet user needs, demonstrate the new capabilities and use to answer questions of specific interest.

Remaining characters 1215

Has this proposal (or a very similar one) been submitted in the past 2 years in response to a call for proposals under the 7th Framework Programme, Horizon 2020 or any other EU programme(s)? ○ Yes ◉ No

Proposal ID **676557** *Acronym* **VeriBlue**

Declarations

1) The coordinator declares to have the explicit consent of all applicants on their participation and on the content of this proposal.	☒
2) The information contained in this proposal is correct and complete.	☒
3) This proposal complies with ethical principles (including the highest standards of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity — and including, in particular, avoiding fabrication, falsification, plagiarism or other research misconduct).	☒

4) The coordinator confirms:

- to have carried out the self-check of the financial capacity of the organisation on https://ec.europa.eu/research/participants/portal/desktop/en/organisations/lfv.html. Where the result was "weak" or "insufficient", the coordinator confirms being aware of the measures that may be imposed in accordance with the H2020 Grants Manual (Chapter on Financial capacity check); or	◉
- is exempt from the financial capacity check being a public body including international organisations, higher or secondary education establishment or a legal entity, whose viability is guaranteed by a Member State or associated country, as defined in the H2020 Grants Manual (Chapter on Financial capacity check); or	○
- as sole participant in the proposal is exempt from the financial capacity check.	○

5) The coordinator hereby declares that each applicant has confirmed:

- they are fully eligible in accordance with the criteria set out in the specific call for proposals; and	☒
- they have the financial and operational capacity to carry out the proposed action.	☒

The coordinator is only responsible for the correctness of the information relating to his/her own organisation. Each applicant remains responsible for the correctness of the information related to him and declared above. Where the proposal to be retained for EU funding, the coordinator and each beneficiary applicant will be required to present a formal declaration in this respect.

According to Article 131 of the Financial Regulation of 25 October 2012 on the financial rules applicable to the general budget of the Union (Official Journal L 298 of 26.10.2012, p. 1) and Article 145 of its Rules of Application (Official Journal L 362, 31.12.2012, p.1) applicants found guilty of misrepresentation may be subject to administrative and financial penalties under certain conditions.

Personal data protection

Your reply to the grant application will involve the recording and processing of personal data (such as your name, address and CV), which will be processed pursuant to Regulation (EC) No 45/2001 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data. Unless indicated otherwise, your replies to the questions in this form and any personal data requested are required to assess your grant application in accordance with the specifications of the call for proposals and will be processed solely for that purpose. Details concerning the processing of your personal data are available on the privacy statement. Applicants may lodge a complaint about the processing of their personal data with the European Data Protection Supervisor at any time.

Your personal data may be registered in the Early Warning System (EWS) only or both in the EWS and Central Exclusion Database (CED) by the Accounting Officer of the Commission, should you be in one of the situations mentioned in:
-the Commission Decision 2008/969 of 16.12.2008 on the Early Warning System (for more information see the Privacy Statement), or
-the Commission Regulation 2008/1302 of 17.12.2008 on the Central Exclusion Database (for more information see the Privacy Statement) .

Proposal ID **676557** *Acronym* **VeriBlue**

2 - Administrative data of participating organisations

PIC	***Legal name***
999484024	*PLYMOUTH MARINE LABORATORY*

Short name: PML

Address of the organisation

Street Prospect Place, The Hoe

Town PLYMOUTH

Postcode PL1 3DH

Country United Kingdom

Webpage http://www.pml.ac.uk/

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code - Not applicable

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Earth Observation
	☒ Same as organisation address
Street	Prospect Place, The Hoe
Town	PLYMOUTH
Postcode	PL1 3DH
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Mike** Last name: **Grant**

E-Mail: **mggr@pml.ac.uk**

Position in org.: Senior Earth Observation Scientist

Department: Earth Observation

☒ Same as organisation address

Street: Prospect Place, The Hoe

Town: PLYMOUTH Post code: PL1 3DH

Country: United Kingdom

Website: http://www.pml.ac.uk/ http://rsg.pml.ac.uk

Phone: +441752633100 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Ben	Calton	bac@pml.ac.uk	+441752633151

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
999627681	*OPEN GEOSPATIAL CONSORTIUM (EUROPE) LIMITED*

Short name: OGCE

Address of the organisation

Street 1st Floor, Gray's Inn Road 236

Town LONDON

Postcode WC1X 8HL

Country United Kingdom

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code 93 - Other service activities

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Interoperability Program
	☒ Same as organisation address
Street	1st Floor, Gray's Inn Road 236
Town	LONDON
Postcode	WC1X 8HL
Country	United Kingdom

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr. Sex: (•) Male ( ) Female

First name: **Bart** Last name: **De Lathouwer**

E-Mail: **bdelathouwer@opengeospatial.org**

Position in org.: Director

Department: Interoperability Program

☒ Same as organisation address

Street: 1st Floor, Gray's Inn Road 236

Town: LONDON Post code: WC1X 8HL

Country: United Kingdom

Website: http://www.opengeospatial.org

Phone: +3233367547 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Other contact persons

First Name	***Last Name***	***E-mail***	***Phone***
Ingo	Simonis	isimonis@opengeospatial.org	

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
999895013	*TARTU ULIKOOL*

Short name: UTARTU

Address of the organisation

Street ULIKOOLI 18

Town TARTU

Postcode 50090

Country Estonia

Webpage www.ut.ee

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... yes
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code 853 -

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Department of Remote sensing and Marine Optics, Est. Marine Inst.
	☐ Same as organisation address
Street	Mäealuse 14
Town	Tallinn
Postcode	12618
Country	Estonia

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Tiit** Last name: **Kutser**

E-Mail: **tiit.kutser@sea.ee**

Position in org.: Head of Department

Department: Remote SEnsing and Marine Optics

[ ] Same as organisation address

Street: Mäealuse 14

Town: Tallinn Post code: 12618

Country: Estonia

Website: www.sea.ee; www.ut.ee

Phone: +3726718947 Phone 2: *+xxx xxxxxxxxx* Fax: +3726718900

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
999646693	*COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH*

Short name: CSIR

Address of the organisation

Street Meiring Naude Road, Brummeria 46

Town PRETORIA

Postcode 0001

Country South Africa

Webpage www.csir.co.za

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... yes
Non-profit ..... yes
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... yes
Small and Medium-sized Enterprises (SMEs) ..... no

Legal person ..... yes

Nace code - Not applicable

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Natural Resources and the Environment
	☒ Same as organisation address
Street	Meiring Naude Road, Brummeria 46
Town	PRETORIA
Postcode	0001
Country	South Africa

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr.

Sex: (•) Male ( ) Female

First name: **Stewart**

Last name: **Bernard**

E-Mail: **sbernard@csir.co.za**

Position in org.: Principal Researcher

Department: Earth Observation

☒ Same as organisation address

Street: Meiring Naude Road, Brummeria 46

Town: PRETORIA

Post code: 0001

Country: South Africa

Website: www.csir.co.za

Phone: +27216582755

Phone 2: *+xxx xxxxxxxxx*

Fax: +27216582744

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
959306430	*SEVEN ENGINEERING CONSULTANTS OE*

Short name: SEVEN

Address of the organisation

Street KALLIDROMIOU ODOS 91

Town ATHINA

Postcode 10683

Country Greece

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code 721 -

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Seven
	☒ Same as organisation address
Street	KALLIDROMIOU ODOS 91
Town	ATHINA
Postcode	10683
Country	Greece

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mrs

Sex: ○ Male ◉ Female

First name: **Maggie**

Last name: **Kossida**

E-Mail: **mkossida@seven-solutions.eu**

Position in org.: Director

Department: *Please indicate the department of the Contact Point above in the organisation*

☒ Same as organisation address

Street: KALLIDROMIOU ODOS 91

Town: ATHINA

Post code: 10683

Country: Greece

Website: www.seven-solutions.eu

Phone: +302130057261

Phone 2: +306932198388

Fax: +302130057261

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
951325270	*TIWAH UG (HAFTUNGSBESCHRAENKT)*

Short name: Tiwah

Address of the organisation

Street Poststrasse 10

Town Rossbach/Wied

Postcode 53547

Country Germany

Webpage www.tiwah.com

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code 721 -

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Research
	☒ Same as organisation address
Street	Poststrasse 10
Town	Rossbach/Wied
Postcode	53547
Country	Germany

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Dr. Sex: (•) Male ( ) Female

First name: **Hans-Peter** Last name: **Plag**

E-Mail: **hpplag@tiwah.com**

Position in org.: President

Department: *Please indicate the department of the Contact Point above in the organisation*

☒ Same as organisation address

Street: Poststrasse 10

Town: Rossbach/Wied Post code: 53547

Country: Germany

Website: http://www.tiwah.com

Phone: +49-2638-94337 Phone 2: *+xxx xxxxxxxxx* Fax: *+xxx xxxxxxxxx*

Proposal ID **676557** *Acronym* **VeriBlue**

PIC	***Legal name***
999732829	*TERRADUE SRL*

Short name: TERRADUE

Address of the organisation

Street VIA G. LUNATI 10

Town FRASCATI

Postcode 00044

Country Italy

Webpage

Legal Status of your organisation

Research and Innovation legal statuses

Public body ..... no
Non-profit ..... no
International organisation ..... no
International organisation of European interest ..... no
Secondary or Higher education establishment ..... no
Research organisation ..... no
Small and Medium-sized Enterprises (SMEs) ..... yes

Legal person ..... yes

Nace code - Not applicable

Proposal ID **676557** *Acronym* **VeriBlue**

Department(s) carrying out the proposed work

Department 1

Department name	Research and Innovation
	☐ Same as organisation address
Street	Via della Bufalotta, 378 (Scala N)
Town	Roma
Postcode	00141
Country	Italy

Dependencies with other proposal participants

Character of dependence	***Participant***	

Proposal ID **676557** *Acronym* **VeriBlue**

Person in charge of the proposal

The name and e-mail of contact persons are read-only in the administrative form, only additional details can be edited here. To give access rights and basic contact details of contact persons, please go back to Step 4 of the submission wizard and save the changes.

Title: Mr.

Sex: (•) Male ( ) Female

First name: **Fabrice**

Last name: **Brito**

E-Mail: **fabrice.brito@terradue.com**

Position in org.: Chief Executive Officer

Department: Research and Innovation

[ ] Same as organisation address

Street: Via della Bufalotta, 378

Town: Roma

Post code: 00141

Country: Italy

Website: http://www.terradue.com

Phone: +390687090551

Phone 2: *+xxx xxxxxxxxx*

Fax: *+xxx xxxxxxxxx*

Proposal ID **676557** *Acronym* **VeriBlue**

3 - Budget for the proposal

Participant	Country	(A) Direct personnel costs/€	(B) Other direct costs/€	(C) Direct costs of sub-contracting/€	(D) Direct costs of providing financial support to third parties/€	(E) Costs of inkind contributions not used on the beneficiary's premises/€	(F) Indirect Costs / € (=0.25(A+B-E))	(G) Special unit costs covering direct & indirect costs / €	(H) Total estimated eligible costs / € (=A+B+C+D+F+G)	(I) Reimburse-ment rate (%)	(J) Max. grant / € (=H*I)	(K) Requested grant / €
PML	UK	477 385	181 638	0	0	0	164 756	0	823 779	100	823 779	823 779
OGCE	UK	244 331	62 500	0	0	0	76 708	0	383 539	100	383 539	383 539
UTARTU	EE	119 700	49 600	0	0	0	42 325	0	211 625	100	211 625	211 625
CSIR	ZA	134 064	17 500	0	0	0	37 891	0	189 455	100	189 455	189 455
SEVEN	EL	228 389	40 000	0	0	0	67 097	0	335 486	100	335 486	335 486
Tiwah	DE	230 560	15 000	0	0	0	61 390	0	306 950	100	306 950	306 950
TERRADUE	IT	289 050	24 320	0	0	0	78 343	0	391 713	100	391 713	391 713
Total		1 723 479	390 558	0	0	0	528 510	0	2 642 547		2 642 547	2 642 547

Proposal ID **676557** *Acronym* **VeriBlue**

4 - Ethics issues table

1. HUMAN EMBRYOS/FOETUSES		Page
Does your research involve Human Embryonic Stem Cells (hESCs)?	○ Yes ◉ No	
Does your research involve the use of human embryos?	○ Yes ◉ No	
Does your research involve the use of human foetal tissues / cells?	○ Yes ◉ No	
2. HUMANS		**Page**
Does your research involve human participants?	○ Yes ◉ No	
Does your research involve physical interventions on the study participants?	○ Yes ◉ No	
Does it involve invasive techniques?	○ Yes ◉ No	
3. HUMAN CELLS / TISSUES		**Page**
Does your research involve human cells or tissues (other than from Human Embryos/ Foetuses, i.e. section 1)?	○ Yes ◉ No	
4. PERSONAL DATA (ii)		**Page**
Does your research involve personal data collection and/or processing?	○ Yes ◉ No	
Does your research involve further processing of previously collected personal data (secondary use)?	○ Yes ◉ No	
5. ANIMALS (iii)		**Page**
Does your research involve animals?	○ Yes ◉ No	

Proposal ID **676557** *Acronym* **VeriBlue**

6. THIRD COUNTRIES		Page
Does your research involve non-EU countries?	(•) Yes ( ) No	63,87
South Africa		
Do you plan to use local resources (e.g. animal and/or human tissue samples, genetic material, live animals, human remains, materials of historical value, endangered fauna or flora samples, etc.)? (v)	( ) Yes (•) No	
Do you plan to import any material from non-EU countries into the EU? *For data imports, please fill in also section 4.* *For imports concerning human cells or tissues, fill in also section 3.*	( ) Yes (•) No	
Do you plan to export any material from the EU to non-EU countries? *For data exports, please fill in also section 4.* *For exports concerning human cells or tissues, fill in also section 3.*	( ) Yes (•) No	
If your research involves low and/or lower middle income countries, are benefits-sharing measures foreseen? (vii)	( ) Yes (•) No	
Could the situation in the country put the individuals taking part in the research at risk?	( ) Yes (•) No	
7. ENVIRONMENT & HEALTH and SAFETY See legal references at the end of the section. (vi)		Page
Does your research involve the use of elements that may cause harm to the environment, to animals or plants? *For research involving animal experiments, please fill in also section 5.*	( ) Yes (•) No	
Does your research deal with endangered fauna and/or flora and/or protected areas?	( ) Yes (•) No	
Does your research involve the use of elements that may cause harm to humans, including research staff? *For research involving human participants, please fill in also section 2.*	( ) Yes (•) No	
8. DUAL USE (vii)		Page
Does your research have the potential for military applications?	( ) Yes (•) No	
9. MISUSE		Page
Does your research have the potential for malevolent/criminal/terrorist abuse?	( ) Yes (•) No	

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10. OTHER ETHICS ISSUES		Page
Are there any other ethics issues that should be taken into consideration? Please specify	○ Yes ◉ No	

I confirm that I have taken into account all ethics issues described above and that, if any ethics issues apply, I will complete the ethics self-assessment and attach the required documents. ☒

Proposal ID **676557** *Acronym* **VeriBlue**

5 - Call specific questions

Open Research Data Pilot in Horizon 2020

If selected, all applicants will participate in the Pilot on Open Research Data in Horizon 2020[1] , which aims to improve and maximise access to and re-use of research data generated by actions. Participating in the Pilot does not necessarily mean opening up all research data. Actions participating in the Pilot will be invited to formulate a Data Management Plan in which they will determine and explain which of the research data they generate will be made open.

Applicants have the possibility to opt out of this Pilot and must indicate a reason for this choice.

Participation in this Pilot does not constitute part of the evaluation process. Proposals will not be evaluated favourably because they are part of the Pilot and will not be penalised for opting out of the Pilot.

We wish to opt out of the Pilot on Open Research Data in Horizon 2020.	○ Yes	◉ No

[1] *According to article 43.2 of Regulation (EU) No 1290/2013 of the European Parliament and of the Council, of 11 December 2013, laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" and repealing Regulation (EC) No 1906/2006.*

Data management activities

The use of a Data Management Plan (DMP) is required for projects participating in the Open Research Data Pilot in Horizon 2020, in the form of a deliverable in the first 6 months of the project.

All other projects may deliver a DMP on a voluntary basis, if relevant for their research.

Are data management activities relevant for your proposed project?	◉ Yes	○ No

A Data Management Plan will be delivered (Please note: Projects participating in the Open Research Data Pilot **must** include a Data Management Plan as a deliverable in the first 6 months of the project).	☒
Data Management is part of a Work Package.	☒
Data Management will be integrated in another way.	☐

VeriBlue: Virtual Environment for Research and Innovation for Blue Planet

List of participants

Participant No *	Participant organisation name	Country
1 (Coordinator)	Plymouth Marine Laboratory (also incorporates POGO)	UK
2	Tiwah UG (haftungsbeschränkt)	DE
3	University of Tartu	EE
4	SEVEN Engineering Consultants	EL
5	OGC Europe	UK
6	CSIR	ZA
7	Terradue Srl	IT

Please use the same participant numbering as that used in the administrative proposal forms.

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1 Excellence

The impact of humanity on the ecosystem is now large enough to be clearly measurable, with changes in atmosphere, ocean and land, and the present unmanaged approach is unsustainable in the medium to long term. We are crossing the boundaries of the "safe operating space for humanity" (Rockstroem et al., 2009), entering Earth system states unknown to humanity during the Holocene. There is an urgent societal need for greater understanding, broader monitoring and quicker analysis and reaction to changing circumstances and conditions new to modern society. In many areas, the speed of reaction of science to emerging issues is currently hindered by disorganised and segmented research communities, lack of common standards in data, processing or analyses, lack of knowledge sharing across disciplinary boundaries particularly with respect to work flows, lack of a suitable infrastructure and/or underdeveloped inter-disciplinary communication, and the absence of well developed and sustained linkages between scientific knowledge creation and the policy and decision making bodies. The approach taken in this project to address these issues is widely applicable. The research community around which the approach is developed is the specific case of the "Blue Planet" GEO Marine task. The Group on Earth Observation (GEO) Work Plan Task SB-01: "Oceans and Society: Blue Planet" covers a wide range of monitoring and research activities and brings together a diverse international community with significant European participation. The wide range of priority activities of Blue Planet and the diverse community involved constitute an ideal use case for the development of a Virtual Research Environment (VRE), i.e., the Virtual Environment for Research and Innovation for Blue Planet (VeriBlue).

As the single overarching marine programme in GEO, and the vehicle in GEO through which the EC communicates on marine affairs, Blue Planet is committed to optimising the societal benefit of ocean observations. To fulfil this role, Blue Planet sees the need for a major increase in coordination of the research activities of the relevant parties through the provision of a VRE offering access to related tools, data, and knowledge. We propose to develop this VRE integrating tools, data and knowledge relevant for Blue Planet and providing an environment for the coordination and collaboration of the research communities linked to Blue Planet.

1.1. What is Blue Planet?

Blue Planet seeks, through the mobilisation of expert knowledge, to raise public awareness of the role of the oceans in the Earth system, of their impacts (good and bad) on humankind, and of the societal benefits of ocean observations; to coordinate the various marine initiatives within GEO and develop synergies between them; and to advocate and advance the establishment and maintenance of a global observing network for the oceans, which acknowledges the value of ocean observations and their contribution to helping alleviate societal issues in multiple areas.

Understanding and managing of the oceans is a highly complex task with critical impacts on human activities, from fisheries to climate to leisure. Any evidence-based policy must be informed by a coordinated and active research community spread across many disciplines, with access to a diverse range of data and the tools necessary to link, analyse and refine observations, models and policy.

A great deal of work in bringing together the Blue Planet communities has taken place at the higher organisational and scientific levels, via intergovernmental bodies such as the IOC, GEO, and WMO, as well as non-governmental organisations such as POGO, and through voluntary cooperations such as ChloroGIN and various Communities of Practice.

This project will provide an interoperable VRE for the Blue Planet initiative, promoting collaboration, sharing of data, information and analyses, and providing essential tools to derive new knowledge from existing data. The intended audience is the multi-disciplinary global community of researchers already committed to the Blue Planet aims, and the body of students, coworkers and

citizen scientists working with them. The beneficiary will be society at large. The Blue Planet Kick-Off Symposium (November 2012) brought together 68 participants from 24 countries, comprising leaders and representatives of various international organisations and networks (including the GEO Secretariat Director, Dr Barbara Ryan), research scientists and postdoctoral and graduate students. The initiative has gained much momentum since then, with new organisations and programmes requesting to join. The Blue Planet Task is a partner of the EC in support of the Transatlantic Ocean Research Alliance, and a stakeholder implementating the Galway Statement.

It is led by 5 main organisations: the Partnership for Observation of the Global Oceans (POGO), the Global Ocean Observing System (GOOS), the Committee on Earth Observing Satellites (CEOS), GODAE OceanView, and the GEO Coastal Zone Community of Practice (CZCP). Each of these organisations represents a community of hundreds to thousands of researchers. For example, POGO is a partnership between 38 oceanographic research institutes in 19 countries. GOOS is a body within the Intergovernmental Oceanographic Commission, which consists of 147 Member States. CEOS is a grouping of 55 space agencies operating 112 satellites. GODAE OceanView is a network of forecasting systems, around the world. The CZCP has an open membership with 50 to 100 participants attending each of the workshops organized by the CZCP in different geographical regions. Thus, it is evident that the Blue Planet represents a vast and multi-disciplinary community, representing both in situ and space-based observations, as well as forecasting and information systems and bringing together both providers and users of data. This community continues to grow, as the Blue Planet is a voluntary partnership that can be joined by any relevant, interested organisation. It is anticipated that the 2nd Blue Planet Symposium (Cairns, Australia, May 2015) will bring in many new participants to the Blue Planet community.

This proposal brings together several of the main players in the Blue Planet Components (listed below), as well as the lead organisation and founder of Blue Planet: the Partnership for Observation of the Global Oceans. POGO is an international consortium of oceanographic institutions, and a forum for the promotion of a global oceanography, in particular sustained, long-term ocean observing systems; shared use of infrastructure, data and information; capacity building and public outreach. The POGO Secretariat is hosted by Plymouth Marine Laboratory, the lead partner in this proposal, and is staffed by PML employees. PML is a member of POGO, and the two organisations work closely together on a number of projects, involving coordination of ocean observations, capacity building and public outreach. Although POGO comes under the umbrella of PML in the work packages, it will be responsible for a specific set of Tasks in the proposal, related mainly to capacity building, communications/outreach, linking to Blue Planet, and sustainability after the project end, while the direct PML involvement is more technical in nature.

The Blue Planet is divided into six components. They are:

C1: Sustained Ocean Observations: to deliver a sustained ocean observing system meeting societal and scientific needs for data and information. More specifically, it will encourage, facilitate, develop and expand existing and new observing systems, coordinations, cooperations and capacity.
C2: Sustained Ecosystems and Food Security: to provide sustained, integrated and globally-complete observations of the ocean ecosystem for use first by the scientific community to assess and anticipate possible changes in structure and function following environmental perturbations (e.g. climate change or overfishing); and second by the decision makers responsible for ocean stewardship. This covers networks such as ChloroGIN (http://www.chlorogin.org) that promote the availability of in-situ monitoring data as collected from ships, buoys and other platforms. Important applications include fishes/aquaculture, harmful algal blooms and ocean acidification. It also covers ecosystem related monitoring systems (e.g. mangroves, coral reefs, and estuaries).

C3: Ocean Forecasting and Services: to raise capability of ocean forecasting and analysis; in support of the safety of life and property at sea and in coastal areas, risk management for ocean-based economic / commercial / industrial activities, the prevention and control of marine pollution, sustaining healthy and productive oceans, and developing integrated coastal area management services. Some of the main deliverables are development and testing of models, sharing data with other forecasting applications (such as weather, climate change and coastal impacts), intercomparisons and maritime safety.

C4: Services for the Coastal Zone: to improve access to environmental intelligence for all stakeholders in the coastal zone, and to support deliberations on coastal zone management as well as decision making related to the sustainable development of the coastal zone. This covers information systems, water quality and sea level forecasting.

C5: Ocean Climate and Carbon: to advance the development and implementation of the marine component of the observation systems for both Climate and Carbon, and in particular to address the

issues and synergies across the climate-carbon interface for the marine environment. Key tasks relate to addressing the interface between climate and carbon communities, coordinating observations and developing a information system compromising both datasets.
C6: Developing Capacity and Social Awareness: to maintain, develop and expand capacity-building in the field of ocean observations. The principal outcome is a larger pool of trained personnel, more representative of the world scale of the demand for such personnel, and more highly trained in the collection and interpretation of ocean data, both in -situ and remotely sensed. Developing social awareness is undertaken initially via production of a series of videos and, in the longer term, identifying the best ways to transfer information from the observing systems to the decision-making function.

1.2. Objectives

The overall aim is to implement, in a VRE, a technical and human infrastructure supporting the Blue Planet GEO task and uniting many research, observation and political communities through their shared interest in the impact on and use of the oceans by human society, and associated implications for human and environmental health. VeriBlue and the approach to the interoperable integration of data, models and knowledge into VeriBlue will be adaptable to other similar monitoring and coordination efforts, including other GEO tasks, and the platform will explore new ways to facilitate creativity and encourage collaboration in a community-oriented research environment based on open standards.

Specific Objective 1: Development of a scalable, flexible VRE with explicit support for collaboration, exploration and inspiring creative experimentation. VeriBlue aims to provide a novel combination of new technologies for collaboration and well-developed existing technologies from industry, from a number of other past projects and from the expertise of the partners, avoiding the repetition of prior work. The new technologies explored here are containerisation (see specific objective 2), integration of sharing and collaboration functionality (including session sharing and voice via WebRTC) and use of semantic, usage and comment/rating metadata to provide interactive suggestions that may lead to new and creative combinations of data. The other aspects of VeriBlue, such as web portal technologies, discovery, security, data services and cloud deployment rely on commonplace, well-tested and easily-integrated solutions. The measure of success in this objective may be determined by the existence of these capabilities in the finished VRE and in its availability via open-source repositories.

Specific Objective 2: Use of the new containerisation technologies, such as Docker, to provide a new way of remote processing with lower burdens and greater flexibility. In the last couple of years, a new approach to encapsulating functionality has arisen out of the Virtual Machine (VM) technologies developed for cloud-based hosting. As VMs have separated one from having to deal with the “bare metal” of a computer, containers separate one from the complication of configuring the basic software environment on a VM. By providing a standard, well-defined base and environment, configuration of a container is much simpler and the resulting object much smaller (as the complete OS must not be included). This offers opportunities to simply include almost arbitrary analysis code into a container and send it nearer the data to process locally, something that would be difficult with other remote processing approaches. As most of the security and other technologies for VMs also largely apply, and VeriBlue will use standardised interfaces, the risk in hosting running code is significantly reduced. Deploying this novel approach as a solution to the difficulties of remote processing will provide valuable experiences to other similar societal-challenge and technical areas as well as a unique opportunity to address the needs of the Blue Planet initiative. Aside from the successful technical deployment of this approach, the primary measure of success will whether it is adopted into the OGC standards processes for discussion alongside the

other approaches to remote processing. More directly, the inclusion of VeriBlue containers into common container repositories and publication of the experiences will also be a metric of success.

Specific Objective 3: Greater integration of the BP communities such that the relevant societal-benefit areas can be more rapidly addressed. The Blue Planet initiative has been slowly cohering a number of diverse organisations and communities from nearly 20 countries. The aim is that this VRE provides a nucleation point around which to crystallise these communities around, such that the objectives within the GEO Marine Task can be more easily reached, that new collaborations and capabilities are made possible, and that the overall capacity of the area and it's ability to transfer information up the chain is improved. This may be measured through growth in attendance at symposia and training events, completed studentships and in the usage statistics of VeriBlue for collaborations, analyses, teaching and exploration.

Specific Objective 4: Application of VeriBlue to real Blue Planet goals: There are many objectives within the Blue Planet initiative embedded in the list of priority activities. A number of these relate to science questions, others to data-combination or computation that is too difficult to accomplish at present or with the skills available in the interested organisations. In this project, we include a number of use case Joint Research Activities (JRAs), that address genuine BP goals enabled via the use of VeriBlue, and used within the project to ensure that VeriBlue is user-driven. In addition to validating VeriBlue by exploring the BP questions, the results of the JRAs should be a draw to the community and publishable in themselves. The success of this objective may be measured by the publishable outcomes of the JRAs.

Specific Objective 5: Sustainability. An infrastructure project that lasts three years and then disappears is of no lasting value. This project is designed to support multiple routes to sustainability. Aside from the proven commitment of existing organisations, the technical infrastructure and exploitation path are set up such that any interested organisations can maintain VeriBlue into the future, or parts of it, or an independent setup, in the vein of many open-source projects. On the human side, significant effort is being put into networking activities to maximise the chance of embedding VeriBlue into work processes in the Blue Planet initiative. Governance and ownership is also explicitly addressed, with a clear plan for adoption of VeriBlue into the fabric of the Blue Planet, through creation of a technical committee reporting to the BP steering committee. The success of this objective may be measured by creation of this subcommittee and its adoption of VeriBlue.

1.3. Relation to the work programme

This proposal specifically addresses the work programme laid out in "EINFRA-9-2015 – e-Infrastructures for virtual research environments (VRE)".

Elements of the call EINFRA-9-2015	How will VeriBlue address these issues?
Specific challenge: There is yet considerable potential and room for development in the use of virtual research environments. The objective is to address this challenge by supporting **capacity building** in **interdisciplinary research communities** to empower researchers through **development and deployment** of service-driven digital research environments, services and tools **tailored to their specific needs**.	The community engagement activities in WP2 will build awareness of the project at an early stage with the aim of ensuring that researchers have a clear influence on the direction that VeriBlue takes from the outset. Training and studentships over a range of ocean-research disciplines underpin the capacity building work, in combination with capability-enabling tools from the technical services. Providing the research community with the ability to draw on a catalogue of existing tools, as well as being able to develop their own tools, will allow researchers to address problems that previously they weren't able to because of restrictions or limitations of their own computing infrastructure.
These virtual research environments (VRE) should **integrate resources across all layers** of the e-infrastructure (networking, computing, data, software, user interfaces), should **foster cross-disciplinary data interoperability** and should provide functions allowing **data citation** and **promoting data sharing and trust.**	The involvement of the Open Geospatial Consortium (OGC) in this project in work package 5 will ensure that open standards are promoted, used and maintained. These standards allow data produced in a variety of different ways to be accessed across disciplines without users having to understand how the data were produced or the technicalities of the underlying infrastructure that is used to serve them. The cloud- and container-based processing capabilities cleanly integrate computing resources and software. Sharing and collaboration are explicitly built into VeriBlue.
Scope: Each VRE should **abstract from the underlying e-infrastructures** using **standardised building blocks** and workflows, **well documented interfaces**, in particular regarding APIs, and **interoperable components**.	The implementation of VeriBlue in work packages 3, 4, and 5 will ensure that the constituent parts can operate independently of each other as loosely coupled entities. Being loosely coupled, each element will have a well-documented API, which will allow other interested parties to use, and further develop, the outputs of this project. The standards-based approach provides maximum interoperability and, where standards are lacking or inadequate, the inclusion of the OGC allows a clear route to improving or creating these standards.
Over time VREs will be composed of **generic services** delivered by e-infrastructures and domain specific services **co-developed and co-**	Within VeriBlue the wide range of Networking Activities planned will foster a culture of co-operation and co-development between the participants and other relevant stakeholders from the

operated by researchers, technology and e-infrastructure providers, and possibly commercial vendors.	research, the industry and the business sectors; several SMEs are represented in the consortium. The technical approach is explicitly aimed at a component-style breakdown of services, albeit via a novel route (container-based), and designed to allow all entities to create and distribute components.
The VRE proposals should **clearly identify and build on requirements from real use cases**, e.g. for integration of **heterogeneous data from multiple sources** and value-added services for **computing, modelling, simulation, and data exploration, mining and visualisation,** taking due account of privacy aspects. They should **re-use tools and services from existing** infrastructures and projects at national and/or European level as appropriate.	The Blue Planet initiative have clearly defined objectives expressed in priority activities and this project will directly address the needs of many of these objectives. One of the key aims of this project is to provide an environment where researchers can combine datasets from disparate sources using a suite of tools to get answers to real world questions. Rather than re-inventing the wheel, the project will make use outputs of previous EU projects including GEOWOW, EuroGEOSS, OPEC, Earth2observe and Egida. The specific use cases are derived from the Blue Planet priority activities. In addition to the technical integration described earlier, the project integrates across the networking, service and JRA layers, each mutually supporting one another to ensure a user-driven approach. The VRE will be able to be used anonymously for most functions, and collaboration functionality is opt-in.
Where data are concerned, projects will define the **semantics, ontologies, the 'what' metadata**, as well as the best computing models and levels of abstraction (e.g. by means of open web services) to process the **rich semantics at machine level** (the so called 'how' metadata), as to **ensure interoperability**. **They may also support** proof of concept, prototyping and deployment of advanced data services and environments, and access to top-of-the-range connectivity and computing.	Several of the Blue Planet priority activities are cross-domain activities that require ontologies to ensure interoperability of data services and models. The project will develop a cross-domain semantic approach to the documentation of models and workflows to enable knowledge sharing at the “how to do” level. The use of OGC standards and the insight into the drafting process ensures access to the new work semantic metadata. The container-based technology used in the project is novel and represents a new approach to advanced computing services.
VREs may target any area of science and technology, especially interdisciplinary ones, including ICT, mathematics, web science and social sciences and humanities. **Focusing on the ICT infrastructures needed for addressing the Societal Challenges is especially encouraged**.	We are addressing specific societal challenges relating to Oceans and Society. The proposed activities are harmonised with the Blue Planet mission, itself adopted by GEO as the Marine Task, seeking to mobilize and increase knowledge on the role of the oceans in the Earth system, on their impacts (good and bad) on humankind, and on the societal benefits of ocean observations. We are further contributing to the establishment and

	maintenance of a global observing network for the oceans, which acknowledges the value of ocean observations and their contribution to helping alleviate societal issues in multiple areas. The VRE will also support rapid responses to research needs that are likely to arise as a result of climate change impacts by facilitating ad hoc collaboration between diverse groups with broad access to integrated databases and model webs.
Proposals should indicate the number of researchers they target as potential users.	The Blue Planet community is truly global. It is led by 5 main organisations: the Partnership for Observation of the Global Oceans (POGO), the Global Ocean Observing System (GOOS), the Committee on Earth Observing Satellites (CEOS), GODAE OceanView, and the GEO Coastal Zone Community of Practice (CZCP). Each of these organisations represents a community of hundreds to thousands of researchers. Some of the partners are key members of this community, and one (CSIR) brings access to and experiences from the developing world through it's work in GMES-Africa.
Expected impact: VREs are expected to result in **more effective collaboration** between researchers and **higher efficiency** and creativity in research as well as in higher **productivity** of researchers thanks to reliable and easy access to discovery, access and re-use of data.	Blue Planet VRE addresses both components which lead to higher efficiency and productivity: the "e-infrastructure" and "human infrastructure". The e-infrastructure will integrate resources across all layers, (developed through the described service activities of WP3, 4, 5) to provide the necessary basis, while the human infrastructure (mobilised through the described networking, joint research and dissemination activities of WP2, 6, 7) will act as a catalyst to maximise the exploitation of VeriBlue. Many of the tasks envisaged are currently difficult for most of the Blue Planet organisations to accomplish, and the community is not yet tightly enough knit. The VRE will provide an anchoring point on which to cohere the community.
They will accelerate innovation in research via an integrated access to potentially **unlimited digital research resources, tools and services across disciplines and user communities** and enable researchers to process structured and qualitative data in **virtual and/or ubiquitous workspaces**.	Access to VeriBlue will undoubtedly lead to faster discovery and processing of data. Preconfigured and rapidly deployable tools will mean that researchers can focus on the data rather than being concerned with installing and configuring software, or waiting for data to download. The ability to address "what if" questions within VeriBlue will also stimulate exploration and innovation in research, with inclusion of functionality to encourage serendipitous discovery of related datasets, workflows or co-workers..
They will contribute to **increased take-**	One of the aims of the project is to encourage

up of collaborative research and data sharing by new disciplines, research communities and institutions.	collaboration so that researchers can learn of the discoveries made by others. This allows users of VeriBlue to identify other researchers who may be tackling similar scientific problems, perhaps from a very different perspective or a slightly different goal, and allow them to work together. The VRE will also allow groups to identify and solicit experts with expertise not available in the group but needed to address complex problems and societal challenge

1.3.1. Explanation

The state of the ocean ecosystem is of critical importance to humanity, and data about it is sparse compared with more accessible parts of the Earth's surface. Physical and chemical changes in the state of the ocean, including changes in circulation, sea level, and acidification, have potentially severe impacts on society. Although a great deal of research has been undertaken to improve our understanding of the role of the ocean in the Earth system, a more structured approach is needed; one that gathers together the different research communities and their data and facilitates the collaboration of large, interdisciplinary and distributed research teams. The vastness and complexity of the ocean requires a system-based approach, the integration of very large and diverse datasets, the cross-discipline linking of models, and very large e-infrastructure resources for research. Even the largest ocean research groups only can address selected facets of ocean research. A state of the art e-infrastructure can provide an integrating platform for these communities by incorporating and unifying the available data, by integrating data and ensuring model interoperability, by specifically targeting the needs of the researchers with tools, information, analyses and inherent networking capabilities, and, above all, by providing unique capabilities and scalable resources not available at individual organisations.

Such an infrastructure can truly unify only when effort is put into the human infrastructure as well as the technical one. However, we do not seek to coordinate the existing research organisations and observing infrastructures directly; other efforts and proposals target this need. The focus of this proposal is on the e-infrastructure and on securing its future sustainability, which requires a critical mass of knowledgeable and committed users in addition to the tools and data. We aim to achieve this through work-packages that will grow capacity through training and dissemination, including in developing regions and countries where the resources or experience do not exist to do the work independently, through engaging the existing international community by actively demonstrating at and participating in symposiums and workshops, and through JRAs that address open Blue Planet science objectives and priority activities using the infrastructure. Via this coordination between the technical, scientific and training goals, the development of the infrastructure will remain tightly bound to and driven by the users' needs.

Providing an infrastructure scalable to the massive volume of modern Earth Observation data and responsive to varying demand, while still being cost efficient is a difficult proposition with large collections of dedicated hardware. The cloud offers a well-proven way to accommodate this scale when needed and to scale down when not, with computing power available from commercial providers or contributions from interested organisations. In combination with a decentralised approach, this offers cost-efficiency and sustainability beyond the lifetime of the project, as organisations can either pay for or contribute their own resources for their own purposes, or offer idle resource to their associates and community. This project uses containerisation via what are effectively very lightweight virtual machines (e.g. Docker or, more recently, Rocket) to accomplish

this decentralisation and cloud compatibility. Analytic tasks may be incorporated into these containers and instantiated in the cloud or, ideally, migrated to near the source of the data and operated there, where transfer costs (financial and latency/speed) are lowest. Interfaces based around the OGC standards will be used to facilitate interoperability without having to deal with the many different data formats, and part of this project will specifically test and further develop this interoperability between the different communities.

By using this open, standardised and decentralised approach, there is a higher chance of gaining widespread community adoption, as the model allows anyone to "own" the containers, components and potentially the infrastructure they use, while still encouraging large organisations to contribute resource to the community in the form of idle infrastructure. The overall design is based on new technology and concepts (Docker was first released in 2013) and is thus exploratory, but the concept could easily be applied in many similar areas if successful. As far as possible, the developments will be generic, with specialisation applied to ensure the specific Blue Planet goals are met. The open, standards-based approach will also make it easier for the participating SMEs and others to reuse the components afterwards and, potentially, the use of standards in this field will create new 'markets' for plug-and-play (or best of breed) algorithms to execute specific scientific problems.

A core function of the proposed VRE is to encourage creativity and facilitate collaboration. One aspect of this is encouraging user comments and feedback/ratings of data, models, services or outputs. There are many examples of review and comment functionality across the web, but gaining critical mass is often a major difficulty. This is best accomplished by either being a first mover, by having a very large community, or by peering/federating/syndicating reviews with other similar sites. Of the approaches tried in the research arena, perhaps the FP7 CHARM-E approach is the most flexible (commentary on a specific item is held outside the scope of a single project, so it is potentially available wherever that item is used) – we intend to evaluate and reuse this technology if possible. The GEOSS Science and Technology Stakeholder Network has developed a general feedback utility allowing for the establishment of standardized questionnaires for any dataset, model, services etc. and providing feedback on availability, applicability and usability of the entity. The GEO Label developed in the FP7 Project GeoViqua also addresses user feedback in a novel way and provides a template to be considered for VeriBlue, and has spawned the creation of a Quality DWG in the OGC, an indicator that the work continues to be used beyond the lifetime of a project.

More uniquely, VeriBlue will have sufficient semantic and internal-usage metadata to allow it to make links between different datasets of interest, so that, for example, a user exploring one of the ChloroGIN Africa datasets could be given a hint towards other related datasets for coastal chlorophyll in complex conditions (e.g. "11 people using this dataset also used dataset X" or "Dataset Y contains similar data to this"). By sharing knowledge on workflows, a user implementing an analysis with a particular combination of datasets might be helped towards appropriate pre-built processing libraries, including blueprints for specific tasks.

In addition to these use-enhancing features, true collaboration between globally distributed peers is increasingly common. In addition to simple offline communication such as email/messaging via external services, VeriBlue will support real time session sharing of visualisation and development between self-selecting groups, with the option of full voice communication via WebRTC technologies. This could be used as a teaching aid, enabling an expert to join a training session without the expense and complication of travelling to a developing country, or to establish a "virtual stakeholder table" gathering experts from around the world to address a specific issue in relation to a rapidly developing situation, or even to simply allow coordination between people with different

skill sets, such as an analyst-programmer needing some guidance from a scientist when analysing a situation in response to a request from a coastal environment manager.

1.4. Concept and approach

We aim to develop a VRE for the Blue Planet initiative use cases, using novel technologies for containerisation, sharing and collaboration functionality and use of semantic, usage and comment/rating metadata to assist and advice users on other possibilities for what they are trying to do. Other technical aspects of VeriBlue rely on commonplace, well-tested and easily-integrated solutions. The networking aspects of the project are aimed towards bringing together the community around VeriBlue, and enhancing the communities capabilities, both technically and in a human capacity sense. The JRAs guide the development of VeriBlue, holding it to the BP user needs, demonstrate the new capabilities and use to answer questions of specific interest.

1.4.1. Service activities

The bulk of the proposal resources focus on the development and operation of VeriBlue. This VRE will be a loosely coupled set of high quality, open source tools and services hosted on state of the art infrastructure that are accessed from a common entry point and will link in-situ, satellite and model data hosted in numerous disparate locations as well as allowing users to upload their own datasets. The VRE itself, as well as individual subcomponents, will be portable to other environments and potentially even fully redistributable into the cloud. This is essential to secure long-term stability and reuse, and to provide for easy and scalable expansion into state-of-the-art infrastructures, such as the commercial clouds (Amazon, Azure, etc) or research-domain dedicated clouds (CEMS, EODC, etc).

The Blue Planet website, http://www.oceansandsociety.org/, will be the entry point to VeriBlue. Initially this website will include a sub-site holding project-specific documentation, examples and short shareable posts on new capabilities, libraries, datasets or even selected user-driven analyses. The concept will be that of a web-based workspace giving access to VeriBlue as a work bench. It will also support the demonstration services several of the Blue Planet priority activities are aiming at. For example, a user-created mangrove-monitoring service could issue (moderated) alerts to demonstrate the capability, and interannual to decadal local sea level forecasts produced by a user-created service coulds be made available. The main site will be enhanced with extra information, such as the e-course content, to further draw interest from the communities. Over the course of the project, the main Blue Planet site will fully incorporate the relevant VRE subsite contents into the main site. The VRE itself will use advanced web technologies, with workbench capabilities further described below, and tools and services that enable and support community- and capacity-building activities, particularly training programmes and user workshops. Access to VeriBlue will be full and open.Optional registration will allow users to take advantage of the collaboration features, such as communication features, being able to comment on datasets or being able to use more significant resources. Registered users will be able to, with consent, identify, contact and interact with other users of the dataset of interest or to build expert teams for complex and difficult problems.

Easy data discovery, access and import

Allowing users to effectively search for data is key. GEO has made excellent progress on this front with the Global Earth Observation System of Systems (GEOSS) which offers data discovery tools for publicly available data, including those that have been registered with GEOSS Data-CORE. The GEO Discovery and Access Broker (DAB) was created as part of the FP7 funded project

EuroGEOSS (and used in many other projects, such as GEOWOW) and it became part of the GEOSS Common Infrastructure (GCI) in November 2011. It is a middleware component which is in charge of interconnecting the heterogeneous and distributed capacities contributing to GEOSS. The DAB offers a JavaScript API, which coupled with a GIS map portal, will enable the searching of GEOSS for relevant datasets. Further efforts are ongoing to improve relevance of the search results and these will naturally fold in to uses of the search services.

Data registered with GEOSS forms only part of the solution. Users of VeriBlue will be encouraged to make their data accessible to the wider community, via the Data-Core/Registry and via approaches that allow simple discovery with tools like the DAB, but this may not always be feasible for technical or political reasons. Therefore VeriBlue would allow users to ingest their own data; this may be a dataset hosted remotely and accessible via a service such as OPeNDAP or it could take the form of a CSV file, Excel spreadsheet or a Google Docs file. However and wherever the data are hosted VeriBlue would automatically produce metadata so that data can be referenced with proper citation and good provenance (e.g. following the recently drafted GEOSS data citation standard). An important corollary to easy import of data is easy sharing of data – by making it simple to publish, upload and share data, especially relatively sparse data such as insitu samples, the likelihood of wider usage is encouraged..

Processing and analysis

With the data identified, the users would then have access to a range of tools to process and analyse the data. A library of scripts, both generic ones and ones targeted at core Blue Planet use cases, will be made available, implementing where necessary and reusing where possible. In many cases, these will be fully described workflows, which can be run by a user with little detailed knowledge and thus fit with the GEO Model Web vision of many interacting independent components-as-services. The platform also provides for true programmatic capability for more advanced user, in the form of iPython notebooks, integrated with features to encourage rapid development and greater reuse of pre-existing work (e.g. suitable scripts, models and workflows will be suggested to the user from the library based on the data they have selected and potentially based on what they appear to be doing with it). Users would of course be able to write their own scripts for processing in the cloud environment, add model components, and they would be encouraged to add their scripts and workflow documention to the library for others to use. Open sharing of knowledge is a core facility embedded in VeriBlue.

Functionality applying across many domains will be identified through community consultation and provided in the core. Already identified examples include features for selection of data to a geographic, political or scientific locality, application of algorithms to these locales and automatic alerting when outputs go beyond a threshold. These functions can be combined with diverse datasets and algorithms to meet already-existing Blue Planet activities, such as alerting when harmful algal blooms (identified using regionally tuned algorithms) threaten fish farms or beaches; monitoring of mangrove swamps based on automatically-determined or predefined locations of swamp areas; river discharge monitoring; coral reef or shellfish production-zone health monitoring.

Real time collaboration

Providing a platform for research is important, but providing a virtual stakeholder table around which a group of scientists and, if necessary, other stakeholders, can sit to collaborate effectively is a greater goal. Easy communication and collaboration is a critical requirement for international-scale problems where the experts and data are distributed globally. Collaboration and information sharing is therefore a strong component of VeriBlue. A suite of traditional tools such as news and

RSS feeds will enable users to see what others have been working on, or which new datasets are available, and Twitter would be employed to create networks of users and send updates about who has been working with which data, or which datasets have been combined. These are isolated methods of communication for individual users to consume as and when they please. However, when a group of people opt to work together on a shared analysis/program/view, the use of new and emerging real-time communication technologies will offer the option of simple voice and/or video chat (using WebRTC), instant messaging features, or screen and session sharing to facilitate fast and easy communication.

Dealing with the resource challenges

One of the main challenges currently faced by scientists and researchers is the volume of data and the limitations of their own computers and networks with regard to moving these data around in order to work with them. This is of increasing significance even in technologically advanced countries due to the twin drives of observational and model data volumes growing beyond the capabilities of most research centres and the societal need to enable an ever greater range of people beyond researchers to access, process and analyse community data resources.

The VRE will assist in offering a solution to this problem by taking the users' tools to the data, where scripts/commands/queries can be executed and then just the results are returned. Authenticated users would then be able to deploy pre-configured 'containers' of tools to the server where the data resides, via a web based control panel within VeriBlue, using the open-source software, Docker. The container can contain almost any combination of software and tools; these can be created by more technical users or selected from a library for less technically minded users. The user would be able deploy a number of containers to several locations to perform operations on various data, then have the resulting output combined and further processed in another container.

In the developing world, VREs can be particularly valuable. Developing world research clusters are typically characterised by small and poorly-networked research groups, poor access to numerical programming and IT resources, little in situ observational infrastructure, high dependency on large volume earth observation/global data sets, and poor bandwidth/data access. VREs can therefore play a valuable role in allowing easy access to a range of centralised or curated, well documented and community-proven research and processing tools linked to large volumes of processed or re-processable data. Such capabilities will significantly improve research capability - greatly improving access to data, the ability to process and analyse data, and access to networked scientific expertise. In addition to improved discovery, access and analysis, VREs will play an important facilitation role by either allowing downloading of reduced volume centrally processed/analysed data, or by distributed implementation of toolsets allowing analysis of locally held archives.

The GMES-Africa Marine and Coastal services network, with complementary operational services to be implemented in 2016, will provide a strong developing world marine research network developed through previous EC initiatives: FP7 DevCoCast and EAMNet, PUMA, AMESD and the ongoing MESA project. CSIR as a Regional Implementation Centre will provide access to this network - more than ten African marine research institutes around the continent engaged in a range of research across the Blue Planet and JRA tasks. The complementary nature of the GMES-Africa operational marine and coastal services will ensure data provision, an infrastructure base and leveraged IT capabilities with which to demonstrate the increased research potential coming from VeriBlue.

Security and authentication

Security is a major consideration in the planning of a VRE and system administrators need to be confident that their networks, infrastructure and data are going to remain stable and secure when new elements are introduced. The use of Docker to allow users to deploy a set of tools where the data are hosted means that either the contents of the container or the interactions between the container and the host system must be closely controlled.

Tight security and strong authentication is normally necessary to support the level of locality implied by transporting code into foreign systems; here, the approach includes security via isolating the components within the container so that they can be locally run with limited risk, meaning weaker authentication is possible; a critical factor if an organisation were to offer access to its compute and data resources without having to commit to extensive and time consuming integration work.

Each container that is deployed to a host server is constrained within its own namespace and is given it's own network stack. Docker is built using Linux Containers and a key component of these is Control Groups; these implement resources accounting and limiting, ensuring that a container cannot adversely affect its host machine by using more than its fair share of memory, CPU or disk I/O.

There are some security implications when making local resources, such as file shares or local directories, available to the container. These risks can be mitigated by ensuring that only authorised users are able to deploy well-defined configurations to specific locations or by requiring that all data access passes through standardised interfaces, such as OGC WCS or OPeNDAP. The latter has the advantage that it encourages greater deployment of these interfaces and abstracts away the problem of the vast range of different file types in an organisation, while locality removes the majority of latency and bandwidth issues often associated with using these services.

Some functions and features within VeriBlue will be available anonymously with no need to register in order to gain access, however, other functions will require authentication; for example, the voice/video chat functionality, and the deployment of containers on remote data servers will require the user to be registered. To the extent that authentication is necessary, a well established system will be used, i.e. integration with common providers via OAuth (e.g. Google, Facebook).

Interoperability

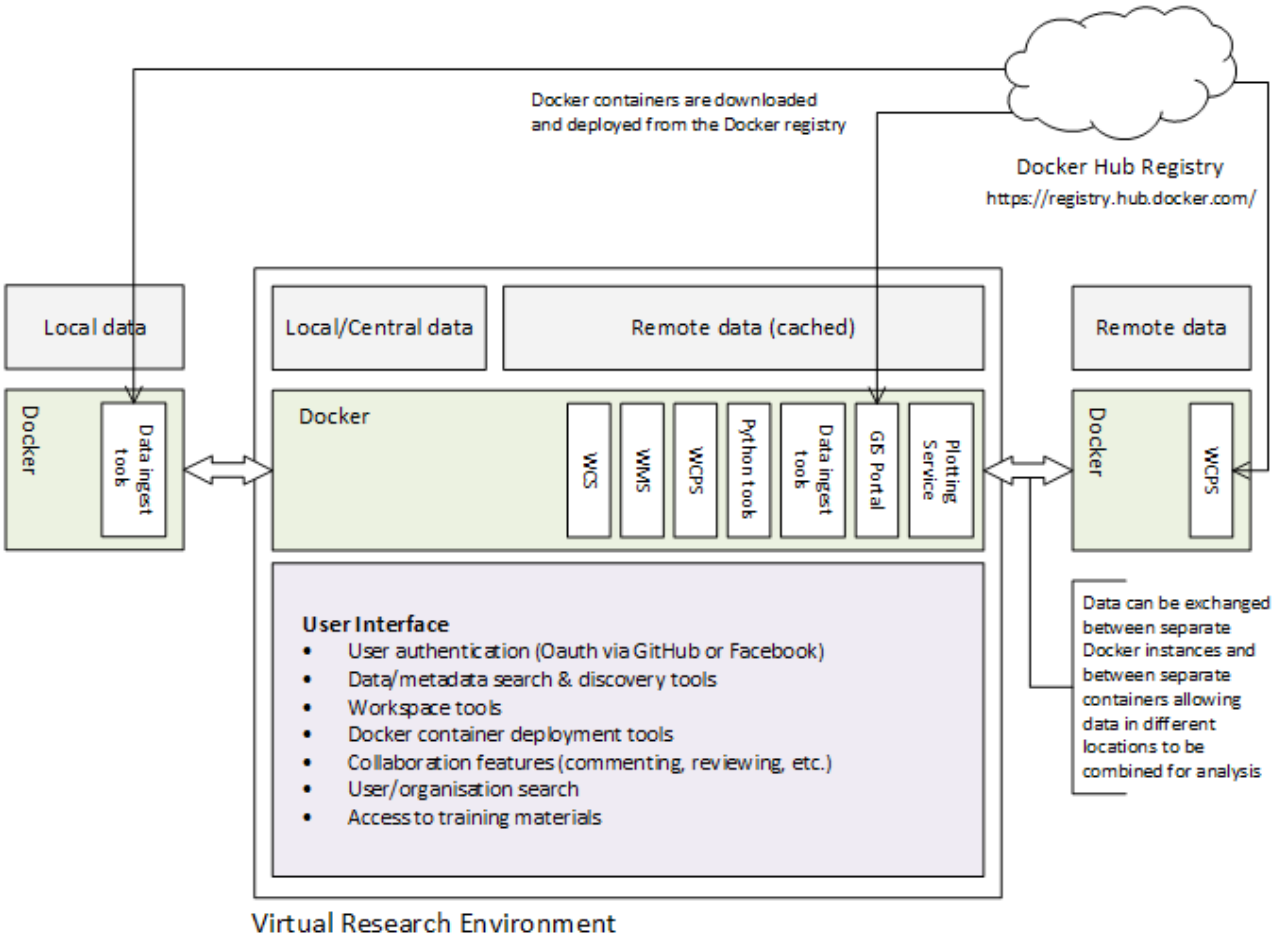
The VRE will adhere to the GEO principle of full and open access to data, and actively encourage users to contribute data for public use, e.g. to the GEOSS Data-CORE. The data itself is held by many organisations, some with suitable hosting, others not. Based on the outcomes of a task examining which specific datasets will be of most use, assistance in hosting may be offered or, ideally, use made of the existing services..

Standard interfaces, such as OGC WCS, SOS and WCPS, will be used in the containers to help protect hosting organisations and, just as importantly, to secure standardised interfaces for processing components, such that these components do not have to handle the vast diversity of data formats that exist. Expanding the deployment of these standards in the ocean community will enable greater access to a wider range of data and services.

The OGC also is exploring metadata for usage, provenance and semantics, above and beyond the simple discovery metadata. Using this has the potential to enable assisted construction of model-

web style workflows, to offer online, reactive assistance or suggestions, and to support well-grounded analyses suitable for publication ; further exploration and standardisation here would benefit all users of the data.

Pictorial overview
The figure below offers an overview of the potential architecture of VeriBlue. An entry portal to VeriBlue would allow users to authenticate with an existing OAuth provider, for example, GitHub or Facebook, although this may not be mandatory. All users would be able to explore the data catalogue to identify datasets of interest; VeriBlue may also suggest datasets that are linked to, or relevant, to the selected dataset. Authenticated users would then be able to deploy pre-configured 'containers' of tools to the server where the data resides, via a web based control panel within VeriBlue, using the open-source software, Docker. The user could deploy a number of containers to several locations to perform operations on the data, and then have the resulting output combined and further processed in another container.



1.4.2. Networking – Community and Capacity Building

While the service activities provide the technical infrastructure, the networking component aims to bring the different research and practitioners' communities together, to encourage cooperation and collaboration, to extend the reach of existing organisations and to build new capacity where it is absent.

In part, this will be achieved by spreading information through workshops and training programmes about the initiative, the observations and how they should be properly used, and the supporting capabilities of VeriBlue. These sessions will be linked to planned and new scientific symposia discussing specific research topics, such that new users are immediately able to see how the outputs and analyses relate to real-world issues and contemporary research. Critically, these networking activities also feed back into the service development and feed forward into the JRA activities to ensure the project is user-driven and remains closely coupled to the immediate needs of its users. Component C6 of the Blue Planet initiative is focussed on capacity building, and is led by POGO, which undertakes a broad portfolio of capacity building activities (http://www.ocean-partners.org/training-and-education) and has provided training to around 600 early career scientists, mainly from developing countries, over the last 15 years. POGO aims not only to provide training but to integrate its trainees into a global network of oceanographers that can work together in the future to improve the global coverage of ocean observations for the benefit of society. To this end, POGO has created a network of nearly 200 alumni from around 40 countries, from its training programmes conducted jointly with the Nippon Foundation. Through this network, called the NF-POGO Alumni Network for Oceans (www.nf-pogo-alumni.org) POGO/PML will contribute to the global dimension of the project, enhancing the engagement of developing countries as well as the participation of POGO member institutions. The Blue Planet Symposia will also constitute a forum for enhancing community engagement (involving both scientists and other users) and providing training related to VeriBlue. There will be scope in particular to organise special sessions/workshops at the Symposium in the USA in autumn 2016.

Another aspect of engagement with the community is through online tutorials and training material, which includes public access and thus potentially citizen participation. POGO works closely with other organisations that are specialised in the collation and provision of online tutorials and other training resources. Some of these are the International Oceanographic Data and Information Exchange (IODE) Project Office of the IOC, the European Space Agency, and GEO. Links would be made to those organisations to disseminate these resources widely. Such a link has already been made with IODE, which has begun to make lectures from POGO teachers available to the world through its Ocean Teacher site. The OGC leads the Architecture Implementation Pilot (AIP) initiative of GEO, which in 2014 focussed on the provision of mobile and web-based applications for enhancing citizen participation in the collection and/or use of Earth Observation data. POGO also participated in this initiative in 2014. The project will make use of those connections to ensure that opportunities for public participation are maximised.

In addition to these e-courses, VeriBlue will also explore a concept of “training-on-the-job” by integrating models and model webs with user guidance and tutorial elements that can be activated when needed. By eliminating the separation of tutorials on the one side and the “real-world’ work task on the other side, the models and model webs can adapt to the level of expertise of a user. This supplements the technical work relating to “helpful suggestions” described above.

The final task of the networking activities is to build the foundation for sustaining the outputs of the project into the longer term. The distributed architecture of VeriBlue, its basis in cloud computing and the open development process will ensure that it is accessible to all and can endure beyond the timeframe of the project, but these technical considerations must be supplemented by the human aspects of sustainability for a successful outcome. This is specifically addressed by a staged handover of governance to the Blue Planet initiative via the formation of a technical subcommittee reporting to the main Blue Planet steering committee, and by the efforts mentioned above to build VeriBlue into the working processes of the people and organisations, and to foster ownership of

VeriBlue as a core part of what binds the different groups.

1.4.3. Joint Research Activities

The Joint Research Activities target the components of the Blue Planet, with the exception of C1 (observations), which is amply supported by other H2020 proposals and funding sources. Each JRA will use VeriBlue, and serves multiple functions: guiding development of VeriBlue to ensure it is directly relevant to the Blue Planet components, demonstrating the new capabilities enabled by the JRE, and driving coherence in the Blue Planet communities by addressing questions of direct interest / expanding human capability.

Two JRAs will address Blue Planet component C2 “Sustained Ecosystems and Food Security”, primarily addressing the integration of in-situ, earth observation and modeled data as a research enabler. A ChloroGIN-focused JRA will build on the existing ChloroGIN partnership (www.chlorogin.org), focusing on the integration of existing large and under-exploited databases of in situ bio-optical data in Northern European and African waters. Research will utilise such data with ocean colour radiometry for validation, regional algorithm optimization and integrated products for fisheries related ecosystem time series analysis and Harmful Algal Bloom (HAB) detection capabilities. A second ecosystems-related JRA will focus on mangrove monitoring associated with the Blue Planet Task Priority Activity “Advance the development of global monitoring services for mangroves, coral reefs, and estuaries” This JRA includes a significant capacity building component and the challenge of integrating resource-poor groups from developing countries into the researcher team. Both JRAs will exploit strong synergy with operational GMES-Africa Marine services and researcher networks.

New VRE capabilities will be used to combine earth observation and models in innovative ways with regard to Blue Planet Component C3 “Ocean Forecasting and Services”. This JRA will focus on coastal and ecosystem research applications, specifically the combined use of sub-mesoscale hydrodynamic models and physical earth observation data in African shelf seas in collaboration with GMES-Africa; and interaction with the CSIR Southern Ocean Carbon and Climate Observatory to showcase VRE utility in research using biogeochemical data from both models and satellites at a variety of scales.

Blue Planet component C4 “Coastal Zone Services “will be addressed by two JRAs focusing on the linkage between the research teams and the societal stakeholders, including the co-design of the research agenda and the co-creation and co-usage of the practice-relevant knowledge created. These JRAs will focus on policy-relevant coastal services that integrate in situ and remote sensing data across the land-ocean boundary to provide that have relevance to land use planning in the coastal zone. The Interannual to decadal local sea level forecasting JRA is derived from the Blue Planet Priority Activity “Assess the observational requirements for decadal forecasts of coastal local sea-level variation and develop a demonstrator forecasting service.” This JRA requires the integration of data from tide gauges, satellite altimetry over ocean and ice sheets, gravity missions, SAR, GNSS, with modular geophysical models to predict local sea level on interannual to decadal time scales. A second C4 focused JRA is derived from the Blue Planet Priority Activity: “Assess user needs and observational requirements for coastal water quality; identify indicators and best practices for coastal water quality, and implement a monitoring service pilot for coastal water quality” In the frame of the proposed project, VeriBlue will be used to address the integration of relevant data across the land-ocean boundary.

Blue Planet component C5 “Ocean Climate and Carbon”, C5, is addressed by two JRAs focusing on coastal and Southern Ocean research. The Coastal Carbon JRA also has the interesting prospect of linking with some of the coastal and inland water work from other projects. Coastal waters are a

very dynamic part of the oceans where most of the exchange of material between land and oceans takes place. Remote sensing is the only tool to map the extent of coastal waters globally, determine the role of coastal waters in the global carbon cycle or study dynamic processes taking place in coastal zone. Dynamic use of remote sensing algorithms is needed, a level of experimentation well suited to exploration in VeriBlue. In lake water satellite-detectable coloured dissolved organic material (CDOM) is the best proxy for DOC and pCO2. Using VeriBlue, it is possible to estimate pCO2 in coastal waters, analyse for the best pC02 proxy and re-evaluate the role of oceans in the global carbon cycle based on the improved coastal results. A second carbon related JRA will use VREs to provide e-infrastructure to the Southern Ocean Observing System, focusing on integrated provision and analysis of data from multi-sensor gliders, autonomous surface vessels, and earth observation data with a strong focus on phytoplankton dynamics and carbon export. The inclusion of data and analysis capabilities for data from mobile multi-sensor autonomous platforms brings a high degree of innovation and impact to this task.

The essential human aspect of developing capacity is dealt with by a JRA that incorporates a studentship programme led by POGO, with VeriBlue providing the technical underpinning to explore questions that will be selected by the Blue Planet community itself in a consultation process. This programme both pushes development of the JRA and helps drive new skill sets into the community.

1.5. Ambition

Traditionally, researchers and scientists would perform their analyses offline, having downloaded the data from its source. Presently, this is becoming more of a challenge as the volume and diversity of the data is growing exponentially due to new observation capabilities, new approaches for automation and a greater commitment to environment research from the world's governments, driven by climate change. The challenge is that this growth will become a barrier, with new satellites and sensors coming online in the near future producing many terabytes of data per day and new reanalyses created without easy means to discover them naturally. The data volume alone is already beyond the capabilities of some medium-sized organisations to deal with.

Our collective ambition within this project is to provide a scaleable infrastructure that pushes back this barrier, and allow researchers full and prompt access to a large range datasets that may extend to petabytes with the tools to work on it, but also to encourage and foster a community where researchers can collaborate quickly and easily, and without the hassle and expense of travelling.

As a relatively small project, the aim is to reuse as many technologies as possible and to target the resources on the novel points that offer benefit above and beyond the state of the art. These are:

- Containerisation: a different approach to remote processing, simpler and with more decentralisation
- Spreading and testing the use of global standards, extending these where necessary with the cooperation of a well known standards body
- Real time collaboration within VeriBlue; a virtual stakeholder table
- Creativity/co-operation enhancing features

In addition to these technical points, the project holds the following non-technical ambitions:

- To bring together the Blue Planet around a technical infrastructure
- Exploration of genuine scientific objectives directly related to BP activities
- An integration of technical, research and teaching activities

Containerisation

Currently, the Terradue Cloud Platform makes extensive use of Virtual Machines, through the OpenNebula Cloud Controller technology, as the basic unit for deploying and scaling application clusters on Cloud environments. New technologies like LXC, Docket, Rocket or even Apache Mesos offer some perspective to optimise the DevOps operations related to the Platform, for the evolution, maintenance, deployment and monitoring of the Platform's infrastructure. These technologies, their process and best practices are still fairly new, and their DevOps operationalization requires investigation and learning for their fine-tuning. It basically provides tools that can package an application and its dependencies in a virtual container that can run on any Linux server, whether it is accessed on premise, public cloud, private cloud, or bare metal. Unlike traditional virtual machine technology, they do not require or include a separate operating system, and relying on Linux kernel's functionality to make use of resources with isolation per application (CPU, memory, block I/O, network, etc.). Indeed Application Containers for Linux (LXC) is an operating system–level virtualization method, for running multiple isolated Linux systems (containers) on a single control host, that does not require starting any virtual machines, and providing fairly isolated environment for applications.
LXC features that enable containers were added to the mainline Linux kernel years ago, providing kernel-level isolation of the application deployments. Progressively, an ecosystem of start-ups has

developed LXC technology in support of industry. Docker is a leading open-source project and company that automates the deployment of applications inside software containers (by providing an additional layer of abstraction of operating system–level virtualization on Linux). Through the Docker developments, another company, CoreOS, has developed an extensive experience in terms of operating system for deploying Linux containers, and recently launched the Rocket initiative to complement the Docker approach to industry.

The Docker community has expanded rapidly over the past 12 months as uptake of the technology has increased. The Docker Hub is a place where users and software providers can upload and share their containers, and as yet, there are no containers in the Docker Hub repository that contain OGC services. The well configured containers that deploy OGC services produced as the outputs of WP4 would be added the repository in order to promote the use OGC services by members of the Docker community, and a part of this exercise will be to inform and educate the Docker community.

Operational gains in using Linux Containers are mainly:

- *Evolvability:* multiple containers can share the same kernel, but each container can be constrained to only use a defined amount of resources such as CPU, memory and I/O process)
- *Autonomy:* lifecycle management, multiple applications, worker tasks, and other processes run autonomously and deployment of nodes can be created and scale up/down on demand
- *Control:* monitoring, distributed scheduling, health checks, events, routing, and metrics all necessary to operate a platform.

This is an interesting technology for platform-as-a-service (PaaS) class of systems. Docker indeed started in 2012 as an internal project within the "dotCloud" PaaS, a platform as a service company. There is an initiative to integrate Docker into Red Hat's "OpenShift Origin" PaaS. There are also plans for integration in Microsoft Server. On March 13, 2014, with the release of version 0.9, Docker dropped LXC as the default execution environment, and a year and a half later, Rocket is coming up to reinforce the standardization effort related to Linux Containers.

Hereafter, we identify the main aspects to study as part of a Linux Containers operational adoption for a large community needs such as encompassed in the Blue Planet initiative:

- Storage: persistent, writable storage for containers, data move between containers started on different hosts, as well as storage replication and back up differ from Virtual Machine images management and require a dedicated attention for Linux Containers.
- Deployment build, rebuild and failover recovery: applications that need to find the web services endpoints to talk to, require the use of a dedicated registry, possibly stable names for services, and efficient endpoint name resolution services e.g. DNS. While in VM-based environments a deployment setup can take several minutes, containers can come back up in seconds. The time taken for service registries or DNS caches to update can therefore become large in comparison and be perceived as a bottleneck. we will consider state of the art approaches (e.g. etcd) in the particular scope of OGC Web Services endpoints in the context of services orchestration.
- Ownerships in the delivery model: impacts of the Linux Containers technology on the roles of the DevOps process, having the Operations Team in charge of providing the container runtime, and the Developers Team in charge for issues solving related to software inside the container.
- Security and standardisation: with the advent of Docker in 2012, the industry started to get more and more engaged with Linux containers, and interested by its advantages. There is now a well-established industry requirement for having a POSIX-counterpart in terms of

standardized containers that can be used with some service level guarantees. Some well-known issues with Docker concern the network security configuration. One aspect is due to the fact that with Docker most images for tools, databases, and microservices ship with insecure default configurations: by default Docker allows arbitrary inter-container communication. It has advantages in reducing friction in adoption, and reducing the deployment learning curve. Strengthen the docker container networks is a task that requires attention.

Decoupling an open specification from the implementations is a well-known process, e.g. also at the heart of the OGC process, that allow allows the industry to explore the trade-offs of implementation choices within agile innovation cycles. CoreOS is leading a specification for a composable, portable, open standard for Linux container image format, runtime environments, and discovery protocol. CoreOs is previously well known for being the Operating system company behind the main Docker adopters, and also for its highly scalable "etcd" key value store for shared configuration and service discovery.

CoreOS started the Rocket initiative as an Open Source community reaction to the new Docker's corporate strategy. Rocket is an implementation of a Client for running a container runtime, based on the App Container specification, with a prototype released end 2014. Once an App Container Image (ACI) is installed on a content addressable storage (CAS), a container can be launched by Rocket. As the execution with Rocket is divided into a number of distinct stages, there is a clear separation of concerns with the initial file system setup, the execution environment, and finally the execution of the apps themselves. Impacts on the way VRE specific software systems are updated, maintained and deployed for Linux Containers will be studied in the project's infrastructure work package, especially when it comes to make extensive use of communication protocols in VREs.

Within VeriBlue, containers offer the opportunity of a new, simpler and safer way to transport arbitrary code close to the data, rather than to move the data to the processing. Other approaches provide some similar capabilities, but with more restrictions on the implementation, or requiring specific approval from administrators, and a more complex set-up process. This new approach has the potential to be broadly applicable across many scientific and industrial domains, and is worthy of exploration and, potentially, eventual standardisation.

Standardisation and creativity

Every piece of technology, that plays a role in the value chain, will ultimately democratize and become available to the masses. This does not happen overnight, but goes through the various stages of the product life cycle. One of the important steps is the convergence of products that do the same thing from various organizations around a commonly agreed upon set of rules – standards – that will encourage market competition, avoid “lock-in” into a proprietary architecture and ultimately lower systems and life cycle costs. These elements, thanks to the creation of common agreed upon standards, help further democratization and access to the technology to the masses. Most of the applicable fields of research here are in the early stages of this process and various OGC standards could help further “democratize” ocean research, raise the public awareness of the role of the oceans in the Earth system through and enable many actors to participate through easier and freer access to data. While not a part of this project, this approach enables even citizens to contribute as “in-situ observers”; so called Citizen Science of Crowd Sourcing. OGC standards also help researchers to chain their various analytical computations and help in the establishment of research networks.

Particularly relevant OGC standards include the Sensor Web Enablement (SWE) suite of standards (Sensor Observation Service, Observations and Measurements model) and the WMS/WFS/WCS + WCPS standards. Others, such as NetCDF (Network Common Data Form) have been adopted and "blessed" from other organisations. NetCDF is a set of software libraries and self-describing, machine-independent data formats that support the creation, access, and sharing of array-oriented scientific data. The conventions for climate and forecast (CF) metadata are designed to promote the processing and sharing of netCDF files. The conventions define metadata that provide a definitive description of what the data represents, and the spatial and temporal properties of the data, and are increasingly the standard in operational oceanography.

The large amount of information produced by the Internet of Things, in combination with the opening of public data resource for re-use will create data sets so large and complex that it becomes difficult to process them using traditional data processing applications. OGC's Web processing Service (WPS) is one way to reverse the computing paradigm and run analytical functions near to the data (e.g. in the cloud) and only download the result for further processing. The FP7 GEOWOW project, FP7 NETMAR and others have done initial research in this domain and proved that OGC's WPS can played an important role. Chaining processes is a known paradigm from the early Unix days that can now be applied to large volume datasets as well through the chaining of OGC's WPS's – the output of a process results will be input for another interoperable process.

For successful chained services to re-use each other's research outputs, semantic interoperability is essential. OGC and the W3C are working together to create a semantically-enabled interoperable geo-web, using linked data in various encodings. This collaboration will bring forward existing best practices and cookbooks, and will also try to bless a common set of core vocabularies to reduce the wildfire of vocabularies (that actually decrease interoperability).

The related area of ancillary, user-generated metadata is currently newer, though initially addressed in earlier projects such as FP7 CHARM-E, GeoViQua and several linked-data efforts, and presents a similar opportunity to field-test and embed the best ways to niclude these data, which underpin novel capabilities in VeriBlue, such as offering automatic suggestions on similar or frequently-combined datasets, assistance on filling in workflow parameters and "social-linking" to encourage people to contact others working in a similar domain.

The ambition relating to standardisation in this project is to more fully deploy OGC standards across the Blue Planet communities, to use them for interactions between processing components, to develop and field-test the necessary semantic and ancillary (user-generated) metadata for interoperability, and to feed back experiences and the new container-based remote processing approach to OGC and thus into the standards process.

Real time collaboration

Many tools exist for collaboration, from simple emails through to video-conferencing and screen-sharing/webcasting; FP7 Earth2Observe is even now offering a novel session-sharing collaborative feature on its interactive data portal, iPythonNotebooks are of increasing interest for shared-coding.

However, integrating collaboration fully into the virtual research environment offers numerous synergies. Being able to form arbitrary groups that can collaborate directly on a visualisation of a dataset, on editing or deploying the analysis code and simply being able to discuss an output or problem opens the door to new forms of remote collaboration, where teams of different skillsets can interact to rapidly solve problems or to come up with analyses of a changing situation. For

example, a virtual stakeholder table could include scientists, programmers and decision-makers, all working together to understand and form a decision on a specific issue. As another example, this form of collaboration could allow remote teaching, with students sharing a session and being able to directly see how the teacher approaches the solution and to interact when things need clarification.

The use of new web standards, such as WebRTC and websockets, for browser-based peer-to-peer communication allows for an encompassing solution without the need to install specific software or plugins and eases users naturally into communicating more.

Non-technical ambitions

The Blue Planet initiative has a diverse and widely distributed community with partners in 19 countries (POGO), as well as scores of others in Members and Participating Organisations of GEO. The current state of Blue Planet is a voluntary, self-organised grouping, with no clear foundation on which to build collaborations and work together to address the objectives. The VRE presents an opportunity to provide that grounding and an anchoring point around which to cohere the communities into a coordinated approach to the activities.

An extensive community engagement effort is a fully integrated part of the project, including capacity-building and addressing questions of direct relevance to the community. The networking, service and JRA activities are interlinked to support one another, with JRAs and networking feeding back to the service developments, service activities providing the infrastructure to address the JRAs and to cohere the community and underpin teaching and collaboration, and networking engaging with sustainability and ensuring the project is strongly tied to users through training, dissemination and consultation..

The use of cutting edge technologies such as Docker used in partnership with established OGC standards offers a different approach to data processing, and has the potential to provide access to data that previously a researcher simply didn't have the infrastructure to process – this is specifically encompassed within the project by the inclusion of a South African partner. Technologies such as WebRTC and websockets offer exciting possibilities for real-time collaboration mean that users will be able to see what people from the community have been working on, and more importantly, actively take part as it is happening.

2. Impact

2.1. Expected impacts

VeriBlue is designed to directly contribute to the expected impacts set out in the work programme, and to serve the needs of the Blue Planet GEO Marine Task within that framework.

As listed in the call, VREs are *expected to result in more effective collaboration between researchers and higher efficiency and creativity in research, as well as in higher productivity of researchers thanks to reliable and easy access to discovery, access and re-use of data*. VeriBlue clearly promotes collaboration and addresses both components which lead to higher efficiency and productivity: the "e-infrastructure" and "human infrastructure", nicely coupled and complementing each other. The e-infrastructure will integrate resources across all technical layers, (developed through the described service activities of WP3, 4, 5) to provide the necessary basis, while the human infrastructure (mobilised through the described networking, joint research and dissemination activities of WP2, 6, 7) will act as a catalyst to maximise the exploitation of VeriBlue. The proposed model will improve innovation capacity by integrating new knowledge, maximising the real-time

collaboration potential, strengthening the growth of research clusters and Communities of Practice which can in the future emerge in the market.

Furthermore, VREs will accelerate innovation in research via an integrated access to potentially digital research resources, tools and services across disciplines and user communities and enable researchers to process structured and qualitative data in virtual and/or ubiquitous workspaces.

Access to VeriBlue will undoubtedly lead to faster discovery and processing of data. The preconfigured and rapidly deployable available tools will secure that researchers can focus on the data rather than being concerned with installing and configuring software, or waiting for data to download. The flexible processing infrastructure allows scalability while retaining an almost-local level of control over what the process itself does, and the script library allows workflows created by experts to be saved and used by other, less technically-able people. Serendipitous discovery of related datasets and other items is assisted by suggestions driven by semantic, usage and comment metadata, in addition to the established discovery frameworks (i.e.. DAB) that will be integrated.

Finally, VREs will contribute to increased take-up of collaborative research and data sharing by new disciplines, research communities and institutions.

A clear target of the project is to encourage collaboration so that researchers and practitioners can learn of the discoveries made by others and support the creation of Communities of Practice. The current Blue Planet communities are not yet well organised into coherent activity, and VeriBlue will provide an anchoring point for this coherence to form. The features supporting in identifying other researchers and practitioners who may be tackling similar scientific problems (and/or real-life problems), perhaps from a very different perspective or a slightly different goal, make it easier to form contacts and the built-in collaboration features allow arbitrary groups to form and to work together on common problems. The latter will be reinforced through the planned networking activities which range in scope and target audience in order to maximise their impact.

The potential for global impact is evident despite the small number of formal partners to this proposal. The inclusion of POGO ensures that the project is able to obtain a worldwide perspective and reach important players from Europe, North America and Australia, as well as from Africa, Latin America and Asia, without needing to include a large number of formal partners and thus spread the resources too thinly to achieve the technical objectives. The linked JRAs are designed to both enhance and guide the development of VeriBlue, through pursuit of common use cases and novel scientific objectives, and simultaneously to grow the Blue Planet community while embeddin VeriBlue as a framework for enhanced collaboration.

The expected results and impacts of VeriBlue will be monitored and quantified using performance metrics and indicators. An indicative list (to be further developed within WP7 activities) is presented below:

VRE statistics (number and distribution of users, number of downloads, number of virtual tables, etc.), number of data providers, collaborative research products, number of e-newsletters and number of recipients, number of users and followers in social media (twitter, etc.), number of users in the forum per target group, statistics on use of the forum, number of events, number of participants (per event, seminar), results of the consultation evaluation questionnaires, number of projects and networks reached for establishing links and interactions. Feedback Information from questionnaire will also be analysed, focusing on: rating the accessibility to knowledge, rating the transparency, rating the opportunity provided by the project to be involved in VeriBlue community, rating the opportunity provided by the project for interaction with other end-users and exchange of knowledge, etc. From these performance metric it will be possible to draw conclusions on the direct effects of the project, although the real impact can only be evaluated in the longer term.

2.1.1. Positive impacts on other environmental and social issues

VeriBlue has positive impacts on the environment and the society as it is linked to the "Oceans and the Society: Blue Planet" Initiative (see section 1.1). Furthermore specific JRAs are foreseen to address components of the Blue Planet, bringing positive impacts of collaborative research on environmental and societal challenges within and outside the EU:

C2 - Sustained Ecosystems and Food Security (Task 6.1)

C3 - Ocean Forecasting and Services (Task 6.2)

C4 - Services for the Coastal Zone (Task 6.3)

C5 - Ocean Climate and Carbon (Task 6.4)

C6: Developing Capacity and Social Awareness (Task 6.5)

The project is highly innovative in exploiting the latest technology to enable researchers to work together in a virtual environment, combining data provision and processing with social media tools. The societal impact and relevance to end-users are maximised through the project's links to Blue Planet, and in particular the user consultation and public aspects of the project. The link to Blue Planet also ensures that the impact will be prolonged beyond the duration of the project itself. The major outputs of the project are reusable in a variety of societal-benefit areas, both directly in a technical sense and from the exploration of the novel concepts for handling large-scale remote processing.

2.1.2. Barriers to intended impacts

The following potential barriers to the intended impacts have been identified. Nevertheless, the project has identified means to overcome them.

Obsolete technology, infrastructure and tools: WPs 3, 4, 5 are carefully designed to provide state-of-art technology and tools to implement VeriBlue services. Terradue and PML are experts in cloud technologies and web-based remote processing. The intended development into container-based processing simplifies both of these while bringing them more naturally together.

Problems integrating users (stakeholders, researchers, practitioners, etc.) in the Networking Activities: The integration of the "human infrastructure" is an important component of VeriBlue to guarantee its uptake and sustainability. A major networking effort has been planned, within the dedicated WP2 and underpinned by WP7, where different means to engage the community have been identified. These activities range in scope (forums, consultation events, training sessions, etc.)so that they can attract the users. Furthermore, the consortium partners (e.g. POGO, OGSE, Tiwah, SEVEN, etc.) have already established wide networks which are easy to mobilise.

Limited interest of the researchers in the JRA topics: The JRA topics (WP6) have been selected from the Blue Planet Initiative components C2-C5, thus are very relevant and contemporary within the research community. They are expected to attract both reserachers and professionals in a common exploration, advancing scientific collaboration. The partners leading the JRA's are well established in these scientific fields and research networks. Furthermore, the training and studentship activities (Tasks 2.5 and 6.5) are expected to stimulate the interest of researchers and the subjects to be directly driven by them. The VRE facility will be designed so that the available data and tools are of good added value to be used, and thus researchers are expected to react positively to the services provided.

Users lack the means (financial, personnel, know-how etc.) to make use of the environment: No significant resources are needed to use VeriBlue. The provided services will be accessible to all users, while technical support and training will be available to support the users.

No market, no after-use for VeriBlue: The suggested VRE is tightly related to the Blue Planet Initiative, and even involved partners of this initiative, but many of the technologies and approaches are broadly applicable. It is thus very relevant to future research and real-life applications, with a clear room in the ERA and the global market. Furthermore, to secure its sustainability, Task 7.5 is dedicated to VeriBlue's future exploitation and sustainability, including the development of an Exploitation Plan (ExP) which will address address governance issues and include a market analysis. The workshops and brokerage events foreseen in Task 7.3 will also contribute to exploring the exploitation potential of VeriBlue and its dissemination across a wider area than just the Blue Planet initiative.

2.2. Measures to maximise impact

2.2.1. Dissemination

Appropriate measures for the dissemination and exploitation of the results and project knowledge are envisioned (described in WP7) in order to pave the way from research to the market. A dedicated Dissemination Strategy Plan (DSP) (Task 7.1) will be developed early on (subject to updating along the course of the project) for coordinating and monitoring dissemination, outreach & communication, and exploitation activities, ensuring timely delivery of targeted high quality dissemination products. Additionally, the Exploitation Plan (ExP) (Task 7.5) will maximize the impact of the project after it is completed, and the uptake of the results by the R&D, business and policy sectors.

Dissemination and exploitation of project results will be maximised through three main methods: (1) electronic communications, (2) meetings and workshops, and (3) capacity building. These will be used in different ways for different user groups, as shown in the table below. Existing networks and their communication channels (e.g. POGO, GEO, Blue Planet, etc) will be exploited from the outset, to ensure that the sustained dissemination and exploitation of results after the end of the project.

The different user groups and dissemination/exploitation measures that will be applied throughout the project and beyond are summarised in the table below.

User groups	**Dissemination and exploitation measures (during project)**			**Dissemination and exploitation measures (after project)**		
	Electronic comms	Meetings / workshops	Capacity building	Electronic comms	Meetings / workshops	Capacity building
Project partner institutions	Project newsletters, website, RSS feeds, Twitter	Project meetings	Studentships (WP6), training workshops (WP 2)	Now included in "wider scientific community"		
Wider scientific community (POGO, GEO, etc)	Project newsletters website, RSS feeds, Twitter; POGO website	Consultation and brokerage events, Project conference, POGO	E-learning; Training materials added to GEO / IODE /	Project website (5 yrs), POGO website, newsletters, mailing lists, Blue Planet	POGO Meetings, GEO Meetings, Blue Planet Symposia	Training resources produced by project promoted and disseminat

	newsletters, mailing lists, Blue Planet website, mailing list, Twitter	Meetings, GEO Meetings, Blue Planet Symposia	ESA catalogues	website, mailing list, Twitter		ed. Link to POGO capacity building (& SCOR, IODE, ESA)
Young scientists / trainees	POGO and NANO websites, NANO News, mailing lists	Blue Planet Symposia, NANO regional meetings	Studentships (WP6), training workshops (WP 2)	POGO and NANO websites, NANO News, mailing lists	Blue Planet Symposia, NANO regional meetings	Link to NANO and POGO capacity building (SCOR, IODE, ESA)
Environnmental managers, industry	Blue Planet website, Twitter,	Consultation and brokerage events, Project conference, Blue Planet Symposia	-	Blue Planet website, Twitter	Blue Planet Symposia	-
NGOs, policy makers	Policy Briefs & Layman Report	Consultation and brokerage events, Project conference, Blue Planet Symposia	-	Blue Planet website, Twitter	Blue Planet Symposia	-
Citizens	Blue Planet website, Twitter, articles in popular science magazines	Public conferences e.g. on citizen science	-	Blue Planet website, Twitter	Blue Planet Symposia	-

Open access: All code, configuration and documentation will be released under open-source licenses (generally aiming at “BSD” or Apache licensing, which are maximally open, although individual components may use GPL variants depending on the licensing of the sub-components reused in them) and a modern open development process will be followed (i.e. github). Publications will follow the open access research policies (gold and/or green open access). The licensing of data is dependent on conditions applied by the suppliers, and will be detailed in a continually-updated Data Management Plan (the project will participate in the Open Research Pilot), but free usage will be encouraged. Similarly, user-created datasets will be encouraged to be under free licenses, though other options will be available ; for example, it is common in some communities holding in-situ data that co-authorship should be offered on any publications using a specific dataset, while Earth Observation data from satellites tends to only request an acknowledgement in publications.

Innovation, sustainability and growth:

The Horizon 2020 research program covers the entire spectrum of technology readiness levels (TRLs) from basic research to deployment of technologies in the private sector. VeriBlue will work at the front end of this spectrum and will implement an e-infrastructure which promotes scientific collaboration, links it to the policy and market needs, while impacting the environment and the society. Innovation in our project is viewed as the application of state-of-art solutions and tools which respond to new research requirements and needs of the planning communities, the business community, the society and the market. In this direction, we adapt a challenge driven approach and we focus on end-user's products and services driven innovation, for a good exploitation and market potential. Sustainability in the project is viewed as VeriBlue being used by different parties in research and real-life applications, creating a positive impact on the society (in the larger sense), while necessary structures for further development are set in place. Growth is reflected as the creation of new business opportunities for either the partners or third parties via the technologies explored.

By maintaining a tight link to the existing Blue Planet governance and community processes, and by eventually handing over leadership to the Blue Planet steering committee, the chances for long term sustainability and growth are maximised. The infrastructure itself is designed such that it can be maintained and resourced by any number of interested parties, and thus is not dependent on a single centralised organisation, but will scale with the needs and resource-availability of those parties. By ensuring it can run in a generic cloud environment and using standard technologies throughout, the interested parties do not even have to own the physical computing infrastructure. While these technical hedges against resource shortages are being put in place, the commitment of a large range of organisations to Blue Planet also gives the best possible prospect of financial backing, beyond any state-based involvement, although the pressing need to better understand the oceans as part of the climate system makes it unlikely that there will be no further governmental funding at some level.

To further achieve sustainability and growth the project will interact, consult and get feedback from all relevant communities (i.e. the research, the business, the policy) and will develop a dedicate Exploitation/Business Plan (Task 6.5). Due to space limitation we include here only the most important components of the ExP:

- Market analysis: target end-users, societal, governmental, business & industry needs, market potential, competitors, etc.
- Features of the target market: size, growth rate, share that the technology/product could reach, driving factors likely to change the market, legal, technical and commercial barriers, other technologies likely to emerge in the near future, etc.
- Product analysis: product characteristics and functionalities, main benefits and innovative aspects in comparison with technologies and products already available, product differentiation and attractiveness, transferability, potential for further development and expansion, compatibility with other market products, etc.
- Targeted dissemination activities: links to the Dissemination Strategy Plan (DSP)

Each partner will contribute to the ExP by providing an exhaustive list of the results and products that may have commercial, industrial or ongoing applications (e.g. models, software, data, generic methodologies, etc.), indicating the owner(s) of each element (individual or joint ownership) and their envisioned exploitation (either commercially and in further research, or by establishing licensing deals, assignments, partnerships, etc.). Additionally, the brokerage events (Task 7.3) are envisioned to strengthen the identification of the market potential, to promote the uptake of VeriBlue by interested sectors, and to initiate a think-tank process for further use of the foreground

with innovative ideas of commercial potential.

2.2.2. Communication activities

The project will use the wide range of communication tools available as detailed in WP7 (website, e-newsletters, social media, RSS feeds, general promotional material, publications). To further maximise the project's impact, the POGO, OGCE and Blue Planet will use their websites. POGO will use its quarterly Newsletter for communication to a broad audience and Blue Planet will use its Twitter account and mailing list. Furthermore, the News and Information Group of POGO, consisting of public relations experts from the respective member institutes, and the newly created, overarching Oceans United (www.oceans-united.org) communications group ("Ocean Communicators United") will be approached for further dissemination of project information to a wide audience. Similar vehicles of partner networks (SCOR, GOOS, GEO, WMO) will also be exploited. The GEOSS Science and Technology Service Suite (GSTSS) will be used to disseminate project results to a broad international science and technology network and to bring new users to VeriBlue. The GEO CZCP will disseminate project information through its web site and link the CZCP membership to the project.

Social media platforms will be used for communication on a more informal level, particularly with the networks of alumni and early career scientists. The participants of the project will make use of opportunities at international meetings to disseminate the work and the findings. In particular, the Blue Planet Symposia and GEO and POGO Plenary Meetings will provide ideal opportunities to showcase the results and gather feedback from the users. POGO will also engage with non-scientist users through NGOs that it already collaborates with (e.g. Surfrider Foundation, Seas at Risk). Under WP 2 and 6, specific capacity-building activities will be undertaken, which will also be a mechanism for broad communication of the project activities.

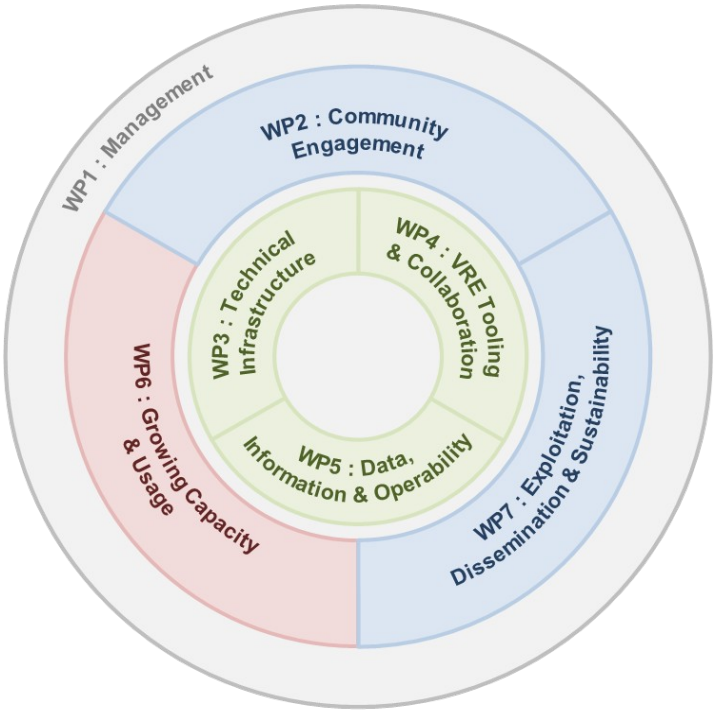
Tailored communication activities are also foreseen for the policy and decision-making community as these are seen as a valuable end-user as well. Policy brief and a Layman's report will be communicated to those groups in order to facilitate the bridging of science and policy. To further impact the wider public and citizens links with projects focusing on Ocean Literacy and Outreach will also be established (e.g. the recently awarded H2020 ReasponSEAble project).

An extensive dissemination work-package, tailored to the size of the project and run by a specialist SME, with a dedicated Dissemination Officer, will ensure that potential users in the technical / business, policy, standardisation and other non-scientific fields are catered for. The major outputs of the project are reusable in a variety of societal-benefit areas, both directly in a technical sense and from the exploration of the novel concepts for handling large-scale remote processing.

3. Implementation

The project comprises of the three types of activity necessary for an infrastructure proposal – service, networking and JRAs.

3.1. Work package structure and organisation



Two work packages, WP2 “Community engagement” and WP7 “Exploitation, dissemination and sustainability”, work in tandem as the networking activities. Important factors here are ensuring VeriBlue development stays tightly bound to the requirements of the Blue Planet communities, that a feeling of ownership and cooperative development is encouraged and, later, that it can be adopted by them for ongoing usage and expansion. WP2 begins the project with a full engagement with the community, gathering requirements and feedback, communicating the development of VeriBlue, raising awareness and providing training and assistance in the use of VeriBlue. Over the course of the project, some of WP2's engagement activities will be increasingly picked by up the dissemination work package, WP7, to ensure that the engagement broadens into ownership. Ramping up WP7's activity as WP2 ramps down aims to match the changeover from initial interest to handover and full exploitation by the community. WP7 will also aim to embed VeriBlue into collaborative scientific / decision processes, to linking into GEO and other international initiatives, to disseminate technologies and experiences to other applicable areas and to encourage the support of a long-lasting strategy for further development and maintenance of the capabilities.

Three technical work packages address the service aspect of the e-infrastructure, with WP3 providing the necessary infrastructure to run VeriBlue, and to research and solve issues with the

new containerisation / cloud approach (e.g. security and interfacing considerations). WP4 deals with the higher level components of VeriBlue, including processing components, collaboration tools and the working environment itself. WP5 addresses the necessary data, the handling and description of the data necessary to discover, use and inspire better reuse of the data, and closely ties it into globally recognized standards through the direct involvement of a major standards body.

Joint research activities are contained within WP6, which aims to demonstrate VeriBlue with usage directly related to the Blue Planet components, ranging from growing capacity through studentships, developing a monitoring capacity customisable to specific areas and through directly exploring the link with carbon, an essentially important task not presently easily achievable by the community.

The management work package, WP1, is of less direct scientific or technical interest, but critically important to ensuring steady progress of the project,solving problems that arise and managing the interaction with the Blue Planet governance processes to guarantee a clean and progressive, transfer of ownership and management to the community. The management processes are described below in section 3.3.

As the focus is on the e-infrastructure, the bulk of the activity falls into the service category, with work packages dealing with the technical infrastructure necessary to run the system (WP3), with the creation/packaging of the specific processing components, collaboration features and information systems to create VeriBlue itself (WP4) and with the data, services, interoperability and metadata to support collaboration (WP5).

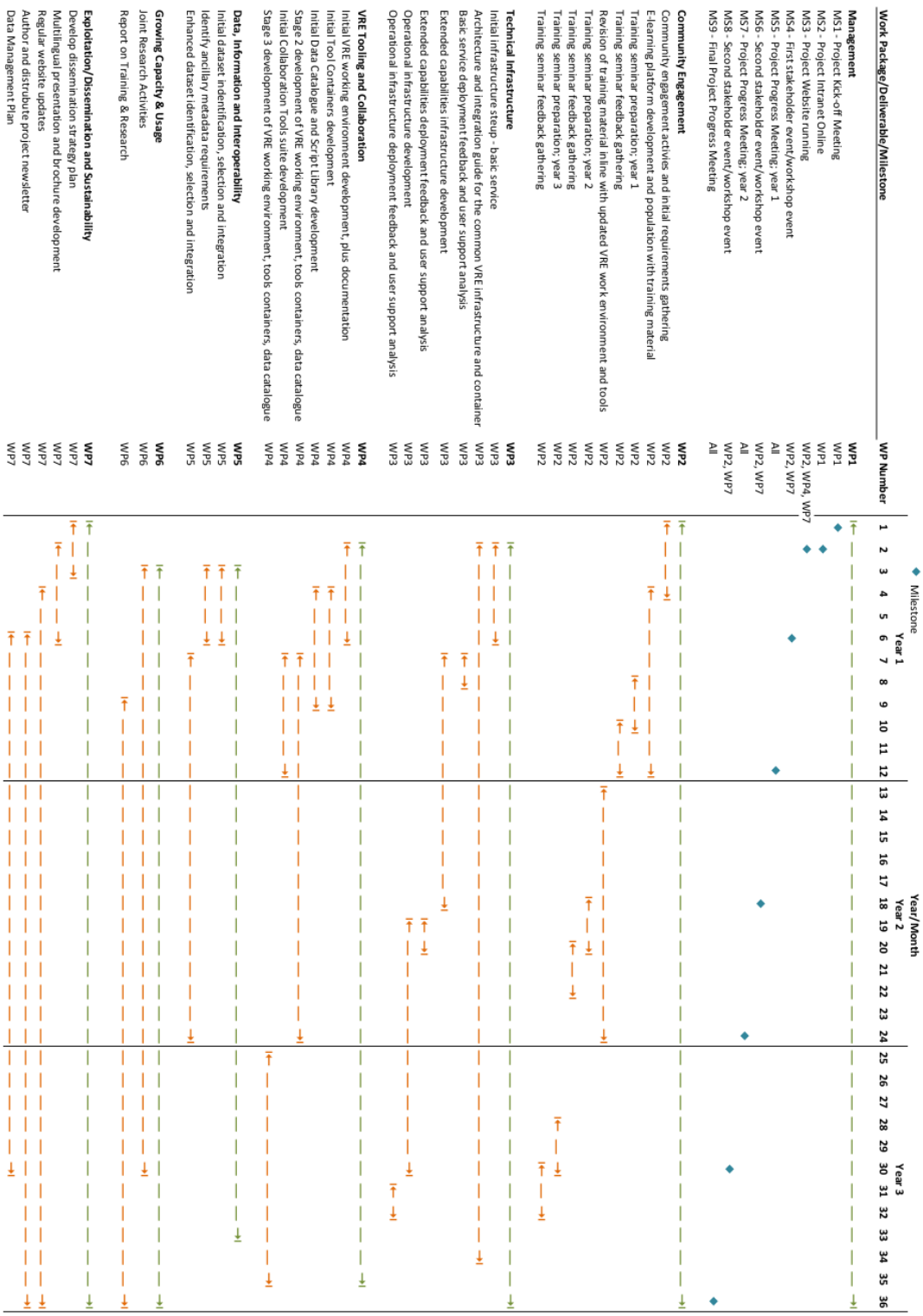
3.2. Work plan — work packages, deliverables and milestones

3.2.1. Work package timing and overview

List of work packages

Work package no	Work package title	Lead participant no	Lead participant short name	Person months	Start month	End month
1	Management	1	PML	24	1	36
2	Community engagement	4	Seven	53	1	36
3	Technical infrastructure	7	Terradue	46	2	36
4	VRE tooling	1	PML	50	2	35
5	Data, information and collaboration	5	OGCE	33	3	33
6	Growing capacity and usage	6	CSIR	38.5	3	36
7	Exploitation, dissemination and sustainability	4	Seven	42	1	36
				286.5		

Timing of work-packages and key tasks



3.2.2. Deliverables

Table of all deliverables (ordered by delivery date)

Deliverable no	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
D1.1	Project Intranet	WP1	PML	DEC	PU	M1
D7.1.	Dissemination Strategy Plan (DSP)	WP7	Seven	R	PU	M3
D7.3.	Multilingual project presentation and brochure	WP7	Seven	R	PU	M3
D2.1.	Report on users'community and requirements (incl. Database of users)	WP2	Tiwah	R	PU	M4
D7.2.	Launch of the populated VeriBlue working environment and regular content updates	WP7	Seven	DEC	PU	M4
D2.2.	Networking Action Plan	WP2	Seven	R	PU	M6, M18
D3.1	PaaS infrastructure architecture and setup	WP3	Terradue	DEC	PU	M6, M18, M30
D4.1	VeriBlue working environment; version 1 release	WP4	Seven	DEC	PU	M6
D4.2	Documentation and instructions of VeriBlue working environment	WP4	Seven	R	PU	M6
D5.1	Report on Selection & Integration of Community Datasets: Recommendations	WP5	CSIR	R	PU	M6
D5.3	Review & Recommendations for Ancillary Metadata	WP5	OGCE	R	PU	M6
D5.5	Periodic Report on Data Management & Standards	WP5	OGCE	R	PU	M6, M12, M18, M24, M30
D7.4.	Periodic project E-Newsletters	WP7	Seven	R	PU	M6, M12, M18, M24, M30, M36
D2.3.	Agendas for the interactive forum (Task 2.2)	WP2	Seven	R	PU	M8, M20, M32
D3.2	Deployments feedback and User support analysis	WP3	Terradue	DEC	PU	M8, M20, M32

Deliverable no	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
D4.3	Tool Containers; version 1 release	WP4	PML	DEC	PU	M9
D4.4	Data Catalogue and Script Library, version 1 release	WP4	Terradue	DEC	PU	M9
D7.6.	Agendas for the Workshops, Conferences, and Brokerage Events	WP7	Seven	R	PU	M10, M22, M32
D2.4.	Questionnaire for users' satisfaction	WP2	Seven	R	PU	M12, M24, M34
D2.7.	Report on the process and results of the users'consultation	WP2	Seven	R	PU	M12,
D2.8.	E-learning platform with training material (Task 2.5)	WP2	POGO	DEC	PU	M12, M24
D3.3	Architecture and integration guide of the Container-based service orchestration	WP3	Terradue	R	PU	M12, M24, M34
D3.4	Architecture and integration guide of the Common VeriBlue data infrastructure	WP3	Terradue	R	PU	M12, M24, M34
D4.5	Collaboration Tool Suite, version 1 release	WP4	PML	DEC	PU	M12
D6.7	Periodic Report on Training & Research	WP6	UT	R	PU	M12, M24, M36
D7.5.	Scientific paper, publications and presentations	WP7	PML	R	PU	M12, M24, M36
D7.7.	Policy briefs	WP7	Seven	R	PU	M12, M24, M36
D2.9.	Schedule of training seminars (Task 2.5)	WP2	POGO	R	PU	M18, M30
D4.6	VeriBlue working environment, version 2 release	WP4	Seven	DEC	PU	M18
D2.6.	VeriBlue Users' Policy	WP2	CSIR	R	PU	M20
D4.7	Tools Containers, Data Catalogue Search, Script Library and Collaboration Tools, version 2 release	WP4	PML	DEC	PU	M24

Deliverable no	Deliverable name	Work package number	Short name of lead participant	Type	Dissemination level	Delivery date
D5.2	Report on Selection & Integration of Community Datasets: Progress	WP5	OGCE	R	PU	M24
D6.1	JRA Outcomes Report: ChlorGIN	WP6	TIWAH	R	PU	M30
D6.2	JRA Outcomes Report: Mangrove Monitoring	WP6	TIWAH	R	PU	M30
D6.3	JRA Outcomes Report: Ocean Forecasting & Services	WP6	CSIR	R	PU	M30
D6.4	JRA Outcomes Report: Sea Level Forecasting	WP6	CSIR	R	PU	M30
D6.5	JRA Outcomes Report: Coastal Water Quality	WP6	UT	R	PU	M30
D6.6	JRA Outcomes Report: Ocean Climate & Carbon	WP6	UT	R	PU	M30
D5.4	Preliminary engineering report on plugfest outcome	WP5	OGCE	R	PU	M32
D2.5.	Consolidated Report on the VeriBlue usage: experiences and feedback	WP2	Seven	R	PU	M35
D4.8	VeriBlue working environment, Tools Containers, Data Catalogue Search, Script Library and Collaboration Tools, final release	WP4	PML	DEC	PU	M35
D4.9	Report on Usage and Uptake of VeriBlue	WP4	Seven	R	PU	M36
D7.8.	Layman’s report for policy and decision-makers	WP7	Seven	R	PU	M36
D7.9	VeriBlue Exploitation Plan	WP7	PML	R	PU	M36

3.2.3. Work Package 1: Management

Work package number	1	**Start date or starting event**	Month 1					
Work package title	Management							
Participant number	**1**	2	3	4	5	6	7	
Person/ months per participant	**18**	1	1	1	1	1	1	

Objectives (Lead: PML)

The coordination objectives are:

- To ensure the administrative, financial and legal management of the project, such that it comes to a successful conclusion
- To implement and maintain the internal project infrastructure, reporting, information exchange and email lists.
- To prepare, execute and post-process major project meetings.
- To assure sustainability through driving a tight linkage between the project development and groups representing the user community and long term governance

Description of work (broken down into tasks), lead partner and role of participants

Task 1.1 Financial and Management Reporting (Lead: PML, inputs from all partners)
This will be undertaken on an annual basis by the coordination group, as required by the REA and defined in the consortium agreement and the workplan. Scientific and technical reporting will be undertaken at 12, 24 and 36 months.

Task 1.2 Internal communication (Lead: PML)
A project intranet will be set up and maintained to allow partners to access and upload internal documents. Code repositories will be established on a suitable open platform (e.g. Github) with appropriate issue trackers, etc. Mailing lists will be created. At suitable intervals, dependent on the needs for coordination, regular teleconferences will be held to ensure progress and maintain a common direction.

Task 1.3 Administer meetings (Lead: PML, inputs from all partners)
This task involves the preparation, execution and post-processing of major project meetings. The

tasks include agendas, invitations, location of meeting places, organization of rooms and equipment, preparation and distribution of materials, minutes and action lists. A kick off meeting will be organised at the start of the project, and an annual progress meeting will be held throughout the life of the project. The purpose of these meeting is to a) monitor progress, b) facilitate scientific discussion, c) encourage communication between partners and d) assist the reporting process. Additional meetings of relevant partners may be held as needed.

Deliverables (brief description and month of delivery)

D1.1 Project Intranet (M3)

MS1 – Kick-off Meeting (M1)
MS2 – Intranet Online (M2)
MS3 – Annual Project Progress Meeting (M12)
MS4 – Annual Project Progress Meeting (M24)
MS5 – Final Project Meeting (M36)

3.2.4. Work Package 2: Community engagement

Work package number	2	**Start date or starting event**	Month 1					
Work package title	Community engagement							
Participant number	1	2	3	**4**	5	6	7	
Person/ months per participant	9	9	2	**20**	3	6	4	

Objectives (Lead: Seven)
The objective of this WP is to create, promote and maintain a close cooperation with the targeted users of VeriBlue to exploit its full potential. Networking activities seek to engage three main user groups: the scientific/ research community, the business community, the policy & decision-making community. Through the engagement of these communities we seek to boost scientific collaboration leading to innovation, to maximise benefits and attain sustainability, and to transfer information to the decision-making function and the policy development process.

Description of work (broken down into tasks), lead partner and role of participants

Task 2.1. Building and Consolidating the Users' Community (Lead: Tiwah, contributing partners: Seven, PML, Terradue, CSIR, UT)
This task will specifically identify potential users of VeriBlue infrastructure and collect their requirements and attempt to engage an ongoing interest. During this process we will liaise with other EC projects and research activities that wish to collaborate with VeriBlue (e.g. EURO-ARGO, GEOWOW, OceanSITES, ChloroGIN, SAFARI etc.) as well as the different agents and actors of the Blue Planet (POGO, GOOS, CEOS, GODAE OceanView and the Coastal Zone Community of Practice). CSIR brings a focus on two non-European communities: the African marine and aquatic research community through GMES-Africa (including ChloroGIN), the international HAB community through GEOHAB/GlobalHAB. Three main user groups will be targeted: the scientific/research, the technical / business, and the policy-influencing & decision-making communities. The level of interest of each group (i.e. simple access to resources, usage of specific tools, provision of data and/or partnering with the project consortium) will be identified, together with their requirements and visions of VeriBlue.

Task 2.2. Networking and liaising activities (Lead: Seven, contributing partners: PML,

Tiwah, UT, OCGE, CSIR, Terradue)
This task will oversee the planning and implementation of the different networking activities (in close collaboration with WP7). A Networking Action Plan (NAP) will be drafted early on, subject to review and updating as the project progresses. The networking activities will target the 3 above mentioned user groups (scientific, business, policy/decision-makers) in order to maximize the uptake of VeriBlue infrastructure, services and ideas by the researchers,businesses operating in similar sectors, promote collaboration, as well as support the transferring of information from observation systems to the decision-making function and thus ultimately to the policy development process. Clustering and coordination actions with national and international initiatives and related projects will be pursued in a targeted manner in order to support the deployment sustainable approaches. Close relations with the data providers will be maintained for supporting data deposition services in relation to task 5.2. Social media and RSS feeds will also be mobilized to maintain a live project spirit. Questionnaires on users' satisfaction (with defined quantification indicators) will be distributed to gather feedback on both the e-infrastructure and the networking activities, and re-design them as needed. A final report consolidating the users' experiences (from the different types of user groups) will be drafted.

Task 2.3. Defining a Common Users' Policy (Lead: CSIR, contributing partners: Tiwah, OGCE)

This task will work with the users' community to define a common data access strategy and users' policy. A Users' Policy Advisory Panel (UPAP) will be set up to steer the process, including (but not limited to) to members of the consortium. An analysis of the data-providers users' policies will be undertaken prior to reaching a common consensus. A relevant VeriBlue Users' Policy will be drafted, in collaboration with WP5, which deals with datasets, access and the data management plan, and WP7, which deals with exploitation and dissemination issues.

Task 2.4. Consultation and networking events (Lead: Seven, contributing partners: Tiwah, PML, CSIR)
This task will oversee the planning and implementation of users' consultation and networking events. It is suggested that 3 such events will be held during the project, with the purpose of improving on one hand the efficiency of the e-infrastructure's management and service provision through consultation, and act as catalysts to networking and collaboration on the other hand. The logistics (participants, agendas, speakers, etc.) will be dealt in time to secure attendance, while opportunities to tight them back-to-back to other main events will be explored. Reports on the process and results of the 3 users' consultation will be drafted. It is envisioned that the consultation events (scheduled around months 10, 22, 32) will provide a valuable feedback and strengthen the links of VeriBlue to the communities.

Task 2.5. Training activities (Lead: PML-POGO, contributing partners: Tiwah, Seven, CSIR)
Training activities targeting all users' groups are foreseen in the project, with the purpose of facilitating the use of VeriBlue but also of spreading good practices to new researchers. Additonally to the studentship programme in task 6.4, training courses, tutorials etc. will be hosted on an e-learning platform, where the opportunity to non-consortium members to formulate a relevant e-course will also be provided. This takes place in the later half of the project, as VeriBlue becomes increasingly more usable, whereas the longer-term POGO studentships in WP6 take place earlier on and contribute to the development of VeriBlue. POGO will establish links to IODE and ESA, which are both specialised in capacity building and e-learning, and both contributors to Blue Planet, and the e-courses will be offered to them.

Deliverables (brief description and month of delivery)

D2.1. Report on users'community and requirements (incl. Database of users) (Task 2.1) (M4)
D2.2. Networking Action Plan (Task 2.2) (M6, M18)
D2.3. Agendas for the interactive forum (Task 2.2) (M8, M20, M32)
D2.4. Questionnaire for users' satisfaction (Task 2.2) (M12, M24, M34)
D2.5. Consolidated Report on VeriBlue usage: statistics, experiences and feedback (Task 2.2) (M35)
D2.6. VeriBlue Users' Policy (Task 2.3) (M20)
D2.7. Report on the process and results of the users'consultation (Task 2.4) (M12, 24, 34)
D2.8. E-learning platform with training material (Task 2.5) (M12, M24)

3.2.5. Work Package 3: Technical infrastructure

Work package number	3	**Start date or starting event**	Month 2					
Work package title	Technical infrastructure							
Participant number	1	2	3	4	5	6	**7**	
Person/ months per participant	8	3	0	0	5	0	**30**	

Objectives (Lead: Terradue)

This work package creates, configures and provides the necessary technical underpinnings to implement the processing, search and display components of VeriBlue. It performs the setup of the Cloud-based PaaS technical infrastructure, allowing different delivery scenarios for user profiles ranging from VRE preparation teams, to end-users accessing ready-made containers images.

Description of work (broken down into tasks), lead partner and role of participants

Task 3.1: Container creation and hosting (lead: Terradue, contributing partners: PML)

- Review of recent developments to select a container runtime, as the field is developing fast, e.g. Docker (more established) or Rocket (stronger security focus, but very new at the time of writing)
- Configuration of suitable containers for holding processing components
- Security implementation and recommendations for hosts

Task 3.2: Cloud support (lead: Terradue, contributing partners: PML)

- Set-up of a hub manager service for the search and selection by users of containers to be deployed on-demand: s Linux Containers service registry
- Deployment onto local clouds (test and operational)
- Deployment onto public clouds (e.g. Amazon, Azure)
- User on-boarding and user support in the exploitation of deployed containers

Task 3.3: Orchestration (lead: OGCE, contributing partners: Terradue, PML)

- Review state of container orchestration, plus how this meshes with OGC standards for orchestration and remote processing

- How various containers are knit together into a processing chain, where this is necessary
- Study how microservices can have a central role as part of IT services operated through decentralized computing capacities, while pulling back huge amounts of data to different central locations to be processed, Linux Containers being a promising candidate implementation technology for that.
- Define a release strategy suitable for the deployment of VRE services to production on a DevOps-oriented code commits approach, investigating and coordinating between partners (mainly Terradue and PML as a start) the use of dedicated tools and approaches like git-flow.

Task 3.4: Common VRE infrastructure (lead: PML, contributing partners: OGC, Terradue, Tiwah)
An infrastructure will be provided to robustly host the core functions of VeriBlue, such as webservers, data hosting and data services (for core datasets not hosted elsewhere), orchestration engines (if needed by task 3.3) and communications support for collaboration. The core infrastructure will initially be normally hosted by PML, but will be developed to migrate into the cloud for long-term sustainability.

Deliverables (brief description and month of delivery)

D3.1 PaaS infrastructure architecture and setup (M12, M24, M36)

D3.2 Deployments feedback and User support analysis (M12, M24, M36)

D3.3 Architecture and integration guide of the Container-based service orchestration (M12, M24, M36)

D3.4 Architecture and integration guide of the Common VeriBlue data infrastructure (M12, M24, M36)

3.2.6. Work Package 4: VRE tooling and collaboration

Work package number	4	**Start date or starting event**	Month 2					
Work package title	VRE tooling							
Participant number	**1**	2	3	4	5	6	7	
Person/ months per participant	**30**	3	3	3	2	3	6	

Objectives (Lead: PML)
This work package will provide a set of tools that users of VeriBlue will be able to deploy to work with remote and local data, and a collaborative platform to launch these tools from. The tools will allow users to discover, manipulate, mine, explore, visualise and analyse data. Users will be able to utilise the tools in isolation working on their own with single, or multiple, datasets, however, one of the aims of this work package is to facilitate and encourage collaboration. There will be a close interaction with Work Package 3, Technical Infrastructure, to ensure that the tools can operate in the distributed cloud environment as intended and provide the desired outcome for the end users; and there will be fundamental interaction with Work Package 5, 'Data, information and interoperability'. Engaging with stakeholders and end users of VeriBlue, via the consultation meetings and workshop events as outputs of tasks 2.3 and 7.4, will ensure that the users' needs and expectations are satisfied; this will ultimately be a key driver of the success and uptake of VeriBlue. A regime of regular testing and quality assurance will guarantee that a robust set of tools are provided.

Description of work (broken down into tasks), lead partner and role of participants

Users will be able to deploy multiple containers, each with a different set of tools, to a single location and then join the containers to achieve the desired result. For example, the first container might contain a WCS client to extract data from the source, a second container might then be used to perform some mathematical transformations, and a third container could then be uses to combine the extracted, processed data with data from another source.

Task 4.1 – VRE work environment – (Lead: Seven, contributing partners: PML, PML-POGO)

This task develops the "landing point" of VeriBlue, the portal that is the initial point of contact that

all users have with the virtual research environment. This web-based environment will be the platform from which interactions with data, tools and other users is initiated. The environment will contain the collaboration features that allow users to communicate directly with one and other, and it will offer full and open access to the data catalogue search facility and script library. Visualisation and exploration functionality will be imported from prior open-source projects and further developed. This web platform will also act as an important general dissemination tool of the project, communicating important updates on the project activities, public deliverables, interesting news and posts on the relevant scientific and policy areas, calendar of upcoming events, brief articles, and so on (the development of the contents and the updating of all these items will be undertaken under Task 7.2).

Task 4.2 – Tool Containers – (Lead: PML, contributing partners: Terradue, OGCE)

Allowing users to deploy a set of tools to where the data are is a key component of the project. This task is concerned with creating a suite of containers that house a range of tools, and making them available in a library that users can search. Each container will contain very distinct set of tools keeping the footprint of the container as small as possible. Users will be able to deploy multiple containers, each with a different set of tools, to a single location and then join the containers to achieve the desired result. For example, the first container might contain a WCS client to extract data from the source, a second container might then be used to perform some mathematical transformations, and a third container could then be uses to combine the extracted, processed data with data from another source.

Task 4.3 – Collaboration functionality – (Lead: PML, contributing partners: Seven, Tiwah)

Encouraging collaboration between users is the core focus of this task. The purpose of this task is to offer virtual groupings where collaborators can meet and share ideas using real-time communication, either by chat room style text interactions (including in-line linking of datasets,scripts or outputs) or by using voice and/or video conferencing using WebRTC directly within the browser. These collaboration functions will also be enabled throughout VeriBlue, effectively adding communication and full session sharing to visualisation, coding or analysis stages, with an action history building a referencable timeline.
A minimal registration and authentication service, perhaps using known and trusted OAuth providers such as Google, GitHub or Facebook will be used to allow access to the communication tools. This task links with 4.4 and 5.2 to incorporate “social” features such as recommending datasets or scripts.

One feature of the collaboration tools suite will be an output of how data are being used; which datasets have been combined, what analytical tools have been applied to these data, and (with their consent) which users have been involved. This output will be used to notify other users of the system of events via the dissemination activities of work package 7.

Task 4.4 – Data Catalogue and Script Library – (Lead: Terradue, contributing partners: PML, CSIR, Tiwah)

Knowing what data is available and how to access it is pivotal, and the data catalogue service and the script library is central to servicing this need. The catalogue will offer access to the GEOSS Data-CORE allowing users to identify data of interest by filtering on keyword, spatial range, temporal range, data producer. The catalogue search will be powered by the data Discovery Access Broker (GEO DAB) produced in the GEOWOW project which offers includes the ability to

suggest related datasets based on metadata of any given dataset.

The script library will initially contain pre-built scripts that perform specific tasks; these scripts may be in a variety of programming languages, and they could be very generic scripts that can be adapted for a variety of purposes, or they could be a very specific script that works with a single dataset. Users will be encouraged to contribute their own scripts to the library so that they may be used by others. The script library will work in conjunction with the data catalogue search such that when a user is viewing data search results they will be presented with relevant scripts, and vice versa. CSIR's input regarding the catalogue and script library is with with particular regard to implementation in infrastructure/bandwidth-limited developing world countries.

Task 4.5 – Internal User Feedback – (Lead: UT, contributing partners: Tiwah, PML, CSIR, Seven)

The VRE must stay close to user needs. This is partly accomplished in tasks 2.4 and 7.3 via participation in meetings and by training, but these tasks rely on volunteer assistance with the requisite limitations on availability. This task takes advantage of the partners in the project that have strong links to the Blue Planet communities to ensure continual availability of internal feedback as VeriBlue is developed. CSIR also brings the developing world perspective,via GMES-Africa,, and will feed back on applications regarding high resolution small/near coastal water bodies and establishing user feedback mechanisms of relevance to these.

Deliverables (brief description and month of delivery)

D4.1 – VeriBlue working environment; version 1 release (M4)
An initial release of the portal which is the output of Task 4.1
D4.2 – Documentation and instructions of VRE working environment (M6)
Written documentation to accompany the initial release of the portal; this will be a living document that continues to be updated for the duration of the project.
D4.2 – Tool Containers; version 1 release (M9)
A first release of tool containers offering the most frequently used tools, i.e. OGC service endpoints, and the tools to deploy containers to the location where the data are.
D4.3 – Data Catalogue and Script Library, version 1 release (M9)
A first release of the search tools allowing users to discover data and scripts to use with the data
D4.5 Collaboration Tool Suite, version 1 release (M12)
A first release of the collaboration tool suite together with user documentation
D4.6 – VeriBlue working environment, version 2 release (M18)
An updated release of VeriBlue and the associated user documentation and instructions incorporating feedback from the events run in tasks 2.4 and 7.3
D4.7 Tools Containers, Data Catalogue Search, Script Library and Collaboration Tools, version 2 release (M24)
An updated release of these elements and associated documentation incorporating feedback from the events run in tasks 2.4 and 7.3
D4.8 VeriBlue working environment, Tools Containers, Data Catalogue Search, Script Library and Collaboration Tools, final release (M35)
A final release of all elements and associated documentation, again incorporating further feedback from the events run in tasks 2.4 and 7.3

3.2.7. Work Package 5: Data, information and interoperability

Work package number	5	**Start date or starting event**	Month 3					
Work package title	Data, information and collaboration							
Participant number	1	2	3	4	**5**	6	7	
Person/ months per participant	6	5	2	0	**13**	3	4	

Objectives (Lead: OGCE)

This work package deals with the many aspects of the cross-disciplinary data in the Blue Planet field of activity, including its availability, the ways it is supplied to users and processing systems, how ancillary metadata that can enhance usage and exploration are included (especially metadata generated by end users, such as reviews, comments and usage counts), and its transformation into information with attached provenance.

A key part of most of the aspects is the standardisation of data, of metadata and especially of interfaces to both. The Open Geospatial Consortium standards hold a clear lead in many of these areas, though implementation is often patchy leading to unreliable results. Some of the datasets supporting Blue Planet already exist in GEOSS and others not, but compliance with standards may be missing – this will be addressed for new and existing services by a testing regime. The experiences in supporting these services and the necessary types of metadata will be fed back via the OGC into the standardisation effort.

Description of work (broken down into tasks), lead partner and role of participants

Task 5.1 Selection and integration of community datasets (Lead: CSIR , contributing partners: PML, UT, Tiwah)
This task is composed of two parts; first, it is to identify an initial set of data that is core to the ocean observation and forecasting community that the users of VeriBlue would require access to. Part of the initial appraisal of the data is to identify how and where the data are hosted, and how access to these data can be made available and discoverable. An important outcome will be the greater availability and use of data sets, linked to the JRA activities in WP6, that are currently considerably underexploited e.g. global coastal bio-optical in situ data from ChloroGIN, and glider

data from the Southern Ocean.
Second, and ongoing, this task will offer a mechanism whereby any interested party that has data to contribute may do so. The VRE will have the ability for users to upload their own data in a variety of formats, or add remote data sources. Whilst the project will encourage the use of established open standards, such as OGC WxS, SOS or Opendap for live data access, uploading data which is accessible by other means will also be possible; for example, CSV files, Excel spreadsheets, Google Docs, etc. In these cases, provenance information will be automatically generated (with the option of manual modification) so that the chain of supply can be traced back.

Task 5.2 Ancillary metadata (Lead: OGCE, contributing partners: PML, Terradue)
This tasks deals with the various methods needed to bind ancillary metadata to the data. This includes standards-covered usage and discovery metadata, but also identifies areas that are gaps in existing standards, such as modal harmonization, semantic interoperability, etc. In addition, several approaches have recently been explored to attach comments and ratings to data (e.g. FP7 CHARM-e, GeoViQua). Other important factors to consider in these and other projects are the necessary metadata for proper provenance and how this should be attached, especially for automatic provenance and citation support. These will be reviewed and a method best fitting with OGC approaches taken forward.

Task 5.3 Increase interoperability through the use of standards (Lead: OGCE, contributing partners: all service-providing partners)
This task checks existing standards for usability within the Blue Planet and other related initiatives, and will organize, run and report on a plugfest to be run around M24 (bringing organizations together in a non-blame environment to test clients against services) to improve the adherence to standards and to connect the BP disciplines with standardisation organisations. It will also re-test existing interoperability arrangements.

Task 5.4 Feedback to standards (Lead: OGCE, contributing partners:)
Based on the outcomes and experiences in task 5.2 and 5.3, feed back recommendations to the various OGC Working Groups and/or present issues at the OGC Technical Committee meetings. Improved standards would be expected to result, through adding new protocols, new encodings, new domain models and profiles, based on the requirements of the project, which spans a large range of use cases. The task goes hand in hand with Task 7.2 and 7.3

Task 5.5 Maintenance of a Data Management Plan (DMP) (Lead: Tiwah, contributing partners: CSIR, PML, UT)
This short task creates a document describing the data and the management life cycle for all data sets that will be collected, processed or generated. This links to task 2.3 in WP2, where a community data policy will be agreed. The document will be regularly reviewed and updated as necessary..

Deliverables (brief description and month of delivery)

D5.1 Report on Selection & Integration of Community Datasets: Recommendations (M6) (T5.1) Identification of datasets, assessment of integration needs & recommendations

D5.2 Report on Selection & Integration of Community Datasets: Progress (M24) (Task 5.1) Assessment of integration implementation & further recommendations

D5.3 Review & Recommendations for Ancillary Metadata (M6) (Task 5.2)
Assessment and selection of ancillary metadata methods

D5.4 Preliminary engineering report on plugfest outcome (M32) (Task 5.3)
To be submitted to the OGC standards process

D5.5 Periodic Report on Data Management & Standards (M6,M12,M18,M24,M30) (Tasks 5.3, 5.4, 5.5)
Periodic reviews of data standards including feedback and data management. This is the **Data Management Plan** deliverable required by the Open Research data pilot.

3.2.8. Work Package 6: Growing capacity and usage

Work package number	6	**Start date or starting event**	Month 3					
Work package title	Growing capacity and usage							
Participant number	1	2	3	4	5	6	7	
Person/ months per participant	9	9	10	0	0	10.5	0	

Objectives

The main objective of this WP is to promote and field-test VeriBlue by using it to address specific components of the BP initiative, especially tasksthat would previously be difficult to do, and by spreading knowledge and experience through training initiatives. The former is accomplished through several JRAs that explore the science, one growing capacity through studentships, one addressing the integration of data (particularly in developing countries) and one addressing a more complex climate data integration and modelling scenario. The JRAs will interface with WP 3 and 4 to ensure the necessary capabilities are implemented and with WP2 and WP7 for feeding back results. The training tasks are accomplished through the well-practiced POGO route, with additional non-scientific content provided by other partners as needed to cover the multiple sectors (academia, technical businesses/SMEs, policy and decision-makers).

Description of work (broken down into tasks), lead partner and role of participants

Task 6.1: Sustained Ecosystems and Food Security (Lead CSIR, contributing: Tiwah, UT)
Addressing Blue Planet component C2 , this task will address the integration of in-situ, earth observation and modeled data through two foci on research enablement across a range of high impact applications related to ecosystem health and food security. These are:

1. ChloroGIN. Building on the existing ChloroGIN partnership the JRA will focus on the integration of existing large and under-exploited databases of in situ bio-optical data (primarily focusing on Northern European (UT) and African (CSIR) waters) with ocean colour data for validation, regional algorithm optimization and integrated data sets for fisheries related ecosystem time series analysis and Harmful Algal Bloom (HAB) detection capabilities. Strong synergy with GMES-Africa services.
2. Mangrove Monitoring: This JRA is derived from the Blue Planet Task Component 2 Priority Activity “Advance the development of global monitoring services for mangroves,

coral reefs, and estuaries: Assess user needs and observational requirements; support related observing networks (e.g. Global Coral Reef Monitoring Network); implement demonstrators for monitoring services; and assess status and trends based on these demonstrators." This JRA includes a significant capacity building component and the challenge of integrating resource-poor groups from developing countries into the researcher team. It will explore strong synergy with GMES-Africa services.

Task 6.2 Ocean Forecasting and Services (Lead CSIR, contributing: PML)
Using the new VRE capabilities in regard to Blue Planet Component C3 and C4 to combine earth observation and models in innovative ways, the task will focus on coastal and ecosystem research applications, specifically the combined use of sub-mesoscale hydrodynamic models and physical earth observation data in African shelf seas in collaboration with GMES-Africa; and interaction with the CSIR Southern Ocean Carbon and Climate Observatory to showcase VRE utility of biogeochemical data from both modes and satellites at a variety of scales

Task 6.3 Coastal Zone Services (Lead: Tiwah, contributing: UT)
This task will focus on policy-relevant coastal services that integrate in situ and remote sensing data across the land-ocean boundary to provide that have relevance to land use planning in the coastal zone. A particular focus of the two JRAs is on the linkage between the research teams and the societal stakeholders, including the co-design of the research agenda and the co-creation and co-usage of the practice-relevant knowledge created. The JRAs are:
1. Interannual to decadal local sea level forecasting: This JRA is derived from the Component 4 Priority Activity "Assess the observational requirements for decadal forecasts of coastal local sea-level variation and develop a demonstrator forecasting service." Using VeriBlue, the JRA will assess the current predictive capabilities for local sea level forecasting. Integrating a a modular sea level system model into VeriBlue, the JRA will research the match of the capabilities with user requirements. This JRA requires the integration of data from tide gauges, satellite altimetry over ocean and ice sheets, gravity missions, SAR, GNSS, with modular geophysical models to predict local sea level on interannual to decadal time scales.
2. Coastal water quality: This JRA is derived from the Component 2 Priority Activity: "Assess user needs and observational requirements for coastal water quality (using the GEOSS User Requirements Registry); identify indicators and best practices for coastal water quality, and implement a monitoring service pilot for coastal water quality (with WA-01 and HE-01); disseminate information particularly to under-served communities (with IN-04)." In the frame of the proposed project, VeriBlue will be used to address the integration of relevant data across the land-ocean boundary.

Task 6.4 Ocean Climate and Carbon (Lead UT, contributing: CSIR)
Linked to Blue Planet component C5, the task will focus on VeriBlue application to long term analysis of carbon export and cycling in the coastal and Southern oceans. The VRE will be used to determine the role of coastal waters (with specific focus on land-ocean interaction in Northern European waters) in the global carbon cycle through improving remote sensing products for optically complex waters, combining the in situ data from different resources and models predicting fluxes of different substances from land to coastal waters. VeriBlue will also be used to provide e-infrastructure to Southern Ocean Observing System through the CSIR Southern Ocean Carbon and Climate Observatory, focusing on integrated provision and analysis of data from multi-sensor gliders, autonomous surface vessels, and earth observation data with a strong focus on phytoplankton dynamics and carbon export. The inclusion of data and analysis capabilities for data from mobile multi-sensor autonomous platforms brings a high degree of innovation and impact to this task.

Task 6.5. JRA: Show cases for research, training and the public (Lead: PML, contributing partners: Tiwah,UT,CSIR)

POGO will manage a studentship programme that will allow graduate students (MSc or PhD level) to spend up to 6 months at a different institute to work on a specific aspect of their thesis. A number of target areas will be proposed that are of particular relevance to the Blue Planet objectives, and that would contribute to the development of novel solutions for accessing, sharing or utilising data. Priority areas will be defined during the 2015 Blue Planet Symposium for each of the Components. The POGO and Blue Planet networks will be used to draw up a list of possible host institutions, although the calls will be open to candidates from any institution, who will be free to select any host institution with the prior agreement of the prospective supervisor. This programme will be loosely based on the POGO-SCOR fellowships (http://www.ocean-partners.org/training-and-education/pogo-scor-fellowships) which will be tailored to suit this purpose.

Deliverables (brief description and month of delivery)

D6.1 JRA Outcomes Report: ChloroGIN (M30), (Task 6.1/1)
D6.2 JRA Outcomes Report: Mangrove Monitoring (M30), (Task 6.1/2)
D6.3 JRA Outcomes Report: Ocean Forecasting and Services (M30), (Task 6.2/1)
D6.4 JRA Outcomes Report: Sea Level Forecasting (M30), (Task 6.3/1)
D6.5 JRA Outcomes Report: Coastal Water Quality (M30), (Task 6.3/2)
D6.6 JRA Outcomes Report: Ocean Climate & Carbon (M30), (Task 6.4)
D6.7 Periodic Report on Research & Training JRA (M12, 24,36), (Task 6.5)

3.2.9. Work Package 7: Exploitation/dissemination and sustainability

Work package number	7	**Start date or starting event**	Month 1					
Work package title	Exploitation/dissemination and sustainability							
Participant number	1	2	3	**4**	5	6	7	
Person/ months per participant	12	4	3	**16**	3	2	2	

Objectives (Lead: Seven)

The objective of this WP is to disseminate the project results, products and knowledge to a broad audience, targeting the scientific, business and policy communities, as well as the general public. The goal is to maximize the uptake and use of VeriBlue and it's concepts, and the impact in the European Research Area (ERA) and beyond. Furthermore, this WP addresses the potential for future exploitation, investigating sustainability options and promoting the development of partnerships with the business and industry sectors. The specific objectives include:
- Design and implement the dissemination strategy in a targeted, coherent and effective manner to maximize its impact;
- Produce quality assured dissemination products and ensure their effective and timely distribution to targeted audiences, stakeholders and the public;
- Exploit full potentiality of the web media (e.g. YouTube webinars, web social media, etc.)
- Develop and use innovative dissemination tools which facilitate not only the diffusion of the results but further support interaction and exchanges among stakeholders
- Develop an Exploitation Plan (including IPR management) addressing the commercialization of the project results with the objective of creating products and services to enhance socioeconomic benefits. For example, feeding the relevant Docker containers back to the Docker Hub, where numerous commercial entities may reuse them.

WP7 will closely interact with all the other WPs for an operational and up-to-date dissemination of the project results and knowledge, contribution to socio-economic impacts, and promotion of innovation. It will seek synergetic activities with other projects in the same field and national/international initiatives (clustering and coordinated actions). All dissemination products will acknowledge the funding received by EU Commission and will follow the publicity rules set by DG Research. Dissemination and Exploitation will be based on a dedicated strategy, and will ensure the effective and timely distribution of all project products and results.

Description of work (broken down into tasks), lead partner and role of participants

Task 7.1. Dissemination strategy and monitoring (Lead: Seven, contributing partners: all partners)
This task involves the drafting and implementation of VeriBlue Dissemination Strategy Plan, subject to review and update during the project, to further strengthen the cooperation among all WPs and to ensure the coherent streamlining of their findings and results into targeted and high-quality dissemination products. This task will also manage the design and content of the relevant products to fit their purpose (following a corporate identity design), will monitor the impact of the various dissemination activities (using selected indicators) and in a timely manner redesign (if deemed necessary) elements of the implemented approach, as and if deemed necessary.

Task 7.2. Dissemination products addressed to all Communities (Lead: Seven, contributing partners: all partners)
In this task a wide range of dissemination products will be developed, aiming to promote the project activities and its foreground to all communities; and to engage with, interact with and raise awareness in the wider general public. The following activities will be implemented:

- Establishing and updating content of VeriBlue work environment (i.e. the main project web platform which constitutes the “landing point” of VeriBlue developed in Task 4.1). This website will be maintained for 5 more years after the project ends, and, besides offering the entry point to the various VeriBlue functions and tools, will be used to disseminate updates on the project activities, public deliverables, interesting news and posts on the relevant scientific and policy areas, calendar of upcoming events, brief articles, and so on.
- Producing periodic E-Newsletters (every 6 months), updating on the project progress and disseminating interesting news, research advancements, interviews, etc. A paper.li application will be set-up for the creation of an automatic newspaper and/or for feeding into the newsletters.
- Contributing as appropriate to social media (e.g. Twitter, LinkedIn), pursuing a Wikipedia entry on the Blue Planet and related issues. Setting up RSS feeds enabling the users to keep up-to-date with the new developments of VeriBlue (new datasets added, new collaboration in the virtual tables, status updates for live datasets, etc.)
- Development of general promotional and informational material (leaflets, brochures, factsheets, posters). The main project presentation and brochures will be translated into several languages to reach a wider audience within the local communities.
- Scientific publications, papers in conferences and peer-reviewed journals
- OGC's relevant Domain Working Groups (DWGs) will also be used to help interact with the communities of practice
- Where appropriate, data, services and technologies will be offered to the GEO’s Architecture Implementation Pilots (AIP) as a basis for stimulating use/reuse and piloting the interoperability aspects.

Task 7.3. Participatory Workshops, Conferences, and Brokerage Events (Lead: Seven, contributing partners: Tiwah, PML, UT, OGCE,CSIR)
This task is closely related with Task 2.4 (consultation and networking events) and 7.4 (exploitation). On top of the 3 consultation events of Task 2.4, 3 workshops and 3 brokerage events will also be planned, with the purpose of boosting interaction and exchanges on specific issues of the Blue Planet components and exploring the exploitation potential respectively.
The 3 workshops will be planned around the Blue Planet components C1-C6: Sustained Ocean Observations, Sustained Ecosystems and Food Security, Ocean Forecasting and Services, Services

for the Coastal Zone, Ocean Climate and Carbon, Developing Capacity and Social Awareness, in close collaboration with the relevant BP leads and projects.
The 2 Brokerage events will target to support the sustainability of the project and its after-life, and they will reach out to the business and industry sectors, the policy and decision-makers in need of such types of infrastructure, and potential funders. The Brokerage events will be well publicized on different portals (e.g. Enterprise Europe Network). Interaction with the relevant OGC TC meetings, reporting on our finding and progress, will likely be included in these..
The Final Blue Planet VRE Conference will be organized with the purpose of bringing together parties from all communities, facilitating the sharing of ideas, presenting the project results and opening the discussion on future needs, science-policy interfacing, project exploitation and business creation.
If possible, all events will be attached to some main events to maximise their impact.

Task 7.4. Linking the Ocean Observation system to the Decision-Making function (Lead: Seven, contributing partners: PML-POGO, Tiwah, CSIR)
This task includes specific science-policy interfacing activities aiming at facilitating the "transfer of information from the observing systems into the decision-making function" as clearly identified among the Blue Planet long-term goals. This can in turn underpin the alleviation of societal issues and challenges by exploiting the societal benefits of ocean observation. As a first step a mapping of e-infrastructures, users (in collaboration with Task 2.1), investments, and so on, in the specific field for supporting local decision-making and policy developments will be undertaken. A Policy and Stakeholder Panel (PSP) will be formed to support this process. Policy Briefs as well as a Layman Report for policy and decision-makers will be drafted. The Layman's Report will be short (50 pp.), precise and addressed to a wide non-technical audience, summarizing findings of the project, and will be launched in cooperation with key stakeholders at a public event.

Task 7.5. Future Exploitation and Sustainability (Lead: PML-POGO, contributing partners: PML-POGO, Tiwah, CSIR)
This task seeks to promote long term sustainability, including:

- Clustering and coordinated actions with the Blue Planet initiatives, maintaining strong links so that VeriBlue stays relevant
- Reinforcing VeriBlue partnership with the industry through targeted outreach and dissemination activities to boost the use of this e-infrastructures by industrial researchers, such as environmental consultancies, and by potentially involving industrial associations in the Business Advisory Panel (BAP).
- Preparation of an Exploitation Plan (ExP) beyond the end of the project. The ExP will address governance issues and include a market analysis identifying:
    - Target end-users, societal, governmental, business & industry needs, market potential, competitors, and so on.
    - Features of the target market: size, growth rate, share that the technology/product could reach, driving factors likely to change the market, other factors.
    - Customer analysis: identification of the potential customers and factors that affect their purchasing decisions.
    - Product analysis: product characteristics and functionalities, main benefits and innovative aspects in comparison with technologies and products already available, product differentiation and attractiveness, transferability, potential for further development and expansion, compatibility with other market products.
    - Exploitation strategy: market model, IPR strategy, confidentiality, standardization, financial planning, funding opportunities for specific exploitation activities.

- Exploring Service Level Agreements and innovative licensing schemes, fostering the adoption of e-infrastructures and the use of other types of research infrastructures by industries.
- Positioning: how the beneficiary entitled to the technology exploitation is positioned (or should be positioned) in the market, and in relation to competing businesses, applications, and technologies.

By the end of the project, VeriBlue will be an integral part of the Blue Planet structure. A Technical Committee will be formed that will report to the Blue Planet Steering Committee. It will be responsible for ensuring that VeriBlue is maintained, used, and promoted to the relevant user communities (including within GEO). It will be embedded in or linked to from the Blue Planet website. POGO and its partners will ensure that relevant training continues to be provided, particularly in developing countries. Through its mandate, POGO is committed to a strong programme of capacity building and technology transfer for ocean observations.
POGO was the prime mover in the establishment of Blue Planet, and continues to take the lead in developing and maintaining its programme. Because its central theme (societal benefit of ocean observations) lies so close to the mandate of POGO, it can be expected that POGO will remain a champion of this GEO Task into the foreseeable future. These sustainability plans will be detailed in the Exploitation Plan deliverable.

Deliverables (brief description and month of delivery)

D7.1. Dissemination Strategy Plan (DSP) (Task 2.1) (M3)
D7.2. Launch of the populated VeriBlue working environment and regular content updates (Task 7.2) (M4)
D7.3. Multilingual project presentation and brochure (Task 7.2) (M3)
D7.4. Periodic project E-Newsletters (Task 7.2) (M6, M12, M18, M24, M30, M36)
D7.5. Scientific papers, publications and presentations (Task 7.2) (M12, M24, M36)
D7.6. Agendas for the Workshops, Conferences, and Brokerage Events (Task 7.3) (M10, M22, M32)
D7.7: Policy briefs (Task 7.4) (M18, M32)
D7.8. Layman’s report for policy and decision-makers (Task 7.4) (M36)
D7.9. VeriBlue Exploitation Plan (Task 7.5) (M36)

3.3. Management structure and procedures

The consortium of VeriBlue consists of 7 partners and is ambitious in its objectives. Good cooperation between the partners is essential to achieve the required project outcomes, and the number of partners allows for a closer interaction than would be possible in larger projects. Therefore a management structure is set-up that allows for smooth integration, management and delegation of the activities of the individual partners and stakeholders within the consortium.

Overview of project management structure

The project management structure consists of the following main components:

- The Project management team
- The Project board
- The Work package teams

The project management team (MT) is led by the project coordinator. The lead partner, PML, has successfully coordinated several research projects within the European Framework Programmes, including OpEc, EAMNet, and VECTORS, as well as leading the ESA Ocean Colour CCI programme. Dr. Mike Grant (PML) is the project coordinator. He will manage the project management team of technical and administrative staff from PML, all with extensive experience in coordination of European Framework Research projects. PML is responsible for all contractual issues, the overall administrative and scientific coherence of the project, the project's progress, planning and quality control and the supervision of all financial aspects and is the official contact between the participants and the European Commission. The project management team will liaise with the project board to supervise the project progress, coordinate progress reporting and schedule the project meetings. Most consortium partners have extensive experience with international large scale projects, including EU FP6, FP7 and H2020.

Coordination

The success of the project will depend on careful planning, allocation and administration of the resources, assessment of the risks and anticipation of the difficulties that may arise, constant monitoring of progress and respect of deadlines, quality control, reporting, and communication. Overall management of the project is under the responsibility of the project coordinator, but significant management tasks are performed by the work package leaders.

All contractual, administrative and financial matters are the responsibility of the coordinator. The administrative and financial responsibility will cope with detailed budget management, transferring the financial payments to the partners, and all contractual matters with the Participants. It will follow on the implementation of the consortium agreement, and solve all questions that might arise in the course of the project.

Decision making:

At every level, consensus in decision-making will be sought. If a major dispute arises between partners the project board will resolve the matter by simple majority. When no decision is reached the Chairperson will have the casting vote.

Communication:

To facilitate communication within the project will make use of face-to-face management meetings, scientific project meetings and targeted workshops, along with video conferencing, email, telephone and web-based tools.

Project Meetings:

There will be a kick off meeting (Month 1), attended by each partner and most of the participating scientists, to launch the project and to facilitate contact among partners and the Commission, as well as to establish good working relationships beyond those that already exist.. Project meetings will be scheduled immediately prior to the reporting period. These major project meetings will occur in months 12, 24, 36 and will be hosted by one of the project partners. Generic agenda items will always include:

- Review of the progress in the workpackages and tasks;
- Discussion and analyses of the results obtained in each WP / task
- Exchange of (technical) expertise and data between partners;
- Review of the milestones and deliverables for the next phase of the project;
- Adjusting the work plan for the subsequent phases of the project.

Internal communication:

The communication strategy adopted in the project aims at keeping all the partners fully informed about the status of the different activities underway. The target is to reach maximum transparency for all parties involved and hence increase synergy. All reports produced (such as meeting and project reports, visit reports, publications, etc.) will be available to all. When relevant information is obtained from sources outside the project (about other projects, and international programmes, from the Commission, or from various agencies), partners are expected to inform the others. The dissemination mechanism will be a combination of email and the project website.

Methods for monitoring and reporting progress

The essence of project monitoring is the identification of deviations from the schedule, budget or work plan. Each annual meeting will review the current status, the budget, and produce a detailed Gantt chart and plan for the activities in the coming year, plus identify any risks and their likely mitigations. Issues coming up within the year will be communicated electronically and appropriate actions or adjustments made. In extraordinary cases, there may be the need for additional or bilateral meetings.

Milestones

The milestones are arranged around the annual project meetings, which correspond to kick-off, basic level of service, extended capability and operational service in terms of the level of functionality required from the technical elements. The studentships and JRAs will be aligned to report at these milestones, though activities may overlap them depending on the exact requirements of each.

Table of milestones

Milestone number	Milestone name	Related work package(s)	Estimated date	Means of verification
MS1	Project Kick-off Meeting	All WP's	M1	Meeting notes and actions list produced

MS2	Project Intranet online	WP1	M2	Intranet access available to all partners
MS3	Project website running	WP1, WP2, WP7	M3	Website online and accessible
MS4	First stakeholder event/workshop	WP2, WP7	M6	Feedback/input gathered from participants
MS5	Project Progress Meeting	All WP's	M12	Meeting notes and actions list produced
MS6	Second stakeholder event/workshop	WP2, WP7	M18	Feedback/input gathered from participants
MS7	Project Progress Meeting	All WP's	M24	Meeting notes and actions list produced
MS8	Third stakeholder event/workshop	WP2, WP7	M30	Feedback/input gathered from participants
MS9	Project Progress Meeting	All WP's	M36	Meeting notes and actions list produced

3.3.1. Risks

In the event of a problem arising, the risk table below provides pre-planned mitigations. Handling the problem shall first be undertake by the appropriate task or WP lead, who will inform the project management team so they can monitor the progress of the mitigation method. If the problem proves more complex, it will be elevated to the project management or the project board for a decision, depending on the nature of the issue.

Description of risk	Work package(s) involved	Proposed risk-mitigation measures
Delays in the exchange/delivery of data	WP 2, 5, 6, 7	A great diversity of datasets exists, so it is likely to be possible to use a different data set or data source. The deliverable from task 5.1 will list necessary datasets and also review “backup” ones for this eventuality.
Failure to engage researchers in VeriBlue		A wide variety of networking and capacity building activities is foreseen, which will start early-on allowing for sufficient time for liaising and mobilising researchers. Furthermore, the partners are already members of research networks, well established in the ERA, which facilitates attracting researchers and users.
Underperformance of a partner	all	A solid project management is foreseen, with a close monitor of all partners’ activities, allowing the detection of any delays early on. Furthermore, the partners are carefully selected, they have successfully participated in EU research projects in the past

		delivering all assigned work. The tasks are also well distributed to allow for a balanced work load.
Limited dissemination	WP7	A dedicated WP is planned for dissemination / exploitation in order to maximize the project impact and the update of VeriBlue. A Dissemination Strategy Plan (DSP) will be developed early on in order to coordinate and monitor the dissemination activities, and re-design them if needed. A wide range of dissemination products are foreseen in order to address all user communities. Furthermore, the early involvement of the users through consultation events, interactive workshops, etc, as well as the creation of specific Advisory Panels (Policy, Business, etc.) will build awareness and strengthen ownership of the products. Finally, partners of the consortium have long-lasting relationships with networks of end-users which will facilitate the dissemination process.
Continuation of VeriBlue after end of project not guaranteed	WP7	A dedicated Exploitation Plan (ExP) is foreseen to be developed in order to identify means for the after-life of the project. The ExP will explore all potential means, governance issues, will include a market analysis (Task 7.5). Strong networking with other sectors is also planned in order to maximize the use of this e-infrastructures by other researchers, and involve industrial associations to secure sustainability. Sustainability of VeriBlue is also guaranteed by the fact that this infrastructure is directly related to the objectives of the Blue Planet Initiative. The foreseen clustering and coordinated actions with the Blue Planet actors can act as a catalyst in VeriBlue staying alive and relevant.
Availability of VRE Tools after the end of the project	WP4	Low – The majority of tools available will be hosted with established, long term, open-source providers, e.g. GitHub, BitBucket, Docker Hub
Availability of the project website and data/tools search facility after the end of the project	WP4, WP7	Low – PML currently host the Blue Planet website so these project deliverables could easily be incorporated into the current hosting environment
Loss of key staff or delays in recruitment	All WP's	Medium – This may lead to delays to the delivery of individual components. It's difficult to mitigate against many aspects of this, but on many occasions the issues can be anticipated. A process exists for adjusting plans as needed in the face of serious problems.
Stakeholders and/or users have inaccurate expectations	WP3, WP4, WP5	Medium – Early engagement with stakeholders and the user community through tasks in WP2 should ensure expectations are managed and met

Failure of the new technology to deliver on its promises	WP3,4	While the approaches used here are novel to the scientific area, they are reaching the tipping point for widespread acceptance in industry already. The containerisation movement is a rapidly growing and successful field in industry. The standard OGC interfaces are also well deployed and tested in many other areas, and present a low risk. In the event of a true failure, there are some options to fall back to earlier approaches.

3.4. Consortium as a whole

The proposed consortium consists of 7 partners that provide an excellent combination of the necessary competences and geographic balance for achieving the project's objectives. We have assembled an interdisciplinary team of researchers, engineers, consultants, entrepreneurs and SMEs working in the fields of earth observation, ocean and marine science, data management and hosting, distributed systems and cloud services, geospatial services. Within this group, there exists a unique combination of cross-cutting skills suited to the concept of a VRE project targeting the Blue Planet initiative and capable of addressing the challenge of the Call Topic EINFRA-9-2015. Most of these organisations have previously worked together in technical, scientific or networking projects, although not previously in this combination, and have well-established relationships and a proven capability to deal with difficulties and tight timelines in a spirit of cooperation to achieve the end goals.
Inclusion of the South African CSIR in the proposal has several significant advantages; it is one of the leading organisations in operational oceanography in Africa and, as part of an extensive African research network, CSIR has the ability to lead training, uptake and feedback from African scientists on emerging VREs. This will provide ability to test VREs in infrastructure-poor developing world scenarios, with the support of an experienced world-class organisation, a situation well suited to uptake of the remote processing and analysis that is the defining feature of these environments. The CSIR role as RIC in the GMES-Africa Marine Services provides considerable synergy with operational marine capabilities. In addition, the CSIR will provide innovative data and application activities from globally important ecosystems: glider, other autonomous and modelled data from the Southern Ocean; in situ and satellite data from the Benguela, Agulhas and other African shelf sea systems.

The expertise of the individual partners is representative for the different components of the proposed project and are summarized below:

- Development of web-based tools and applications
- Development and of provision of engineering distributed systems and Cloud services
- Provision of Earth Observation data and distributed computing platforms for data and applications hosting
- Development and promotion of advanced open systems standards and techniques
- Integration of spatial data and geoprocessing resources into mainstream computing, development and integration of geospatial data and services for operational settings using Grid and cloud technologies.
- Standardisation processes, widescale technical consultation and coordination
- Strategic and applied research in the marine environment
- Strategic and applied research water resources management
- Training, capacity-building, including in developing countries

- Large-scale international coordination
- Science policy interfacing, support in the development and implementation of EU Directives
- Stakeholders' consultation
- Design and implementation of robust dissemination strategies and tools
- Development of exploitation and business plans
- Partnering research to businesses, brokerage events

This combined knowledge, truly interdisciplinary and transdisciplinary in nature, experience and international profile of the participants across disciplines, sectors, and geographical scales ensure that the project has a high chance of success. Furthermore, the partners have extensive experience with European Commission and international projects and have established collaboration and networks in the ERA and beyond. The table below lists selected projects and networks the partners are (or have been) involved, their particular expertise, and their tasks to be addressed across the work packages.

Partner	**Projects & Networks involved**	**Expertise relevant to the project**	**Main contributions to the project**
Plymouth Marine Laboratory (web visualisation team)	OpEc, eartH2Observe, EarthServer, AQUA-USERS, ESA's Ocean Colour CCI	Project management expertise gained from previous EU projects, a very experienced web visualisation team with extensive knowledge of OGC services and the implementation of these services	Project Management, leading WP1 (Management) and WP4 (VRE Tooling and Collaboration)
POGO (hosted by Plymouth Marine Laboratory)	POGO, Blue Planet, GEO, numerous other entities	Leader of a 19 country grouping of interested organisations, founder of the Blue Planet initiative	Coordination and engagement the Blue Planet initiative and its communities (WP1, WP2, WP7), training and studentships (WP2, WP6)
Tiwah UG (haftungsbeschraenkt)			Joint Research Activities partner leading a JRA's focusing on ChlorGIN and mangrove monitoring
University of Tartu	Euroopa Kalandusfond		Joint Research Activities partner leading a JRA focusing on Ocean Climate & Carbon
SEVEN Engineering Consultants	ReasponSEAble, eartH2Observe, Service Contract to support the development and implementation of EU freshwater policies [DG ENV], SPADIS,	Design and implementation of dissemination strategies, products and tools, science-policy interfacing, policy briefs, participatory work with stakeholders, consultation, organi-	Lead WP2 (community engagement) and WP7 (exploitations/dissemination)

	ABOT, CIS Working Groups	sation of events/workshops, outreach, e-learning, water resources management, impact assessment.	
OGC Europe	GIGAS. SANY, RISE, GINIE	Integral in promoting the development and use of advanced open systems standards and techniques to enable the full integration of geospatial data and geoprocessing resources into mainstream computing and widespread use of interoperable, commercial geoprocessing software throughout the global information infrastructure.	Leading WP5 (Data, Information & Interoperability)
CSIR			Leading WP6 (Growing Capacity & Usage)
Terradue Srl	GEOWOW, G-POD, ngEO, SENSYF, E-CEO, GENESI-DEC	Vast expertise in cloud based computing and containerisation of applications	Leading WP3 (Technical Infrastructure)

3.5. Resources to be committed

Summary of staff effort

	WP1	**WP2**	**WP3**	**WP4**	**WP5**	**WP6**	**WP7**	**Total person months**
1. PML (includes POGO)	**18**	9	8	**30**	6	9	12	92
2. Tiwah	1	9	3	3	5	9	4	34
3. UT	1	2	0	3	2	10	3	21
4. Seven	1	**20**	0	3	0	0	**16**	40
5. OGCE	1	3	5	2	**13**	0	3	27
6. CSIR	1	6	0	3	3	**10.5**	2	25.5
7. Terradue	1	4	**30**	6	4	0	2	47
	24	53	46	50	33	38.5	42	286.5

Work-package leader for each WP is identified by a bolded person-month figure.

3.5.1. Other direct costs

These tables shows ‘other direct costs’ for participants where those costs exceed 15% of the personnel costs or where an unusual budget item exists.

1. PML	Cost (€)	Justification
Travel	109,140	Travel for project participants to meetings and travel for students to attend training workshops and for studentships
Equipment	19,999	PML computing costs and equipment for training courses/studentships
Other goods and services	32,999	Workshop running costs (printing, videoconferencing, refreshments)
Total	162,139	

“PML” is effectively two partners, with POGO included within the finances. The training (WP2 & WP7) represents the bulk of the “other direct costs” in addition to personnel costs. The training is divided into two categories: short training workshops and longer-term (6 months) studentships for Masters or PhD-level students to undertake research visits to other laboratories to work on specific contributions to VeriBlue. For the workshops, the funds will be used to pay for trainees’ travel to the training course, as well as meals and coffee breaks, and additional workshop running costs (printing, software, hardware, etc). For the studentships, the funds will cover travel costs and a monthly stipend for the student to cover living and accommodation expenses. The equipment line includes some funding for the studentships and also a pro-rata computing cost to cover the use of PML infrastructure (internal rental-style model)

2. SEVEN	Cost (€)	Justification
Travel	15000	Travel costs to the project meeting, workshops, conferences, events (1,000 € per person per travel)
Equipment		
Other goods and services	25000	Printing services and material, consumables (1,000) Organisational costs for 3 workshops, 3 consultation events, 2 brokerage events (venue, catering, etc.) (3,000 € per venue, total 24,000 8)
Total	40000	

3. UT	Cost (€)	Justification
Travel	26600	4 annual 2-day meetings for 2 people + attendance at a conference once per year (Estonia's location leads to higher travel costs)
Equipment	20000	Server to host data and services for use in WP6
Other goods and services		

Total	49600	

5. OGCE	**Cost (€)**	**Justification**
Travel	62500	The project uses and develops standards that are used on a world wide scale. Interaction and engagement with the standards communities of practice are organised on a frequent basis on all continents. Attending the standards developing organisations (such as OGC and ISO) technical committee meetings is an essential part of influencing the standards making process (the project's work is input to the standards process) and gain visibility and adoption of the outputs. Also, OGC plays a central role in the establishment of the core architecture - this is not only a technical endeavour, but also requires teams to agree on a common interoperability arrangement, where personal interaction plays an important role. We have learned this from previous projects, where OGC, as a neutral partner, can bring parties together.
Equipment		
Other goods and services		
Total	62500	

7. Terradue	**Cost (€)**	**Justification**
Travel	4320	Kick off plus annual meetings travel expenses plus daily allowance
Equipment		
Other goods and services	20000	Commercial Cloud bursting relying exclusively on European based providers, supporting the pay-as-you-go cost model, and including a fine grain Infrastructure-as-a-Service in the portfolio
Total	24320	

Terradue justificiation: Commercial Cloud bursting: Terradue has a private Cloud infrastructure supporting commercial Cloud APIs, bursting to cope with the complete data management cycle. The result of this approach is a Cloud infrastructure composed of a set of Virtual Processing and Archiving centres. The underlying hardware includes a number of 12-core with 64 GB RAM, each supported by two 2TB local SATA 6 Gb/s Enterprise HDDs storage in RAID-1 configuration and private storage accessible by S3 protocol. The infrastructure is connected to the Internet with 960Gb connectivity. The commercial Cloud bursting relies exclusively on European based providers, supporting the pay-as-you-go cost model, and including a fine grain Infrastructure-as-a-Service in the portfolio. A comprehensive number of CPU-hours and storage space to support Blue Planet VRE activities has been included in the overall resources commitment. A total of €20,000 is allocated to rent CPU-hours and storage space within WP3.

3.6. Letters of support

(see optional annex upload for full PDF copy)

GROUP ON EARTH OBSERVATIONS

Our Ref: 2015-09/GEO/BluePlanet
ct

Dr Mike Grant
Plymouth Marine Laboratory
Prospect Place
Plymouth PL1 3DH
United Kingdom

Geneva, 14 January 2015

Dear Dr Grant,

I write in support of the Blue Planet Virtual Research Environment (Blue Planet VRE) proposal which will fill a vital role in accelerating and coordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels.

The Blue Planet initiative was created within the Group on Earth Observations (GEO) to bring together all the marine initiatives within GEO, and to bring new activities into the GEO portfolio. Since its Kick-Off Meeting in 2012, Blue Planet has gained much momentum and support from the ocean observing community, and it is now considered one of the "global initiatives" within GEO. Although Blue Planet has been very successful in bringing a community together, there is still work to be done to facilitate interactions, collaboration and data sharing within this community. The Blue Planet VRE proposal is extremely timely in that it would respond directly, and in an innovative fashion, to this need.

I am particularly pleased to note that this proposal brings together several active participants within GEO and key players in the Blue Planet. Both the Partnership for Observation of the Global Oceans (POGO) and the Open Geospatial Consortium (OGC) are Participating Organizations within GEO, and some of the proposed consortium members are part of GEO national delegations and members of GEO committees and boards. The proposal includes networks of hundreds of organizations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and OGC are the obvious bodies to lead the development of this Virtual Research Environment and ensure that it is linked to the GEO community and to the Global Earth Observation System of Systems (GEOSS). In addition, POGO brings its extensive experience in international coordination and capacity building to the effort, as well as the link to societal benefits and end-users via the Blue Planet.

On behalf of GEO, I therefore fully support this proposal.

Yours sincerely,

Barbara J. Ryan
Secretariat Director

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The Blue Planet Virtual Research Environment proposal

To Whom it may concern

The Blue Planet Virtual Research Environment (BluePlanet VRE) proposal will fulfill a vital role in accelerating and co-ordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels. The Blue Planet is an important initiative with widespread global participation, and this proposal to speed up its Implementation is therefore of utmost importance and worthy of the strongest support.

The applicants are ideally placed to do this with their networks of hundreds of organisations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and POGO (Partnership for Observation of the Global Ocean), the applicants I know best, are the obvious bodies to accept the challenges of developing operational products from marine environmental data, co-ordinating rapid dissemination worldwide, and capacity building. The South African CSIR is a major role player in a developing country, with experience throughout Africa and beyond.

This proposal has the strongest support of the University of Cape Town Marine Research Institute and the Nansen Tutu Centre for Marine Environmental Research.

Prof. John G Field

Chair: Partnership for Observation of the Global Ocean (POGO)

Chair: Nansen-Tutu Centre for Marine Environmental Research

12 January 2015.

ALFRED-WEGENER-INSTITUT
HELMHOLTZ-ZENTRUM FÜR POLAR- UND MEERESFORSCHUNG

Biological Institute Helgoland, Kurpromenade 201, 27498 Helgoland, Germany

Dr. Mike Grant
Plymouth Marine Laboratory
Prospect Place
Plymouth PL1 3DH
United Kingdom

Datum/date 13th January 2014
Betreff/subject Horizon 2020 EINFRA-9-2015 proposal for a Blue Planet VRE

Dear Dr. Grant,

The Blue Planet Virtual Research Environment (BluePlanet VRE) proposal will fulfill a vital role in accelerating and co-ordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels. The Blue Planet is an important initiative with widespread global participation, and this proposal to speed up its Implementation is therefore of utmost importance and worthy of the strongest support.

The applicants are ideally placed to do this with their networks of hundreds of organisations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and POGO (Partnership for Observation of the Global Ocean), the applicants I know best, are the obvious bodies to accept the challenges of developing operational products from marine environmental data, co-ordinating rapid dissemination worldwide, and capacity building.

For the last 2-3 years, the Alfred Wegener Institute for Polar and Marine Research (AWI) has been leading efforts, within POGO, to improve and coordinate access to long-term data. There are many repositories and portals for time-series data around the world, but currently these are lacking in visibility and ease of access, with a strong divide between European and US data providers. The Blue Planet proposal provides innovative solutions to this problem. It provides a technical underpinning that allows the different communities to work together more easily - both through having a common online platform that flexibly allows people to piece together data and processing to implement ideas ranging from simple correlations, to automated mangrove swamp monitoring, to testing out new algorithms in a supportive environment. The environment itself tries to encourage collaboration and creativity by, for example, incorporating features to share sessions and communicate by voice (potentially useful for teaching as well as working with others), and by suggesting similar or relevant datasets or functions while one is building something in the environment.

On behalf of the AWI, and as the incoming Chair of POGO, I therefore fully support this proposal.

Prof. Dr. Karen Helen Wiltshire
Vice-Director Alfred Wegener Institute for Polar and Marine Research
Head of Biologische Anstalt Helgoland and Wadden Sea Station List

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HELMHOLTZ ASSOCIATION

4. Members of the consortium

4.1. Plymouth Marine Laboratory

Plymouth Marine Laboratory (PML) is an International Centre of Excellence in Marine Science & Technology and a Collaborative Centre of the UK Natural Environment Research Council. PML carries out innovative and timely fundamental, strategic and applied research in the marine environment from the uppermost reaches of estuaries to the open ocean. The research at PML is highly relevant to UK and international societal needs and has at its core the mission to contribute to the issues of global change and sustainability. It is an independent, impartial provider of scientific research in the marine environment, with a focus on understanding biodiversity and ecosystem function, which is critical to providing solutions in terms of measures of ecological sensitivity, biogeochemical cycling, pollution and health, scaling biodiversity and forecasting the role of the oceans in the Earth System. It has centres of expertise providing skills and knowledge, which are leading in their respective fields internationally, particularly in molecular science, development and application of novel technology, marine systems modelling and satellite remote sensing.

There are two groupings within PML that are contributing to this proposal. The technical part, based in PML's web visualisation team (a sub-group of the remote sensing group) and POGO (see description below. The POGO Secretariat is hosted by Plymouth Marine Laboratory, the lead partner in this proposal, and is staffed by PML employees. PML is a member of POGO, and the two organisations work closely together on a number of projects, involving coordination of ocean observations, capacity building and public outreach. Although in this case POGO comes under the umbrella of PML in a financial and project management sense, it will be responsible for a specific set of Tasks in the proposal.

PML will be responsible for the overall management of the project, work package 1, as well as leading work package 4, VRE Tooling and Collaboration. Through POGO (see below), it will also be responsible for training under work packages 2 and 6, and for ensuring future exploitation and sustainability (work package 7).

4.1.1. Technical sub-group

The PML web visualisation team has a combined experience in excess of 45 years of developing web based tools and applications, including GIS and collaboration tools.

Staff profiles / key persons

Dr. Mike Grant (male) is a Senior Scientist with a computing background and a long-term interest in large scale processing technologies, applied to EO data. He leads work on improving the accessibility, delivery and visualization of airborne and satellite data via several EC FP7 projects, guides technical developments in two UK services and the ESA ocean colour climate change initiative project. His current interests include the characterisation, distribution and use of uncertainty information in EO data, advanced web-based GIS, and technologies for large-scale data processing.

Ben Calton (male) is a Senior Consultant. He has more than 10 years' experience of web development technologies. Ben leads the Web Visualisation team at PML and is currently working on the eartH2Observe project developing an advanced web-based GIS portal with integrated analysis and collaboration tools.

Steve Groom (male) has 30 years' experience in satellite and aircraft remote sensing with special

interest in near-real time and operational water quality monitoring. He has managed over 30 commissioned research projects as principal investigator funded by the UK NERC, the EC, ESA, British National Space Centre (BNSC) and Ministry of Defence. Steve is PML APPLICATIONS LTD Head of Science for Earth Observation Science and Applications; coordinator of the recent EC FP7 Europe Africa Marine EO Network (EAMNet); and a a principal investigator in the UK GloboLakes project that will investigate water quality in >1000 lakes world-wide. Steve heads the team responsible for the ChloroGIN web portal (www.chlorogin.org).

Peter Walker (male) is a Computing Scientist. He has more than 25 years' experience as a software developer. He is currently working on the EC FP7 NETMAR project with responsibility for web services and visualization. His work for the Western Channel Observatory involved setting up ingestion routines to load data into a relational database and publishing the data through an OGC Web Feature Server. He is also working on visualisation tools which will allow the data to be accessed through the Western Channel Observatory web portal. He previously worked on the EC FP6 InterRisk, FP7 NETMAR and OPEC projects, developing web services using Open Geospatial Consortium WxS standards and building a web portal to access both these and other WxS compliant services..

Relevant projects

FP6 DISMAR, FP7 InterRisk were a connected pair of projects exploring early use of web services and web portals; the first produced a leading portal for the European marine research community and the second took it further, making the portal more generic and with one of the first European inclusions of flexible graphing functionality and simple WPS calls. The InterRisk portal code was made open-source, and several components reused in other projects or by other organisations.

FP7 NETMAR ; a follow-on in spirit from InterRisk, aside from the increasingly standard portal technologies, NETMAR explored service-chaining by WPS (with PML making major contributions to the open-source PyWPS server). A major first for the project was the creation of a graphical service-chaining editor, allowing drag-and-drop creation of processing chains from WPS processing components and OGC data sources, orchestrated by Taverna. It also explored new ways to bind semantic metadata to the components, so that it was not possible to connect a numerically-compatible but semantically-incompatible data source to a processing unit (e.g. temperature data being fed into a chlorophyll-estimating algorithm that requires reflectances).

FP7 OPEC deals with the use of models for operational ecology. From the PML side, it took the outputs of NETMAR and has developed the portal technology significantly, concentrating now on ease of use and graphical appeal, with web 2.0 style interaces. The development is fully public on github and has a number of independent (non-PML) branches for other projects, including the ESA CCI and FP7 Earth2Observe.

FP7 Earth2observe has taken the OPEC portal and is currently further improving it, particularly in the graphing functionality, and is adding collaborative session sharing (another first in this field) of visualisation, so that geographically separated parties can cooperate on a shared view. The development is again fully open-source.

Relevant publications

Shutler, Jamie D; Davidson, Keith; Miller, Peter I; Swan, Sarah C; Grant, Michael G; Bresnan, Eileen; An adaptive approach to detect high-biomass algal blooms from EO chlorophyll-a data in support of harmful algal bloom monitoring,Remote Sensing Letters,3,2,101-110,2012,Taylor & Francis

de Jesus, Jorge; Walker, Peter; Grant, Michael; Groom, Steve; WPS orchestration using the Taverna workbench: The eScience approach,Computers & Geosciences,47,,75-86,2012,Elsevier

de Jesus, J; Walker, P; Grant, M; Creating OGC Web Processing Service workflows using a web-based editor,EGU General Assembly Conference Abstracts,14,,5734,2012,

Warren, Mark A; Taylor, Benjamin H; Grant, Michael G; Shutler, Jamie D; Data processing of remotely sensed airborne hyperspectral data using the Airborne Processing Library (APL): Geocorrection algorithm descriptions and spatial accuracy assessment,Computers & Geosciences,64,,24-34,2014,Pergamon

Brewin, Robert JW; Mélin, Frédéric; Sathyendranath, Shubha; Steinmetz, François; Chuprin, Andrei; Grant, Mike; On the temporal consistency of chlorophyll products derived from three ocean-colour sensors,ISPRS Journal of Photogrammetry and Remote Sensing,97,,171-184,2014,Elsevier

Significant infrastructure

PML undertakes operational NRT and Delayed Time regional and global EO processing and distribution for a variety of projects including NEODAAS, MyOcean2and ChloroGIN. This entails NRT download of global and regional data from the UK receiving station, ESA stations and NASA. In NRT data are processed from MODIS-Aqua; VIIRS; AVHRR; and MODIS-Terra. Those sensors are also processed from archives, with the addition of MERIS and SeaWiFS. PML has extensive hardware, rack mounted within a dedicated computer room. This includes a Linux-based Sun Grid Engine, consisting of 6 redundant master nodes and over 140 compute nodes connected via Gigabit Ethernet to one another and approximately 2 petabytes of network attached storage accessed over a 10Gb network. Storage, networking and key servers are protected by redundant power supplies and UPS systems. PML has its own dedicated 1Gb/s fibre link to the UK's academic network (JANET). PML disseminates data via FTP, via the satellite/DVB-based EUMETCAST system and via a variety of web-based services. The latter consists of various portal systems, including an advanced interactive portal using JavaScript (AJAX) on the front-end and OGC WxS services on the back-end. PML web services are hosted on a load balanced 4 node cluster with approximately 200TB of dedicated storage and fast (10Gb) connections to the rest of the PML network.

PML has considerable software development capability, with experience including algorithm development, creation and integration of processing systems, data archival / metadata creation, data distribution and web development (including interactive web portals).

4.1.2. POGO Secretariat

PML hosts the Secretariat of the Partnership for Observation of the Global Oceans (POGO, http://www.ocean-partners.org/) and is itself a member of POGO. POGO is an international consortium of major oceanographic institutions. The POGO membership comprises 38 affiliated institutions in 19 countries (14 European institutions in 8 EU countries, see Table below), accounting for most of the world’s capacity to observe and enhance understanding of the open ocean. POGO is dedicated to improving the effectiveness of research infrastructure (including e-infrastructure) for ocean studies through coordination between member institutions; and to raising awareness of the need to establish and maintain a globally-integrated observing system for the ocean for the benefit of society. POGO also has a well-established reputation in the area of training and education of young scientists, particularly from developing countries.

Staff profile/ key persons

Dr Sophie Seeyave (female) is the Executive Director of POGO. Her scientific background is in phytoplankton ecology/Harmful Algal Blooms. She is experienced in project management and international science coordination, communications and outreach, having worked for the Surface Ocean Lower Atmosphere Study (SOLAS) and, since 2010, for POGO. She is a member of the planning committee of the International Quiet Ocean Experiment and has been deeply involved in

the development of international initiatives such as the NF-POGO Alumni Network for Oceans (NANO) and the “Oceans and Society: Blue Planet” Task within GEO. She was on the Editorial Board of the “Oceans and Society: Blue Planet” book published in 2014. She also coordinated a major exhibit at the World Expo 2012 in Yeosu, Korea. She will participate in user consultation through the POGO membership and Blue Planet community; oversee the capacity building elements of the project and ensure that the tight liaison with Blue Planet during the course of the project and into the future.

Prof. Trevor Platt (male) is the coordinator of the Blue Planet Task of GEO, and leader of its component on Capacity Building. He was Executive Director of POGO for some five years. He was the founding Chairman of the International Ocean Colour Coordinating Group, and of the ChloroGIN project of GEO. He was Chairman of the international scientific steering committee of the Joint Global Ocean Flux Study of the IGBP. He is currently Chair of the Steering Committee of the GEO Task “Oceans and Society: Blue Planet”. In this project, he will be responsible for coordination with the Blue Planet and contribute to the science-policy interfacing activities.

Dr Victoria Cheung (female) is the Scientific Coordinator for POGO. Her scientific background is in marine science and genetic ecotoxicology. She is experienced in science communication, project management and financial administration. She was also on the Editorial Board of the “Oceans and Society: Blue Planet” book published in 2014 and has contributed to the creation of two videos related to ocean observations and Blue Planet. She will contribute to the dissemination of project news, information and results, through the Blue Planet website and mailing list; through the POGO and NANO websites, newsletters and mailing lists, and through the News and Information Group of POGO. The News and Information Group comprises the Heads of Communication and Outreach from all major member institutions of POGO. She will also coordinate the capacity building elements of the project.

Miss Laura Ruffoni (female) has been the Administrative Assistant for POGO since 2011. She is experienced in financial and project administration, particularly in support of POGO’s capacity building programme.

Relevant publications

Boyd IL, Frisk G, Urban E, Tyack P, Ausubel J, Seeyave S, Cato D, Southall B, Weise M, Andrew R, Akamatsu T, Dekeling R, Erbe C, Farmer D, Gentry R, Gross T, Hawkins A, Li F, Metcalf K, Miller JH, Moretti D, Rodrigo C, Shinke T (2011). An International Quiet Ocean Experiment. Oceanography 24:174–181.

Seeyave S, Sathyendranath S, Platt T, Cheung V (2014). Towards sustained ocean observations in developing countries. In: Djavidnia S, Cheung V, Ott M, Seeyave S (Eds), Oceans and Society: Blue Planet, Cambridge Scholars Publishing, ISBN: 978-1-4438-5639-3.

IQOE (2015). Tyack P, Frisk G, Boyd I, Urban E, Seeyave S (Eds). International Quiet Ocean Experiment Science Plan (in press).

Table: POGO members organized by country

Country	POGO Member	Contact, Position
Australia	Australian Institute of Marine Science (AIMS)	Dr.John Gunn, CEO
	CSIRO Oceans and Atmosphere Flagship	Dr. Ken Lee, Director
	Institute for Marine and Antarctic Studies (IMAS)	Prof. Mike Coffin, Executive Director
Belgium	Flanders Marine Institute (VLIZ)	Dr. Jan Mees, Director

Brazil	Institute of Oceanography, University of São Paulo	Prof. Frederico Brandini, Director
Chile	Center for Oceanographic Research in the eastern South Pacific (COPAS) and Department of Oceanography, University of Concepcion	Prof. Carina Lange, Director
	Instituto Millenio de Oceanografía (IMO), Universidad de Concepción	José Luis Blanco, Executive Director
	Servicio Hidrográfico y Oceanográfico de la Armada (SHOA)	CN Patricio Carrasco, Director
China	First Institute of Oceanography, China	Dr. Fangli Qiao, Director
	Institute of Oceanology, Chinese Academy of Sciences, China	Dr. Sun Song, Director
France	Institut National des Sciences de l'Univers/Centre National de la Recherche Scientifique (INSU/CNRS), France	Dr. Jean-Marie Flaud, Director
	Institut Francais de Recherche pour l'Exploitation de la Mer (IFREMER), France	Dr. Gilles Lericolais, Director
Germany	Helmholtz Centre for Ocean Research Kiel (GEOMAR), Germany	Prof. Peter Herzig, Director
	The Alfred Wegener Institute for Polar and Marine Research, Germany	Prof. Dr. Karen Wiltshire, Deputy Director, and Director of Biological Station Helgoland
India	Indian National Centre for Ocean, Information Services (INCOIS), India	Dr. Satish Shenoi, Director
	National Institute of Oceanography, India	Dr. S.W.A. Naqvi, Director
Italy	Department of Oceanography, OGS, Trieste, Italy	Dr Alessandro Crise, Director
Japan	Japan Agency for Marine-Earth Science and Technology, (JAMSTEC), Japan	Dr. Yoshihisa Shirayama, Executive Director of Research
Korea	Korea Institute of Ocean Science and Technology (KIOST), Korea	Dr. Jung-Keuk Kang, President
Norway	Institute of Marine Research, Norway	Dr. Erlend Moksness, Director
Russia	P.P. Shirshov Institute of Oceanology, Russian Academy of Sciences	Prof. Robert Nigmatulin, Director
Saudi Arabia	Red Sea Science and Engineering Research Centre, King Abdullah University of Science and Technology (KAUST), Saudi Arabia	Prof. Xabier Irigoien, Director
South Africa	Consortium consisting of MA-RE Institute, University of Cape Town, South Africa; South African Earth Observation Network (SAEON); and Applied Centre for Climate and Earth System Science (ACCESS)	Prof. John Field, Deputy Director
Spain	Instituto Español de Oceanografía (IEO), Spain	Dr. Eduardo Balguerias Guerra, Director of IEO, Madrid

The Netherlands	The Royal Netherlands Institute for Sea Research (NIOZ), The Netherlands	Prof. Henk Brinkhuis, General Director
UK	British Antarctic Survey, UK	Prof. Mike Meredith, Deputy Director of Science
	National Oceanography Centre, Southampton, UK	Prof. Ed Hill, Director
	Plymouth Marine Laboratory, UK	Prof. Steve de Mora, Chief Executive
	The Scottish Association for Marine Science, UK	Dr. Axel Miller, Acting Director
	Sir Alister Hardy Foundation for Ocean Science (SAHFOS), UK	Prof. Nick Owens , Director
USA	Bigelow Laboratory for Ocean Sciences, USA	Dr. Graham Shimmield, Executive Director
	Geochemical and Environmental Research Group, Texas A&M University, USA	Dr. Anthony Knap, Director
	National Oceanic and Atmospheric Administration (NOAA), USA	Dr. David Legler, Division Chief for the Climate Observation Division
	Scripps Institution of Oceanography, USA	Dr. Margaret Leinen, Vice Chancellor & Dean for Marine Sciences
	Woods Hole Oceanographic Institution, USA	Dr. Susan Avery, President & Director

4.2. OGC-Europe

The Open Geospatial Consortium (Europe), London, United Kingdom, is a subsidiary of the Open Geospatial Consortium (OGC). The Open Geospatial Consortium is an international industry consortium of 505 companies, government agencies and universities participating in a consensus process to develop publicly available interface standards. OGC® Standards support interoperable solutions that "geo-enable" the Web, wireless and location-based services and mainstream IT. The standards empower technology developers to make complex spatial information and services accessible and useful with all kinds of applications.

OGC-E was formed in 2001 as a non-profit with the purpose to conduct business in Europe on behalf of the OGC's mission. Focus is on awareness, adoption and outreach around OGC standards to cover:

- Promoting the development and use of advanced open systems standards and techniques to enable the full integration of spatial data and geoprocessing resources into mainstream computing and widespread use of interoperable, commercial geoprocessing software throughout the global information infrastructure; and representing OGC member organizations in Europe with similar vision and mission to that of the OGC, including agencies, collaborators and affiliates of the European Commission.
- By tapping the expertise from the processes and procedures of OGC's Standards Program, Interoperability Program, and Marketing & Communications Program, OGCE will provide a standards-based context for the engineering analysis, technical and consensus process to be considered so that the project delivers sustainable results with a lasting impact.

Key staff

Athina Trakas is Director for European Services at the Open Geospatial Consortium (OGC). In her position she is the contact person for OGC in Europe, responsible for the OGC's activities and networking in Europe.
This includes raising awareness and increase application of OGC standards by technology providers and users, connecting with European stakeholder organisations, the European Commission and members, supporting regional and national forum activities and planning and managing of OGC outreach and recruitment.
Mrs Trakas has presented internationally on geo-information management topics, mainly in the areas of OGC processes, interoperability and standards, geospatial and location data and information and why location matters.
She has a diploma in Geography and started working in the field of GIS in 1998. In 2006, she joined OGC as Director for Business Development on a part time basis. Since 2008 she is charter member of the Open Source Geospatial Foundation (OSGeo). In 2009 she was appointed OGC's Director for European Services.

Bart De Lathouwer is responsible for planning and managing interoperability initiatives such as testbeds, pilots and interoperability experiments with an emphasis on activities in Europe.
Mr. De Lathouwer is responsible for the GEO IN-05-01 task (Architecture Implementation Pilot), piloting the interoperability arrangements for earth observation resources for various Societal Benefit Areas.
Since 2001, Mr. De Lathouwer has worked first as European liaison to the geospatial division of Autodesk and later as Autodesk's Product Manager for Server Technologies. In this role, he also served as member company representative to the OGC. As a company representative, he started the OGC CAD-GIS Interoperability Working Group (which evolved into the OGC 3DIM Domain Working Group) and managed the development of a core data access technology FDO (Feature Data Object) that later went open source in OSGeo. After returning to Europe, he worked as a geospatial expert for both private and government organizations focused on interoperability.
Previously, Mr. De Lathouwer was technical project manager at electric and water utilities as well as telecommunication companies. He holds a BS in Computer Science from the Karel de Grote-Hogeschool.

As Director, Interoperability Programs and Science, **Dr. Ingo Simonis**, who is based in Germany, is responsible for planning, managing and developing architectures for interoperability initiatives such as testbeds, pilots, and interoperability experiments. Simonis has a long history of working in the OGC process as a member, and he brings those years of experience to this role.
Simonis has been a principal architect of OGC's Sensor Web Enablement (SWE) initiative. He was instrumental in the success of the Sensors Anywhere (SANY) FP7 project based on SWE. He authored several OGC standards and has been a member of the OGC Interoperability Program Team. He has served as lead architect for an OGC testbed thread. He has also served as lead architect for the GEOSS (Group on Earth Observation System of Systems) Architecture Integration Pilot activities, which are administered by the OGC on behalf of the GEO organization.
Simonis has led a broad range of international research and development projects and research groups. He co-founded the international open source initiative "52°North" and was the 52°North-Sensor Web community lead. In 2009, he founded with, Martin Klopfer (OGC Technical Director, Europe), the International Geospatial publications Institute, iGSI.
While pursuing all of these activities, Ingo Simonis has also had a distinguished academic career in the fields of ecology and geoinformatics. Most recently he has worked at South Africa's Council for Scientific and Industrial Research and continues to lecture at Carinthia University in Geodata

Information. His recent research has focused on the integration and analysis of complex data structures in the context of large-scale sensor networks.
In 2010, he received the OGC Kenneth D. Gardels award for the extraordinary contribution he has made throughout all phases of the design, development and market acceptance of the OGC Sensor Web Enablement (SWE) standards.

Previous projects or activities

OGC OWS activities
FP7: COBWEB project
ELF project
SANI, EO2HEAVEN project
FP5: GETIS and GENIE
FP6: GIGAS
Share-PSI2.0

4.3. University of Tartu

University of Tartu will be represented by the Remote Sensing and Marine Optics Department of Estonian Marine Institute. The Department is the largest (staff 9 people, 7 with Ph.D.) aquatic remote sensing group in the Baltic Sea region. The Department owns excellent scientific infrastructure from it's own hyperspectral imager (HySpex), in situ optical instrumentation (Thetis bio-optical profiling buoy, WetLabs optical package, field spectrometers, flurometers), lab equipment (flow cytometer, PSICAM) as well as has access to licensed lab of EMI and other units of University of Tartu. The Department has about 35 years of experience in optics and remote sensing of optically complex coastal and inland waters. **8 out of 9 of the current staff are female.**

Staff profile/ key persons

Dr. Tiit Kutser (male) is a Lead Researcher and Head of the Department. He has more than 30 years of experience in optics and remote sensing of optically complex coastal and inland waters. Current research activities are related to determining the true role of lakes in the global carbon cycle, mapping of shallow water benthic habitat and bathymetry as well as detecting and monitoring of harmful algal blooms. He has led several national and international research projects, organised Estonian joining to GEO and is Estonian GEO Principal.

Dr. Ele Vahtmäe (female) is a Senior Scientist. Her main research topic is developing remote sensing methods for mapping benthic habitat and bathymetry in shallow coastal waters, but she is also a co-author pf publications related to monitoring of cyanobacterial blooms and human activities in coastal waters, like deredging.

4.4. SEVEN Engineering Consultants

SEVEN (www.seven-solutions.eu) is a newly established consulting company from Greece providing engineering consulting services. Its fields of intervention are in the areas of Environment, Water Resources, Energy, Geology and Urban Planning, aspiring to provide integrated solutions combining both management consulting and engineering research expertise. Our strategic objective is to provide integrated and workable solutions, combining both advanced consulting and engineering research expertise. We introduce smart thinking, design practical approaches, and bring together interdisciplinary expertise to tackle critical environmental issues and bridge the gap

between science and policy. We are further committed to contribute to the development of a marketplace of ideas for SMEs in the wider water sector, supporting business innovation to develop and test new marketable products or services, partnering businesses to agencies for a smart uptake and advanced capitalization of technological and scientific results. The current staff and associates of SEVEN have proved experience in hydrological and water resources modeling, hydro-informatics, software development and database management, environmental impact assessment, cost-benefit analysis, water management and economics, dissemination strategies and products development. In its short period of operation SEVEN has successfully participated in various projects: eartH2Observe (FP7); ReasponSEAble (H2020 on Ocean Literacy, recently awarded), SPADIS (EIP Water, DG ENV), ABOT (DG ENV), Framework Contract-Support to the EU Freshwater Policies (DG ENV), Implementation of Floods Directive in Greece – RBDs of Macedonia and Thrace ; Drought & Water Scarcity Management Plans for the RBDs of Eastern Sterea Ellada and Attica (Special Secretariat for Water of the Hellenic Ministry of the Environment, Energy and Climate Change); Preliminary assessment of the water supply in Mununa community, Zimbabwe, Africa (Six Billions NGO). Prior to setting up the company, the founders of SEVEN have been participated in numerous EU projects assuming roles of researcher and/or project manager (e.g. ETC/ICM, EPI-Water, MEDDMAN, IWRM.Net, FLOODMED, SPI-Water, FLAPP, etc.).

Main tasks in the project and matching profile

SEVEN will lead WP7 on Dissemination & Exploitation. It will also contribute to WP2. SEVEN staff have good experience in science-policy interfacing, in dissemination and exploitation (currently leading those activities for the eartH2Observe FP7 project), and in participatory work with stakeholders towards developing decision-making and policy options. They have been involved in the dissemination activities of many EU funded projects, and have thus great experience in the development of innovative tools and products for a targeted and effective dissemination, the organisation and facilitation of workshops, training sessions, etc. They have a solid know-how in designing and implementing robust dissemination strategies, supporting the maximization of projects' impact in a wide community of end –users and target audiences. SEVEN's wide network includes people from both the scientific and policy communities, as well as the business community, and will be properly mobilised to support both the dissemination and the potential future exploitation of the project foreground in the most effective way. Furthermore, SEVEN will facilitate partnering businesses to agencies for a smart uptake and advanced capitalization of the project's scientific results.

Short profile of the staff members participating in the project

Maggie Kossida (female). Director and founder of SEVEN, Maggie is a senior hydrologist, with a great experience in integrated water resources management, hydrological modelling, climate change simulation and environmental indicators development. She has been actively involved in different EU programmes as project manager: eartH2Observe, SPADIS, ABOT, EPI-WATER, ETC/ICM, MEDDMAN, IWRM.Net, FLOODMED, SPI-Water, FLAPP. She has acted as Team Leader for Water Quantity of the European Topic Centre on Water-ETC/ICM of the European Environment Agency (2007-2013), is member of WFD CIS WG (Water Accounts, DIS,WS&D) and has also provided consultant services for DG ENV (Framework contract to provide services to support the development and implementation of EU Freshwater Policies, Integration of Natural Water Retention Measures in river basin management, Comparative Study on Pressures and Measures in the major River Basin Management Plans, Water Scarcity & Droughts Policy in the EU – Gap Analysis, EU Water Saving Potential study). She has contributed in policy development process: commenting of the EU Flood Directive, contribution to development of methods for trans-boundary river management, bridging the gap between science & policy, contribution to the Water Scarcity and

Drought Policy Review, contribution to the Blueprint to safeguard Europe's waters.
Klio Monokrousou (female). Assistant Director and co-founder of SEVEN, Klio is a senior environmental engineer. She has a great experience in integrated water resources management, environmental and water policies, wastewater technologies and urban planning. She has been actively involved in different EU programmes as project manager or external expert: eartH2Observe, ABOT, STEP-WISE, MEDDMAN, SPI-Water, ETC/Water, IWRM.Net, FLOODMED, FLAPP etc. She has contributed in policy development process: familiarization with EU and national policies to bridge the gap between science, policy and industry. She has significant experience in spatial and urban planning as she has participated in numerous national projects. She is currently also acting as a water resources coordinator in the NGO MEDITERRANEAN SOS Network (MedSOS) with numerous activities as follows: national policy issues, monitoring and evaluation of RBMPs, public consultation processes, raising awareness, dissemination, training and education on water related issues. She has participated in numerous workshops and conferences with significant expertise on developing participatory approaches addressing to the civil society and other stakeholders.
Anastasia Tekidou (female). GIS Specialist with an MSc in Water Management (Cranfield University, UK) and a BSc (Hons) in Geographical Information Systems from Kingston University (United Kingdom). She has significant experience in the application of ESRI and other GIS software for hydrological application, as well as in hydrological modelling with the use of hydrological software. She has worked in several flood management projects (Stour/Darent Flood Forecasting Model, UK, Test River Flood Forecasting Model, UK, Welland Catchment Flood Management Plan UK, Morpeth Dock Pumping Station, UK, Birket River Flood Study, UK, etc.). Since 2011 she has actively been involved in the European Topic Center on Water of the EEA, developing maps for WISE, contributing to the drafting of EEA Reports. She has participated in DG ENV studies: Assessment of groundwater quantitative status for the DG ENV Study on Pressures and Measures in the RBMPs; Potential for growth and job creation through the protection of water resources – Framework contract to provide services to support the development and implementation of EU Freshwater Policies. She was in past employed by Mott MacDonald, Geoanaly-sis Ltd., and other consultants.
George Karavokiros (male). Expert in Software Engineering, Database Design and Network Modelling. He has particular expertise in network database design, network simplification, simulation and optimisation. Over the past 20 years he has contributed to or led software development projects in the fields of water resource management, urban hydraulics and transportation for both industry and research organizations. His solid theoretical background enabled him to transform innovative methodologies and mathematical models into successful software products. In the last years he has coordinated the software development team of a €2M EU. and government funded project, providing a series of computing tools for the integrated management of complex water resource systems. Further-more, he has coordinated the IT team for the development of the Attica Transportation Master Plan (€0.95M) and was responsible for the dissemination of information of the Greek National Data Bank of Hydrological & Meteoro-logical Information (€1.2M).

Key References

Maccioni, P., Kossida, M., Brocca, L., Moramarco, T. (2014). An assessment of the drought hazard in the Tiber River Basin in Central Italy, and a comparison of new and commonly used meteorological indicators. Journal of Hydrologic Engineering (in press).
Kossida, M., Mimikou, M. (2013). An indicators' based approach to Drought and Water Scarcity Risk Mapping in Pinios River Basin, Greece. Geophysical Research Abstracts Vol. 15, EGU2013-6349, 2013, EGU General As-sembly 2013, 07-12 April 2013, Vienna, Austria.
Panagopoulos, Y., Makropoulos, C., Kossida, M., and Mimikou, M. (2013). Optimal

Implementation of Irrigation Practices: Cost-Effective Desertification Action Plan for the Pinios Basin. J. Water Resour. Plann. Manage. , 10.1061/(ASCE)WR.1943-5452.0000428, 05014005.
Vanneuville, W., Werner, B., Uhel, R., Kjeldsen, T., Miller, J., Kossida, M., Tekidou, A., Kakava, A., Crouzet, P. (2012). Water resources in Europe in the context of vulnerability, EEA 2012 state of water assessment. EEA Report No 11/2012, ISBN 978-92-9213-344-3, EEA, Copenhagen.
Kossida M. (2010). Effect of Sea Level Rise on Groundwater Resources: A Case Study of Southwest Coastal Rhode Island. Geophysical Research Abstracts Vol. 12, EGU2010-1084, 2010

Key research projects
– ReasponSEAble: Sustainable oceans: our collective responsibility, our common interest. Building on real-life knowledge systems for developing interactive and mutual learning media [H2020, DG Research], 2015-2019
– eartH2Observe: Global Earth Observation for integrated water resource assessment [FP7, DG Research], 2014-2017
– Framework Service Contract to provide services to support the development and implementation of EU freshwater policies [DG ENV], 2014-2017
– Flood risk management plans in the RBs of Eastern Macedonia (GR11) and Thrace (GR12), Greece [Spe-cial Secretariat for Water of the Hellenic Ministry of the Environment, Energy and Climate Change], 2014-2016
– SPADIS: Smart Prices and Drought Insurance Schemes in Mediterranean Countries, [European Innovation Partnership on Water, EU 2020 Innovation Union], 2014-
– ABOT: Assessment of water Balances and Optimisation based Target setting across EU River Basins, [Preparatory Action on development of prevention activities to halt desertification in Europe-Desertification 2011, DG ENV], 2012-2013

Significant Infrastructure
Database of end-users and stakeholders, specialized team for website development, graphic designers' team for the development of leaflets, brochures, etc., experience in workshop organization and consultation processes.

4.5. Terradue Srl

Company profile

Terradue Srl (holding company) is a Web 2.0 model 'distributed enterprise' addressing the Earth Sciences research & education sector, with core competencies aimed at engineering distributed systems and Cloud services, providing consultancy for international organizations, and developing partners programs in support of Terradue's Open Source Platforms and Standardization strategy.

Terradue is a leading Cloud Services provider with current developments focusing on empowering researchers within seamless eScience infrastructures, for curating and delivering scientific information, and to create Cloud marketplaces for environmental data analytics. Terradue is an active player in the promotion of an eScience vision, where scientific publications and fully reproducible, verifiable experiments are part of an interoperable ecosystem.

The company founders worked for nearly four years in the development of the Grid infrastructure in ESRIN, the ESA G-POD (Grid Processing on Demand for Earth Observation). Since 2006 Terradue maintains and supports the integration of operational applications and services according to ESA Software Engineering standards. Terradue is also responsible of the integration of the ESA EO routine production processors and Principal Investigators scientific applications on the infrastructure in the frame of a dedicated announcement of opportunities.

Terradue has distributed catalogue solutions including spatial, temporal, EO metadata and online access points with multiple access protocols in a simple Atom/OpenSearch Interface being recognized and adopted as a standard by the Open Geospatial Consortium. Terradue is an active member of the OGC and responsible for the definition of the OpenSearch Geospatial Extensions Draft Implementation Standard, editor of the ATOM encoding of the OWS Context Standard and a voting member of the Catalogue Services, OWS Context and Web Processing Service Working Groups.

Terradue has also a wide experience and knowledge on how to tap the available resources on the Global Earth Observation System of Systems (GEOSS) that is being built by the Group on Earth Observations (GEO). Terradue was involved on the main European contributions to the GCI (GEOSS Common Infrastructure) through the EC-funded GEOWOW and GENESI-DEC projects. In past EC FP7 projects Terradue had an important role in defining infrastructure architecture; developing services focused on data discovery, catalogue, access and processing; and performing research activities targeting the fast data access and computing resources virtualization.

Terradue brings to the consortium its expertise in the provision EO data and of distributed computing platforms for data and applications hosting. It has the have expertise in development and integration of geospatial data and services for operational settings using Grid and cloud technologies.

Curriculum of key persons

Dr. **Pedro Gonçalves**, Terradue founder and Chief Technical Officer. Pedro is an Environmental Engineer and did a post-doc in ESA-ESRIN where he led the development and transfer to operations of the Earth Observation Grid Processing on-Demand (G-POD). He is the editor and collaborator of several Open Geospatial Consortium specifications dealing with discovery and access of Earth science information focusing on integration with the Open Linked Data architecture. He focuses on leveraging the processing power and agility of cloud computing for the development of new exploitation platforms for environmental and climate change data.

Fabrice Brito, Terradue founder and Project Manager. Fabrice deals with the project management aspects of Terradue projects and provides technical support in given areas. Fabrice spent almost four years in ESRIN, first as a Portuguese Trainee and then as on-site contractor where he has been responsible for the Grid processing on-Demand evolution and support. He participated in the development of the G-POD components.

Within Terradue, Fabrice spends part of his time as the Chief Executive Officer dealing with the administrative and management activities and the remaining dedicated to the technical aspects of the Terradue projects.

Emmanuel Mathot has a background in Computer Science and is Terradue's technical leader in several ESA projects (e.g. ngEO Task 4, Cloud Computing Operational Pilots, e-Collaboration for Earth Observation, etc.). Before joining Terradue, Emmanuel spent over five years in ESA ensuring the operations G-POD operations where he managed the hosting of several Principal Investigator scientific algorithms. In Terradue, Emmanuel brought the enhancement of the distributed processing capabilities with the introduction of the private, commercial and hybrid Cloud managed transparently by OpenNebula and the Hadoop Map/Reduce model applied to legacy Earth Observation scientific applications (and thus avoiding the need for a re-engineering process to exploit the distributed processing paradigm).

Relevant publications

- Global monitoring of plankton blooms using MERIS MCI, J Gower, S King, P Goncalves International Journal of Remote Sensing 29 (21), 6209-6216, 2008
- Building a mosaic of clouds, B Di Martino, D Petcu, R Cossu, P Goncalves, T Máhr, M Loichate, Euro-Par 2010 Parallel Processing Workshops, 571-578, 2011
- Variational optimization for global climate analysis on ESA's high performance computing grid, A Löscher, C Retscher, L Fusco, P Goncalves, F Brito, G Kirchengast, Remote Sensing of Environment 112 (4), 1450-1463, 2008
- GENESI-DR Portal: a scientific gateway to distributed repositories, P Goncalves, F Brito, F D'Andria, R Cossu, L Fusco, EGU General Assembly Conference Abstracts 12, 12234, 2010
- Local and remote geoprocessing applications, PP Gonçalves, M Costa, Computers, environment and urban systems 23 (4), 287-303, 1999

Main Projects

G-POD Grid Processing on-Demand (G-POD), an ESA infrastructure available since mid-2006, provides a “user-segment” putting EO data and processors closer together. The G-POD is a hybrid Grid/Cloud based high-performance and high through-put computing infrastructure promoting the access to Earth Observation data, offering on-line access to products with attached computing infrastructure and tools to generation of scientific added value products. Terradue is responsible for the maintenance and evolution of the system and manages the integration of the ESA EO routine production processors and Principal Investigators scientific applications

ngEO The ngEO project (Next Generation User Services for Earth Observation) of the European Space Agency (ESA) is a set of generic services: product metadata catalogue, browsing images, data access, shop-cart management, dataset/authorization/data access service management, etc for all the GMES/COPERNICUS and past Earth Observation Mission. Terradue is responsible for development of ngEO Web Server that acts as the GMES/COPERNICUS data discovery and access main decision point.

SENSYF A FP7 project kicked-off in January 2013, and will last until the end of 2015. The project provides a specialised Sandbox Service with tools and development/validation platforms where developers are allowed to develop and test of new processing chains and methods for Sentinel and Copernicus/GMES contributing mission data on a continuous basis, and the delivery of higher-level products and services complementing the information provided by the operational services. Terradue’s responsibilities are the service integration, deployment, operations and support of the SensyF infrastructure. The backbone of the SenSyF project is provided by Terradue’s cloud platform based in the company’s experience in Earth observation data processing and applications development.

E-CEO This on-going ESA project will allow the set-up of on-line contests and will offer an appealing way of conducting research, with scientists tackling new research problems in a “parallel and collaborative way”. It delivers a collaborative platform that trough data challenges contests will improve the adoption and outreach of new applications and methods to processes EO data. Terradue manages and develops the ESA e-Collaboration for Earth Observation platform

GENESI-DEC The EC FP7 GENESI-DEC was a FP7 project that provided data discovery, access, processing and visualization mechanisms to several Digital Earth Communities with a strong accent on distributed infrastructures security, semantics, ontology and advanced workflow

management. Terradue had a major role in the infrastructure architecture and services (data discovery, catalogue, access and processing) and performed research activities targeting the fast data access and computing resources virtualization

GEOWOW The EC FP7 GEOWOW project addressed the challenge to evolve the GEO Global Earth Observation System of Systems (GEOSS) in general and the GEOSS Common Infrastructure (GCI) in particular in terms of interoperability, standardization and functionality, to the final purpose of providing users with improved discovery, access and usability of Earth Observation data and services. Terradue made contributions to the GEOSS architecture with special emphasis on data discovery, access and processing using the Developer Cloud Sandboxes.

MELODIES The MELODIES project (Maximizing the Exploitation of Linked Open Data In Enterprise and Science) is a European Union (FP7) project about using diverse sources of Open Data to develop new applications and technologies that benefit society in a variety of ways. Terradue Cloud Platform applies the latest technologies in cloud computing and data-handling to exploit these data to their best advantage. Terradue's responsibilities are the service integration, deployment, operations and support of the MELODIES infrastructure.

SSEP The SuperSites Exploitation Platform (SSEP) The SSEP project brought together existing software components and EO data allowing geo-hazard scientists to apply their algorithms and tools to analyse the data. It represented ESA contribution to the GEO Supersites initiative. The developments contributed by Terradue comprised an instance of an exploitation platform for radar imagery in the context of geo-hazards, for the sharing of SAR data and the exploitation of interferometry processing on those data.

OWS-10 The Open Geospatial Consortium's (OGC) Interoperability Testbed (OWS-10) focused on the Performance of OGC Services in the Cloud. The activity conducted by Terradue, in collaboration with CNR-IREA (SBAS processing chain) and with grant program from Amazon Web Services Education & Government Solutions demonstrated the performance enhancements for a Cloud deployment of the processing application with the use of WPS and OpenSearch OGC Web Services for the production of On-demand Ground Deformation Maps. The deployment exploited resources from Terradue (Cloud Controller), AWS (public Cloud), Interoute (public Cloud), and the GEO Supersites Virtual Archive (Cloud Storage of massive ESA SAR data).

Facilities

The Terradue's Operational IT Infrastructure (TOI) is located at Hetzner in Germany. Hetzner Online AG (http://www.hetzner.de) is a strategic partner of Terradue and it is responsible of the bare metal maintenance operations and it guarantees the normal working of the IT infrastructure itself. TOI constitutes a Private Cloud platform to provide PaaS and SaaS services to the Earth Observation scientific community and it is built as a cluster of management servers and a cluster of high performance workers nodes. Each server of the worker nodes cluster has a capacity of 12 Virtual Machines (VMs) with 2 virtual CPUs and up to 4.5 GB of RAM and a storage space for each server of 2TB (RAID1). Different VM configurations also exist in order to serve different computing requirements. The management part of the infrastructure provides services to the infrastructure and users like the VPN service, the first level Support system, the IaaS cloud controller, the HTTP proxy, DHCP and DNS. The total storage space of the management cluster is equal to 20TB (RAID1).

The Terradue's Development Infrastructure (TDI) is located at Rome on the Terradue's own premises. The maintenance operations are performed by the Terradue's Operational Team. TDI constitutes a Private Cloud platform to provide PaaS and IaaS services to the Terradue's Development Team. It is built as a cluster of management servers, a cluster of workers nodes and a cluster of storage nodes. Each server of the worker nodes cluster has a capacity of 4 Virtual

Machines (VMs) with 2 virtual CPUs and up to 2 GB of RAM and a variable storage space for each server. Different VM configurations also exist in order to serve different computing requirements. The management part of the infrastructure provides services to the infrastructure and T2 Staff users like the VPN service, the IaaS cloud-dev controller, the HTTP proxy, DHCP, SVN and secondary DNS. The storage cluster realises a Distributed Storage Filesystem that is currently under performance assessment. It provides a total storage space of 11TB (with replica factor of two).

All the servers (both bare metal or virtual) of the infrastructure are deployed and under configuration management with Puppet, an Automated Configuration Management Software (http://puppetlabs.com/), and they are monitored with Nagios, the industry standard for the IT Infrastructure Monitoring (http://www.nagios.org/). Each bare metal server, management node or VM has its own configuration, as prepared and distributed from the automated configuration software. In this way it is possible to have a unified approach to manage heterogeneous environments - physical, virtual, or on a Public Cloud - and to define a desired state of the entire infrastructure, enforcing automatically that state. Each server uses a configuration built in a modular manner using a stack of basic modules that do a particular kind of service. The monitoring service allows knowing immediately when an issue occurs on one of the resources monitored, at different levels of granularity. Also in the case of the monitoring service, each server has its own stack of services to monitor, based on the type of the server itself.

4.6. Tiwah UG (haftungsbeschränkt)

Overview

Tiwah UG (haftungsbeschränkt) is a German SME focusing on consulting in a wide range of Earth observation-related research. A particular focus is on information needs for sustainable development across all societal sectors and topics. The company has been central in the development of the GEOSS User Requirement Registry (URR) and the GEOSS Science and Technology Service Suite (GSTSS). Tiwah UG has contributed to the population of the URR with user needs related to the coastal zone and disaster risk management. The GSTSS provides access to several GEOSS services including a Science and Technology Portfolio and a utility to organize and document GEOSS-related session and major international S&T meetings. The GSTSS has been a central utility for the organization of the GEOSS S&T Stakeholder Workshops. The GSTSS also includes a feedback utility for Earth observation data sets and services. Tiwah UG is also developing the virtual stakeholder table as part of a coastal information system.

The contribution of Tiwah UG to the project directly derives from previous activities related to the URR and the GSTSS. The involvement in the GEOSS S&T Stakeholder Network also provides a basis for the company's contribution to the linking of S&T communities to the project.

The core people

Dr. Hans-Peter Plag (male) has been engaged in GEO since its initial inauguration in 2003. He has made many contributions as member of committees and implementation boards, Task lead and point of contact for task components, and co-chair of Coastal Zone and Geohazards Communities of Practice. He has been instrumental in linking S&T communities to GEO and both the development and use of GEOSS. He currently leads the GEO Task ID-03 “Science and Technology in GEO,” which plays a central role in linking the proposed project to GEO and GEOSS. In the Blue Planet GEO Task, he is a co-lead of Component 2 and the Point of Contact for Component 4.

Shelley Jules-Plag (female) has been active in several GEO Communities of Practice and

contributed to the development of the GEOSS URR and the GSTSS. She also contributed to the organization of the GEOSS S&T Stakeholder Workshops. She has taken the lead in identifying information needs particularly for geohazards, climate change, and sea level rise. She is an expert in Geographical Information Systems (GIS) and contributes to the development of the coastal zone information system and the virtual stakeholder table.

Publications

Plag, H.-P., Brocklebank, S., Brosnan, D., Campus, P., Jules-Plag, S., Stein, S., 2015. *Extreme Geohazards - Reducing the Disaster Risk and Increasing Resilience*. European Science Foundation, Strasbourg.

Plag, H.-P., Jules-Plag, S., 2013. *Sea-Level Rise and Coastal Ecosystems*. In Pielke Sr., R. A., Seastedt, T., Suding, K. (eds.): *Vulnerability of Ecosystems to Climate, Volume 4 of: Climate Vulnerability: Understanding and Addressing Threats to Essential Resources*, 163-184, Elsevier.

Plag, H.-P., Jules-Plag, S., 2013. *Sea-Level Rise and Health*. In Pielke Sr., R. A., Adegoke, J., Wright, C. (eds.): *Vulnerability of Human Health to Climate. Volume 1 of: Climate Vulnerability: Understanding and Addressing Threats to Essential Resources*, 39-47, Elsevier.

Plag, H.-P., Jules-Plag, S., Callaghan, C., McCallum, I., 2013. *Linking science and technology communities to GEOSS*. In Nativi, S., Mazzetti, P., Plag, H.-P. (ed.): *Towards a Sustainable GEOSS (Global Earth Observation System of Systems): Some Results of the EGIDA Project*. ISBN 978-88-98262-05-2, pages 13-34.

Plag, H.-P., Foley, G., Jules-Plag, S., Kaufman, J., Ondich, G., 2012. *The GEOSS User Requirement Registry: Linking users of GEOSS across disciplines and societal areas*. Preliminary Proceed. of IGARSS 2012, Munich, Germany, July 23-27, 2012.

Projects

Tiwah UG has contributed to the development of the GEOSS URR. Tiwah UG is currently leading the development of a concept for a GEOSS knowledge base defining and documenting information needs and Earth observations needed by a wide range of users, which was requested in the Ministerial guidance for the second 10-year phase of GEO. This knowledge base “Socio-Economic and Environmental Information Needs” (SEE IN) is the next step of the URR and will be a crucial element of the GEOSS Common Infrastructure (GCI), particularly for any gap analysis.

Tiwah UG is leading a white paper (WP) on extreme Geohazards funded by the European Science Foundation. This WP has identified the risk associated with extreme volcano eruptions as one not sufficiently accounted for in disaster risk reduction and argues for a comprehensive volcano monitoring system.

Tiwah UG has developed the GSTSS and is maintaining the GSTSS, which provides services to S&T communities linking to GEOSS.

Infrastructure

Tiwah UG contributes the GSTSS () to the project. The company is further developing this software into a comprehensive service suite with the goal to link S&T communities to GEOSS through useful services. Besides providing a number of services that link S&T communities to GEOSS, the GSTSS also support the organization of workshops for S&T Stakeholders.

Tiwah UG is engaged in transitioning the current GEOSS URR, which is based on propriatary software, into a open-source utility, which will be available to the project. Moreover, the company has committed to the development of the SEE IN knowledge base. A first version of SEE IN will be available to the project. Tiwah UG also owns the web work space for GEO Tasks available at and provides the web services for several GEO Communities of Practice (Coastal Zone, Geohazards, and the emerging Sea Level Rise CoP).

4.7. CSIR (South-Africa)

The Council for Scientific and Industrial Research (CSIR) is one of the leading scientific and technology research, development and implementation organisations in Africa. It undertakes directed and multidisciplinary research, technological innovation as well as industrial and scientific development to improve the quality of life of the country's people. The CSIR is committed to supporting innovation in South Africa to improve national competitiveness in the global economy. Science and technology services and solutions are provided in support of various stakeholders, and opportunities are identified where new technologies can be further developed and exploited in the private and public sectors for commercial and social benefit.

The organisation has extensive experience of large multi-partner national and international research projects, including several under FP6 and FP7, including FP7 DevCoCast, FP7 EAMNet and FP7 GreenSeas. The Earth Observation group, based at the CSIR Centre for High Performance Computing, is the major provider of marine remote sensing expertise and products for sub-Saharan Africa and is a candidate Regional Implementation Centre for GMES-Africa Marine and Coastal Services. The EO group has extensive expertise in ocean colour, SST and radar based research and applications, including algorithm development, validation, multi-data integration and harmful algal bloom, ecosystem and fisheries applications The CSIR Southern Ocean Carbon and Climate Observatory (SOCCO) is one of the leading Southern Ocean research groups globally, using SeaGliders, WaveGliders and Bio-Argo floats in conjunction with high resolution models and earth observation to better understand high resolution variability in phytoplankton carbon dynamics.

Staff Members:

Dr. Stewart Bernard has been involved in marine remote sensing and bio-optical research in southern Africa for twenty years ,with 35 publications. His main research interests are in the field of bio-optics in eutrophic waters: phytoplankton optical and radiative transfer modelling, algorithm development particularly for harmful algal bloom applications, ocean colour validation, and application of these algorithms for ecosystem characterisation in upwelling and freshwater systems. He also has interests in technological development, such a low-cost buoys and optical sensors, and developing operational earth observation systems. Teaching and building capacity, particularly in Africa, is important and he has taught several bio-optical courses and has supervised or is supervising fifteen PhD and M.Sc students. He is chair of the International Ocean Colour Coordinating Group.

Dr Sebastian Swart: research interests are focused on understanding the physical circulation and dynamics in the open ocean, particularly in the Southern Ocean. His is presently researching the variability of the upper mixed layer and how this impacts the regional biogeochemistry and oceanic carbon cycle. This is undertaken by employing remotely sensed satellite data and in situ observations from gliders, ships and profiling floats in remote/harsh ocean environments (open

ocean and sea ice regions) to test novel hypotheses related to upper ocean stratification and mixed layer processes. Dr Swart also heads a national engineering facility called the South African Marine Engineering & Robotics Centre allowing him to pioneer cutting-edge technology and methods to obtain high-resolution ocean observations. He is currently the Physics Vice-Chair of the international Southern Ocean Observing System (SOOS).

Dr Marjolaine Rouault has signifcant expertise in the use of multidisciplinary earth observation analysis of the Agulhas current. She has more than 15 years of experience in oceanographic and meteorological data processing, developing geo-spatial and oceanographic analysis software, and the development of web-based monitoring and geo-spatial dissemination systems using remote sensing data.

4.8. Third parties involved in the project (including use of third party resources)

No third parties are involved.

5. Ethics and Security

5.1. Ethics

There are no ethical issues relating to this project, other than the inclusion of a non-EU country, South Africa, where CSIR is based.

Inclusion of the CSIR in the proposal has several significant advantages; it is one of the leading organisations in operational oceanography in Africa and, as part of an extensive African research network, CSIR has the ability to lead training, uptake and feedback from African scientists on emerging VREs.

This will provide ability to test VREs in infrastructure-poor developing world scenarios, with the support of an experienced world-class organisation, a situation well suited to uptake of the remote processing and analysis that is the defining feature of these environments.

The CSIR role as RIC in the GMES-Africa Marine Services provides considerable synergy with operational marine capabilities. In addition, the CSIR will provide innovative data and application activities from globally important ecosystems: glider, other autonomous and modelled data from the Southern Ocean; in situ and satellite data from the Benguela, Agulhas and other African shelf sea systems.

5.2. Security

There are no activities or results raising security issues in this project. No EU-classified information is used as background or produced as a result.

GROUP ON EARTH OBSERVATIONS

Our Ref: 2015-09/GEO/BluePlanet ct

Dr Mike Grant
Plymouth Marine Laboratory
Prospect Place
Plymouth PL1 3DH
United Kingdom

Geneva, 14 January 2015

Dear Dr Grant,

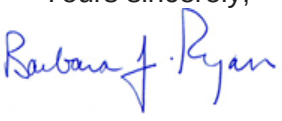
I write in support of the Blue Planet Virtual Research Environment (Blue Planet VRE) proposal which will fill a vital role in accelerating and coordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels.

The Blue Planet initiative was created within the Group on Earth Observations (GEO) to bring together all the marine initiatives within GEO, and to bring new activities into the GEO portfolio. Since its Kick-Off Meeting in 2012, Blue Planet has gained much momentum and support from the ocean observing community, and it is now considered one of the "global initiatives" within GEO. Although Blue Planet has been very successful in bringing a community together, there is still work to be done to facilitate interactions, collaboration and data sharing within this community. The Blue Planet VRE proposal is extremely timely in that it would respond directly, and in an innovative fashion, to this need.

I am particularly pleased to note that this proposal brings together several active participants within GEO and key players in the Blue Planet. Both the Partnership for Observation of the Global Oceans (POGO) and the Open Geospatial Consortium (OGC) are Participating Organizations within GEO, and some of the proposed consortium members are part of GEO national delegations and members of GEO committees and boards. The proposal includes networks of hundreds of organizations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and OGC are the obvious bodies to lead the development of this Virtual Research Environment and ensure that it is linked to the GEO community and to the Global Earth Observation System of Systems (GEOSS). In addition, POGO brings its extensive experience in international coordination and capacity building to the effort, as well as the link to societal benefits and end-users via the Blue Planet.

On behalf of GEO, I therefore fully support this proposal.

Yours sincerely,



Barbara J. Ryan
Secretariat Director

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Datum/date 13th January 2014
Betreff/subject Horizon 2020 EINFRA-9-2015 proposal for a Blue Planet VRE

Dear Dr. Grant,

The Blue Planet Virtual Research Environment (BluePlanet VRE) proposal will fulfill a vital role in accelerating and co-ordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels. The Blue Planet is an important initiative with widespread global participation, and this proposal to speed up its Implementation is therefore of utmost importance and worthy of the strongest support.

The applicants are ideally placed to do this with their networks of hundreds of organisations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and POGO (Partnership for Observation of the Global Ocean), the applicants I know best, are the obvious bodies to accept the challenges of developing operational products from marine environmental data, co-ordinating rapid dissemination worldwide, and capacity building.

For the last 2-3 years, the Alfred Wegener Institute for Polar and Marine Research (AWI) has been leading efforts, within POGO, to improve and coordinate access to long-term data. There are many repositories and portals for time-series data around the world, but currently these are lacking in visibility and ease of access, with a strong divide between European and US data providers. The Blue Planet proposal provides innovative solutions to this problem. It provides a technical underpinning that allows the different communities to work together more easily - both through having a common online platform that flexibly allows people to piece together data and processing to implement ideas ranging from simple correlations, to automated mangrove swamp monitoring, to testing out new algorithms in a supportive environment. The environment itself tries to encourage collaboration and creativity by, for example, incorporating features to share sessions and communicate by voice (potentially useful for teaching as well as working with others), and by suggesting similar or relevant datasets or functions while one is building something in the environment.

On behalf of the AWI, and as the incoming Chair of POGO, I therefore fully support this proposal.

Prof. Dr. Karen Helen Wiltshire
Vice-Director Alfred Wegener Institute for Polar and Marine Research
Head of Biologische Anstalt Helgoland and Wadden Sea Station List

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The Blue Planet Virtual Research Environment proposal

To Whom it may concern

The Blue Planet Virtual Research Environment (BluePlanet VRE) proposal will fulfill a vital role in accelerating and co-ordinating access and response to new and existing marine environmental data from a variety of sources, including remote sensing satellites, meteorological stations, buoys, ships and unmanned sampling vessels. The Blue Planet is an important initiative with widespread global participation, and this proposal to speed up its Implementation is therefore of utmost importance and worthy of the strongest support.

The applicants are ideally placed to do this with their networks of hundreds of organisations and countries, technical skills, and capacity building experience using new digital technologies in both developed and developing countries. The Plymouth Marine Laboratory (PML) and POGO (Partnership for Observation of the Global Ocean), the applicants I know best, are the obvious bodies to accept the challenges of developing operational products from marine environmental data, co-ordinating rapid dissemination worldwide, and capacity building. The South African CSIR is a major role player in a developing country, with experience throughout Africa and beyond.

This proposal has the strongest support of the University of Cape Town Marine Research Institute and the Nansen Tutu Centre for Marine Environmental Research.

Prof. John G Field

Chair: Partnership for Observation of the Global Ocean (POGO)

Chair: Nansen-Tutu Centre for Marine Environmental Research

12 January 2015.

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