Integrating Earth observation products into numerical lake modelling to improve algal bloom forecasting

Cumbrian Lakes Research Forum

Maud Siebers

University of Stirling, Stirling, Scotland

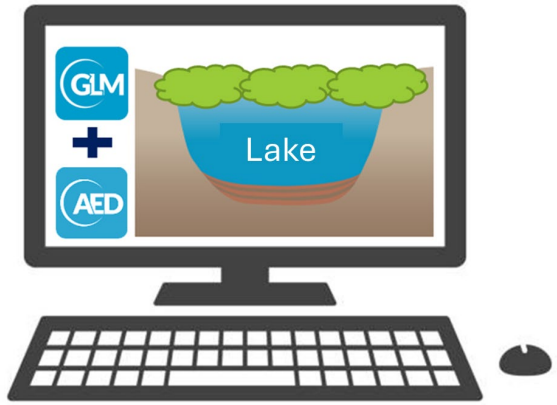
Supervisors: Peter Hunter, Ian Jones, Tom Shatwell
Contributors: Mortimer Werther, Eleanor Mackay, Linda May

This project has received funding from the European Union`s Horizon 2021 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 956623

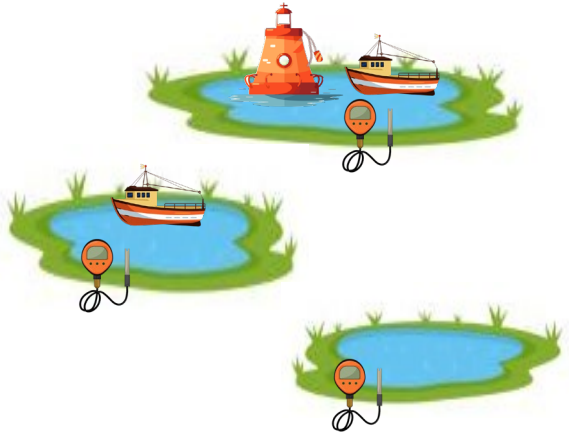
Background

Algae blooms

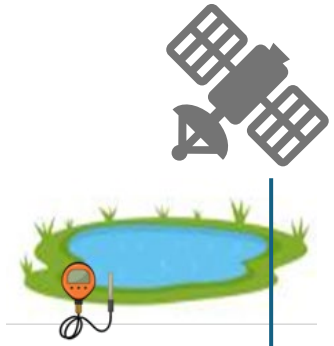
Models for mitigation



Data Availability

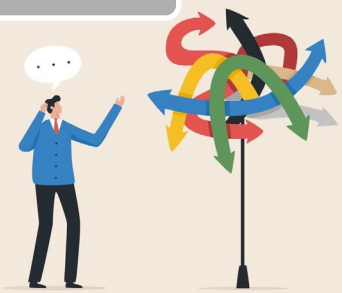


Satellite Earth Observation

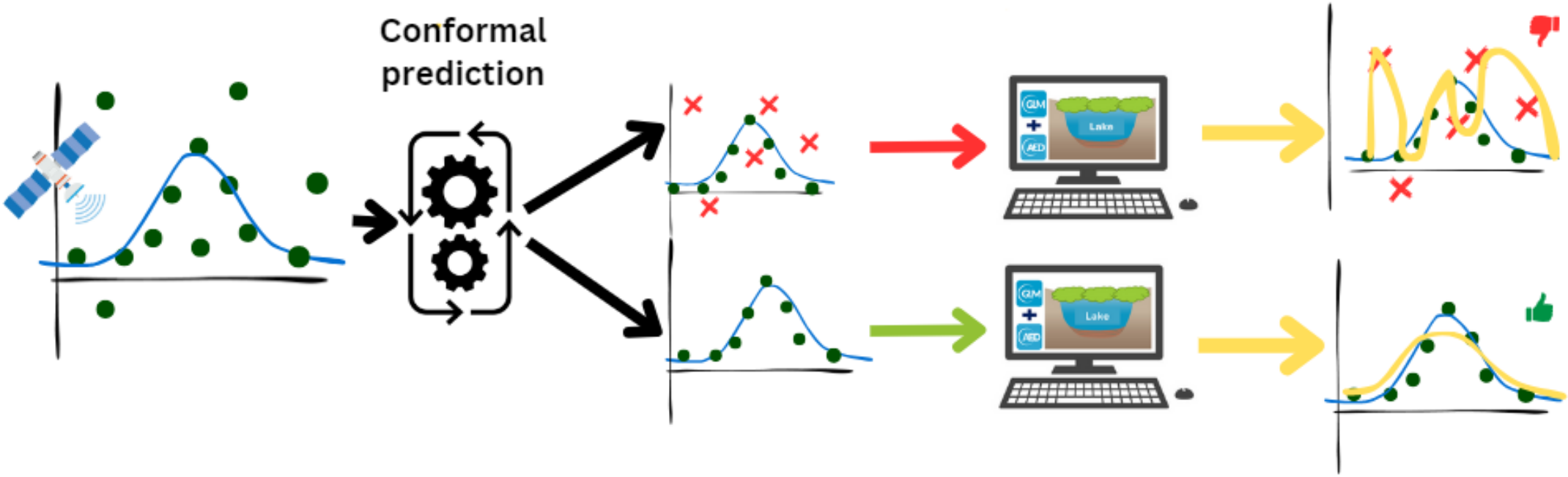


Atmospheric correction
Chl-a algorithms
Computing
.....

Uncertainties

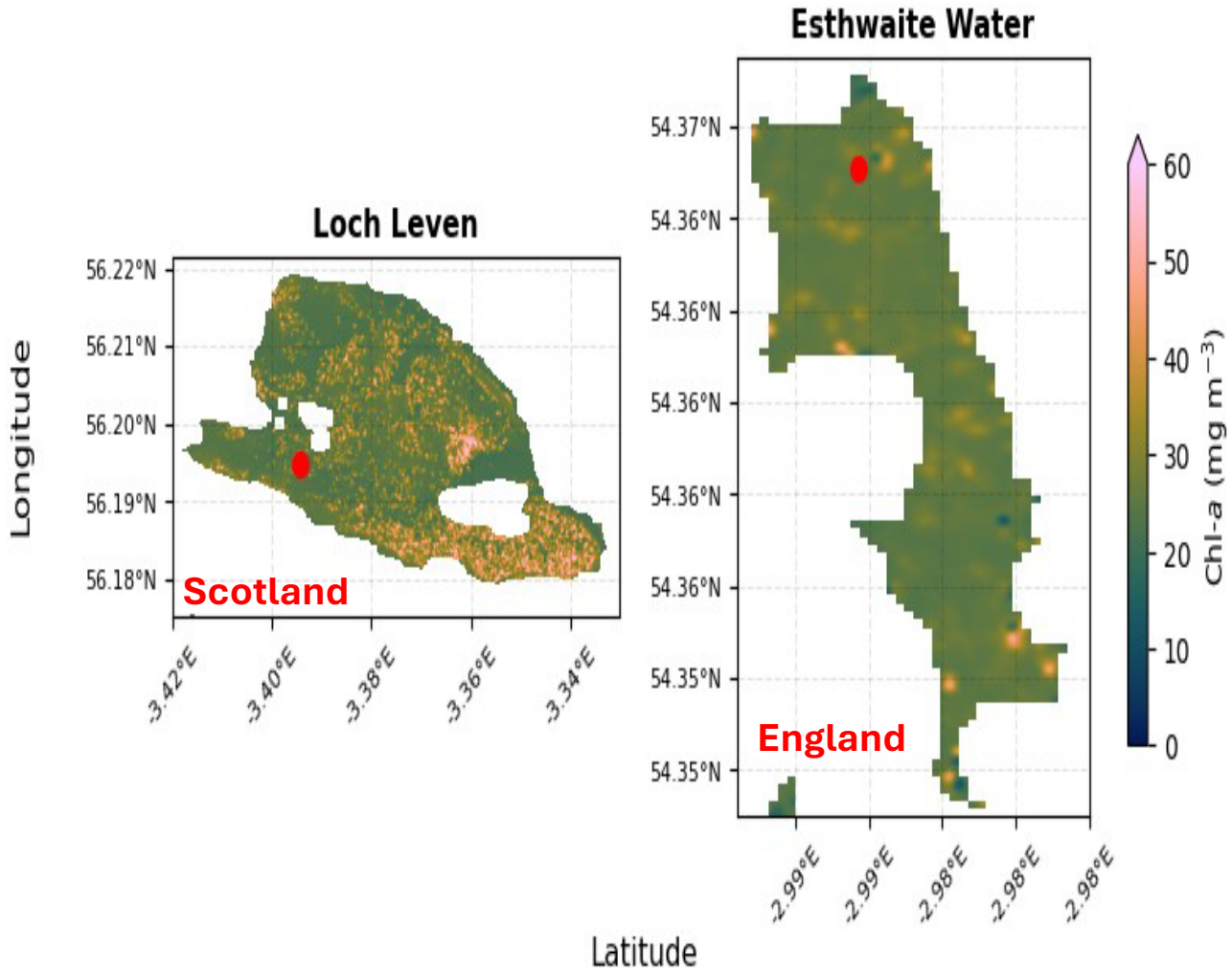


The plan



The Lakes

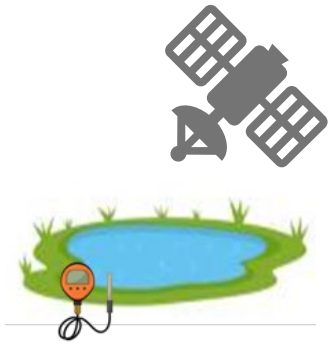
- Freshwater
- Algae blooms
- Not to deep



Methods

Earth Observation

Satellite data



Atmospheric Correction

Chl- a* Algorithms

**Chlorophyll a (Chl-a) is a proxy for Algae blooms*

Chl-a dataset

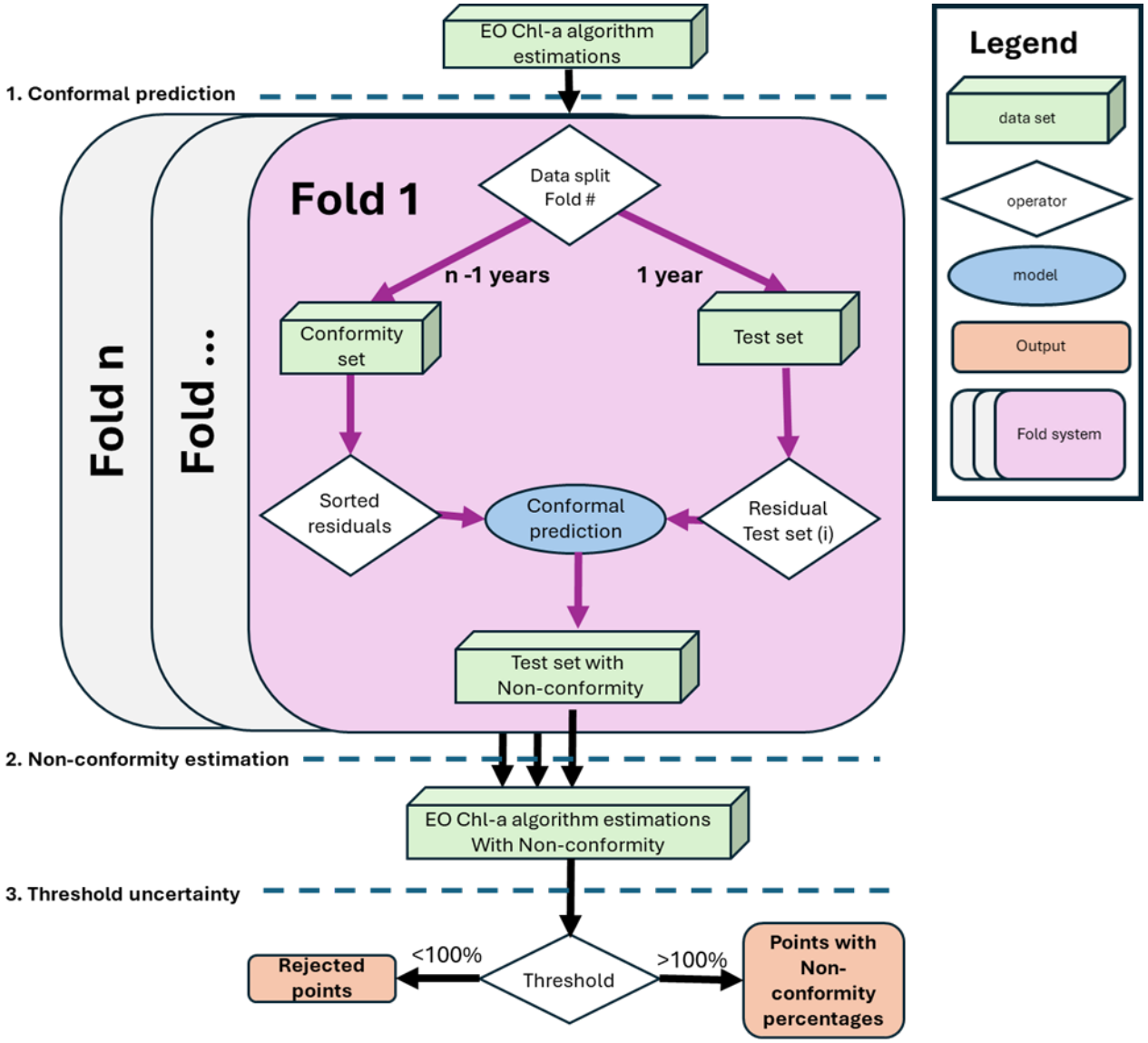
Date	Chl-a (mg/m3)	In Situ (Chl-a)
03-02-24	12.3	x
06-02-24	6.3	5.6
10-02-24	18	x
…	…	…

Methods

Conformal prediction

In simple terms:

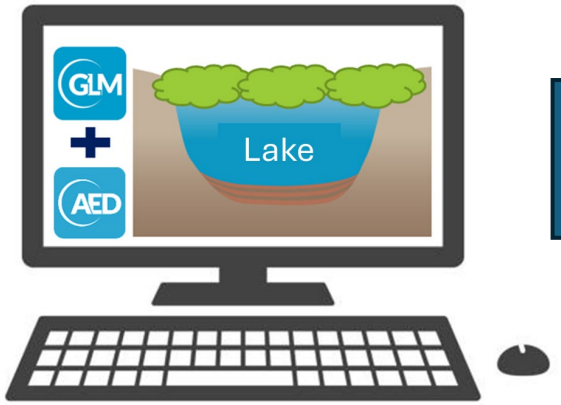
‘Assigning a measure of uncertainty to each EO datapoint’



Methods

Model

GLM-AED



1D Lake ecosystem model

Input

Meteorology, Inflow

Calibration data

Chl-a

Calibration with

Calibration Scenarios

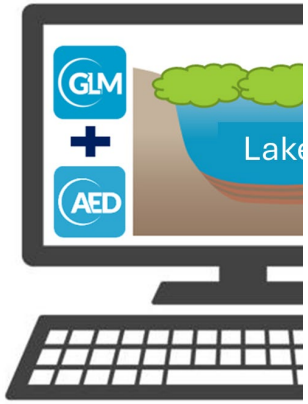
1. In Situ
2. All EO data
3. High NC
4. Low NC
5. All EO data + In Situ
6. High NC + In Situ
7. Low NC + In Situ

Output

1. Does EO improve the model?
2. Does Conformal prediction improve the use of EO in the model?
3. Does EO improve the ability to simulate blooms?

Meth

GLM-A



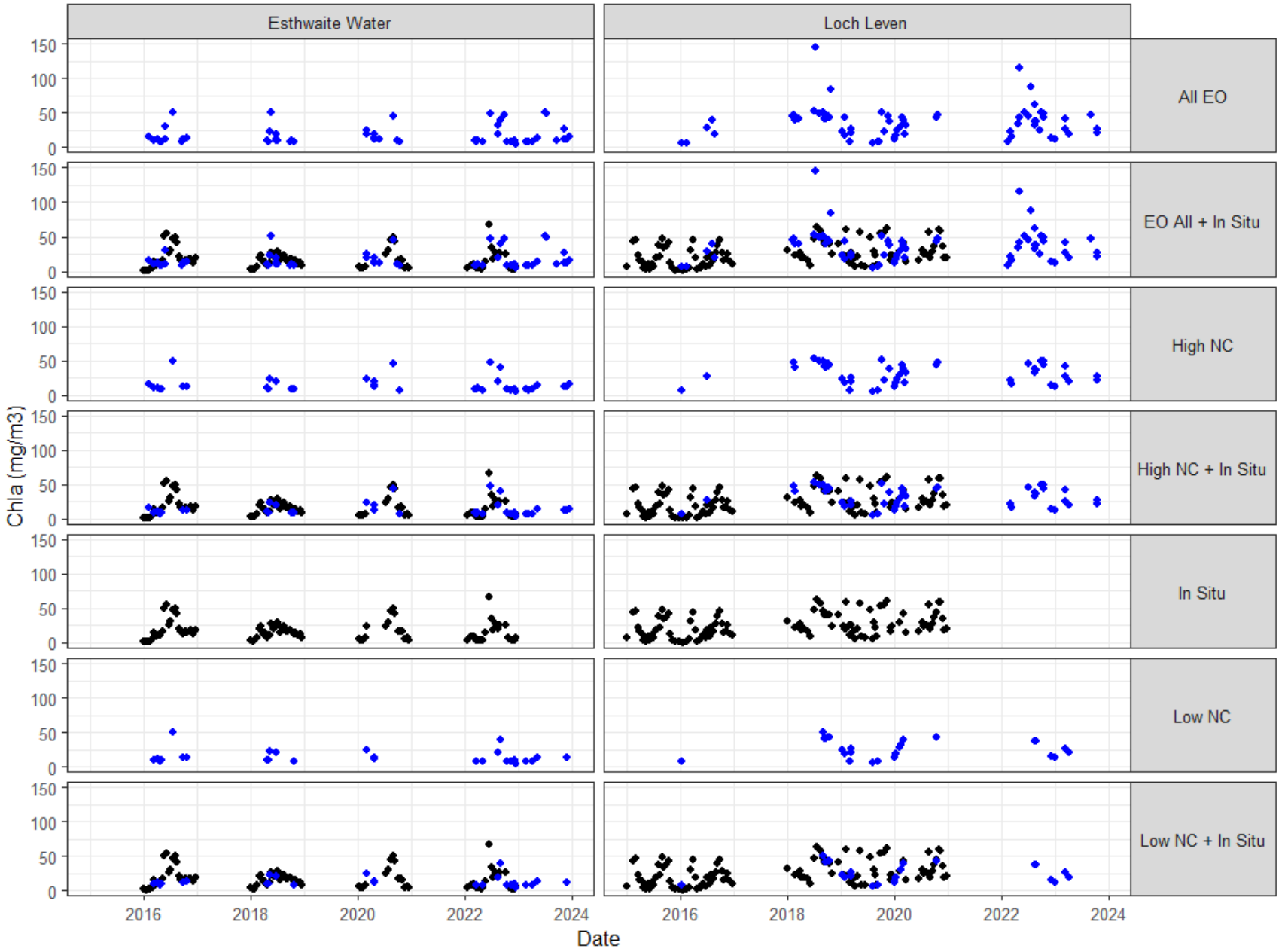
1D Lake ecos

Input

Meteorology, Inf

Calibration dat

Chl-a

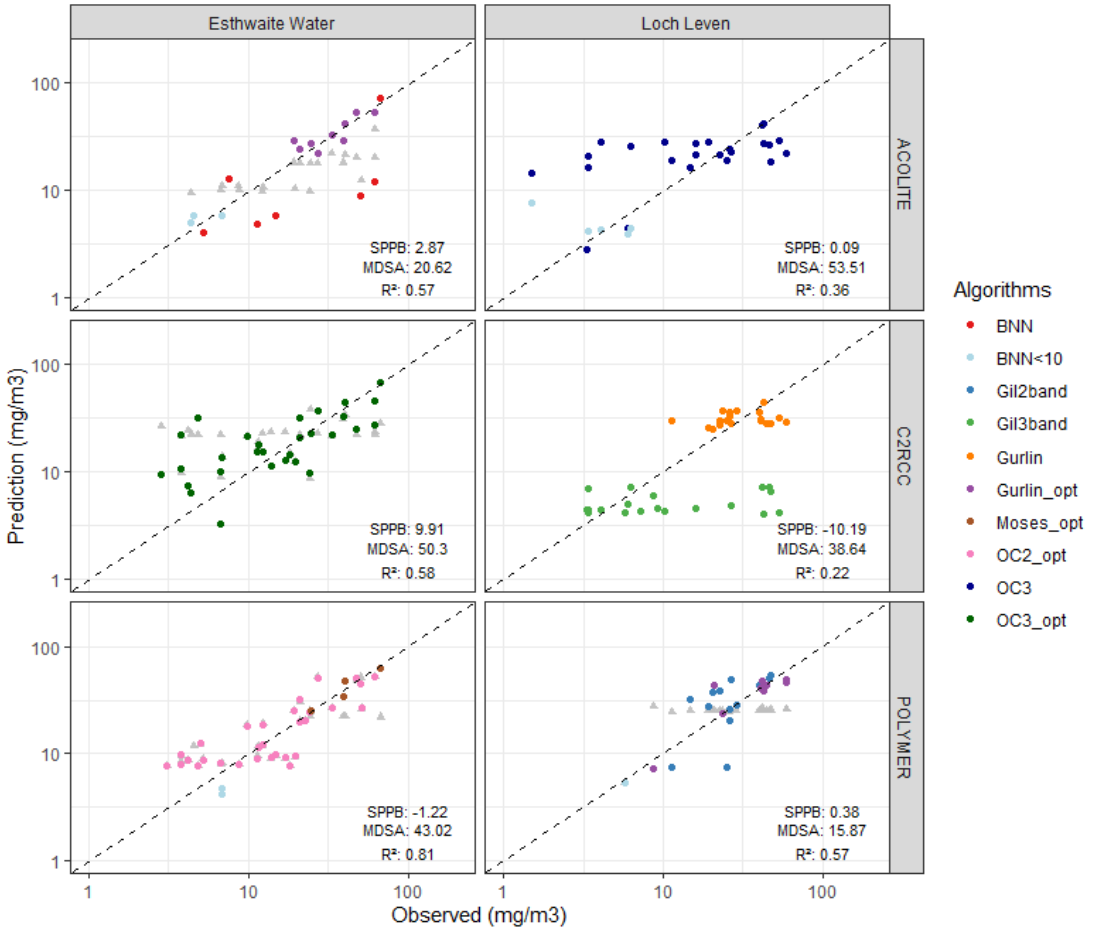


:O improve
odel?
Conformal
tion
ve the use
n the
?
:O improve
ility to
te blooms?

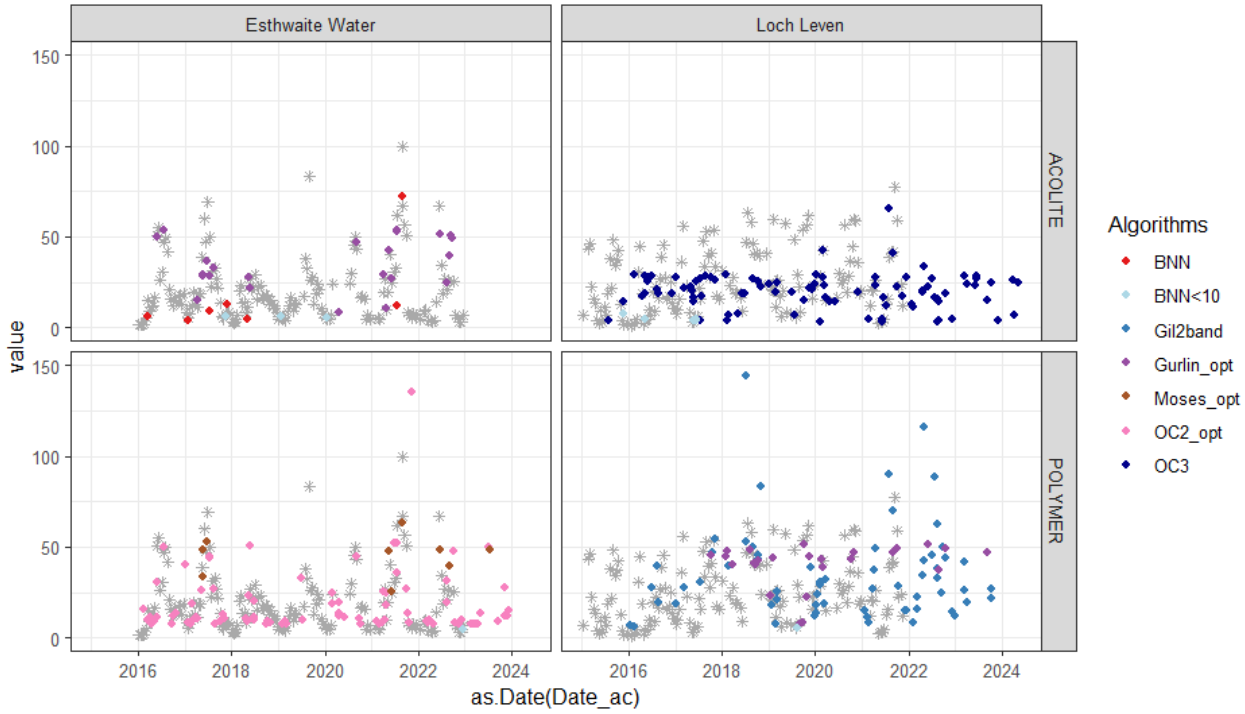
Results

Earth Observation

Atmospheric correction & Chl-a algorithms

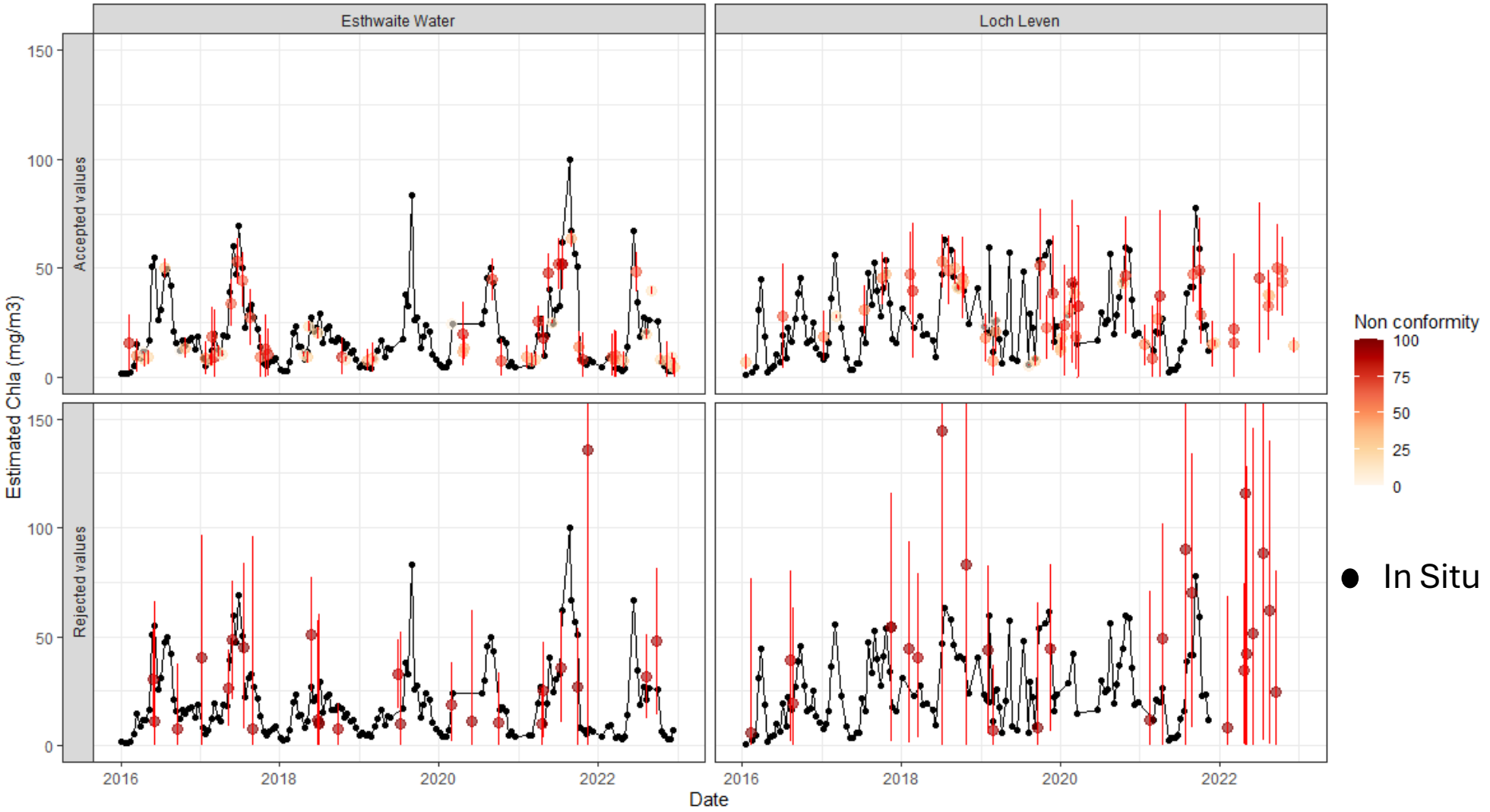


EO vs In situ



Results

Conformal Prediction



Results

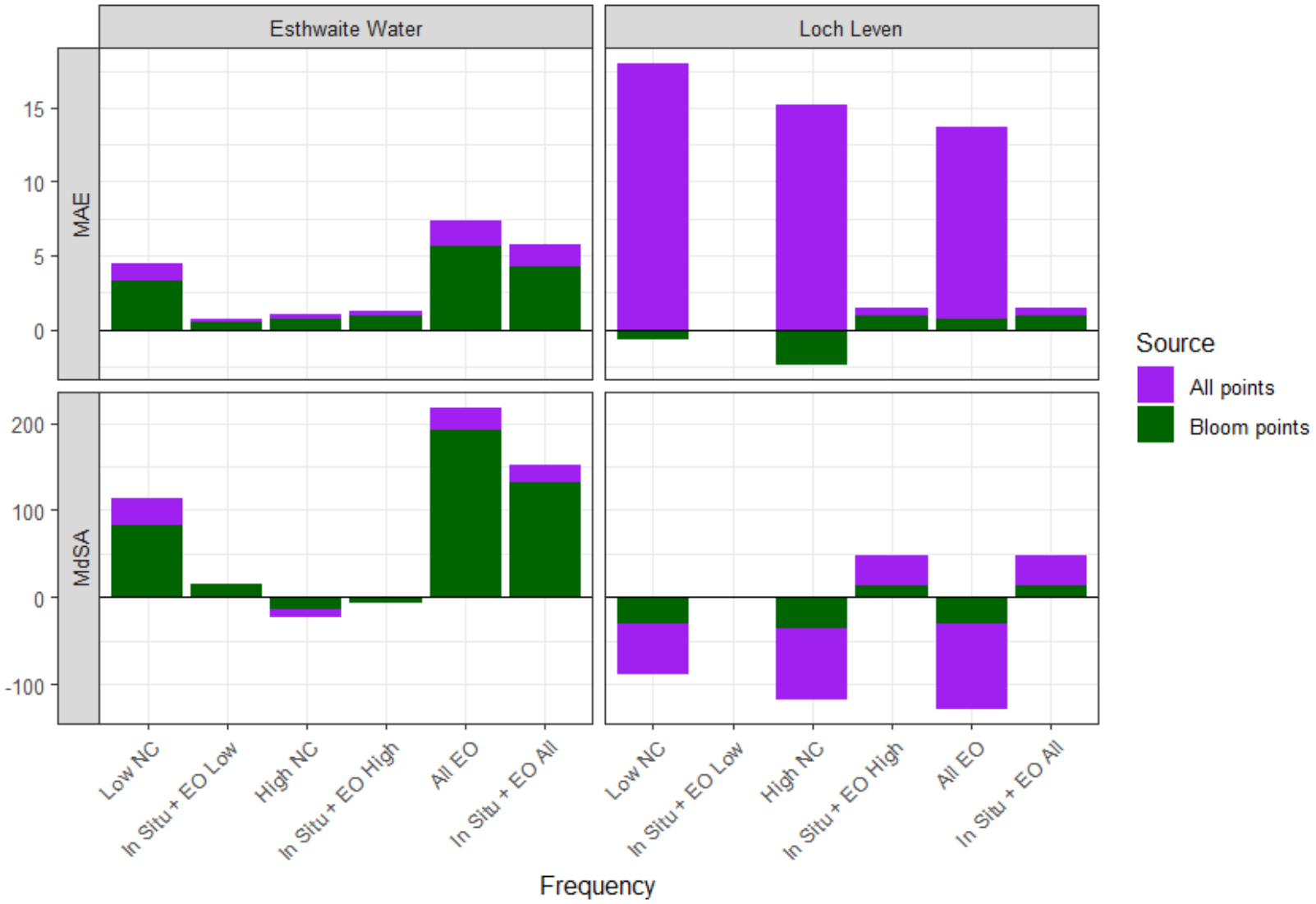
GLM-AED

Difference in MAE and MdSA from model calibrated with In Situ

Esthwaite Water
All EO & All EO + In Situ scenario make it worse

Loch Leven
EO scenarios worsening the MAE in all points, but improving Bloom points.

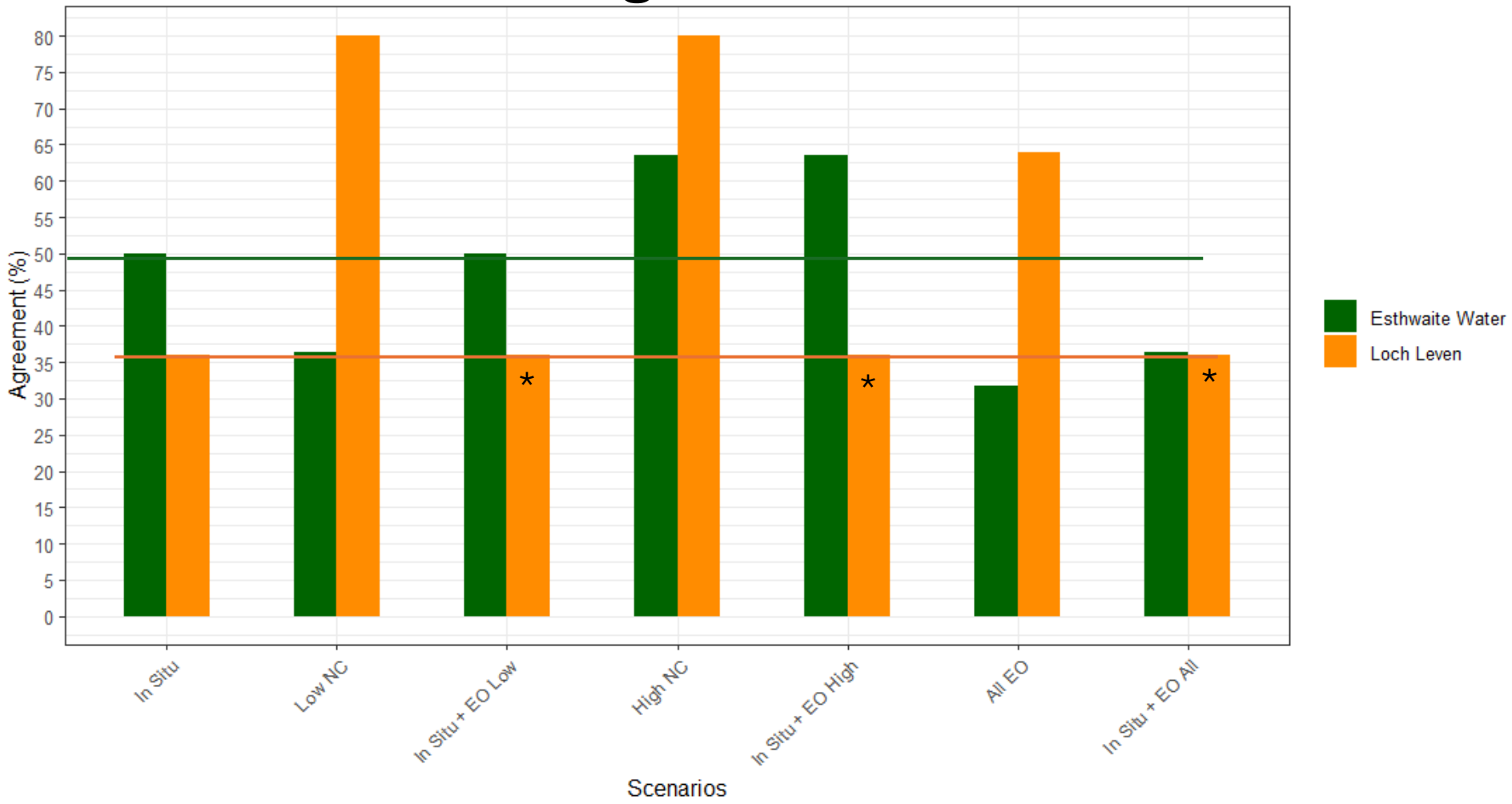
EO scenarios improving the MdSA in all the points and the Bloom points.



Results

GLM-AED

Bloom agreement



Major improvements

Loch Leven

Low NC

All EO

High NC

Esthwaite Water

High NC

In Situ + High NC

Major deterioration

Esthwaite Water

Low NC

All EO

In Situ + EO All

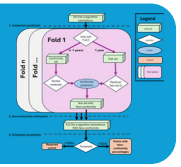
*In Situ in Loch Leven doesn't improve at all

Conclusion

EO can be effectively used over eutrophic lakes to generate Chl-a estimates

Difference in atmospheric correction of Chl-a algorithms result in significant differences

Conformal prediction can be successfully used to filter EO Chl-a estimates for downstream use

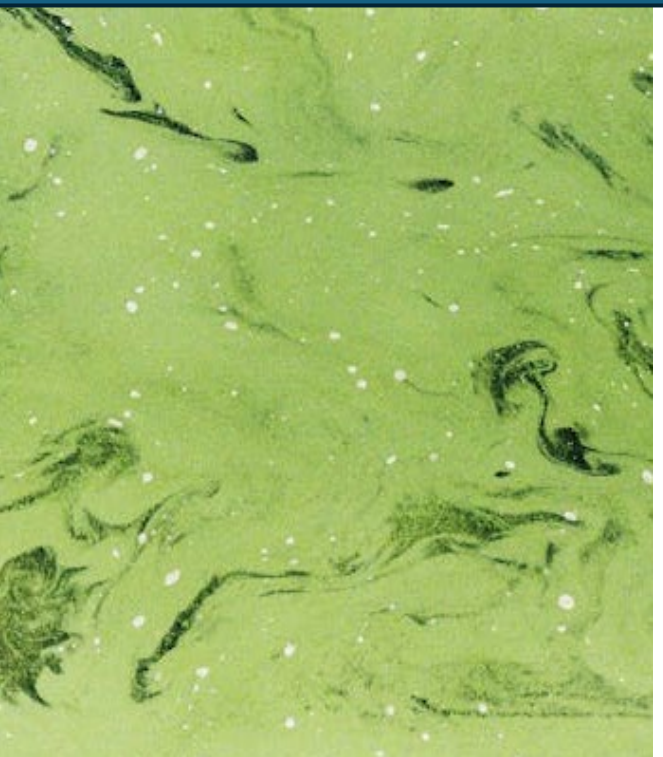


GLM-AED calibration can be improved using EO Chl-a estimates

Algal bloom detection can be significantly improved using EO Chl-a estimates in combination with GLM-AED

Thank you

Any Questions?



Contact details
Maud Siebers
University of Stirling
Maud.Siebers@stir.ac.uk
Or talk to me today until 14:00