GloboLakes

Global Observatory of Lake Responses to Environmental Change

NATURAL ENVIRONMENT RESEARCH COUNCIL

Global Observatory of Lake Responses to Environmental Change

Workshop 1

University of Stirling

Andrew Tyler

Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL
University of Dundee
The University of Edinburgh
University of Glasgow
PML Plymouth Marine Laboratory
University of Stirling

Workshop Objectives

- Introduce GloboLakes to the Scientific Community
- Bring together the *Project Partners* and other key scientist working in Earth Observation of Lakes
- Review the *State of the Art*
- Establish the working synergies with other national and international programmes and researchers
- Identify possible efficiencies
- Agree on the ***data sharing policy***
- Collectively provide the basis for a ***position paper on the lake remote sensing***

Workshop Structure

Day 1	Day 2	Day 3
Overview	State of the Art	Directions
Introduction to GloboLakes	Techniques in Lake Ecology	Remote Sensing of Lakes
End User Needs	Remote Sensing of Lakes	Discussion Session

Rationale

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- 300 million lakes globally
- Providing essential ecosystem goods & services
- Fundamental to global food security
- Global concerns over future water security (Unsustainable use; MEA 2005)
- Important in global biogeochemical cycling (Bastviken et al. 2011, *Science*)
- Yet:
  - Hard to monitor
  - Existing Monitoring
    - Very small proportion (<0.00003 %)
    - Inconsistently

Rationale

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- Lakes are ‘sentinels’ of environmental change
- These can trigger internal interactions & direct responses leading to:
  - loss of habitat
  - eutrophication
  - fish kills
  - loss of species (highest proportion of species threatened with extinction; MEA 2005)
  - altered communities & shifts to less desirable species


Nutrient enrichment


Land use change & deforestation


Water abstraction


Climate change


Invasion of non-native species

Lake Chad, Africa


Kankaria Lake, India


Dianchi Lake, China

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Rationale

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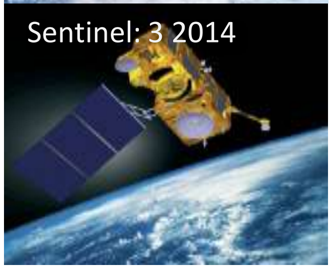
Timeliness:

- Increasing robustness of algorithms and ensemble approaches
- Capability for processing huge data volumes in near real time
- MERIS: spectral and temporal resolution (until April 2012)
- GMES: ESA planned launches – superior capabilities (2014)

Opportunity:

Access to nearly 20 years of data on 1000 lakes of different types across the globe will give a unique opportunity to ask fundamental ecological questions in relation to the status and change in the condition of the world's lakes



The Consortium

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- **Andrew Tyler**, **Peter Hunter**, Evangelos Spyrakos
  University of Stirling, UK
- **Steve Groom**, Victor Vicente-Martinez, Gavin Tilstone, Giorgio Dall'Olmo
  Plymouth Marine Laboratory, UK
- **Christopher Merchant**, Stuart MacCallum
  University of Edinburgh, UK
- **Mark Cutler**, John Rowan, Terry Dawson, Eirini Politi
  University of Dundee, UK
- **Stephen Maberly**, Laurence Carvalho, Stephen Thackery
  Centre for Ecology & Hydrology, UK
- **Claire Miller**, Marion Scott
  University of Glasgow, UK

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Questions

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What controls the differential sensitivity of lakes to environmental perturbation?

Some pressing questions:

- What is the present state & evidence for long-term change for the 1000 lakes?

Condition

- To what extent are patterns temporally coherent & what are the causes?
- Is there evidence for phenological change & what are the causes?

Change

- What factors control cyanobacterial blooms?
- What factors control the concentration of coloured DOC?

Controls

- How sensitive are different lake types to varying environmental perturbation?

Resilience

- Can we forecast the future response of phytoplankton composition & abundance, & risk of cyanobacterial blooms, for lakes in different landscapes?

Forecasting

Aims and Objectives

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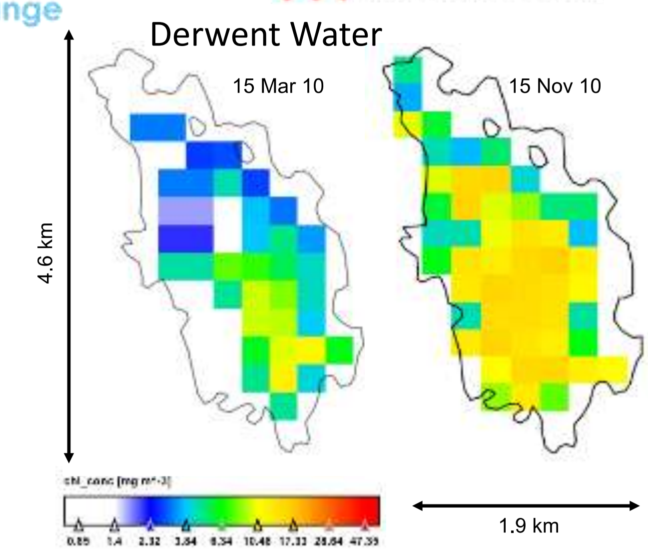
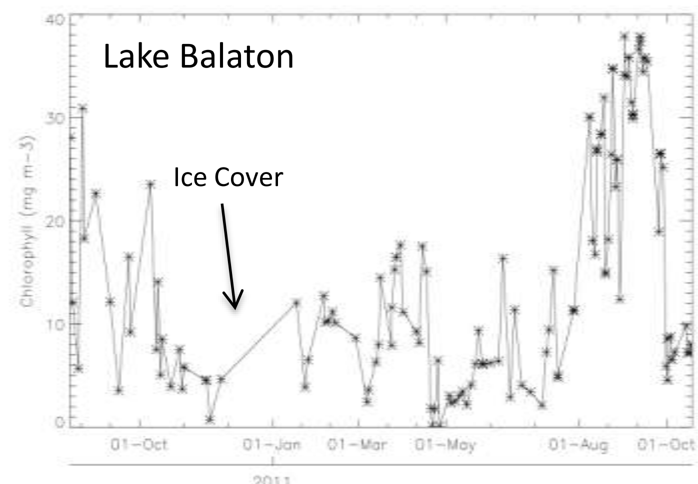
Investigate the state of lakes & their response to environmental change drivers:

- Near real time processing satellite based observatory
- Processing archived data for up to 20-year time series
- Including: (i) LSWT; (ii) TSM; (iii) CDOM; (iv) Chl a; (v) PC
- Detect spatial & temporal trends & attribute causes of change for 1000 lakes worldwide (1/3 of inland water, 2/3 of all inland water > 1km^2)
- Forecast lake sensitivity to environmental change
- Apply findings into lake management
- Tied PhD – Primary Productivity





Foundations

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GloboLakes

esa ARC Lake

chloroGIN

NEODAAS
NERC Earth Observation Data Acquisition and Analysis Service

espa ecosystem services for poverty alleviation

UKLEON
NERC Sensor Network Programme

GLEON
global lake ecological observatory network

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EUFAR European Facility For Airborne Research
Remote sensing & bio-optical properties of phytoplankton blooms in Lake Balaton, Hungary

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E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL
EHH: Strategies to monitor toxic cyanobacterial blooms in lakes

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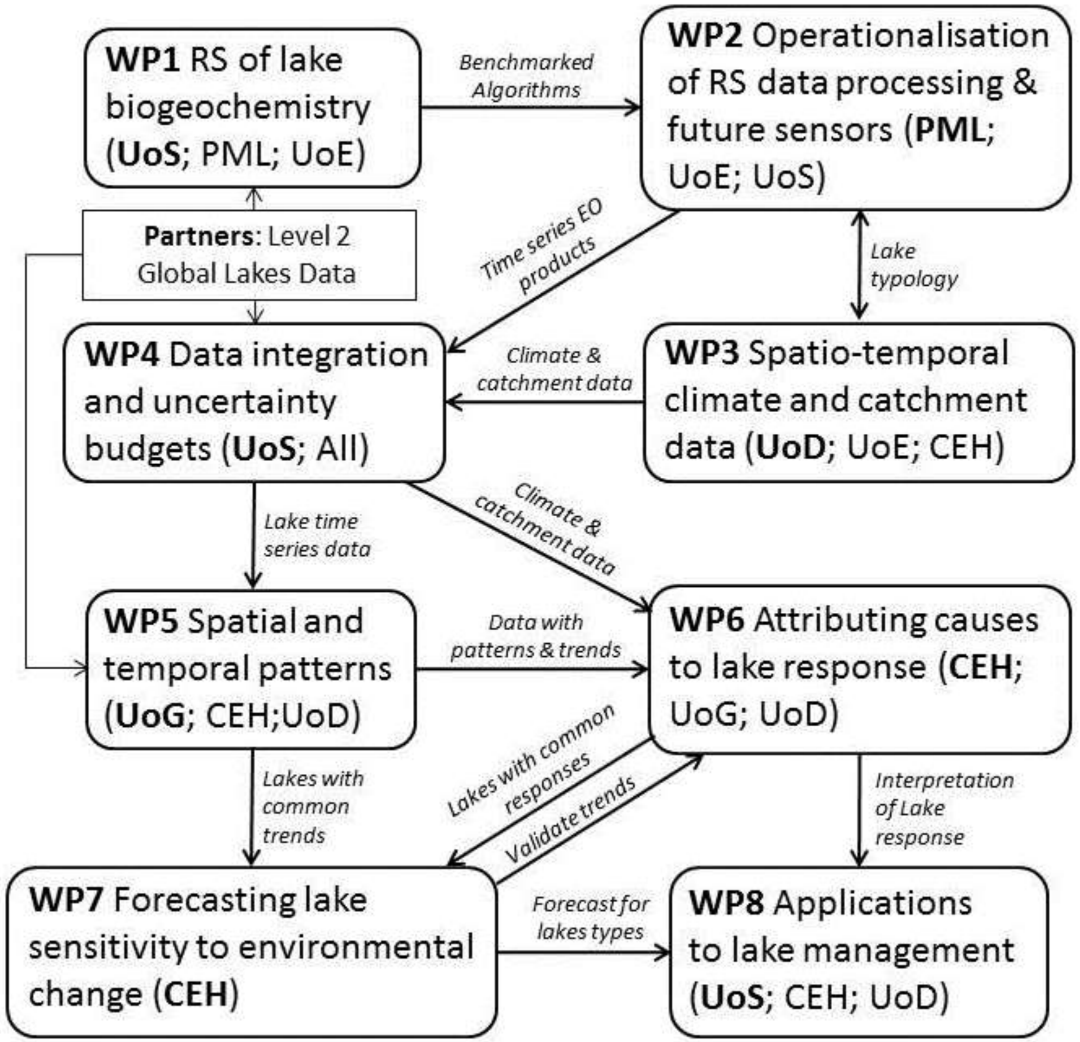

Work package Structure

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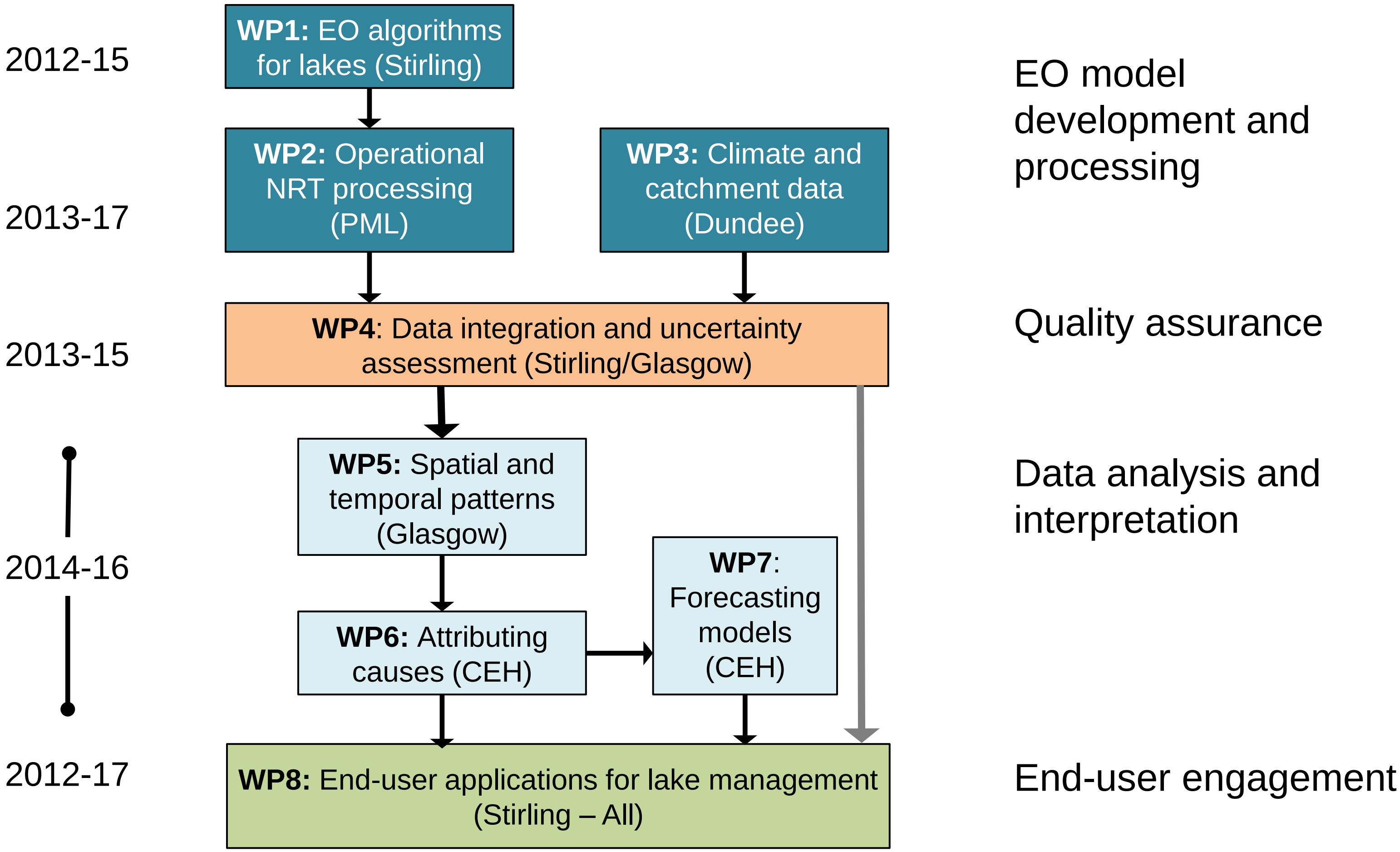

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Gantt Chart Start Date: 1 October 2012 Duration: 60 Months End Date: 30 September 2017

WP	Tasks	Year 1				Year 2				Year 3				Year 4				Year 5			
	month of project activities	1 - 2 - 3	4 - 5 - 6	7 - 8 - 9	10 - 11 - 12	1 - 2 - 3	4 - 5 - 6	7 - 8 - 9	10 - 11 - 12	1 - 2 - 3	4 - 5 - 6	7 - 8 - 9	10 - 11 - 12	1 - 2 - 3	4 - 5 - 6	7 - 8 - 9	10 - 11 - 12	1 - 2 - 3	4 - 5 - 6	7 - 8 - 9	10 - 11 - 12
WP1	**RS Algorithm Development**																				
D1.1	Space-time variability in lake optical properties								D1.1												
D1.2	Intercomparison and benchmarking of algorithms								D1.2		D1.2										
D1.3	Ensemble algorithm for global scale operation										D1.3										
D1.4	Extend ARC-Lakes LSWT data set								D1.4												
WP2	**Algorithm Operationalisation**																				
D2.1	Automated data processing Chain											D2.1									
D2.2	Consistent MERIS and Sentinel 3 data sets																D2.2				
D2.3	Operational Global Lakes Observatory													D2.4							
D2.4	Archived Data dissemination																				D2.4
D2.5	LSWT time series 1991-2007																				D2.5
WP3	**Climatic & Nonoclimatic Drivers**																				
D3.1	Selection of sentinel lakes	D3.1																			
D3.2	Datasets of long term trends in climatic variables			D3.2																	
D3.3	Characterisation of landcover/land use trends									D3.3											
D3.4	Modelling run off, sediment & nutrient inflow												D3.4								
D3.5	Hydromorphological alteration assessment							D3.5													
WP4	**Data Integration & Uncertainty Budgets**																				
D4.1	QA'd intercomparable and documented datasets								D4.1				D4.1								
D4.2	Measures of uncertainty on lake observations								D4.2												
D4.3	Uncertainties with catchmen and climate drivers		D4.3						D4.3		D4.3		D4.3								
D4.4	Measures of uncertainty on EO products												D4.4								
WP5	**Detecting Spatial and Temporal Patterns**																				
D5.1	Inventory of lake condition > 1000 global lakes												D5.1								
D5.2	Indentification of long term patterns of change																	D5.2			
D5.3	Identification of clusters of common signals																	D5.5			
D5.4	Identification of non conforming lakes																	D5.6			
WP 6	**Attributing Causes of Lake Response**																				
D6.1	Causes of coherence for different senssed lakes characteristics																				D6.1
D6.2	Causes of phenological change																				D6.2
D6.3	Factors controlling cyanobacterial blooms																				D6.3
D6.4	Assessment of factors controlling CDOM																				D6.4
WP 7	**Interpretation and forecasting Lake sensitivity**																				
D7.1	The identification of lake types vulnerable																				D7.1
D7.2	Cyanobactria risk under a range of scenarios																				D7.2
WP 8	**Apply Data for Lake Management**																				
D8.1	Stakeholder requirements and research capabilities	D8.1						D8.1					D8.1								D8.1
D8.2	UK wide understanding of change in lake condition	D8.2						D8.2					D8.2								D8.2
D8.3	Future threats to lakes at a global scale																				D8.3
D8.4	A sustainable future for Globolakes																				D8.4
Project Meetings (T = Teleconference; M = meeting)																					
	GloboLakes Team)	M	T	T	T	M	T	T	T	M	T	T	M		T	T	T	M	T	T	M
	Project Advisory Board	M				M				T			M					T			M
Dissemination of Outputs																					
DO.1	Project Web Site	DO.1																			
DO.2	News Letters	DO.2				DO.2				DO.2				DO.2				DO.2			DO.2
DO.3	Publications																				
Impact Plan																					
DI.1	Project launch	DI.1																			
DI.2	End User Workshops	DI.2											DI.2								DI.2
DI.3	Partners Workshop Calibration	DI.3							DI.3				DI.3								DI.3
DI.3	Partners Workshop Validation												DI.4				DI.4				DI.4
DI.4	Secondments				DI.5					DI.5								DI.5			
	KEY		Workpackage effort			D1.1	Timing of individual components and month of deliverable, i.e. D1 (e.g. start, mid or end quarter)														

Lake Data

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Level 1 UK Lakes
Intensive field campaigns to evaluate & benchmark EO algorithms

UK study lakes (**UoS**; CEH; PML; UoE)

Hydrolight computations; atmospheric corrections, adjacency effect correction (**UoS**; PML; UoE)

Testing *Refining*

Level 2 International Lakes
Validation of most promising algorithms using partner data sets from contrasting lakes

Validation data:
UK; Belgium; Estonia; Hungary, Italy; Spain
USA; Canada; Australia; South Africa

High temporal resolution buoy data
UKLEON – NERC funded buoy sensor network
GLEON – NSF funded international buoy sensor network

Group on Earth Observation (GEO) Coast & Inland Waters: Network
ChloroGIN: Network
ARC-Lake user group

Output

Level 3 Global Time-Series
>1000 lakes & 20 years

GloboLakes WP1

Existing data from partners

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WP4: Uncertainty budgets

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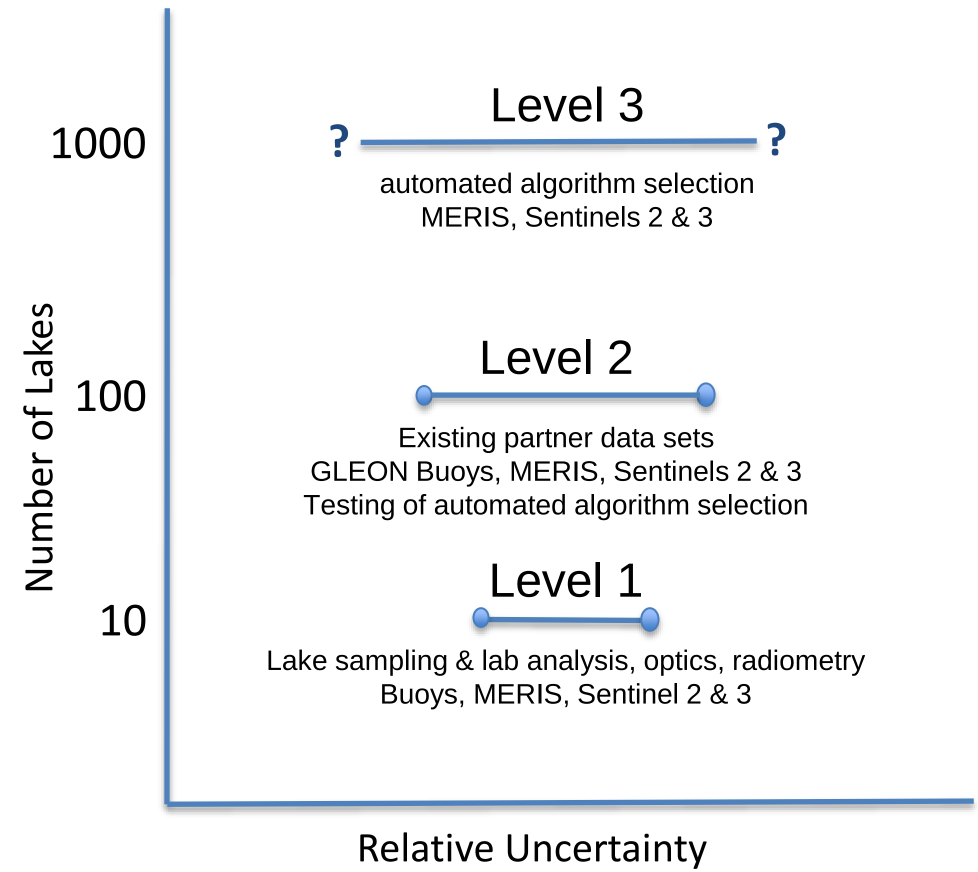
Aim: Construct uncertainty budgets for each of the different data sources to incorporate in the EO calibration

4.1 Estimation of errors & uncertainties associated with in-situ data sets of lake state & condition for EO validation

4.2 Full assessment of errors & uncertainties associated with the generated EO products as inputs into WPs 5 & 6

Observation	Method: uncertainty estimation & QA
Lake	ISO methods, heterogeneity, preservation, calibration, maintenance
Lab	preparation, analytical technique for each determinant, intercomparison
EO	processor flags, comparison across observation types: Bayesian hierarchical models, Berkson errors



Impact

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Beneficiaries

Regulatory Agencies
Environment Agency
Scottish Environment Protection Agency
Northern Ireland Environment Agency

Conservation Agencies
Joint Nature Conservation Committee
NE, SNH, CCW, Broads Authority
Council for Nature Conservation and Countryside

Government and NGOs
DEFRA, Scottish Government
DFID – Global Health Programme
WHO, UNESCO

Industry
Water Utilities

Impact Activities

Project Advisory Board
International Scientists
Regulators
Industry

Partner workshops
Calibration workshops
Validation workshops

Secondments
PDRAs and PhD with key beneficiaries

End Use Work shops
Beneficiaries

Media
Media Communications
Web page, News letters

Science days
Undertaken by PDRAs and PhD

Success of GloboLakes will rely on contributions from across the EO and end-user communities

- More than 20 scientific partners from over 15 nations
  - CSIRO, Australia; CSIR, South Africa; VITO, Belgium
  - Environment Canada; Estonian Marine Institute;
  - EC Joint Research Centre; CNR-IREA, Italy;
  - INTA, Spain; CUNY, USA; Creighton, USA
  - South Florida, USA; Institute of Limnology, Nanjing…
- Engagement with end-users including UK environmental regulators (EA, SEPA, NIEA)
- Engagement with UK National Centre for Earth Observation (NCEO), European Environment Agency, ESA and GEO

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Engagement

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Year	Year 1				Year 2				Year 3				Year 4				Year 5			
Quarter	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Project Advisory Board	M				M				M/ T			M					M/ T			M
Stakeholder																				
End User Workshops																				
Partners Calibration																				
Partners Validation																				

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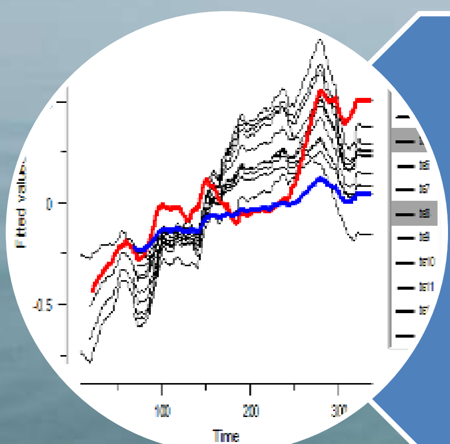
We all recognise:

- *Long-term data sets provide some of the most powerful tools that we have to describe ecosystem function, variation & resilience to environmental change*
- *For Lakes – a critical interface with society – Earth Observation provides a powerful approach to monitor lakes globally*



GloboLakes will deliver:

- *Long-term data sets across the globe*
- *Consistent measures of physical & biological condition*
- *Data enabling hypotheses on processes that operate over large scales & long time frames to be tested*
- *Data for the effective and sustainable management of these dynamic environments*

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