Autonomous glider observations for understanding Lake Erie (and other Great Lakes..) hypoxia

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US EPA Great Lakes Toxicology and Ecology Division (GLTED)

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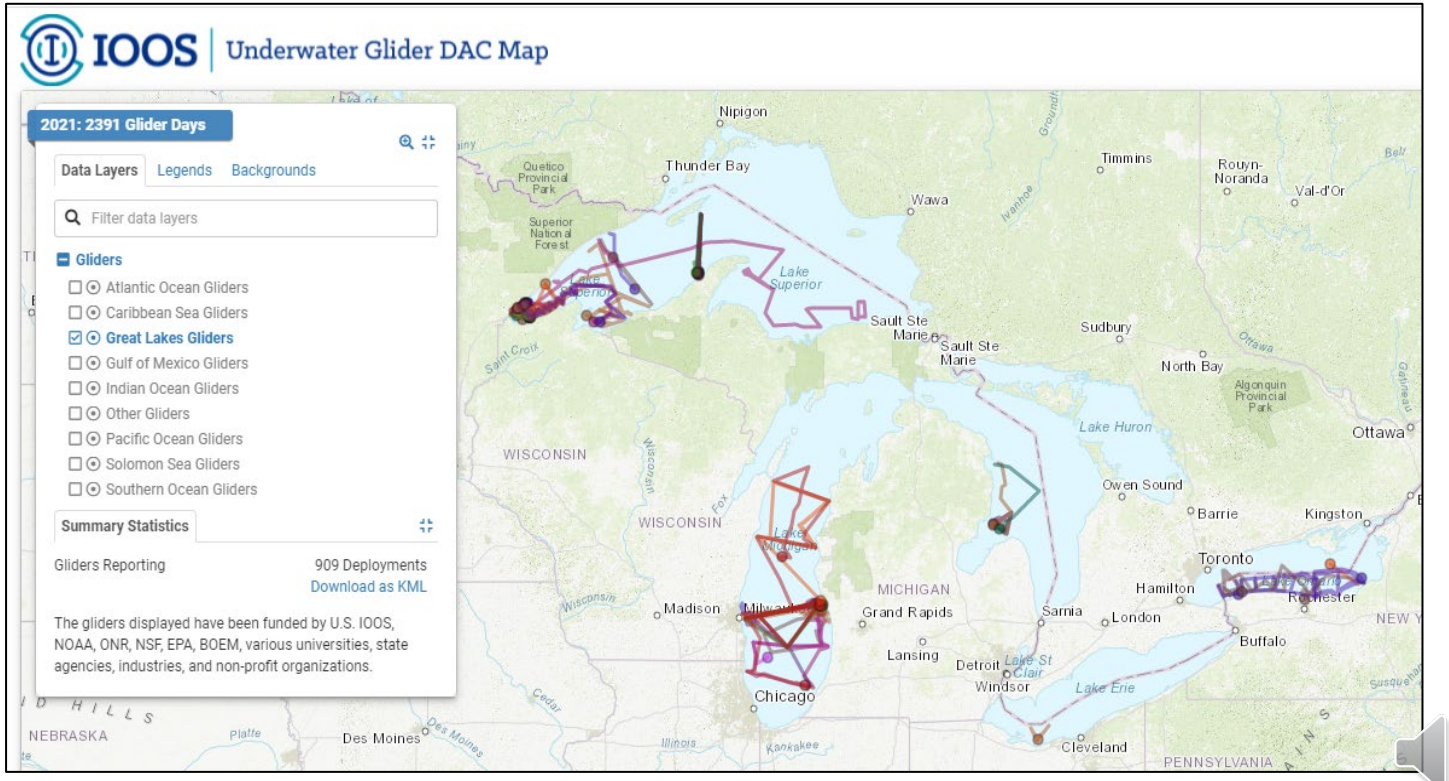
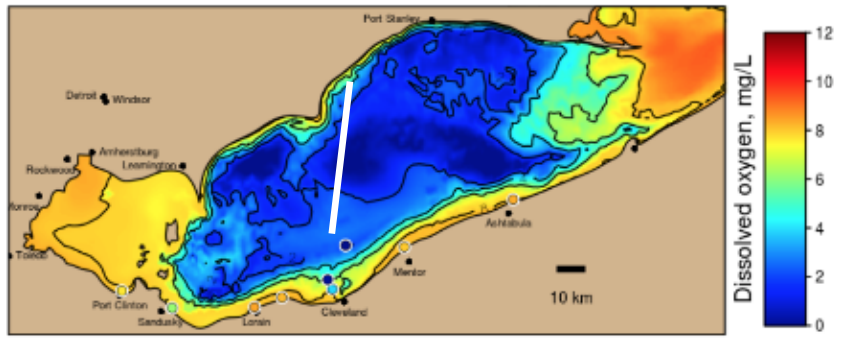
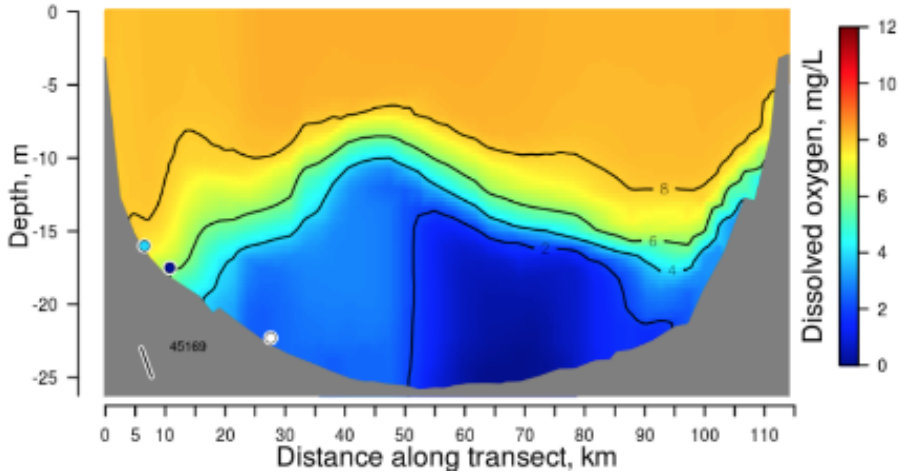
- Cooperative agreement with University of MN Duluth
  - Jay Austin Lab
- Great Lakes glider community
  - CIGLR/GLERL
  - Univ. Windsor/RAEON.
  - See Cailin Burmaster presentation Friday 9:30 am



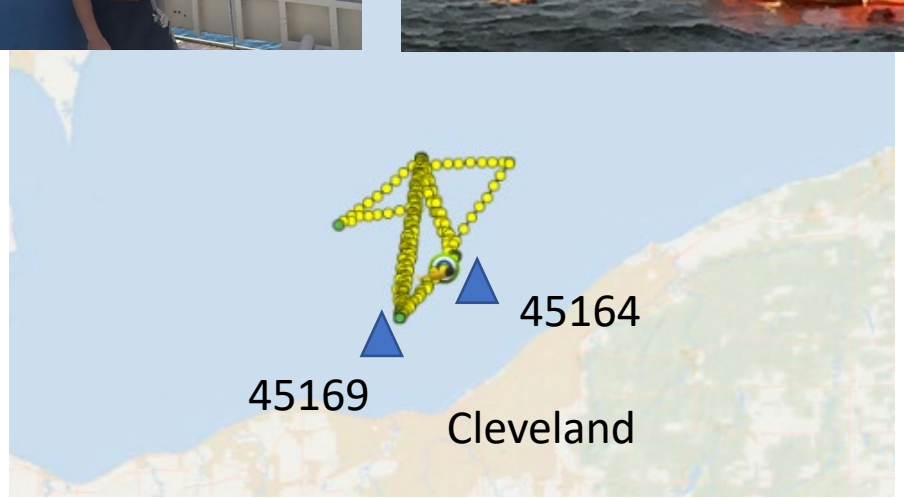
Late summer glider deployment (hypoxia expected). Sept 5 – Sept 27. Deploy and recover from RVLG.
Objective: Characterize near bottom conditions in central basin where water depths are 18 – 24 meters

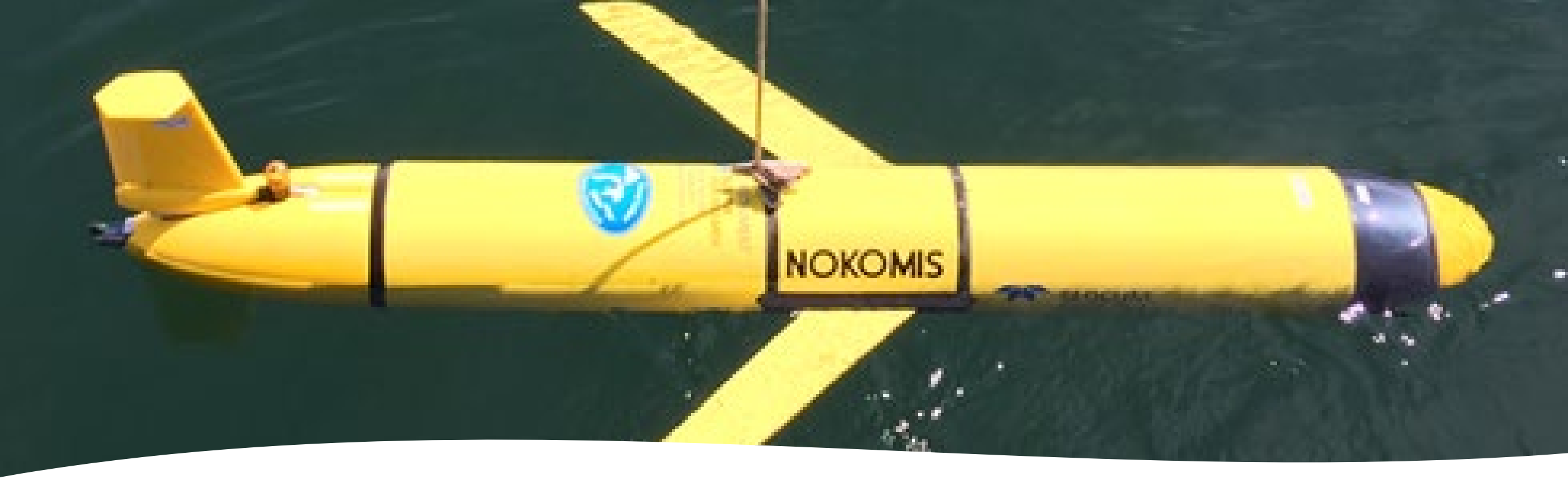
NOAA GLERL Lake Erie hypoxia model example





Lake Erie glider deployment 2019 CSMI





Buoyancy-driven glider

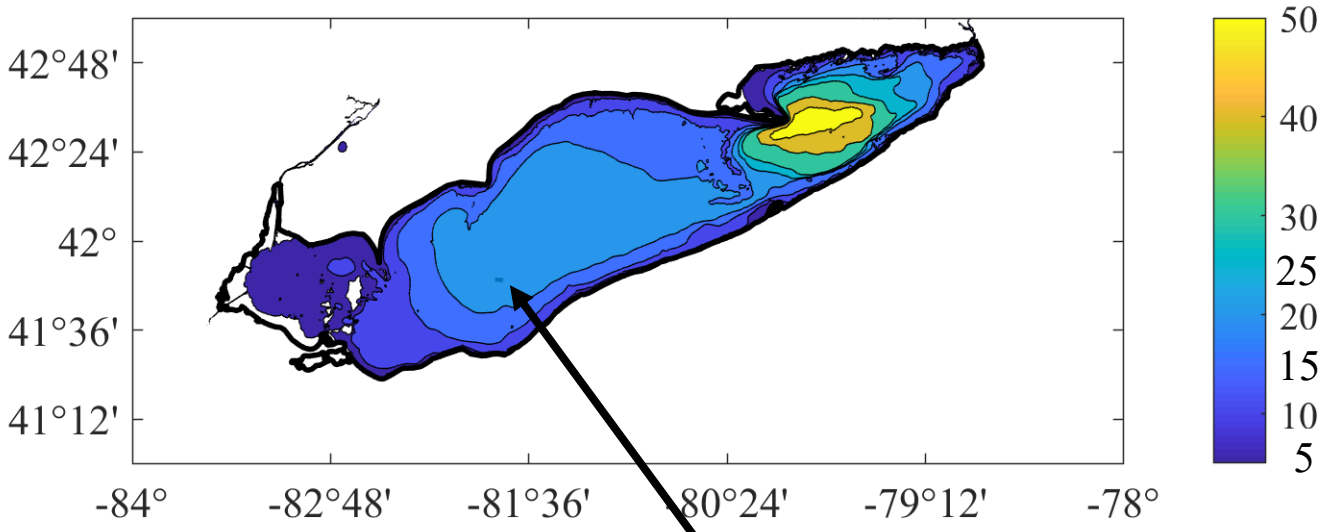
Autonomous

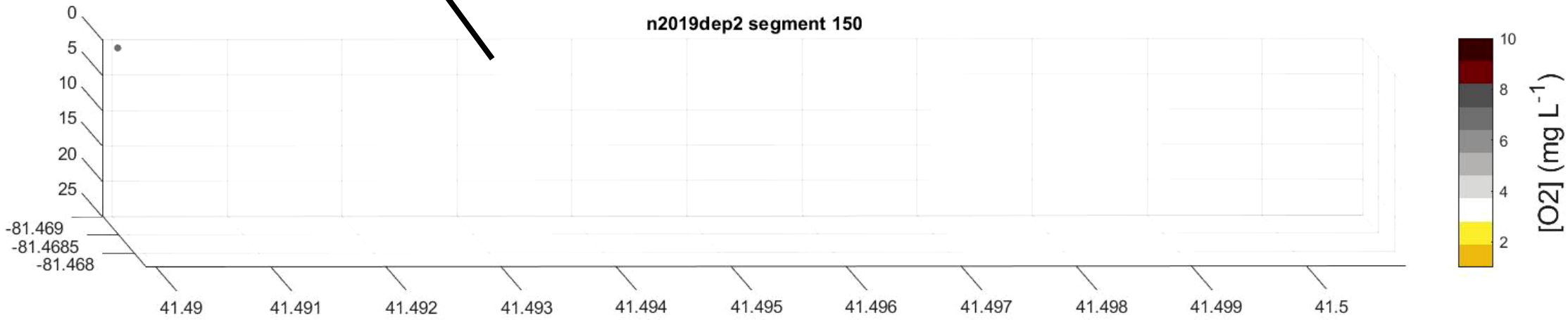
Dive/climb speed ~10cm s^{-1}

Sampling rate for CTD 0.5 Hz , optical sensor 1.0 Hz

- ~20cm vertical resolution CTD, 10 cm for optical (Chlor, CDOM, Backscatter)

This is generally adequate for vertical gradients

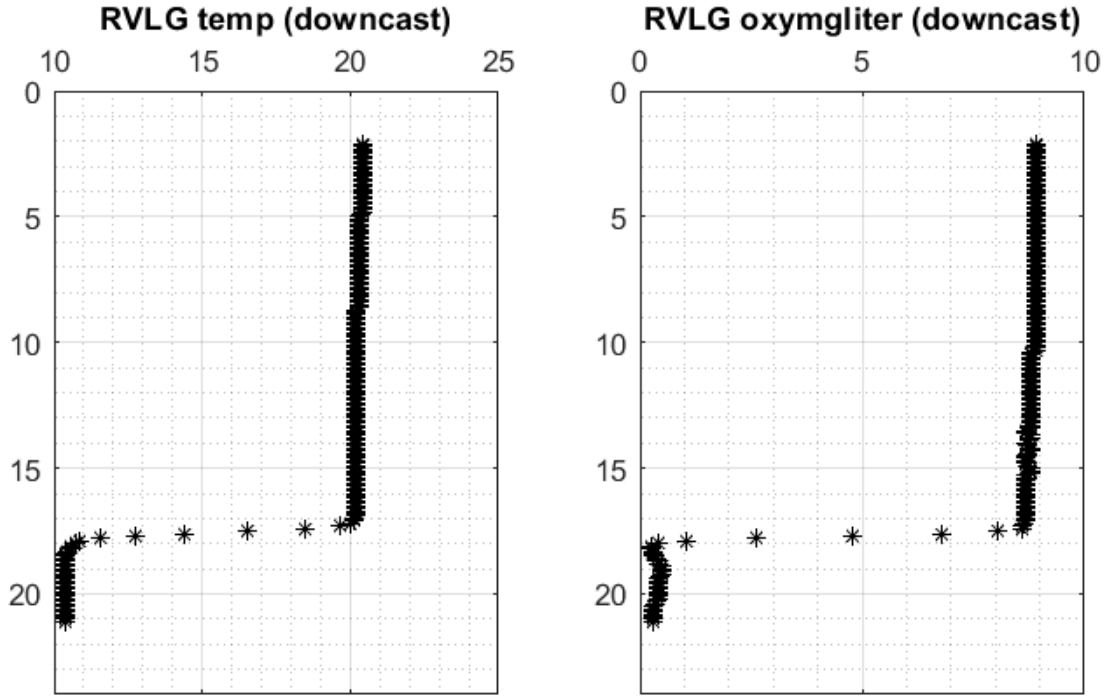




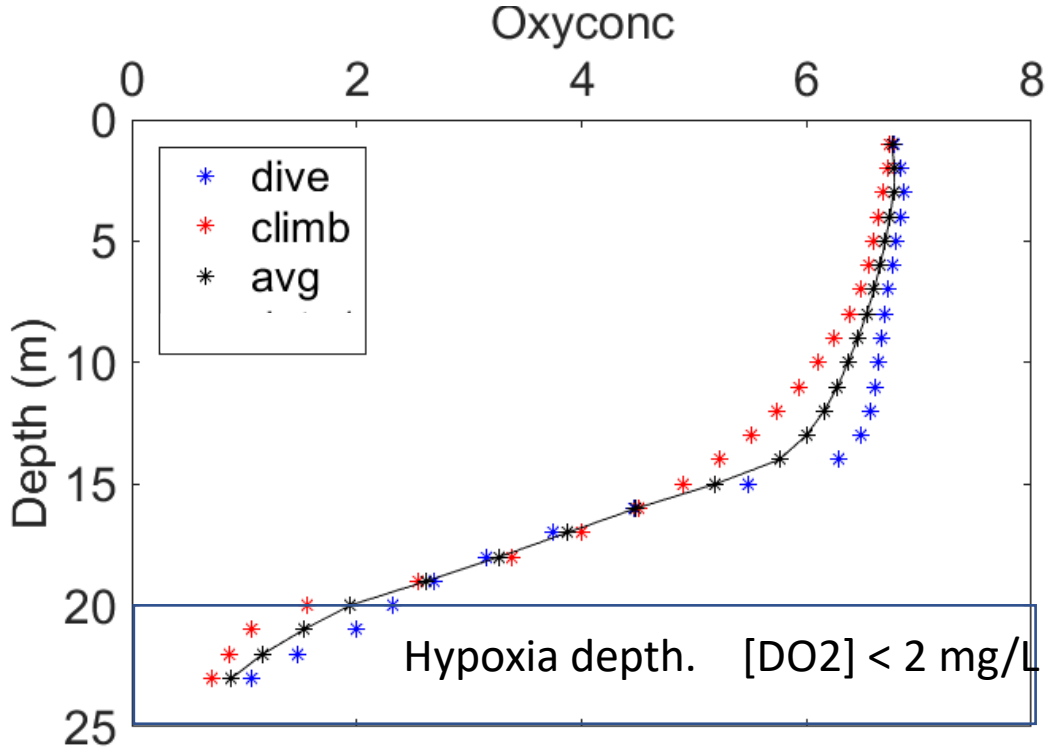
Two-hour segment | 23 'yos' | distance: 2.03 km | 'yo' frequency: ~ 6minutes ~100 meters

Comparison: CORRECTED glider data and high resolution CTD / DO profiles from RV Lake Guardian

CTD and dissolved oxygen profiles RV Lake Guardian

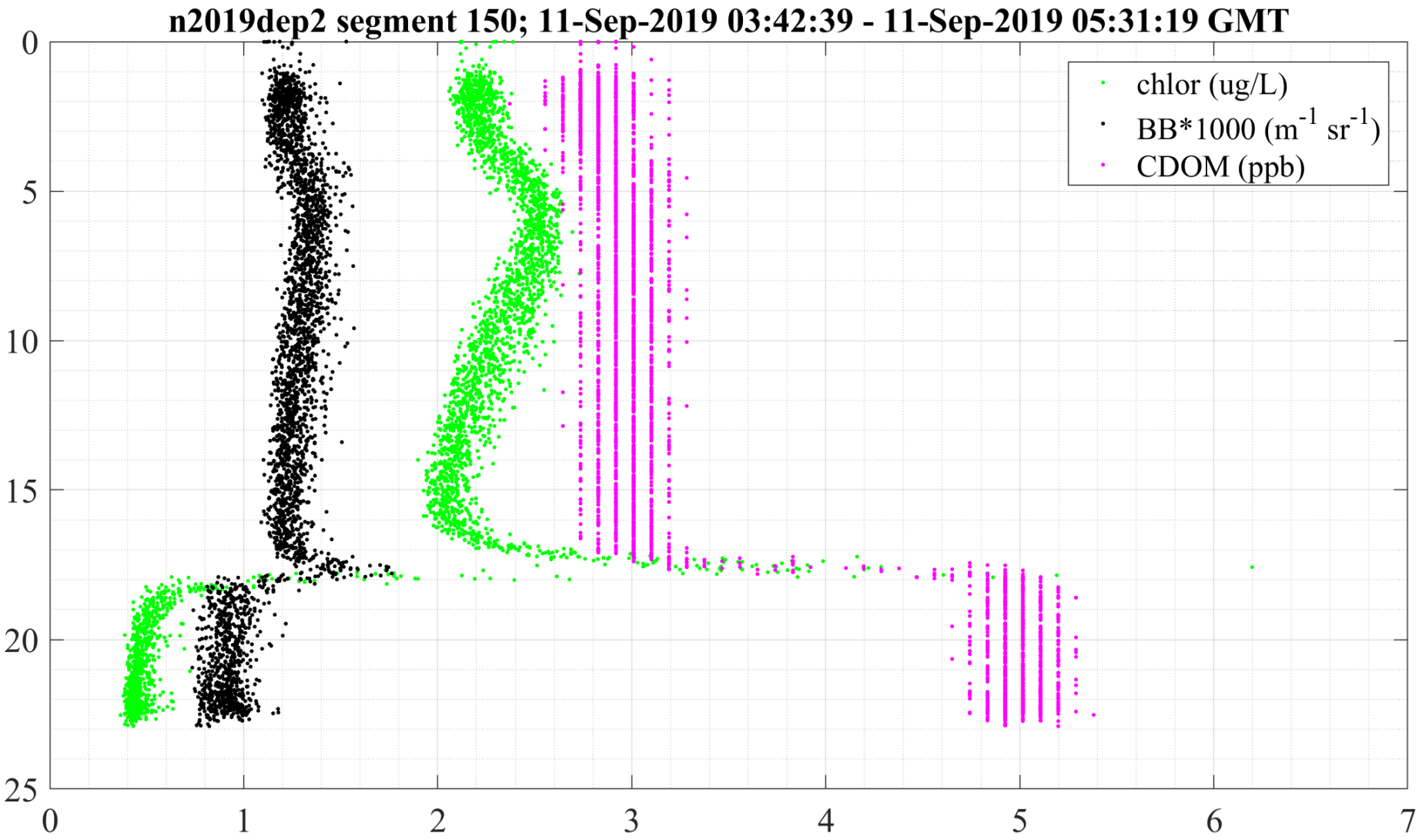


GLIDER segment 150, 23 yos, corrected



profiles from RVLG Sept 6 show thermocline/oxycline/redoxcline boundary is extremely sharp.
CORRECTED dissolved oxygen data overestimates depth of the transition by 2m (20m vs 18m)
Need SUB-METER resolution to resolve the boundary !

WetLabs Ecopuck optical sensor : backscatter @700nm, fluorescence (‘chlor-a’ and ‘cdom’)
Faster sampling rate, no inherent sensor lag. This is two hours of data, 23 yos (46 vertical casts).



Lesson learned #1: “A tinge of orange”

High conductance in anoxic zone

Christine Kitchens etal

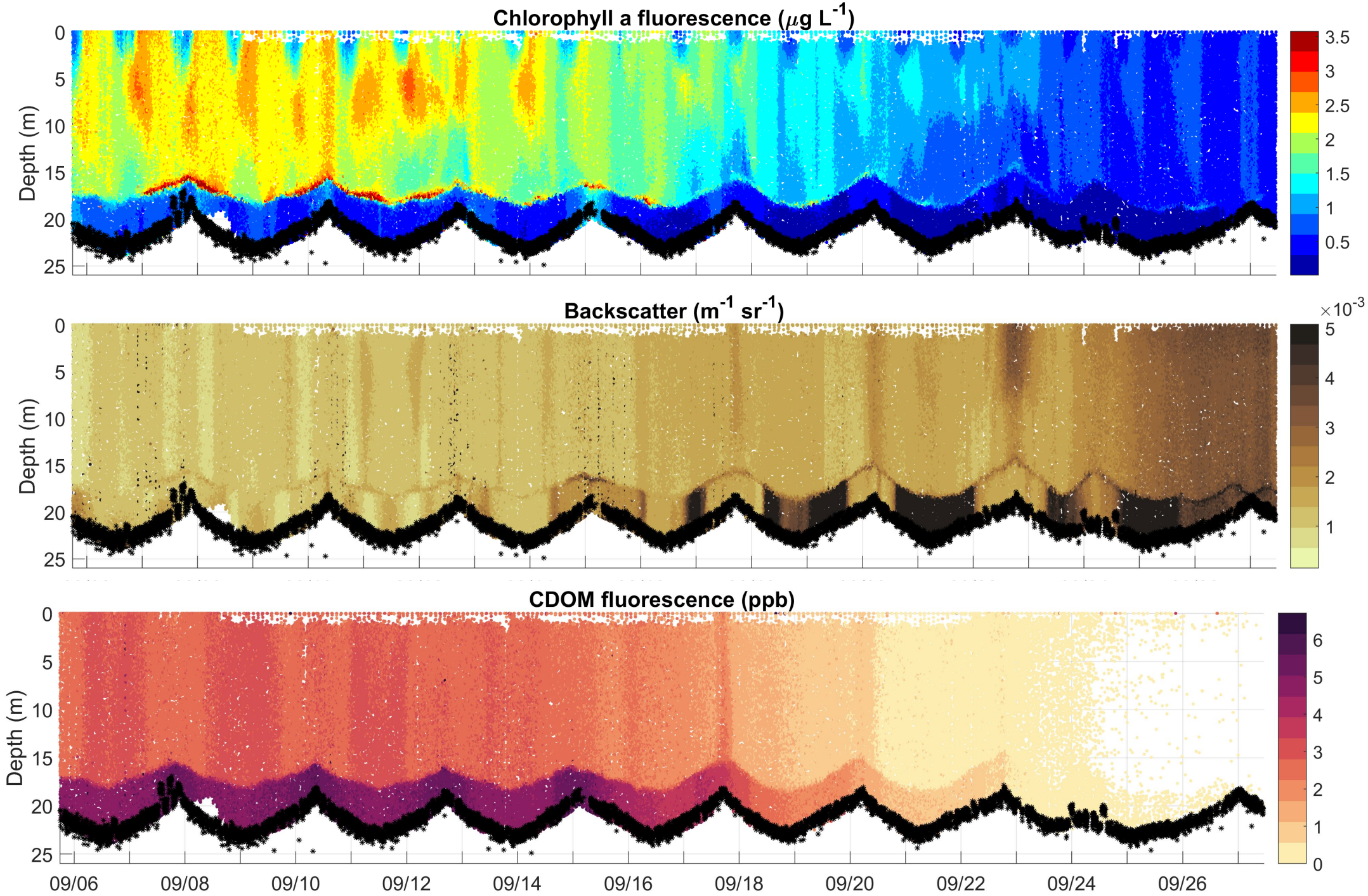
previous presentation:

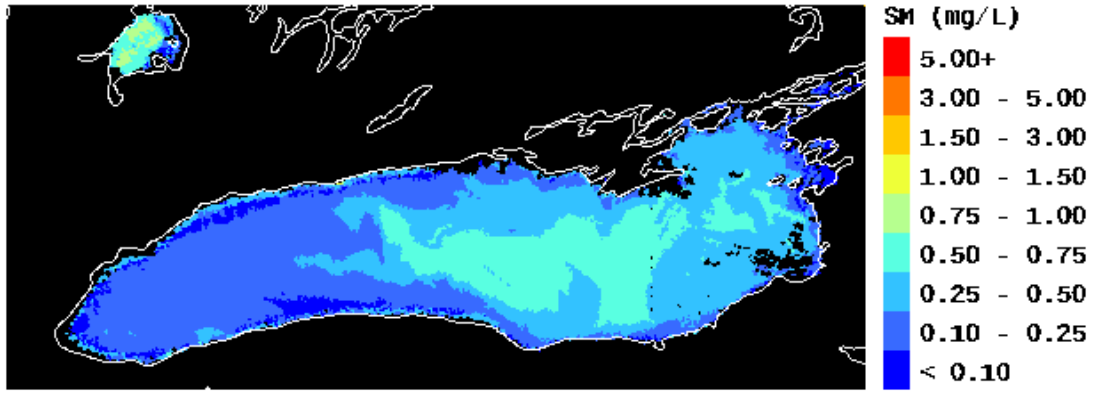
“Seasonal hypoxia in Lake Erie’s central basin can cause the release of the heavy metal manganese (Mn) from sediment,

Anderson, H. S.,et al. (2021). *Continuous in situ nutrient analyzers pinpoint the onset and rate of internal P loading under anoxia in Lake Erie’s central basin. ACS EST Water.*

Hollenhorst et al. IAGLR LAKES LETTER , Fall 2019

Photo: Ben Alsip

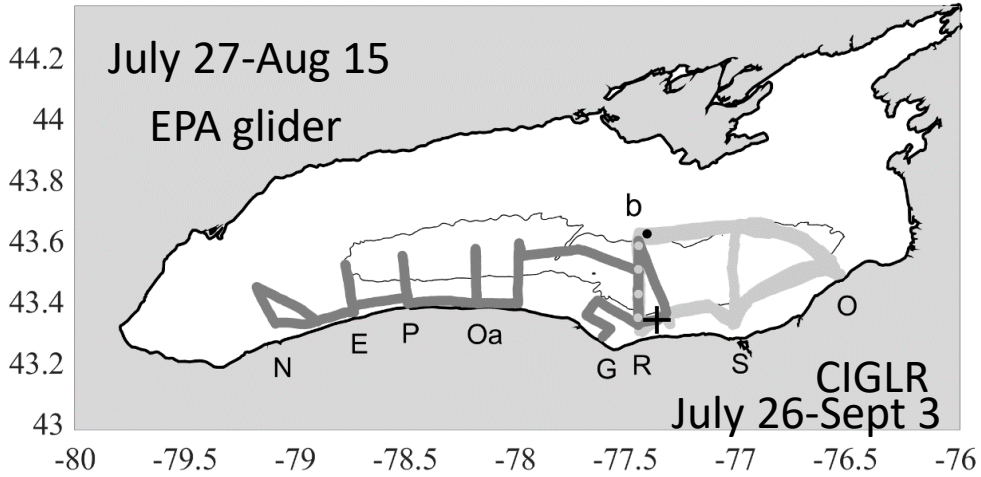

Chlorophyll a fluorescence (μg L^{-1})
Depth (m)
0
5
10
15
20
25
3.5
3
2.5
2
1.5
1
0.5
Backscatter (m^{-1} sr^{-1})
Depth (m)
$\times 10^{-3}$
5
4
3
2
1
CDOM fluorescence (ppb)
Depth (m)
6
5
4
3
2
1
0
09/06
09/08
09/10
09/12
09/14
09/16
09/18
09/20
09/22
09/24
09/26

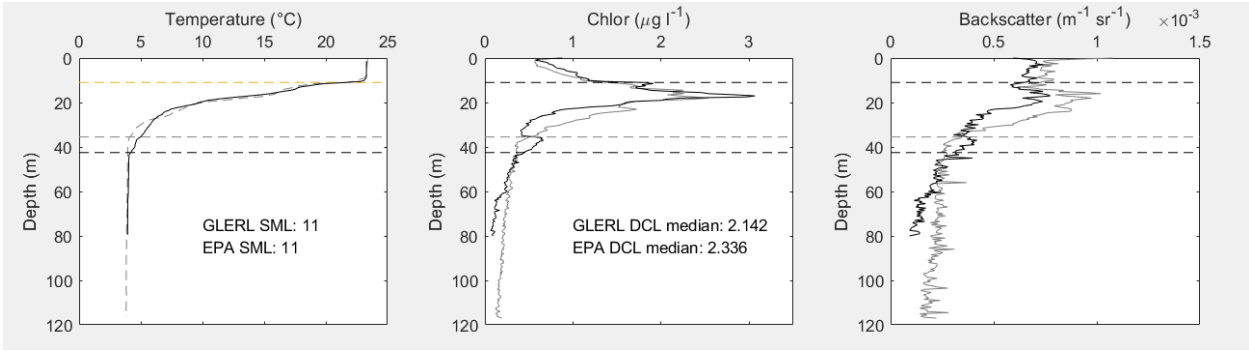


Coastwatch Color Producing Agent. Sept 3, 2018

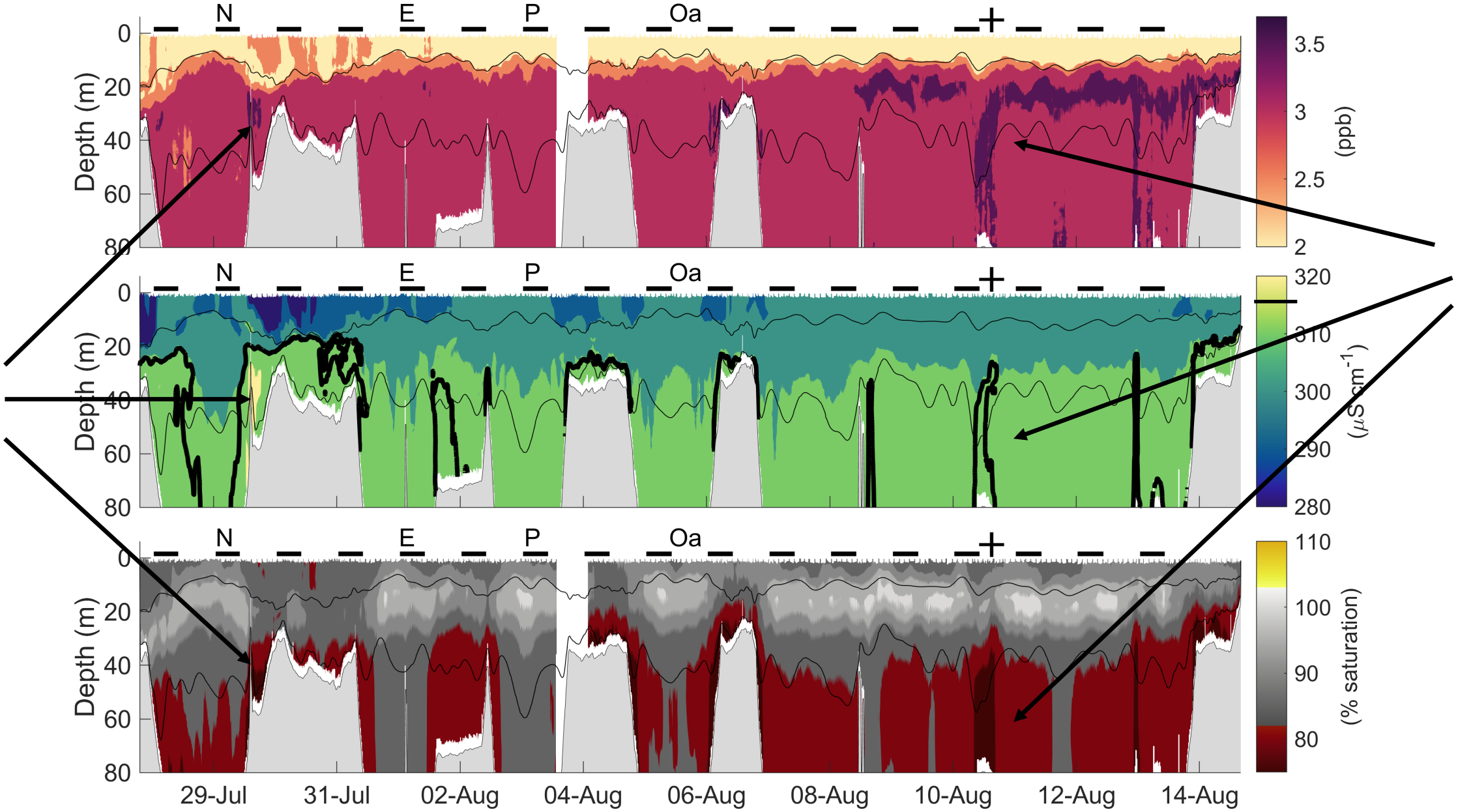
Lake Ontario whiting event observed Aug – Sept, 2018

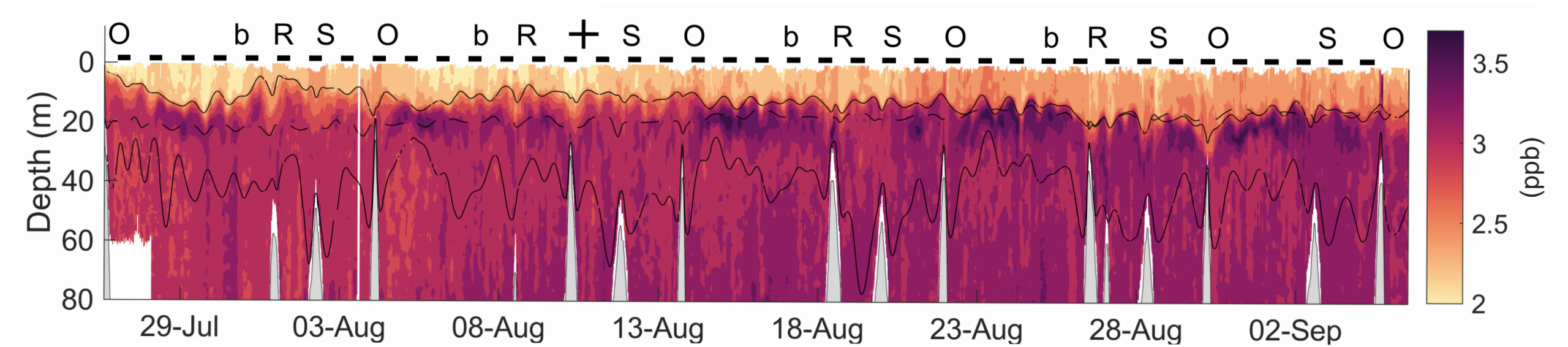
MODIS , August 11, 2018

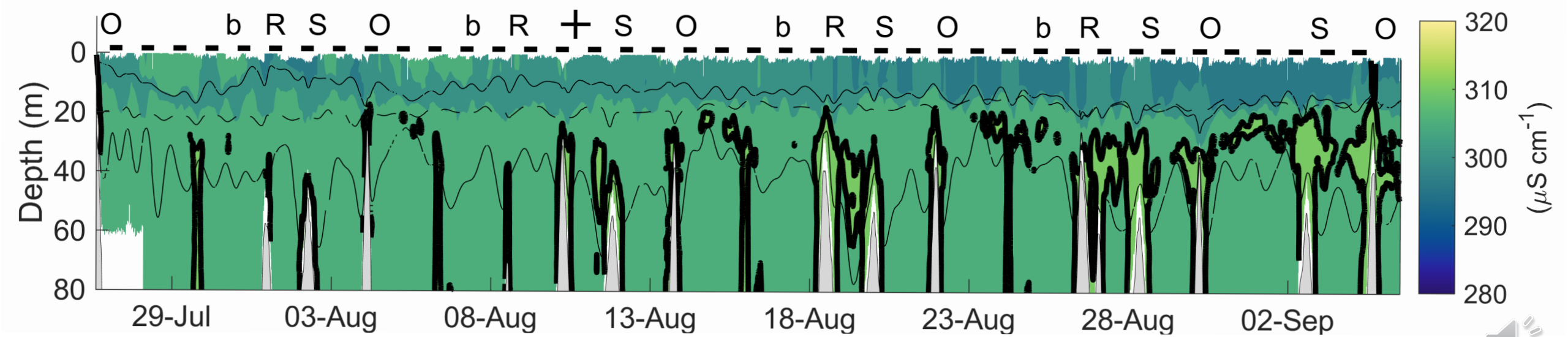


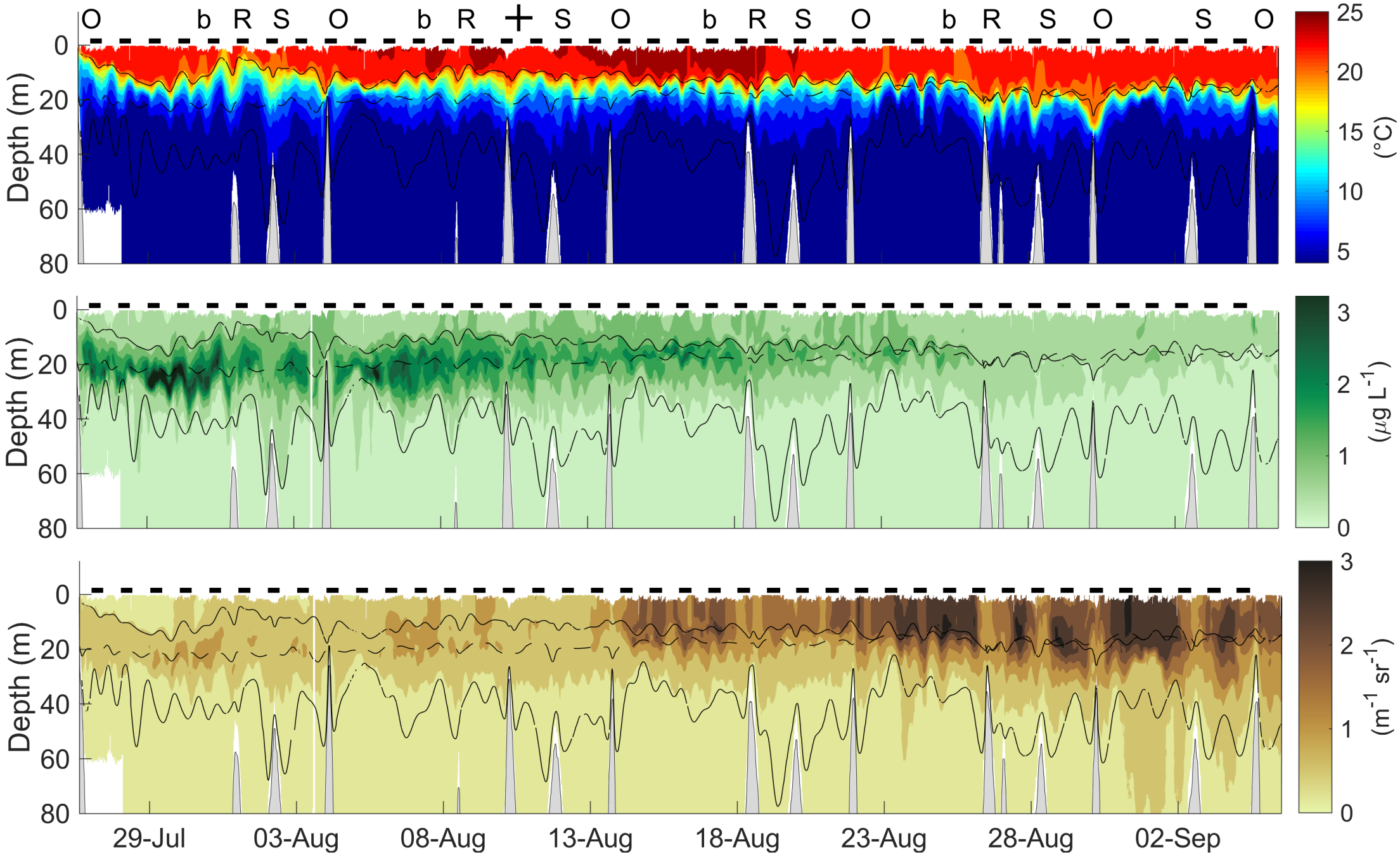


Are low oxygen levels (bottom) related to anomalies in hypolimnion Conductance (middle) and CDOM (top)?




O b R S O b R + S O b R S O b R S O S O
0
20
40
60
80
Depth (m)
29-Jul
03-Aug
08-Aug
13-Aug
18-Aug
23-Aug
28-Aug
02-Sep
3.5
3
2.5
2
(ppb)


O b R S O b R + S O b R S O b R S O S O
0
20
40
60
80
Depth (m)
29-Jul
03-Aug
08-Aug
13-Aug
18-Aug
23-Aug
28-Aug
02-Sep
320
310
300
290
280
(μS cm-1)


O b R S O b R + S O b R S O b R S O S O
Depth (m)
0
20
40
60
80
25
20
15
10
5
(°C)
3
2
1
0
(μg L-1)
(m-1 sr-1)
29-Jul
03-Aug
08-Aug
13-Aug
18-Aug
23-Aug
28-Aug
02-Sep

CONCLUSION:
Gliders may provide a method for identifying areas of anomalous conditions that can be followed up on later using traditional intensive methods.