Continuous Vertical Profile Monitoring: Detection and suppression of a cyanobacteria bloom

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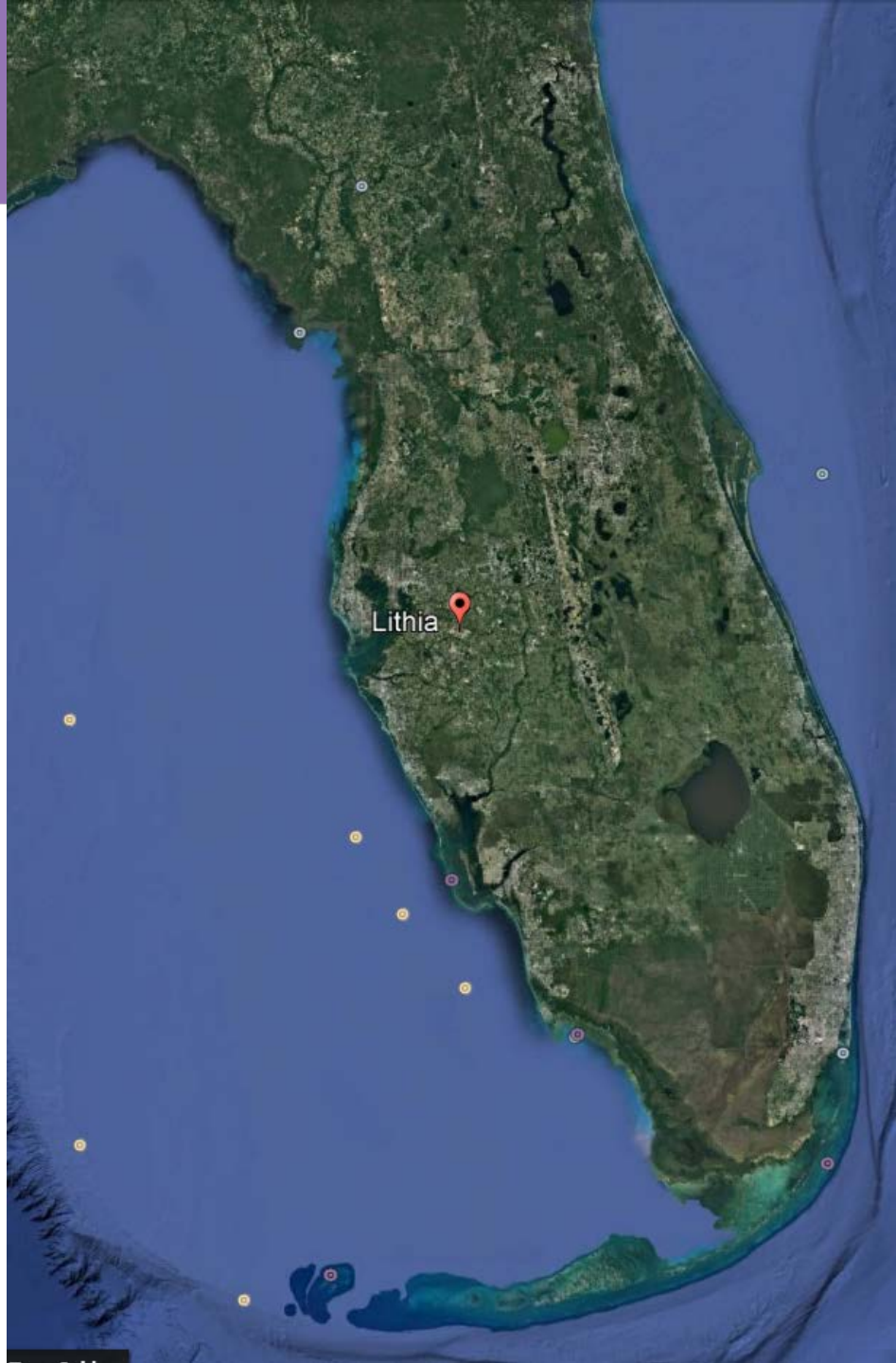
C.W. Bill Young Reservoir

- Sidestream reservoir supplied by Alafia and Hillsborough Rivers
  - Aeration 63M m^3 (15.5 BG)
  - 450 ha (1100 ac) at full stage
  - Max depth: 30 m (72 ft)
  - TP > 100 µg/L, Secchi ~1.5 m
  - Reconstruction finished 2014
- Aeration systems:
  - Partial lift hypolimnetic aeration
  - Destratification aeration
- CH2M Role: Owner Engineer



Overview

- Situational awareness
  - **Monitor for “bud” before bloom**
- Predictive analyses
  - **Aeration protocol targeting cyanobacteria weakness**
  - **Theory developed in The Netherlands (Huisman et al 2003)**
- Real time optimization
  - **Nip the bud. Keep monitoring**

ch2m

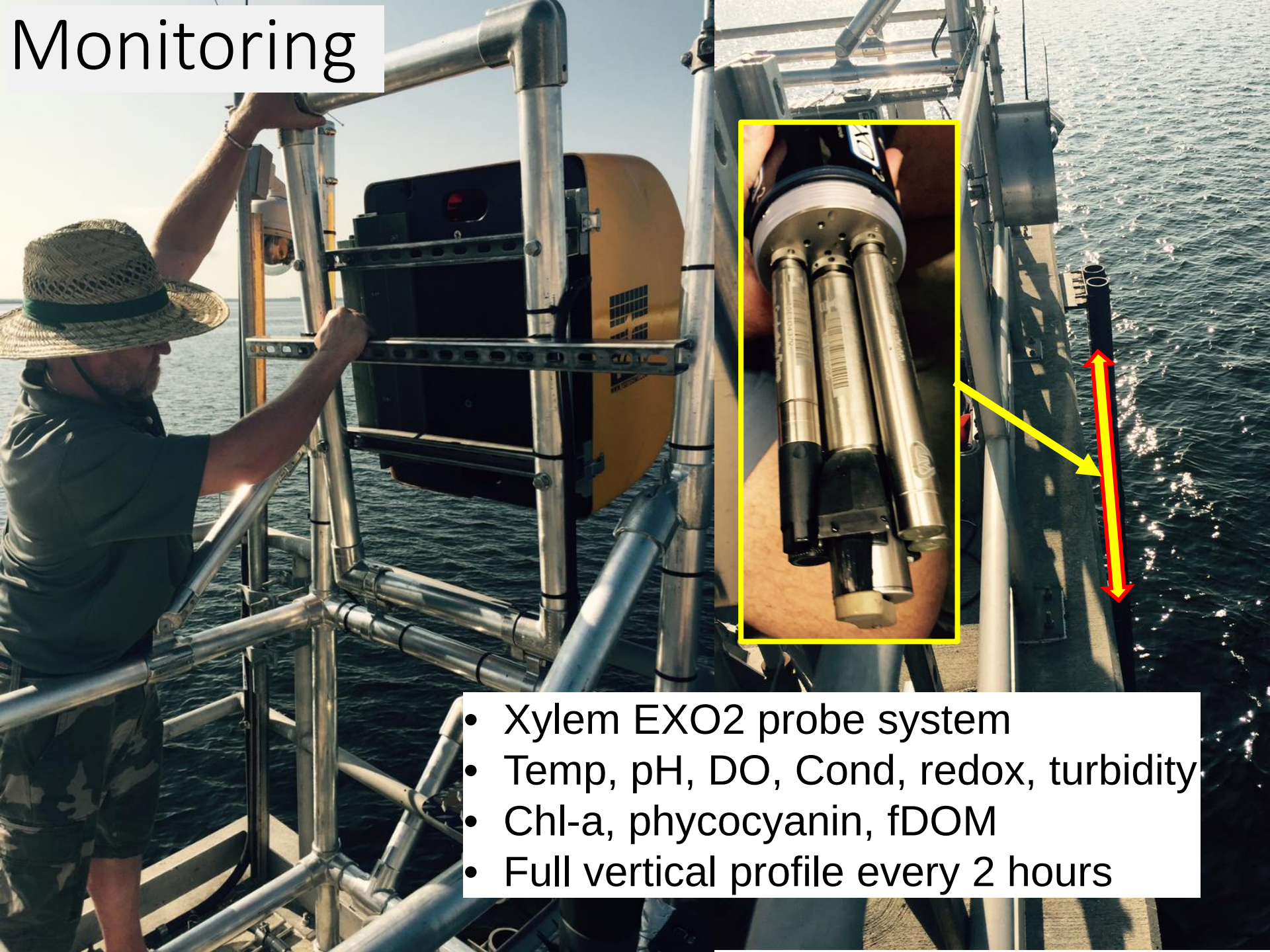
Hypolimnetic aeration system

- For use at depths > 14 m (47 ft)
- 6 towers, 1200 SCFM total flow

Destratification aeration

- Designed use:
  - Depth < 14 m
  - Cyanobacteria bloom any depth

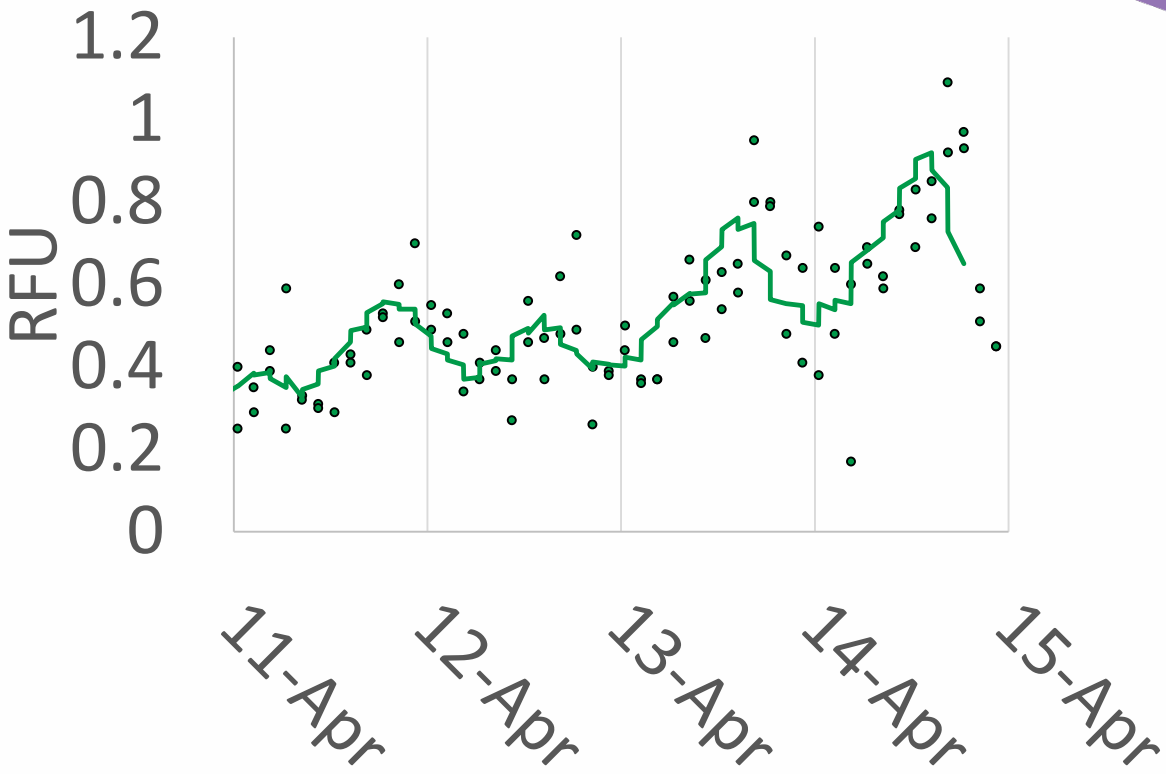
Monitoring



- Xylem EXO2 probe system
- Temp, pH, DO, Cond, redox, turbidity
- Chl-a, phycocyanin, fDOM
- Full vertical profile every 2 hours

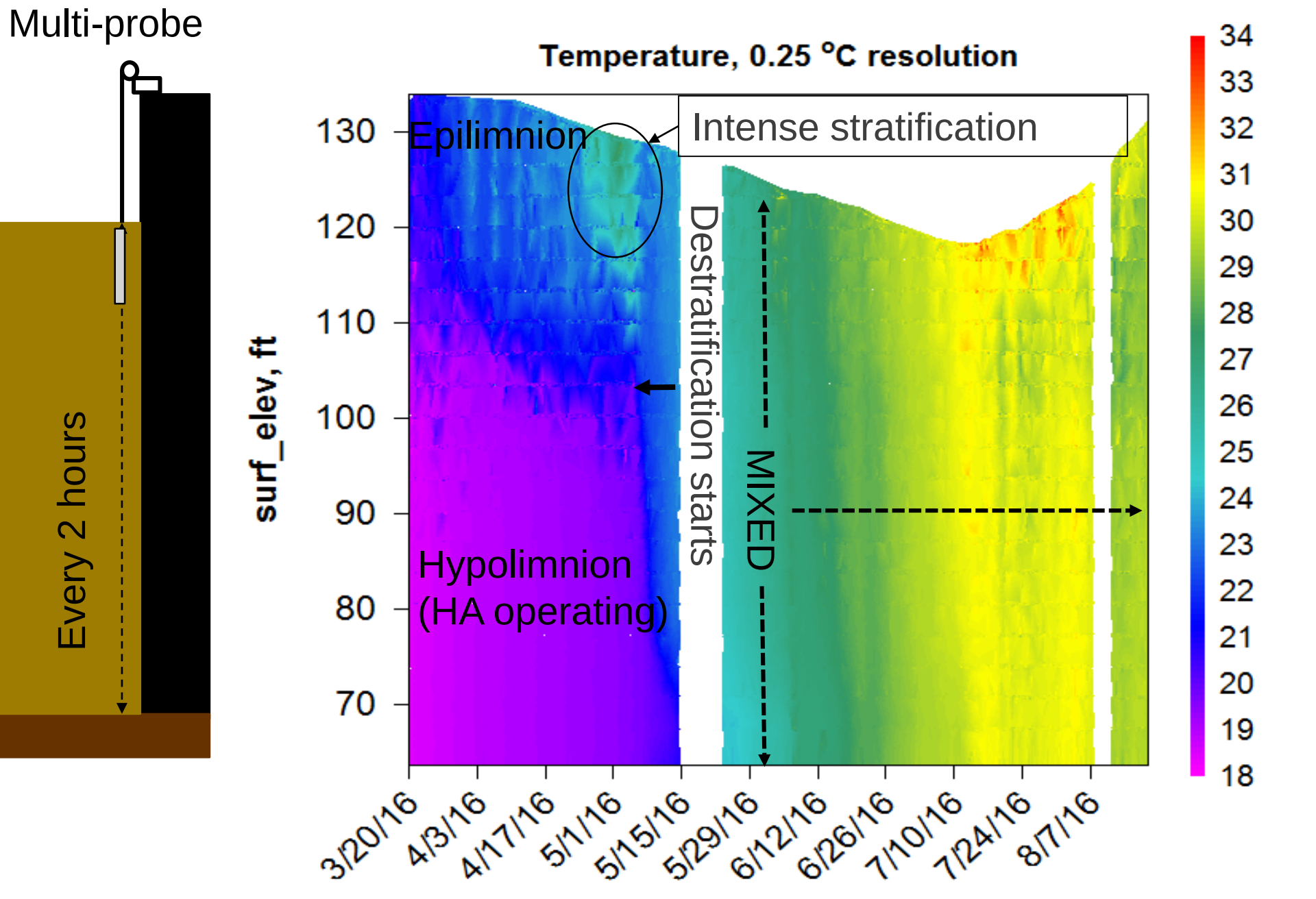
Cyanobacteria biophysical ecology

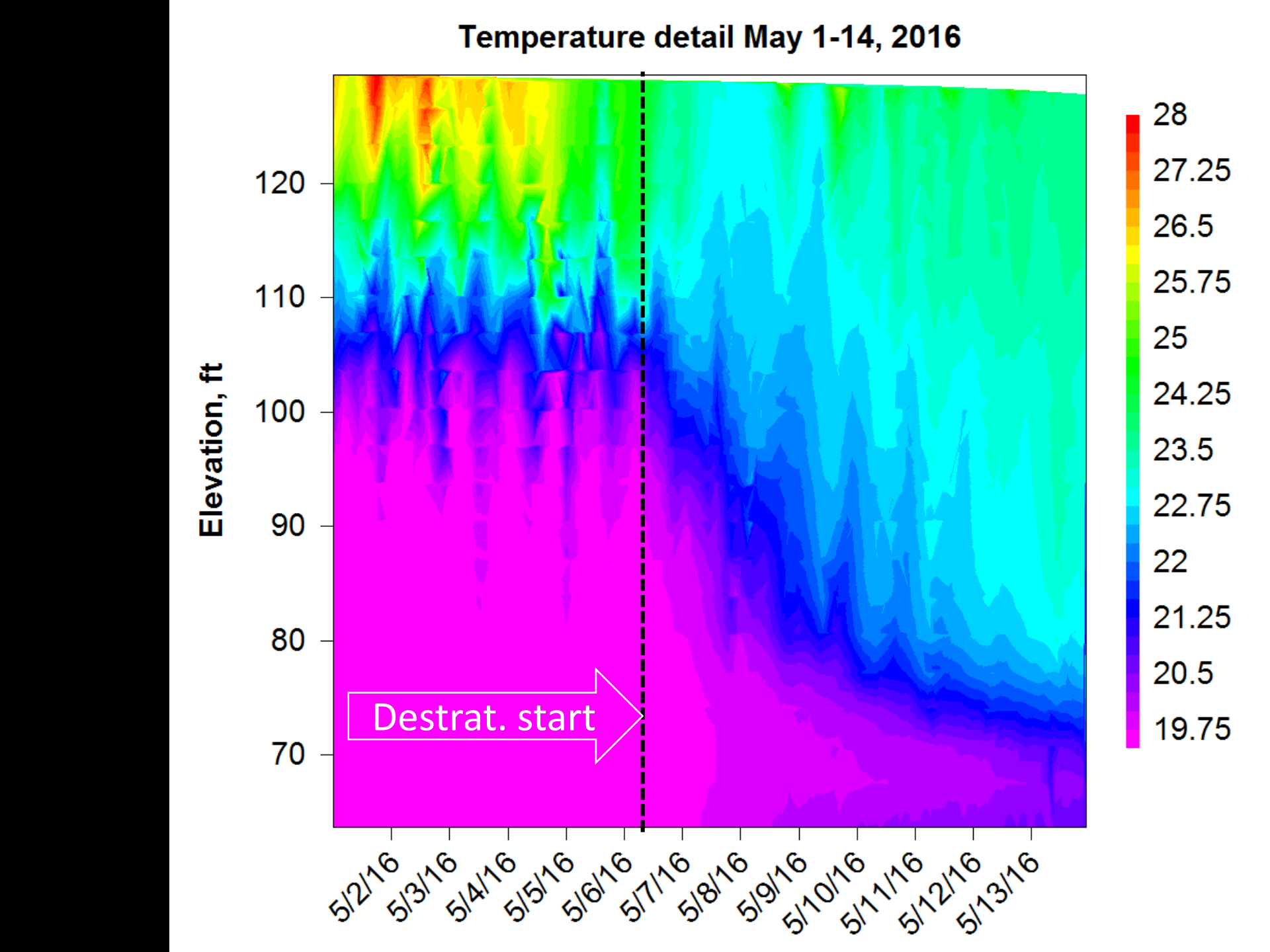
- ❑ Fix carbon at surface
- ❑ Sink to nutrients
- ❑ Consume carbon
- ❑ Make CO_2 bubbles
- ❑ Float
- ❑ Do it again
- ❑ Concentrate

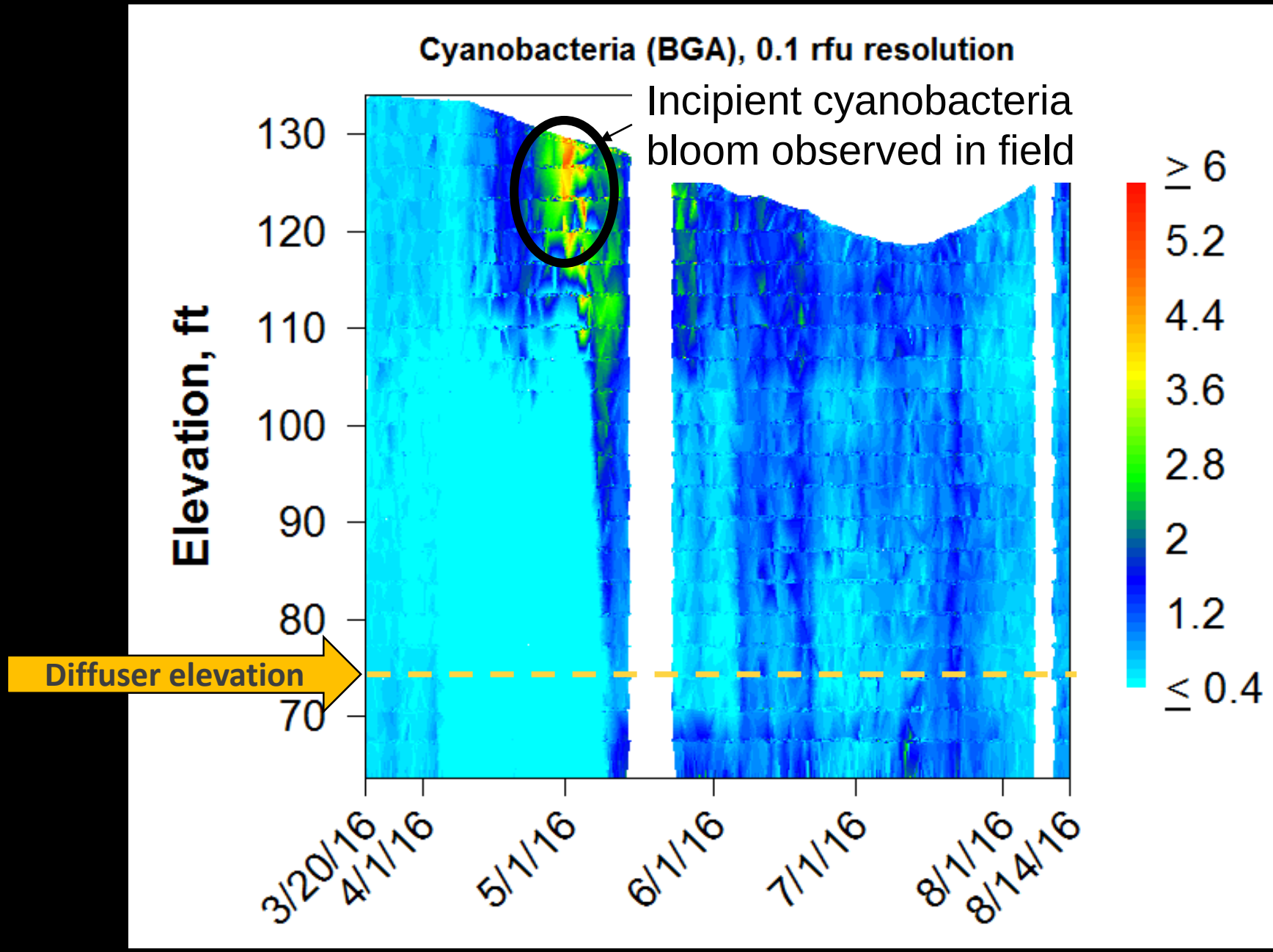


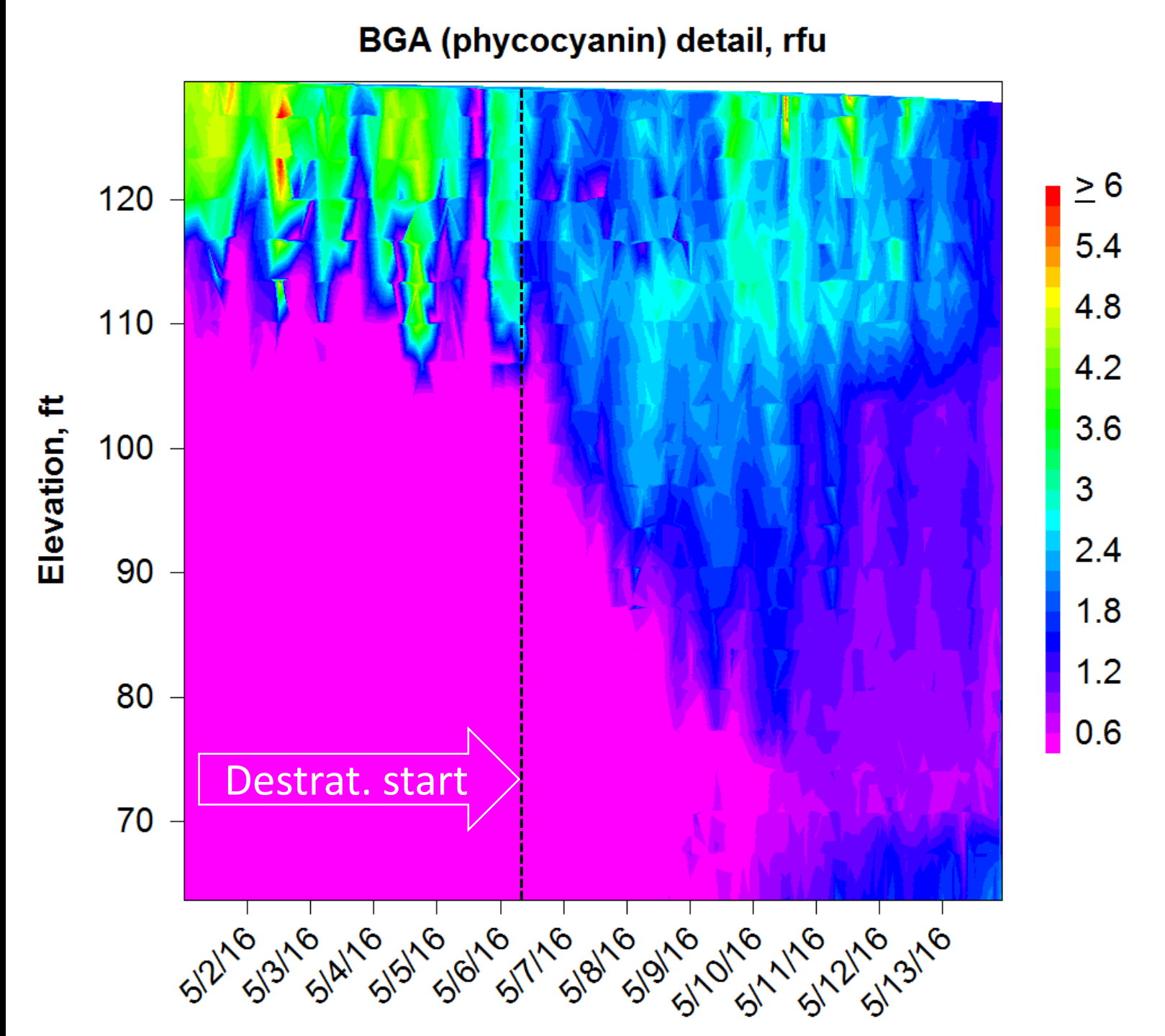
- **Graph**: Phycocyanin at surface
- **Line**: 12-hour moving average

ch2m


Multi-probe
Every 2 hours
Temperature, 0.25 °C resolution
surf_elev, ft
130
120
110
100
90
80
70
Epilimnion
Intense stratification
Destratification starts
MIXED
Hypolimnion
(HA operating)
3/20/16
4/3/16
4/17/16
5/1/16
5/15/16
5/29/16
6/12/16
6/26/16
7/10/16
7/24/16
8/7/16
34
33
32
31
30
29
28
27
26
25
24
23
22
21
20
19
18


Temperature detail May 1-14, 2016
Elevation, ft
120
110
100
90
80
70
Destrat. start
5/2/16
5/3/16
5/4/16
5/5/16
5/6/16
5/7/16
5/8/16
5/9/16
5/10/16
5/11/16
5/12/16
5/13/16
28
27.25
26.5
25.75
25
24.25
23.5
22.75
22
21.25
20.5
19.75

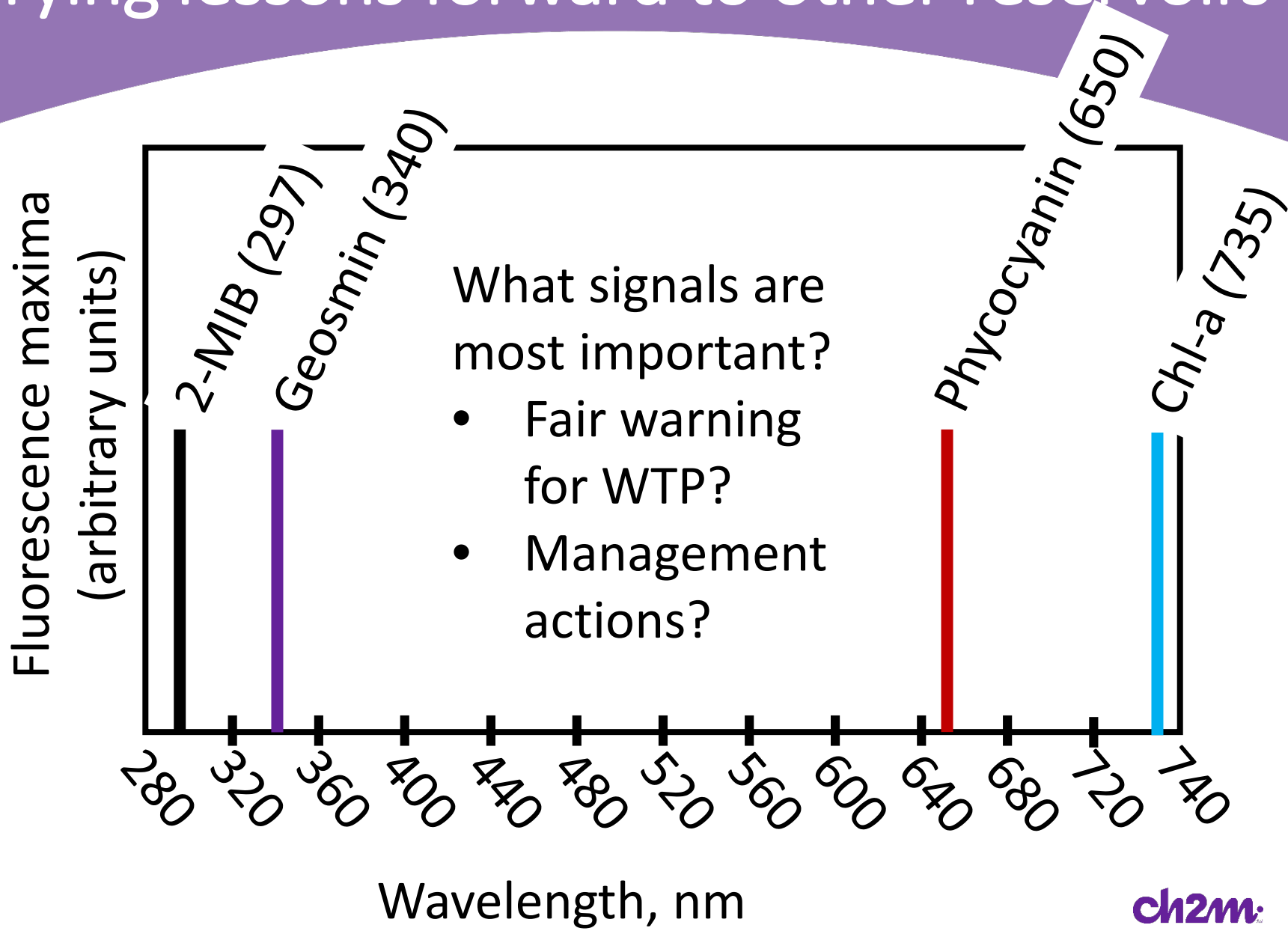

Cyanobacteria (BGA), 0.1 rfu resolution
Incipient cyanobacteria bloom observed in field
Elevation, ft
130
120
110
100
90
80
70
Diffuser elevation
3/20/16
4/1/16
5/1/16
6/1/16
7/1/16
8/1/16
8/14/16
≥ 6
5.2
4.4
3.6
2.8
2
1.2
≤ 0.4

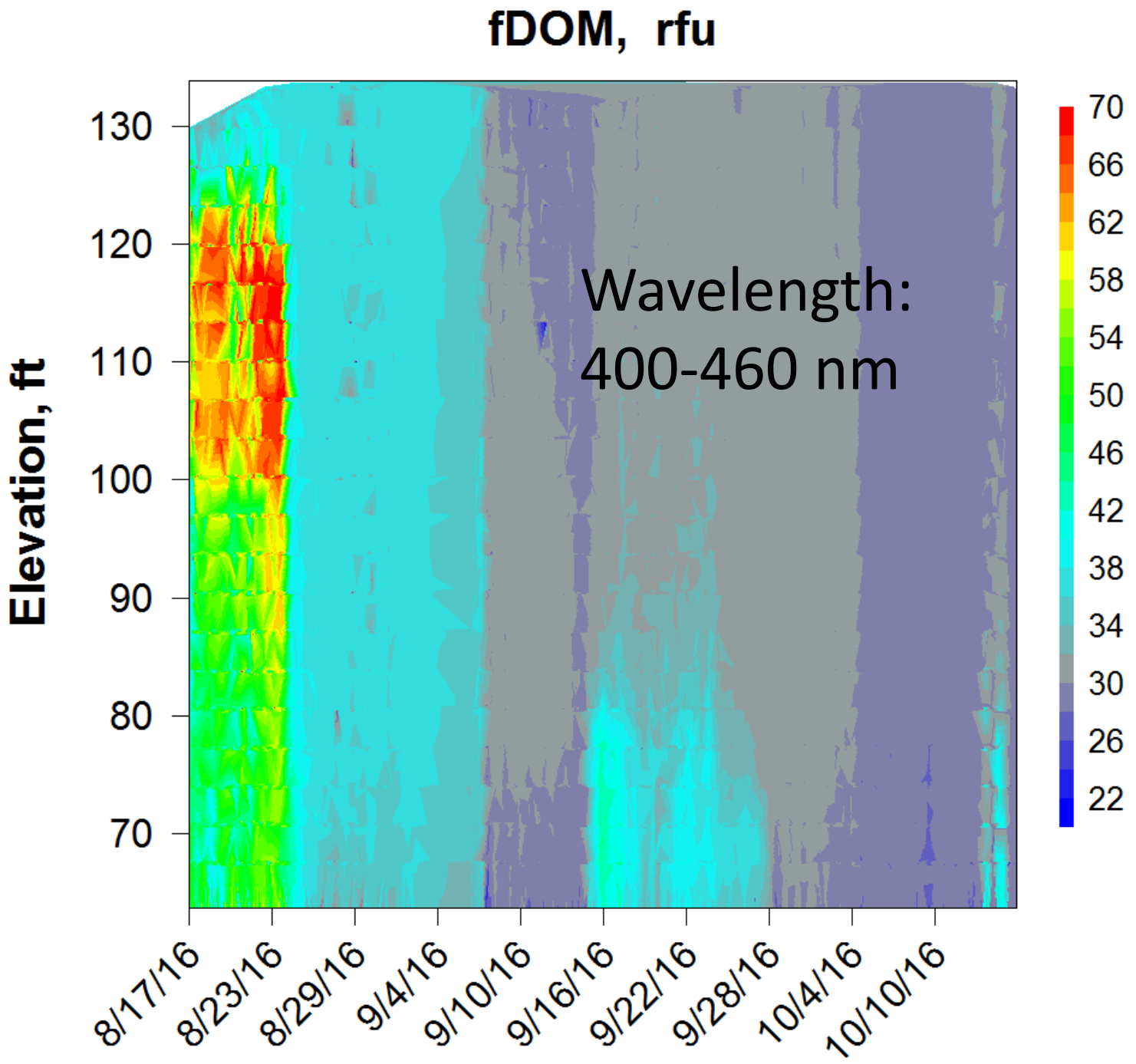

BGA (phycocyanin) detail, rfu
Elevation, ft
120
110
100
90
80
70
Destrat. start
5/2/16
5/3/16
5/4/16
5/5/16
5/6/16
5/7/16
5/8/16
5/9/16
5/10/16
5/11/16
5/12/16
5/13/16
≥ 6
5.4
4.8
4.2
3.6
3
2.4
1.8
1.2
0.6

Lessons learned

- Clear signal (phycocyanin) from reservoir – “Bloom coming”
- Signal triggered management action based on sound eco-hydrodynamic theory
- Why argue with success or court risk? Further optimization of aeration to save energy costs hard to sell

Carrying lessons forward to other reservoirs

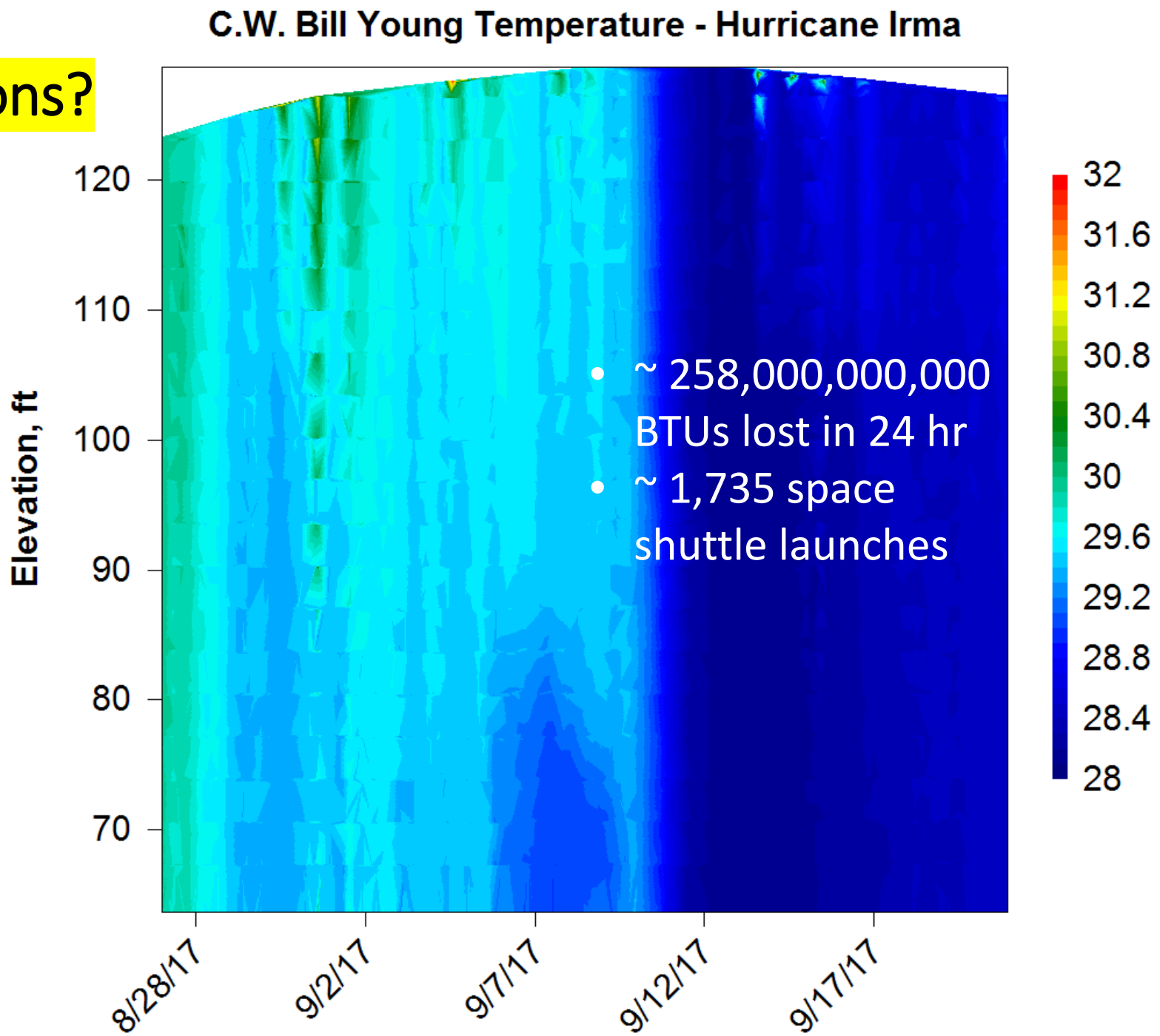



fDOM, rfu
Elevation, ft
130
120
110
100
90
80
70
Wavelength:
400-460 nm
70
66
62
58
54
50
46
42
38
34
30
26
22
8/17/16
8/23/16
8/29/16
9/4/16
9/10/16
9/16/16
9/22/16
9/28/16
10/4/16
10/10/16

The Reservoir is Unit Process #1

- Put gages on it!
- Learn its ways (data science exercise)
- Manage it to work for the WTP, not against it
- No one will do the operational research for utilities to optimize raw water quality but the utilities themselves

Questions?


C.W. Bill Young Temperature - Hurricane Irma
Elevation, ft
120
110
100
90
80
70
8/28/17
9/2/17
9/7/17
9/12/17
9/17/17
32
31.6
31.2
30.8
30.4
30
29.6
29.2
28.8
28.4
28
• ~ 258,000,000,000 BTUs lost in 24 hr
• ~ 1,735 space shuttle launches