Global seasonality of lake phytoplankton

Ellie Mackay, Steve Thackeray, Stephen Maberly, Laurence Carvalho, Claire Miller, Mengyi Gong, Marian Scott, Ruth O'Donnell, Eirini Politi, Mark Cutler, John Rowan, Stefan Simis, Peter Hunter, Vagelis Spyrakos & Andrew Tyler

Final project meeting, Stirling, 29th August 2018

GloboLakes

Global Observatory of Lake Responses to Environmental Change

Centre for Ecology & Hydrology — Natural Environment Research Council | University of Dundee | University of Reading | University of Glasgow | PML Plymouth Marine Laboratory | University of Stirling

Questions

At a global scale:

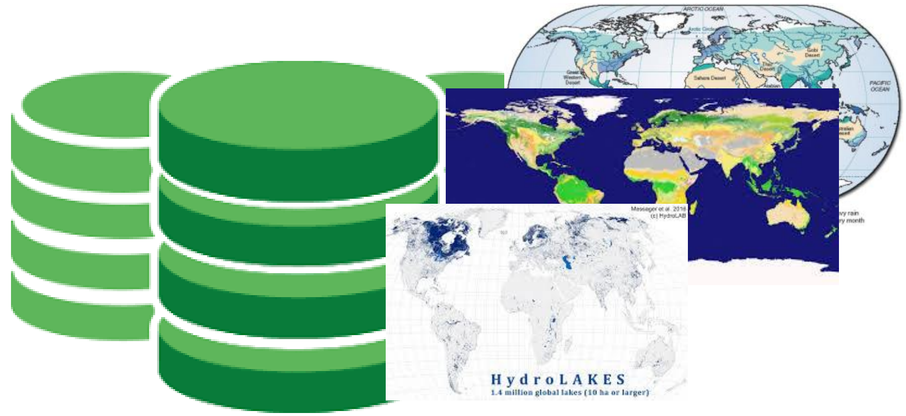
1. **Are there systematic variations in the availability of chlorophyll data?**

2. **What are the dominant seasonal patterns in chlorophyll concentration?**

3. **What are the key drivers of the seasonal variations in chlorophyll concentrations?**

Data

- Monthly observations of chlorophyll from the Calimnos dataset (Meris data).
- No chlorophyll concentration cap
- All lakes initially retained (n = 1000)
- Data available from July 2002 to May 2012



- Driving data on climate, catchment and lake characteristics from University of Dundee database v.2.1

Chlorophyll seasonality analysis

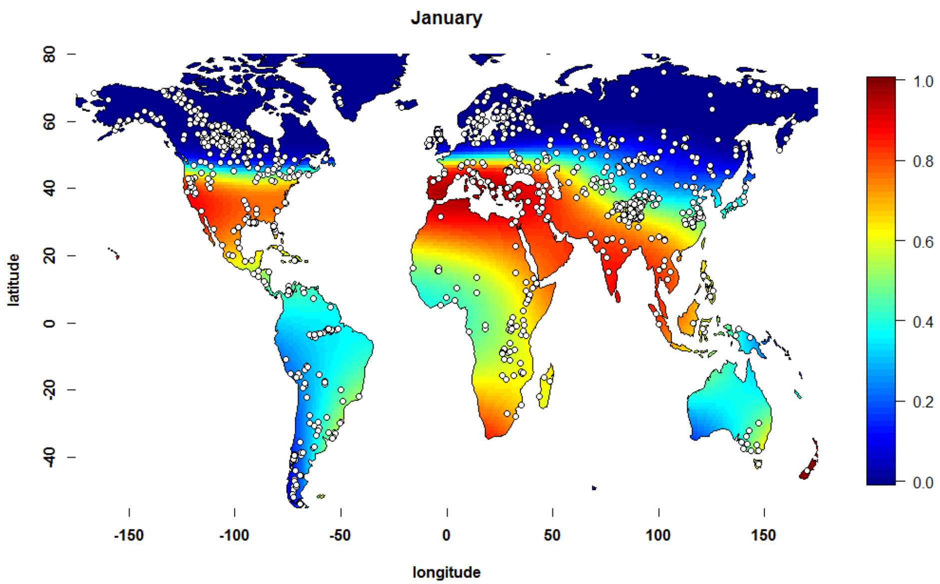
Chlorophyll seasonality analysis methods

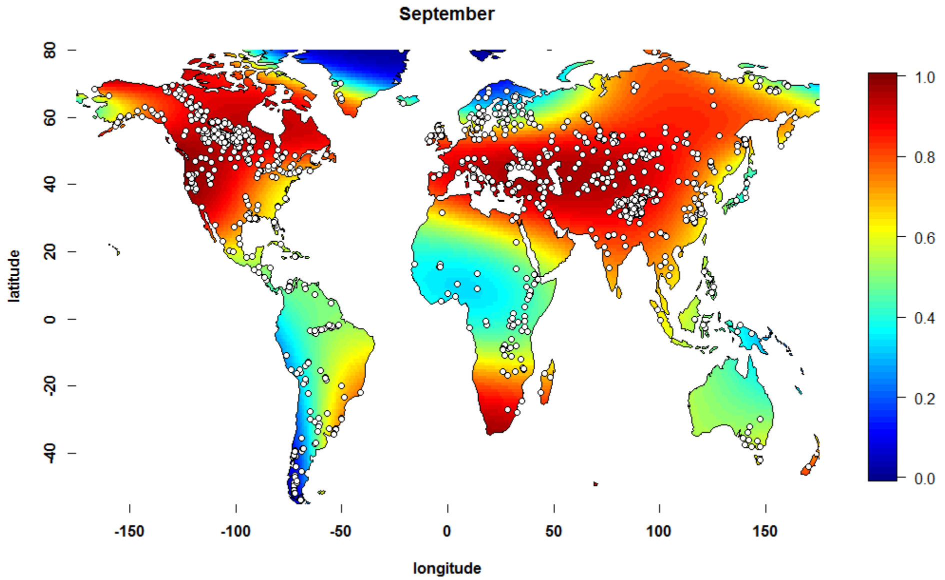
- **Data availability analysis**:
  - Binomial (data presence or absence) General Additive Model (GAM)
  - Smooth predictor terms for year, month, lake area, lake depth, elevation, longitude and latitude

- **Seasonality analysis**:
  - Gamma (skewed continuous data) distributed GAM
  - Smooth 2d & 3d terms allow seasonality (month) to interact with environmental variables
  - Model weighted according to data availability

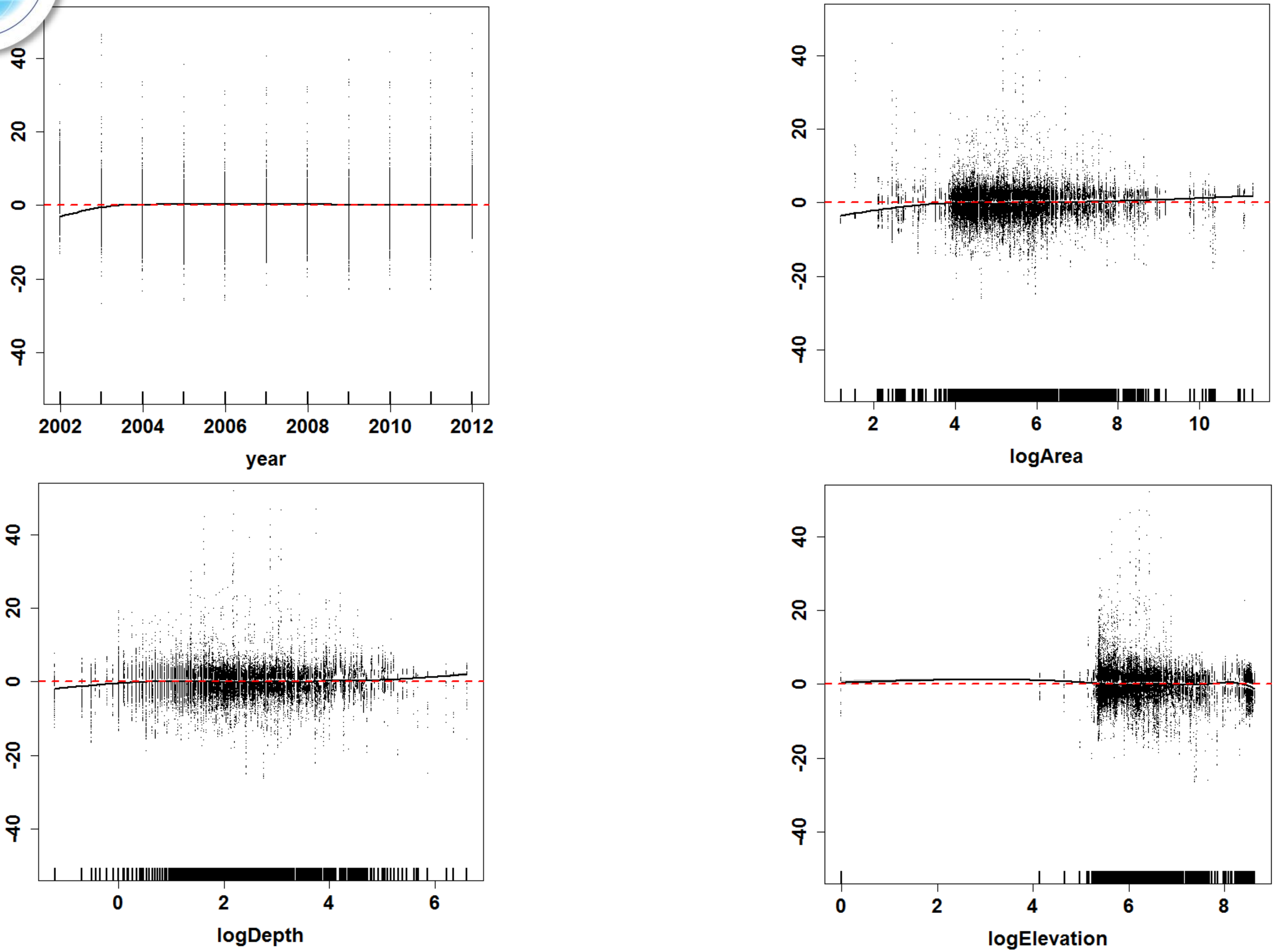
- **Drivers of seasonality**:
  - Drivers grouped into categories: geography, lake characteristics, climate and land use to enable comparison across groups
  - Glasgow University attribution of seasonality clusters

Results – Data availability across the globe





Data availability by time and lake characteristics

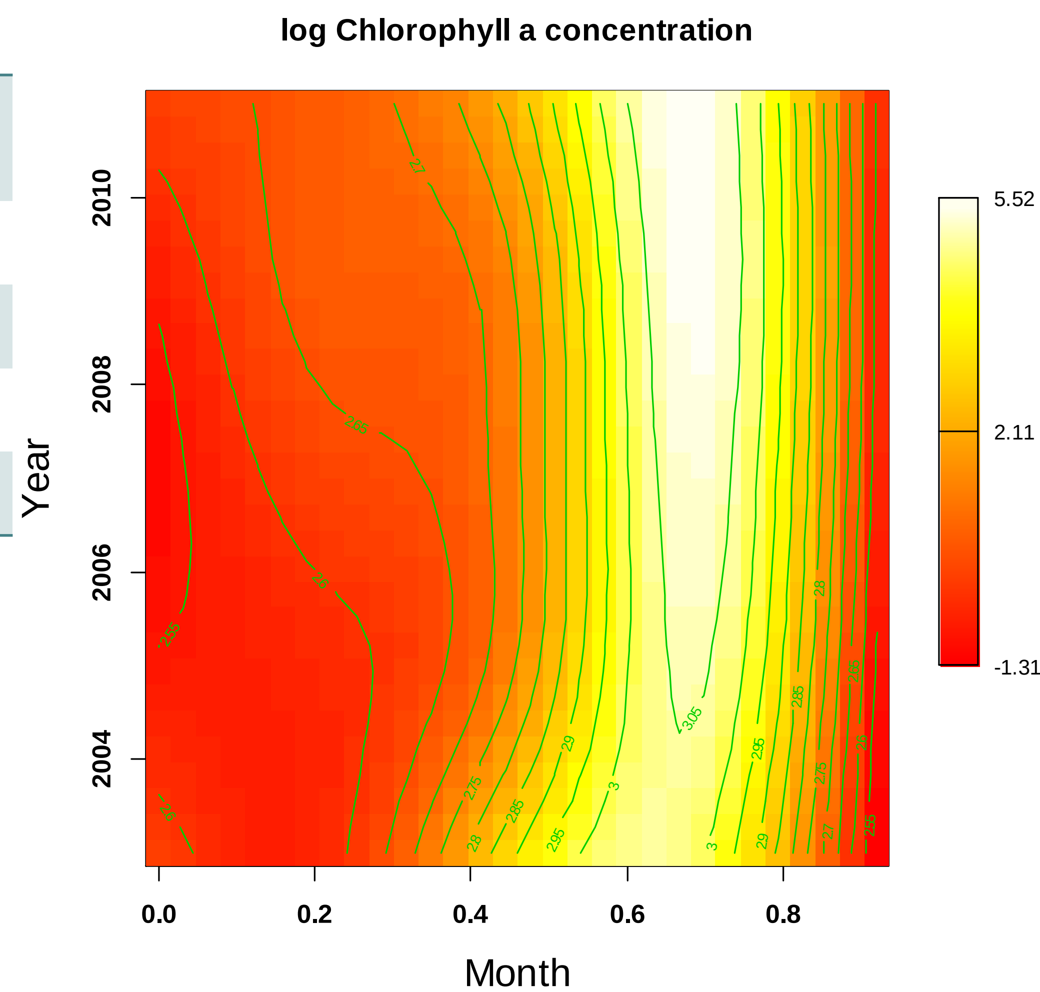


Results - Driver model comparison

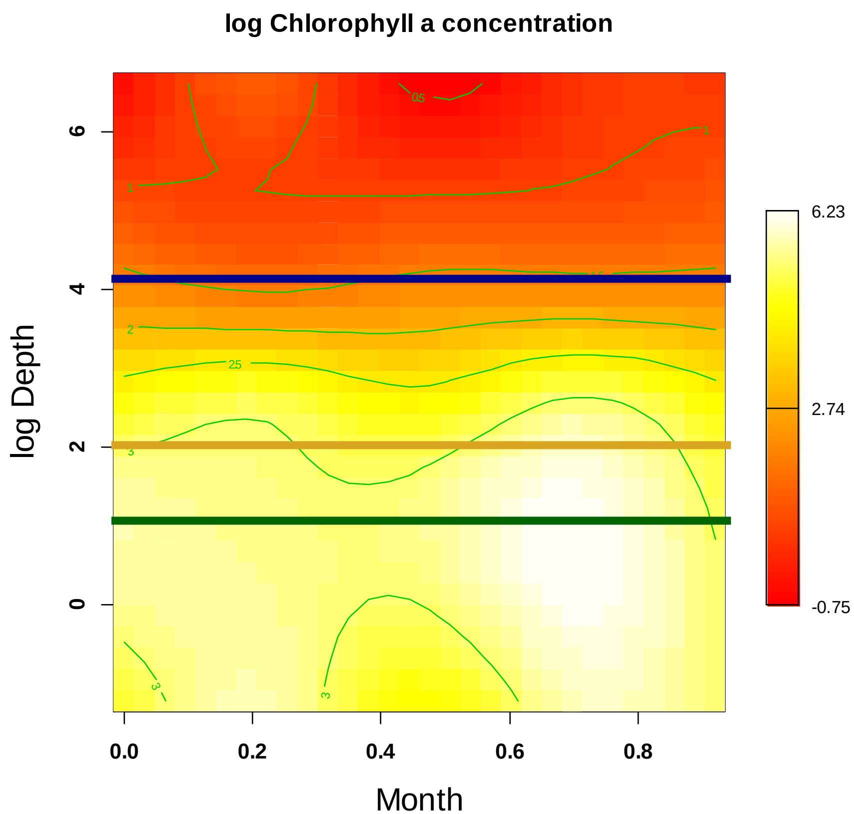
Model	AIC	Deviance explained
lake characteristics	265730.4	33.8%
geography	267616.5	31.2%
climate	275553.8	17.3%
land use	276952	14.7%
null	283096.1	2.1%

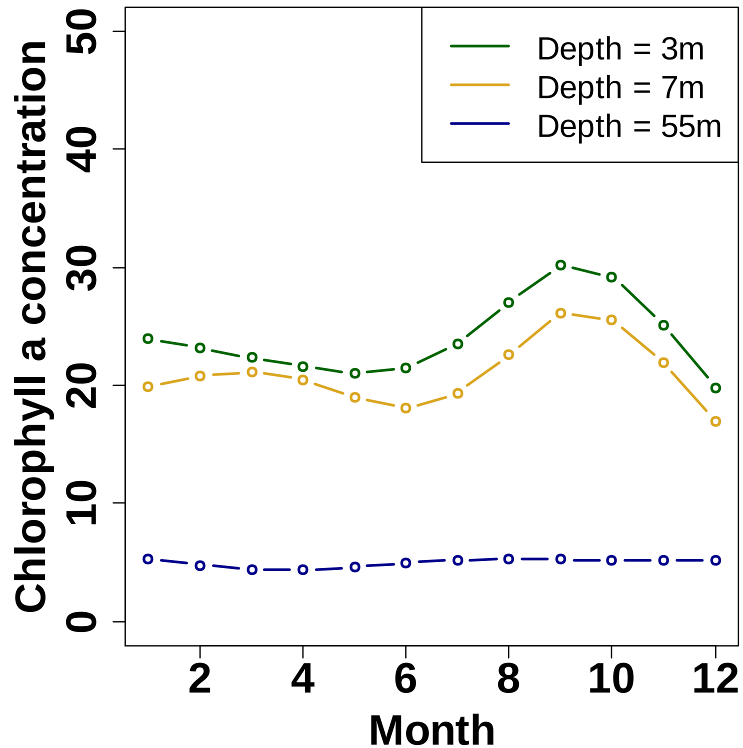
- Lake characteristics – area, depth, retention time
- Geography – latitude, longitude, elevation

Null model – year*month



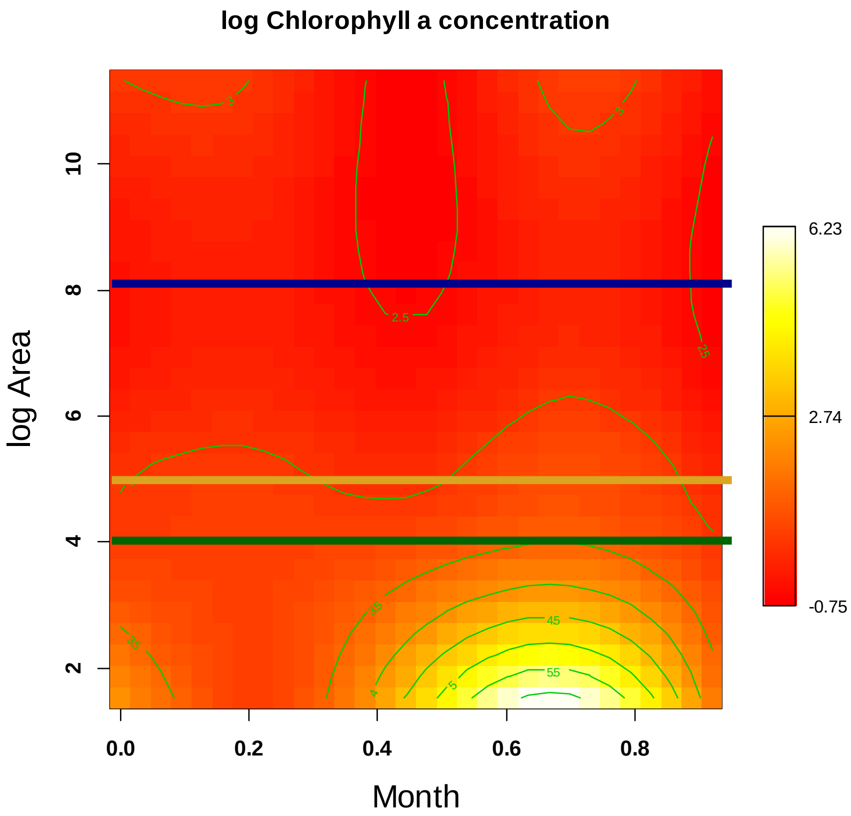
Results - Lake characteristics

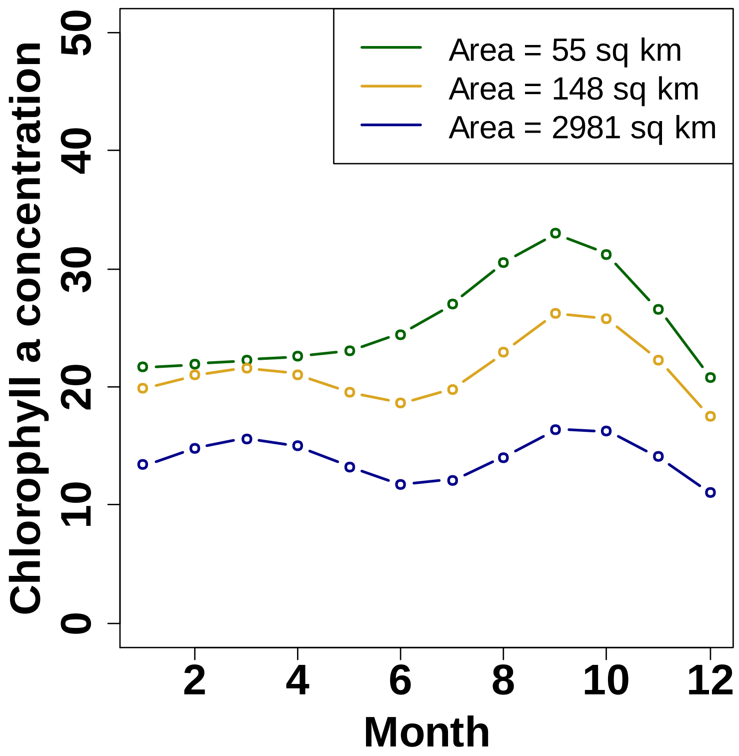




- Extracting seasonal patterns for 5th, 50th and 95th percentiles of the data

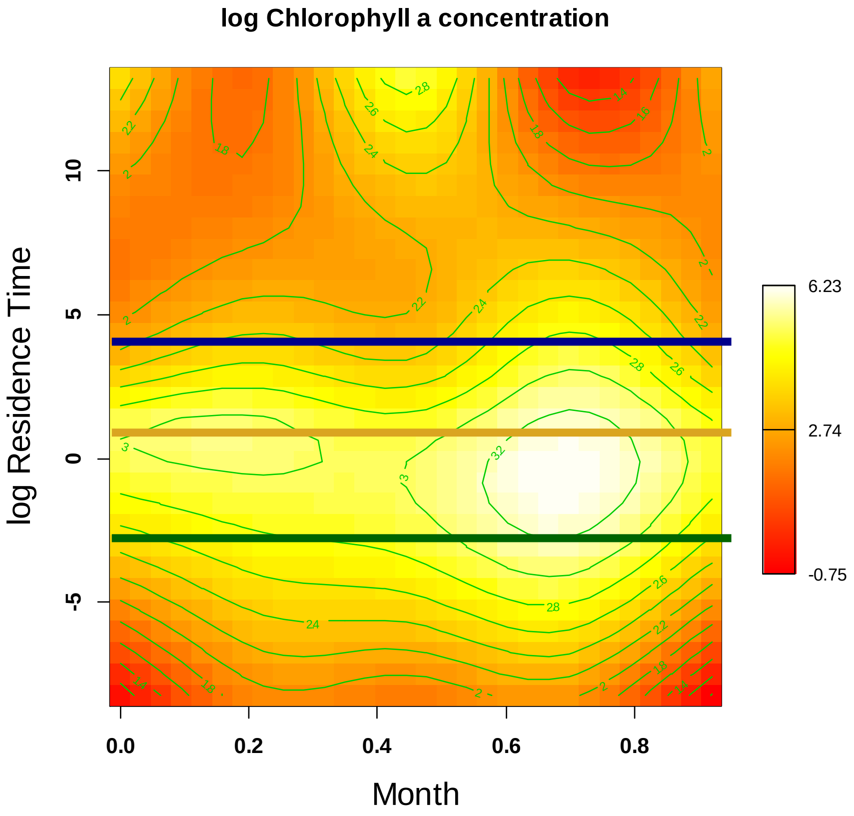
Results - Lake characteristics

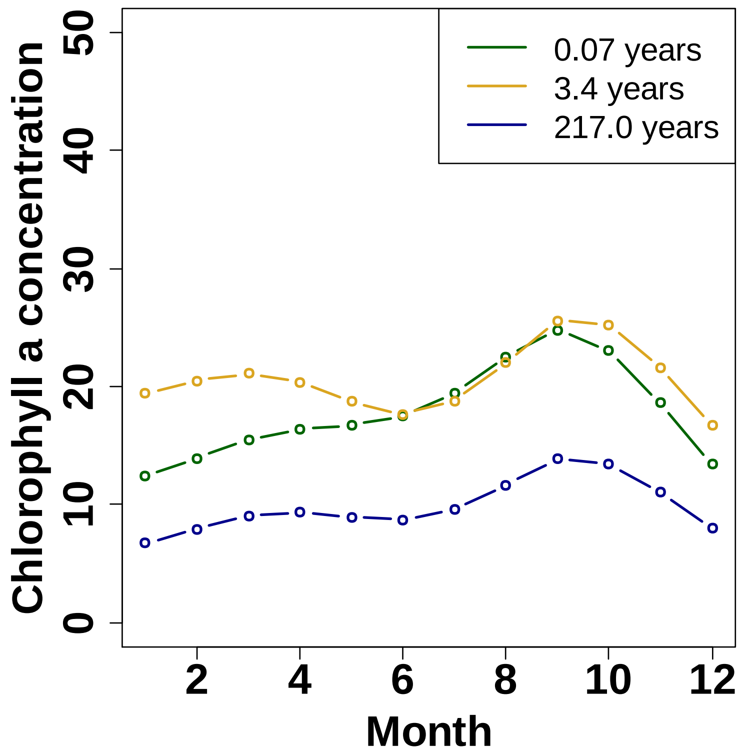




- Extracting seasonal patterns for 5th, 50th and 95th percentiles of the data

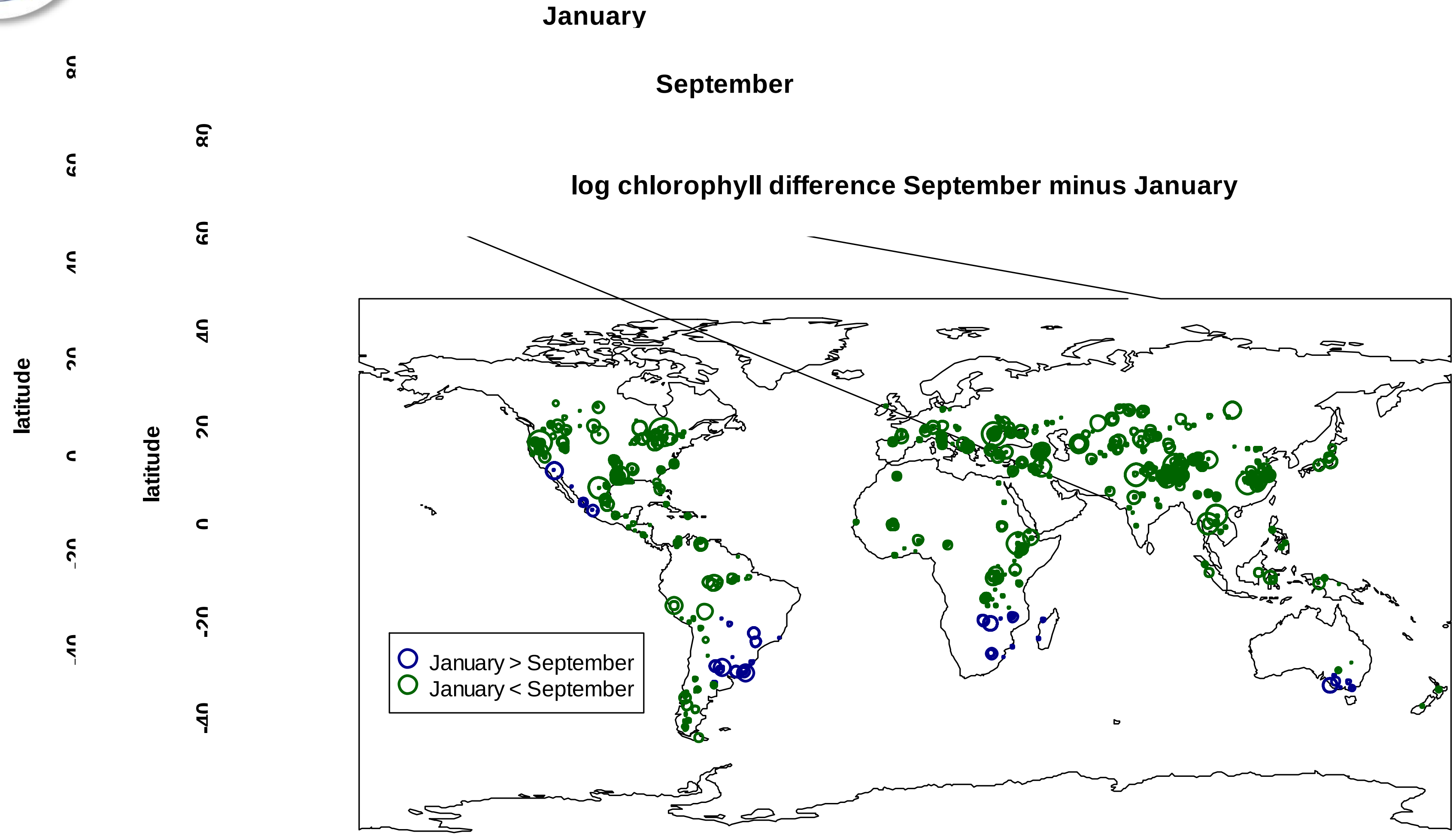
Results - Lake characteristics



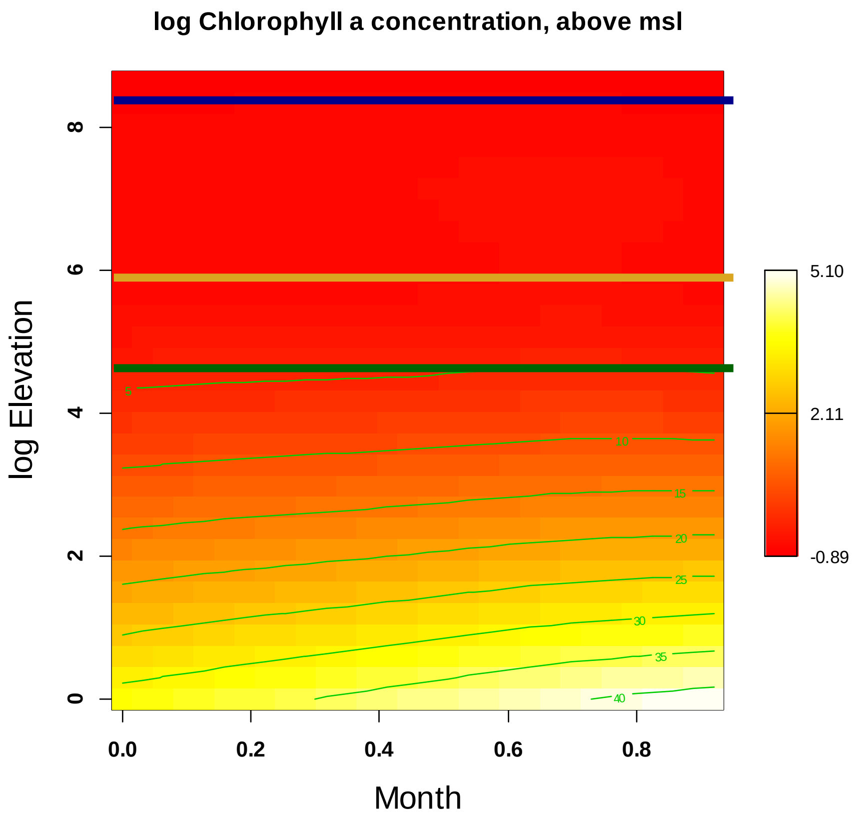


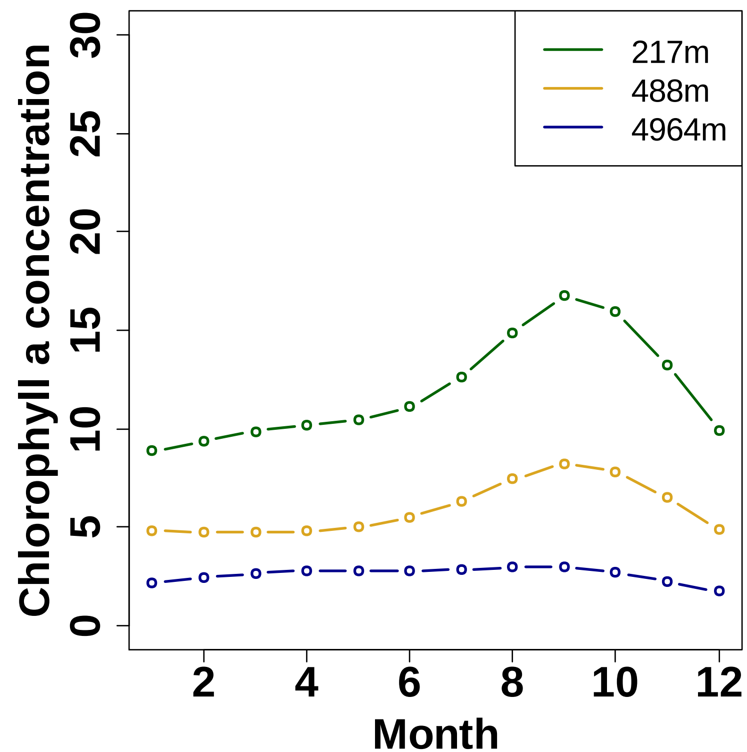
- Extracting seasonal patterns for 5th, 50th and 95th percentiles of the data

Results - Geographical patterns



Results - Elevation

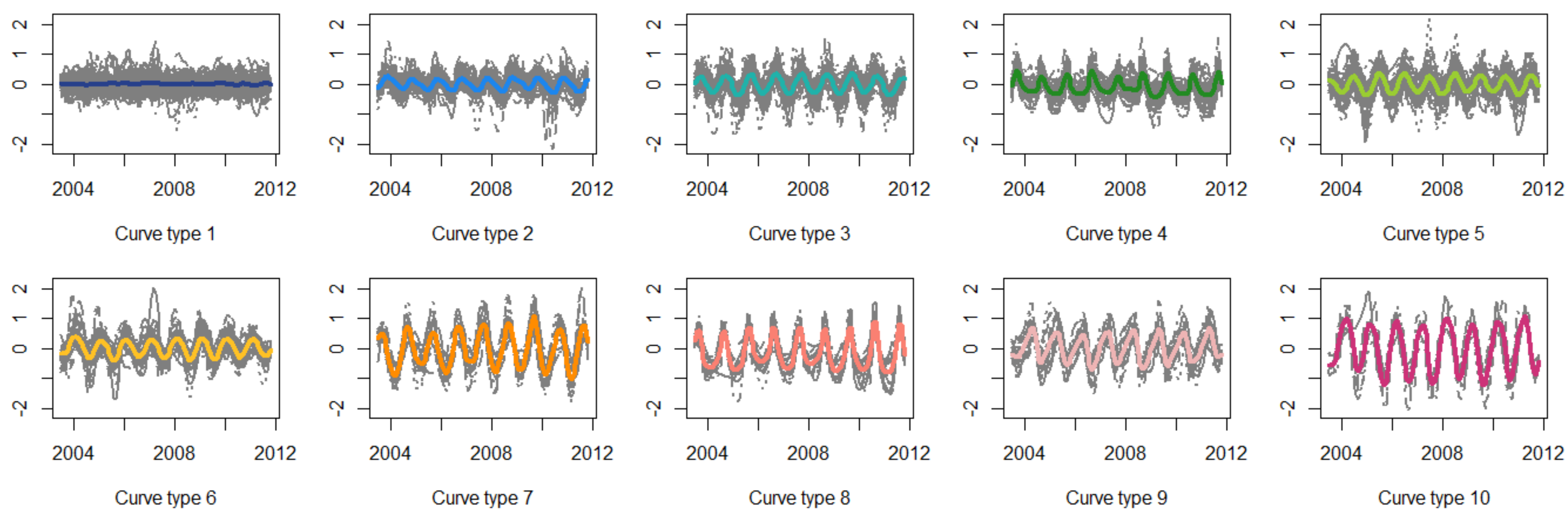




- Extracting seasonal patterns for 5th, 50th and 95th percentiles of the data

Results - key drivers of chlorophyll seasonality

- Smoothed Chl-a **seasonal signals** and cluster mean curves
- Attribution of cluster mean curves to drivers – what variables are important in explaining the different seasonal patterns?



Conclusions and future work

1. There are systematic patterns in data availability that need to be considered when interpreting the results.
2. Northern hemisphere lakes are dominating the overall seasonal signal.
3. The amplitude of chlorophyll seasonality varies with attributes of lake morphometry.
4. The geographical patterns in chlorophyll seasonality are complex.

Future work: combine drivers from different groups to identify best model(s) for describing global seasonality in chlorophyll

Acknowledgements

- Natural Environment Research Council (NERC) funding (grant no: NE/E009328)

- Thank you for listening

Contact: Ellie Mackay
Lake Ecosystems Group, Centre for Ecology & Hydrology
Email: ellcka@ceh.ac.uk
@DrEllie_Mackay

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