Uses and challenges of Earth observation data for inland water quality: A GloboLakes perspective

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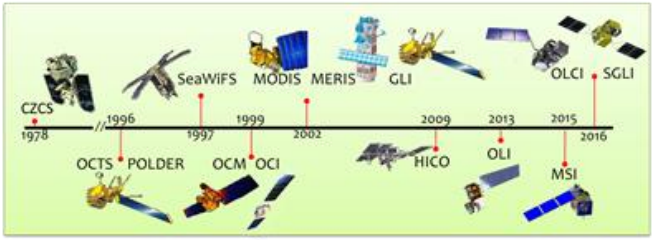
Global Observatory of Lake Responses to Environmental Change

UNIVERSITY OF STIRLING
CEH Centre for Ecology & Hydrology NATURAL ENVIRONMENT RESEARCH COUNCIL
PML Plymouth Marine Laboratory
University of Glasgow
University of Dundee
University of Reading
NERC SCIENCE OF THE ENVIRONMENT

Lakes are under increasing pressure from climate and other drivers of environmental change

- ~117 million lakes globally: 3% of land area but 85% of fresh surface water
- Global concerns over water security and provision of critical ecosystem goods and services
- Important to global biogeochemical cycles (e.g. Bastviken et al. 2011, *Science*) and biodiversity
- Very small proportion routinely monitored in a consistent manner
- Increasing regulatory demands for status assessment (e.g. EU Water Framework Directive)

- Free access to 10-year archive data of Envisat MERIS FR
- L8 OLI potential for smaller lakes
- Forthcoming launch of ESA S3 OLCI/SLSTR & S2 MSI; NASA PACE etc.
- 'Big Data' processing capabilities increasing rapidly
- New EO algorithms for optically-complex waters
- Approximately synchronous projects on EO of inland waters

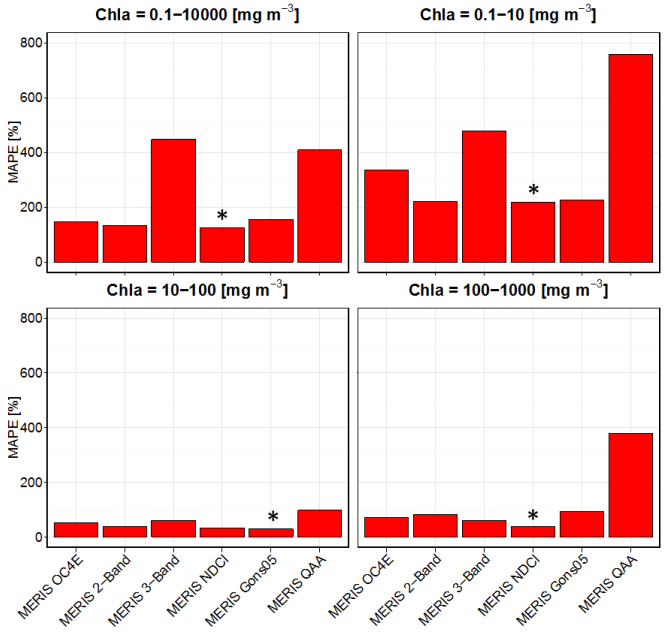


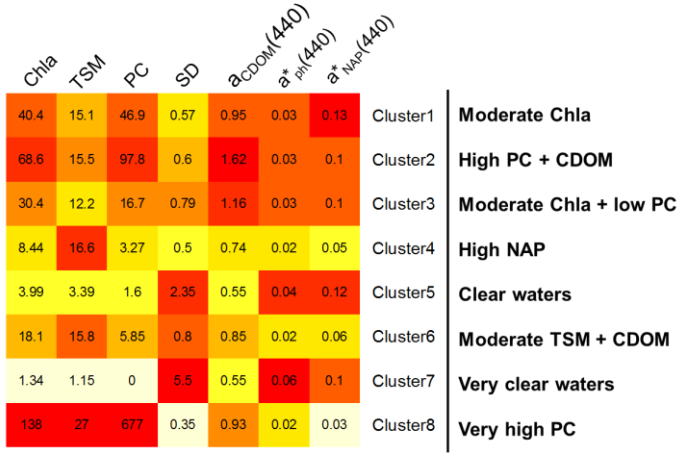
L-8 OLI (24-12-2014): RGB – Rayleigh corrected

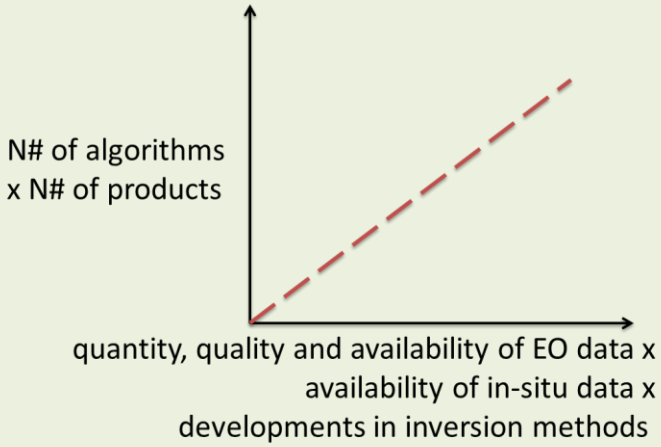
diversity inland waters
esa
GLaSS
GloboLakes
NERC
earthH2Observe
INFORM
CyAN

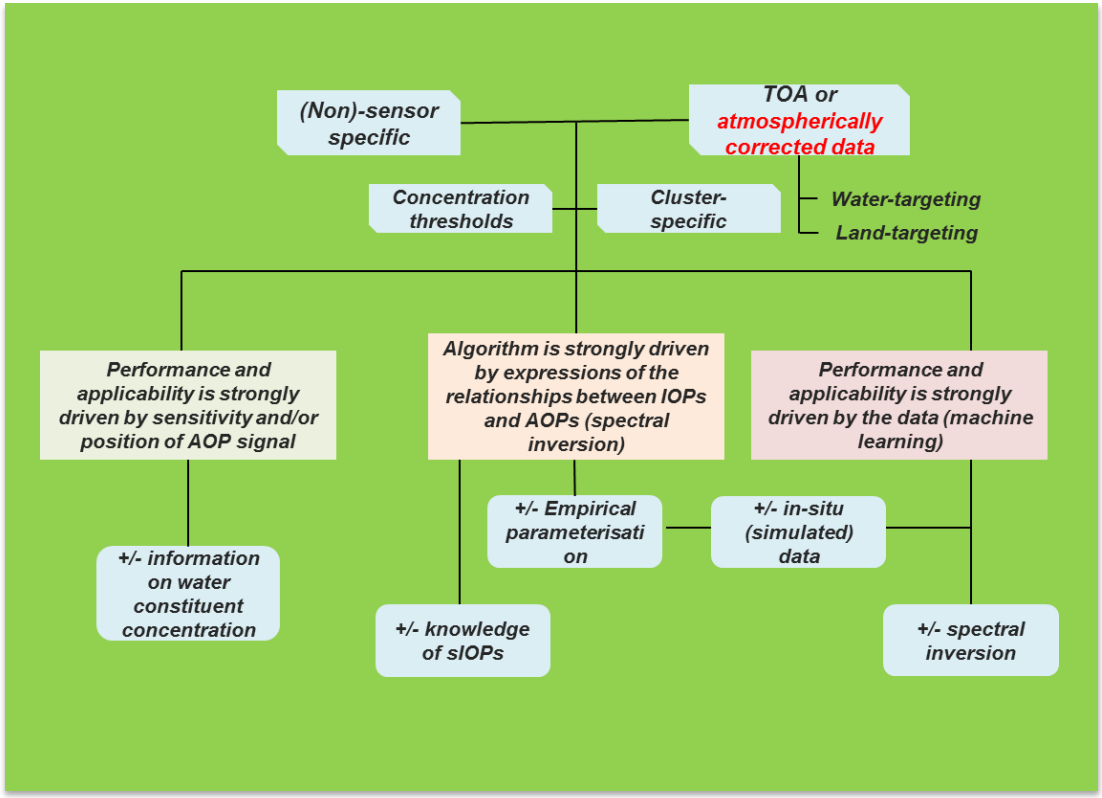
EO key challenges:

- No standard global physical or biogeochemical EO products for lakes
- Standard OC algorithms perform poorly in optically-complex lake waters
- Diversity in retrieval algorithms & validation approaches
- Inland water remote sensing community appears fragmented
- What is the “global” variability in lake OWTs?









- Subject to EO scientists – end users
- Subject to benchmarking and characterisation

End-users key challenges:

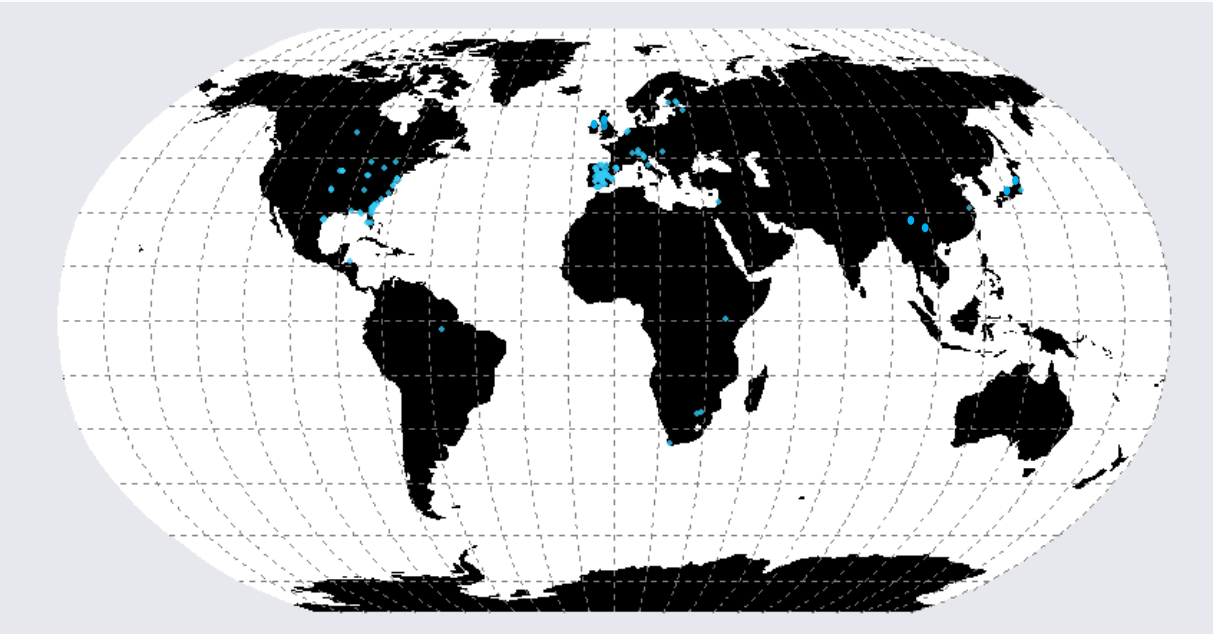
- How to overcome the intimacy with traditional methods?
- How to build confidence on the EO data (accuracy etc.)?
- EU Water Framework Directive (next revision cycle in 2021)

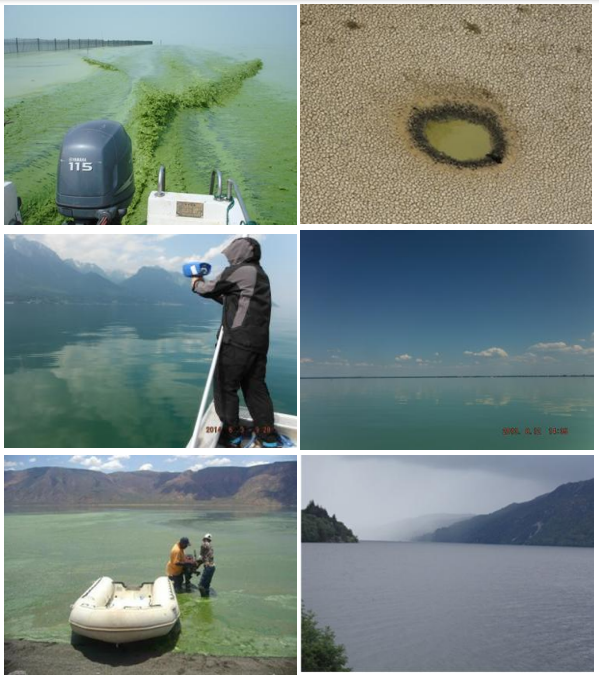
~ M€ 6-11 annual cost to implement WFD in UK and Netherlands (Nocker et al., 2007)
~ M€ 6-9 for Norway, Sweden and Finland (Halleraker et al., 2012)

WISER

	M-GIG
Chl-*a*	3 Months for 3 years
PTI	3 Months for 3 years or 1 month for 6 years
Cyanobacteria biovolume	1 Month for 6 years

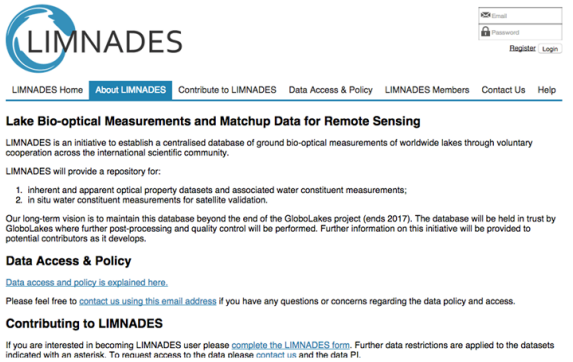
≈ €1 million for 400 lakes



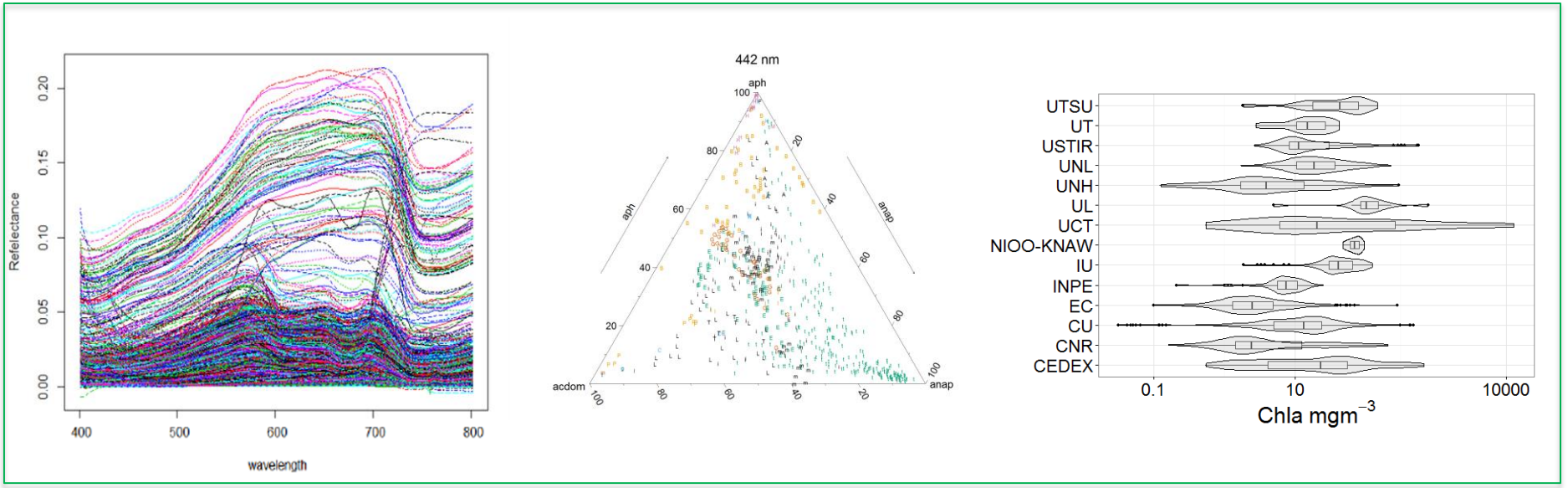


Photos provided by: Y. Zhang; E. Tebbs & A. Tyler

- "not only sql" **MongoDB**
- Data from almost **1500** lakes
- Radiometric data from **>3500** stations on **>250** lakes
- **>650** stations with *in situ* IOP data
- **Chla:** 0.03-13,297 [mg/m^3]; **TSM:** 0.15-2,533 [mg/L]; a_{CDOM}**(440):** 0.03-12.3 [1/m]
- MERIS match-ups



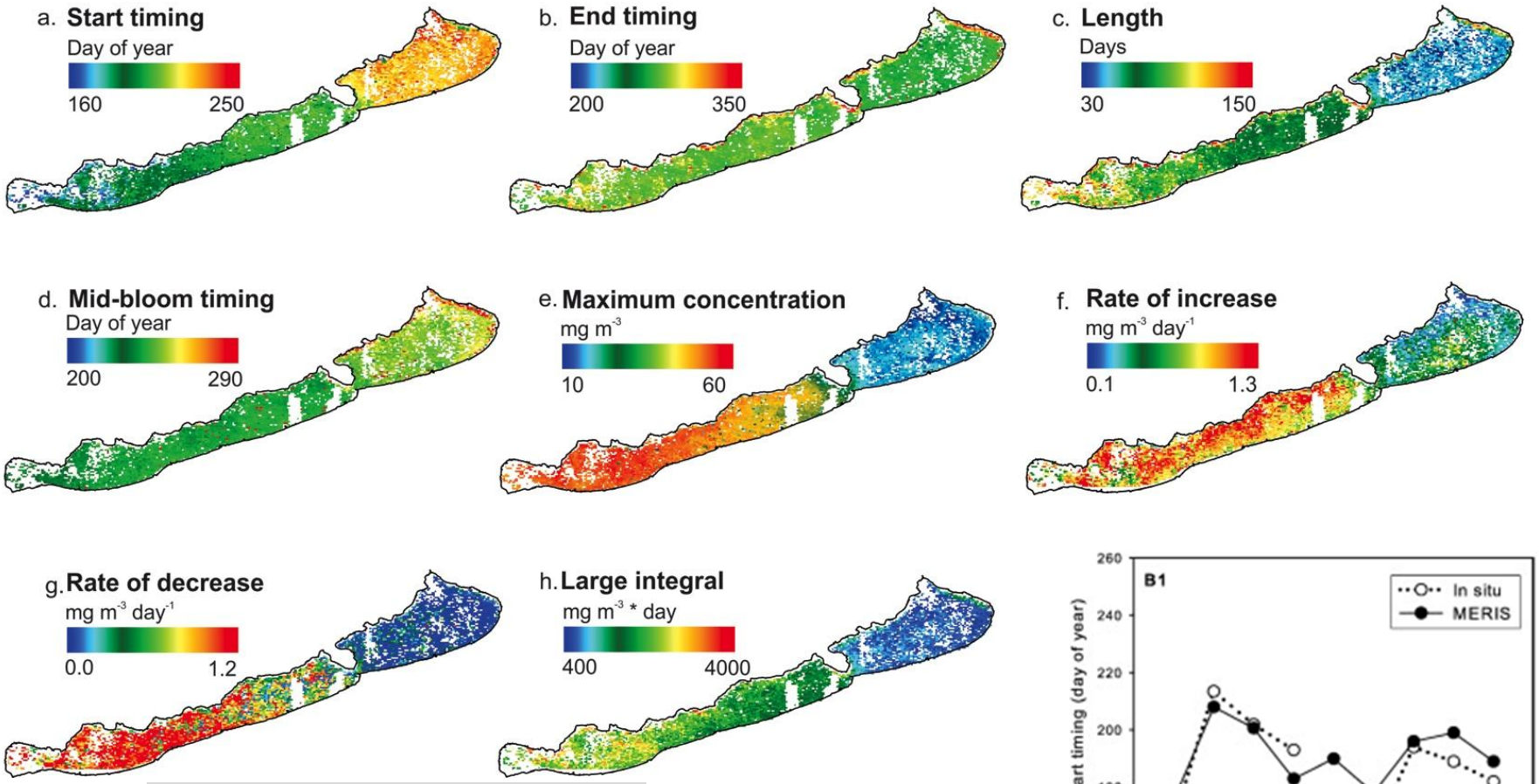
Credit: Celine Addie-Lagorio, Dr Kevin Swingler



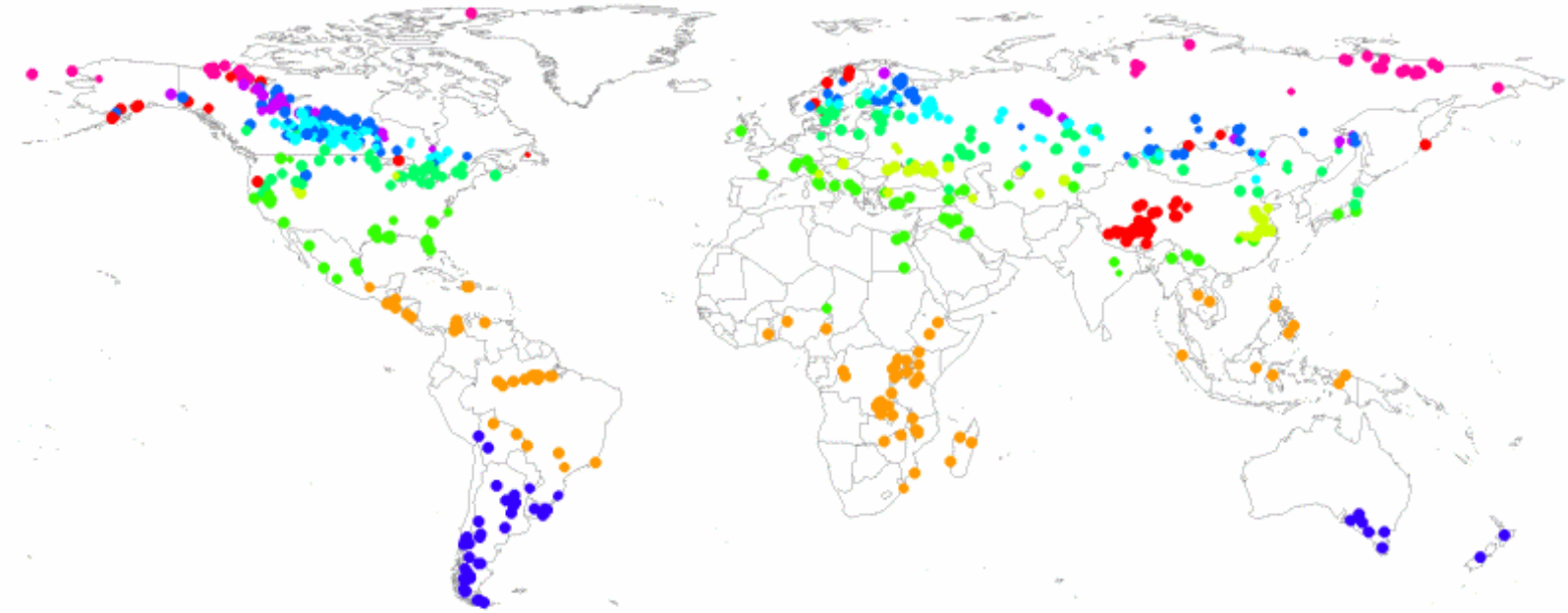
Need for:

- Standardisation of protocols and analytical methods (is this realistic?)
- Inter-comparison exercises (e.g. NERC INCIS-3IVE)
- Development of an (Dynamic/learning) ontology

2003 Summer bloom phenology features



Palmer et al. Remote Sensing of Environment, 158: 441-452



LWST cluster memberships based on model based clustering on the fPCA scores. The size of the points is proportional to the cluster membership probability

Credits to: GloboLakes (University of Glasgow) & ArcLakes (University of Edinburgh/Reading)

- Earth-observing satellites provide a powerful approach to monitor the status of lakes
- Cross-community cooperation is needed to support further algorithm development and validation activities
- LIMNADES is a large and growing database of bio-optical data for inland waters – please consider submitting your data…!

GloboLakes will provide:

- Long-term and consistent lake physical, biogeochemical and catchment data for 1000 lakes globally
- Data to enable hypotheses on processes that operate over large scales and decadal time frames to be tested and to underpin effective and sustainable lake management

- Carsten Brockmann, Daniel Odermatt and colleagues at Brockmann Consult and the ESA Diversity II project;
- NERC (UK Natural Environment Research Council), NERC Airborne Research and Survey Facility & NERC Field Spectroscopy Facility;
- LIMNADES contributors and other international project partners and advisory board members;
- Additional funding and collaboration with FP7 INFORM project and Hungarian TAMOP programme;
- MERIS data provided by the European Space Agency.

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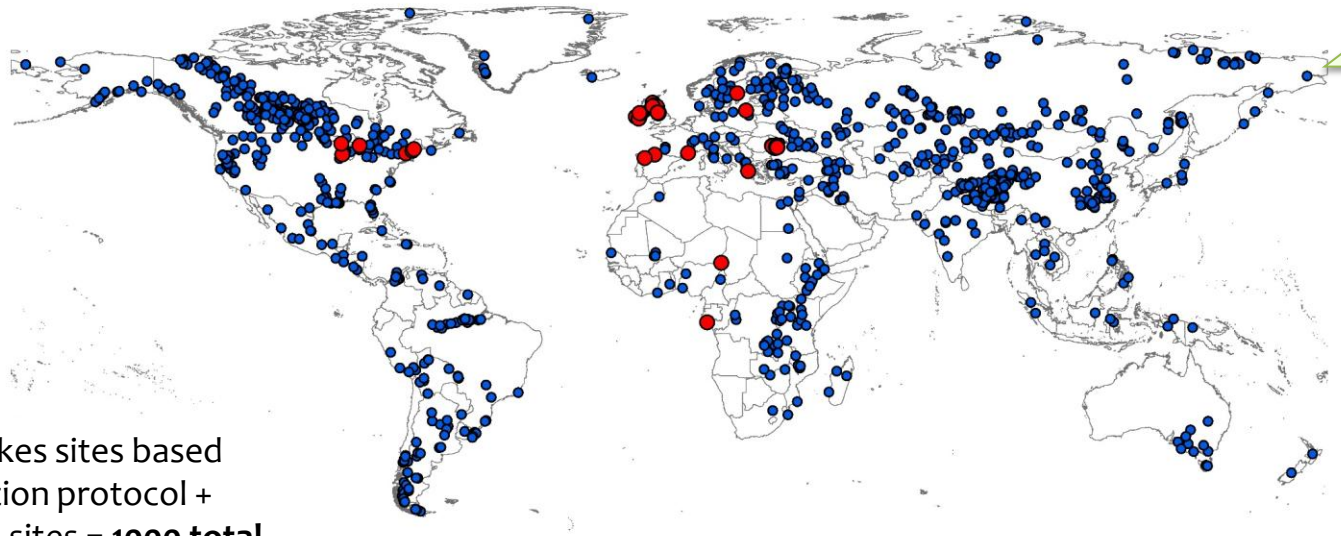
follow @globolakes

| Lake selection

GLWD Level-1 (3,721 water bodies) → R/S water mask → Water-mask-to-lake-area → No. of daytime R/S observations per year → Water body type → 960 lakes, lagoons + reservoirs



+ 40 additional lakes

960 GloboLakes sites based on site selection protocol + 40 additional sites = **1000 total**

| Catchment attributes & drivers of lake change*

* examples, list not exhaustive