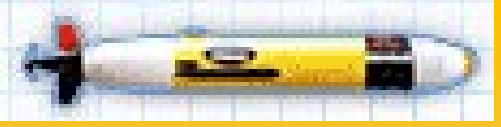

Applications of AUVs in Chesapeake Bay for documenting water quality

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Spatial Variability vs. Temporal Variability

- In any monitoring program or research endeavor to understand the bio-physical processes that dominate ecological systems we face the spatio-temporal dilemma, we can be

- Spatial intensive – lower temporal resolution
  - or
- Temporal intensive – lower spatial resolution
    - May loose vertical dimension
- But, water quality parameters exist in the spatiotemporal domain

Resolving the Spatio-Temporal dilemma

- REMUS 100

- HydroLab DS 5

- NOAA Annapolis Buoy

REMUS 100
Remote Autonomous Environmental Unit s

Physical Specs:

Manufacturer: Hydroid

Body Type: Torpedo

Size (LxWxH): 1.60m x 0.19m x 0.19m Body Size (LxWxH): 1.60m x 0.19m x 0.19m

Hull Material: Aluminum

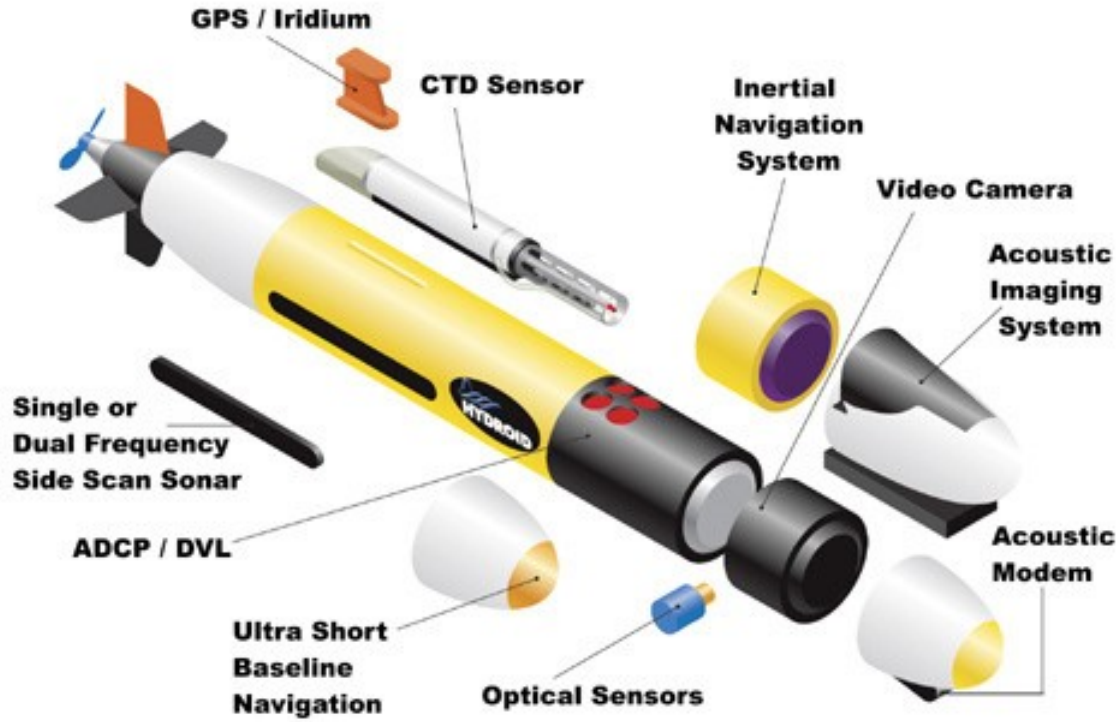
Weight: 37.00kg

Maximum Depth: 100.00 m

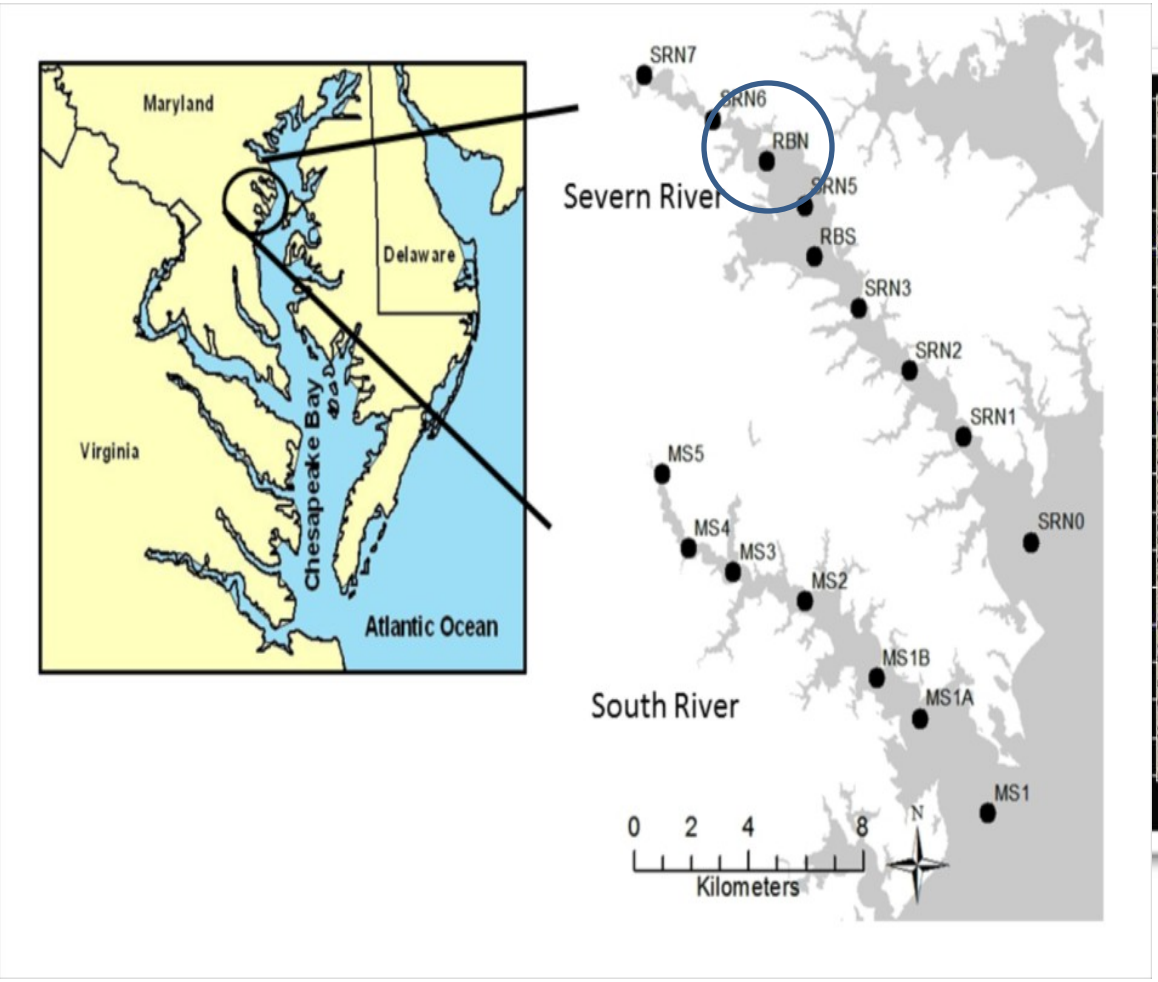
Self-Righting: Yes

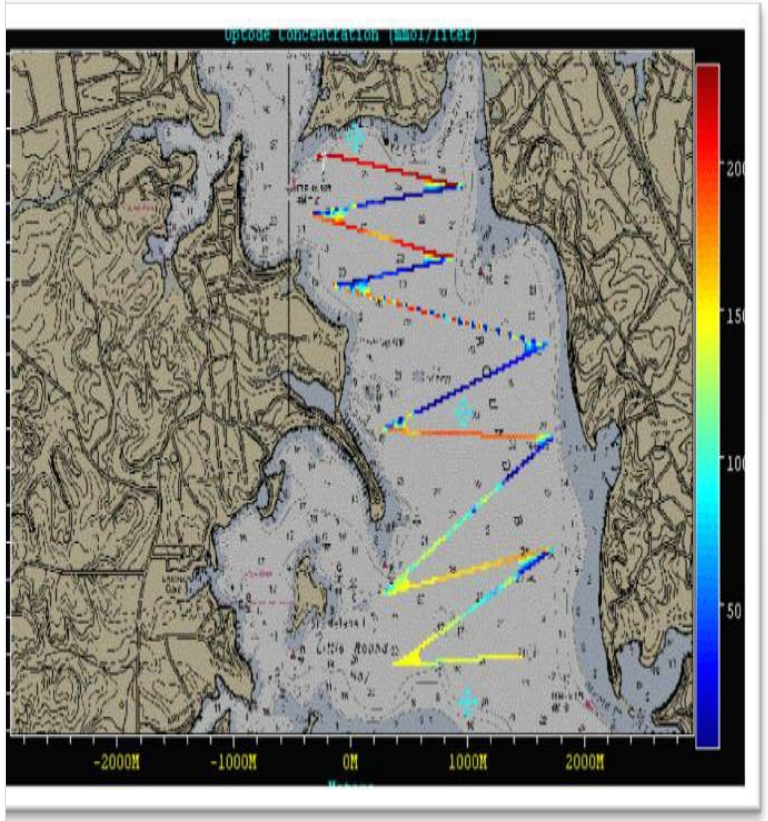
Obstacle Avoidance: No

Endurance (nominal load): 22 hours -

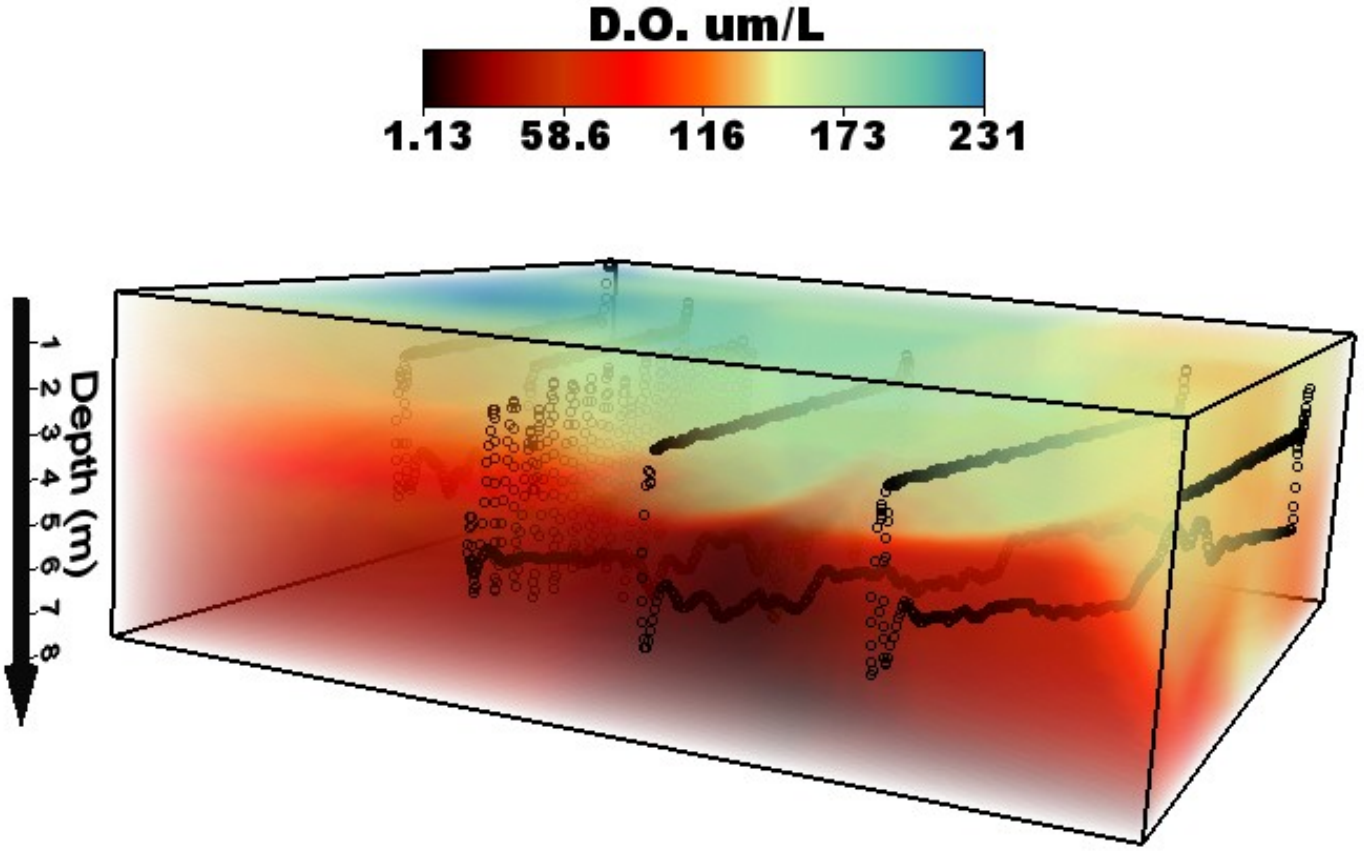


Mission: Round Bay, Severn River hypoxia

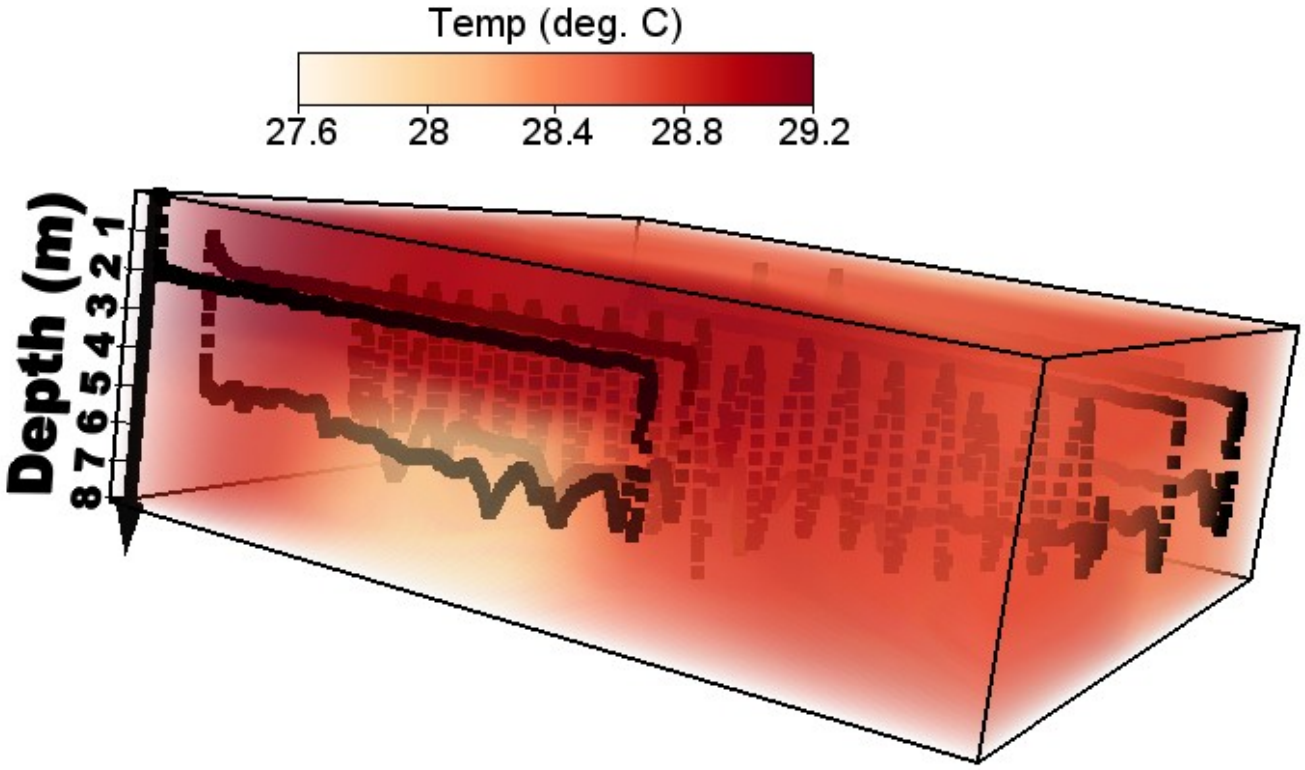




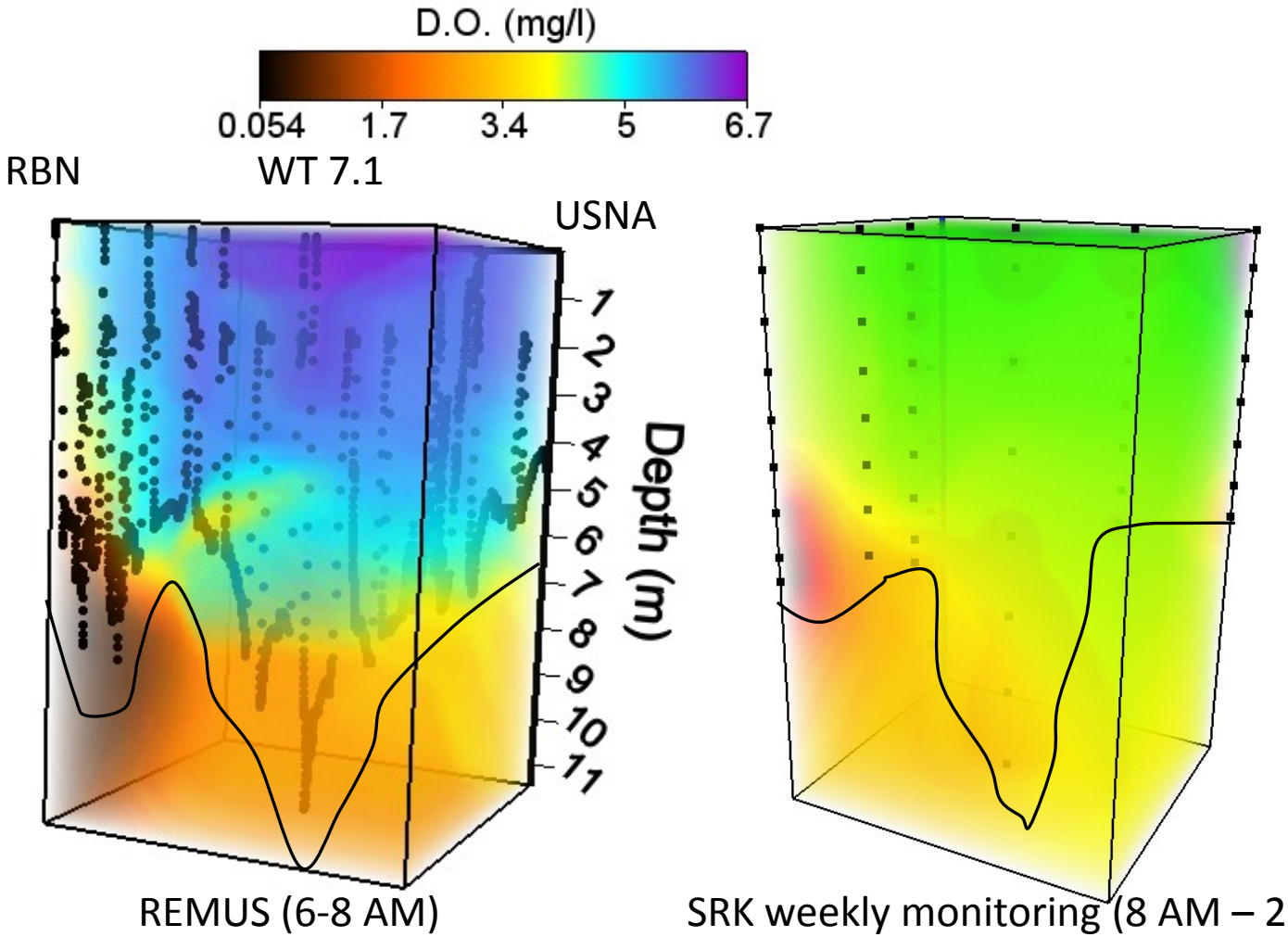
Mission: Round Bay, Severn River hypoxia (Aug 13, 2010)



Mission: Round Bay, Severn River hypoxia (Aug. 13, 2010)



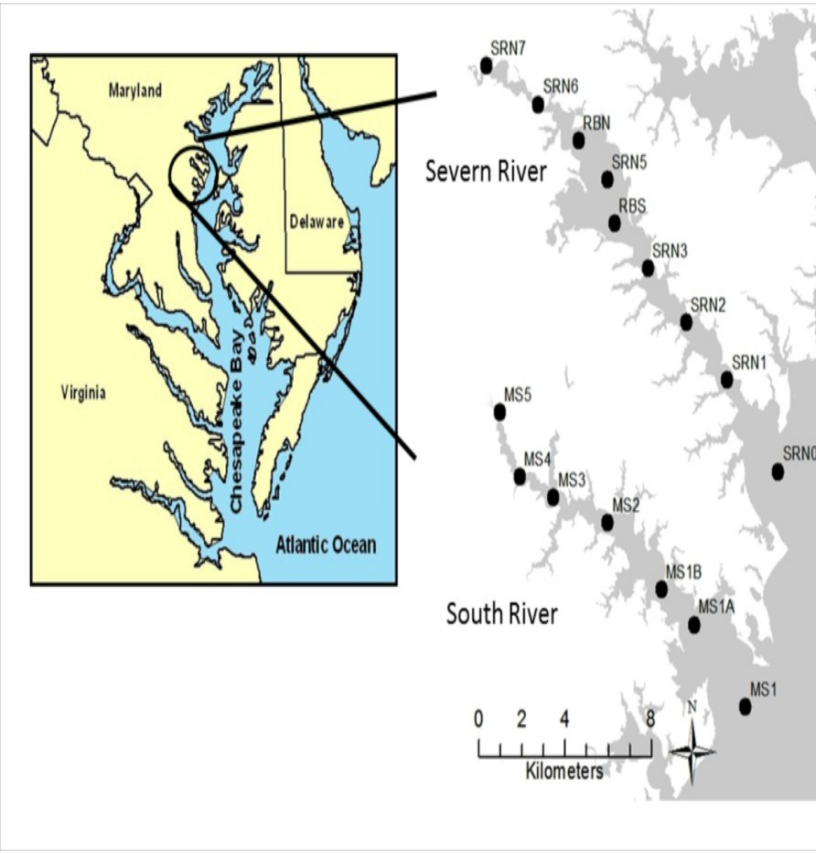
Mission: Severn River
June,15 2011- Round Bay to College Creek

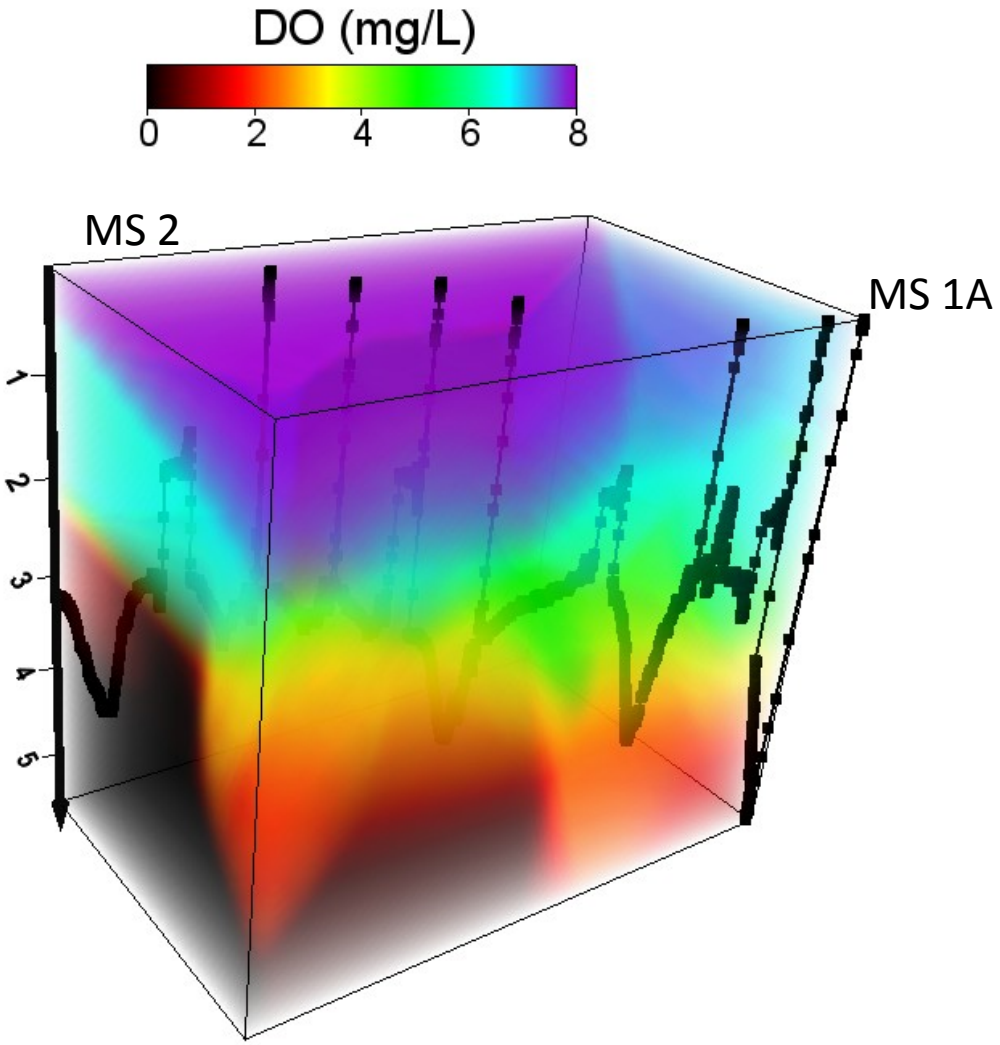


REMUS (6-8 AM)

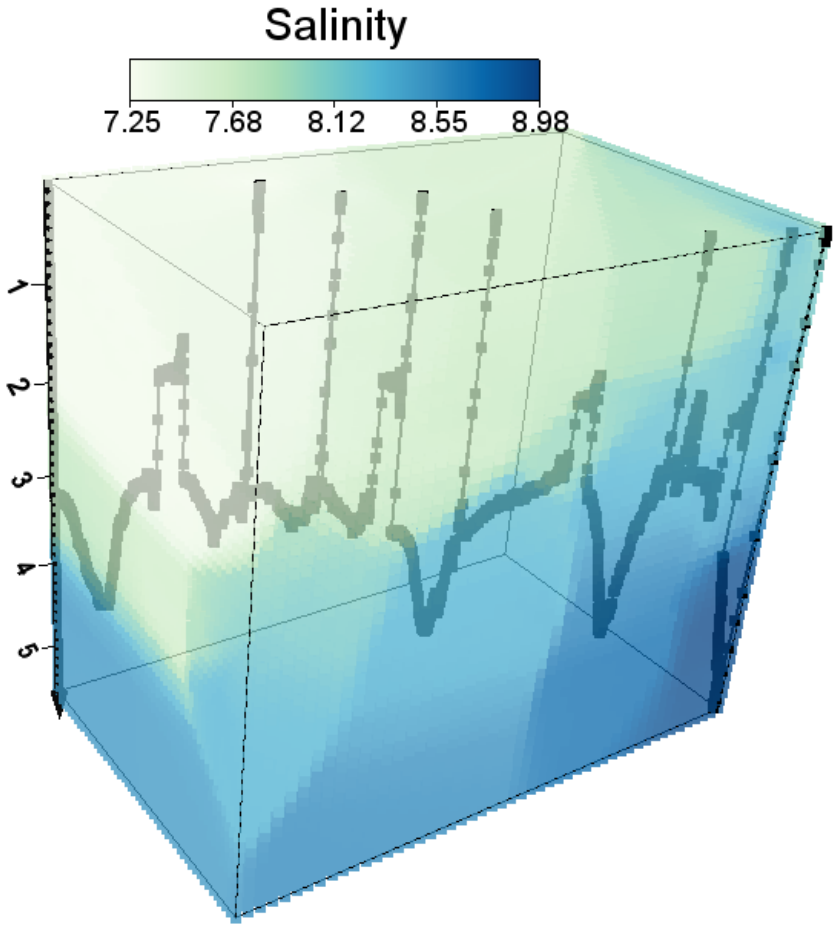
SRK weekly monitoring (8 AM – 2 PM)

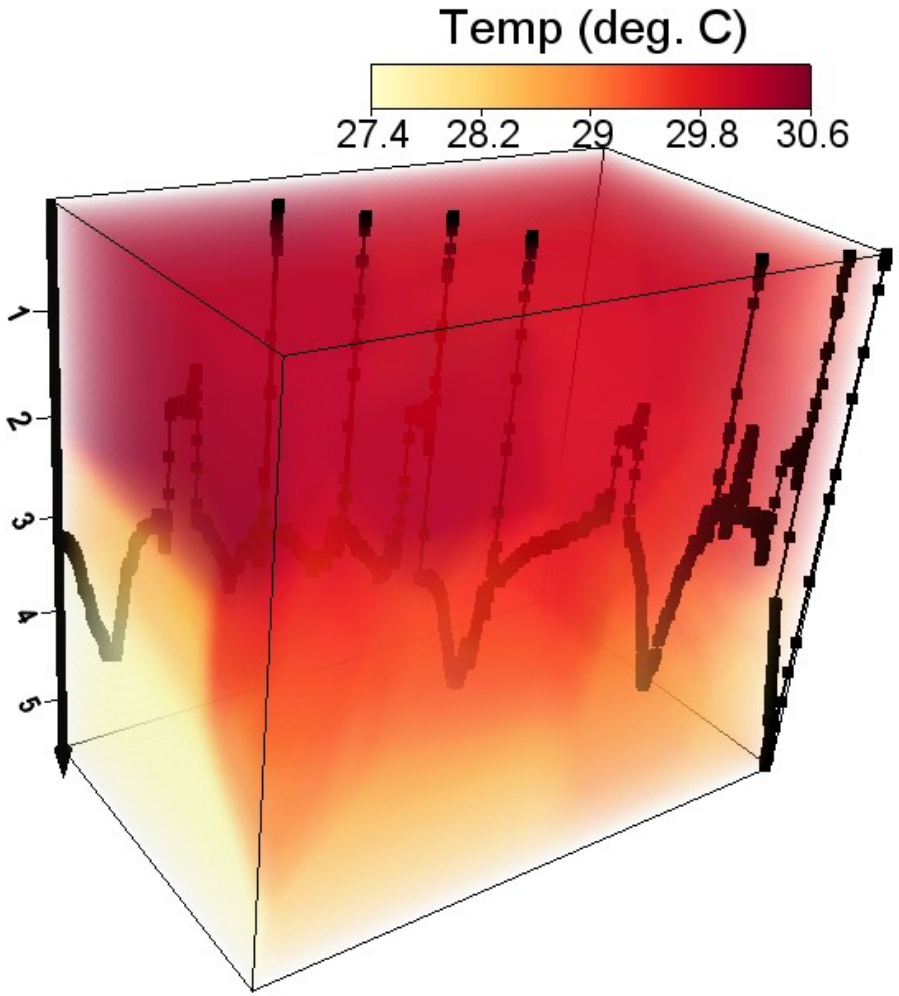
Mission: South River
July 22, 2011





Mission South River
July 22, 2011





Advantages and Disadvantages of Auv's

Advantages

- Rapid recon essence
- Mission Specific
- Large data set
- Long battery life
- Identification of hot spots and potential relationships between fixed historic stations
- Communication – ability to run several simultaneously

Disadvantages

- Learning curve and mission set up
- Longer deployment setup
- Cost – 400k
- Black box configuration?
- Lack of avoidance technology (this model)
- Depth dependence

Increasing the importance and relevance of buoy data and AUVs, building the network

What if you could extract buoy information and cat it throughout the rest of a small tributary.

Theoretical Approach: Slice up the tributary into 1 meter sections.

Consider well mixed within a section; stratification occurs between sections.

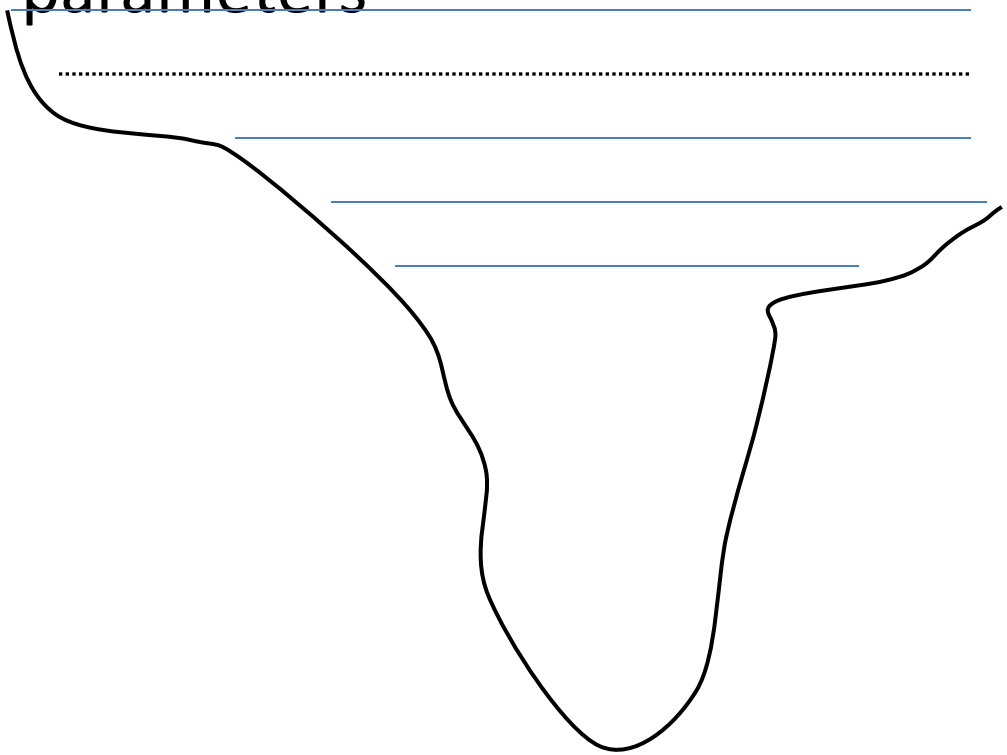
As a result conservative properties may be modeled as Gaussian distribution.

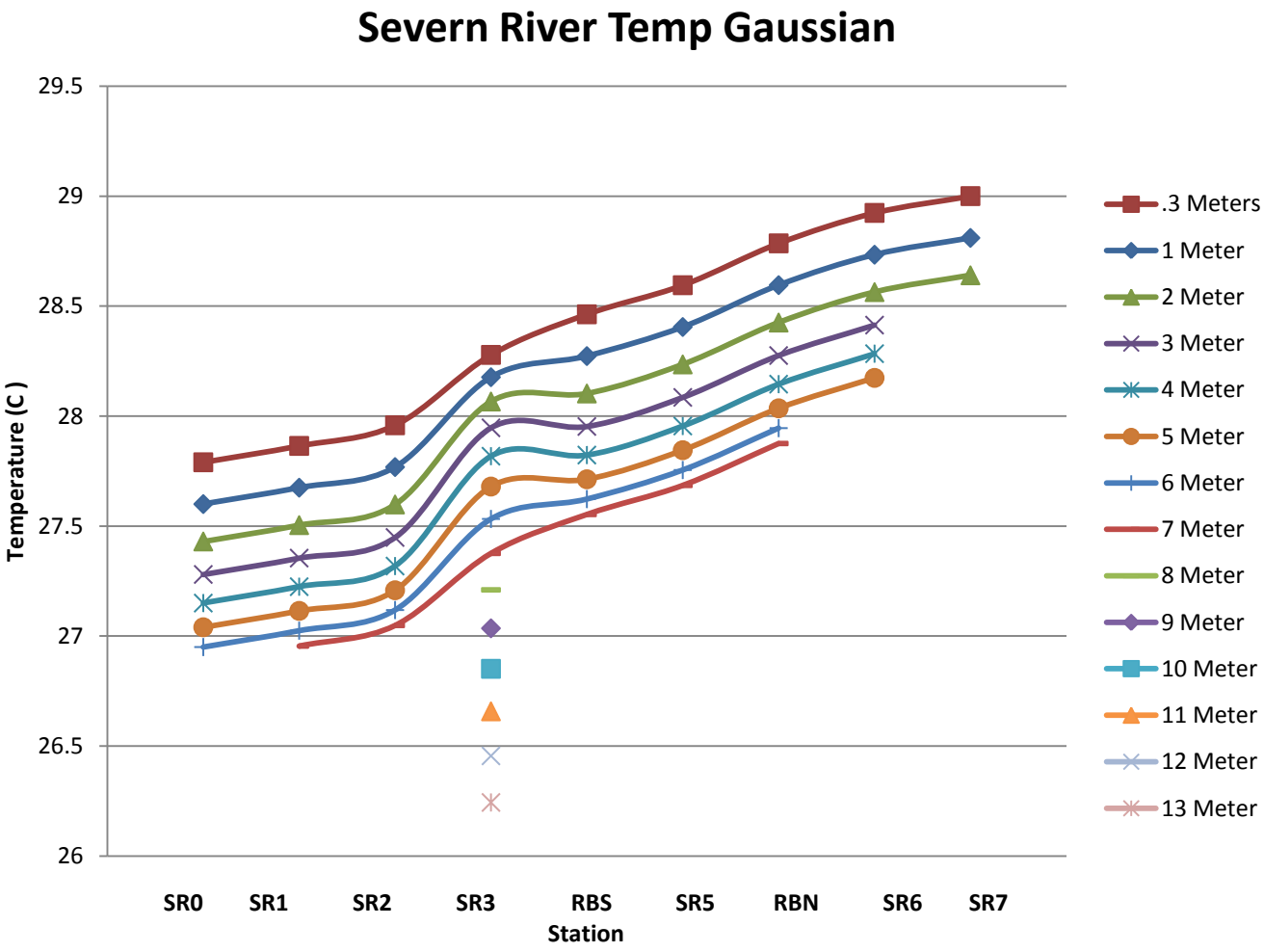
Statistical Methods:

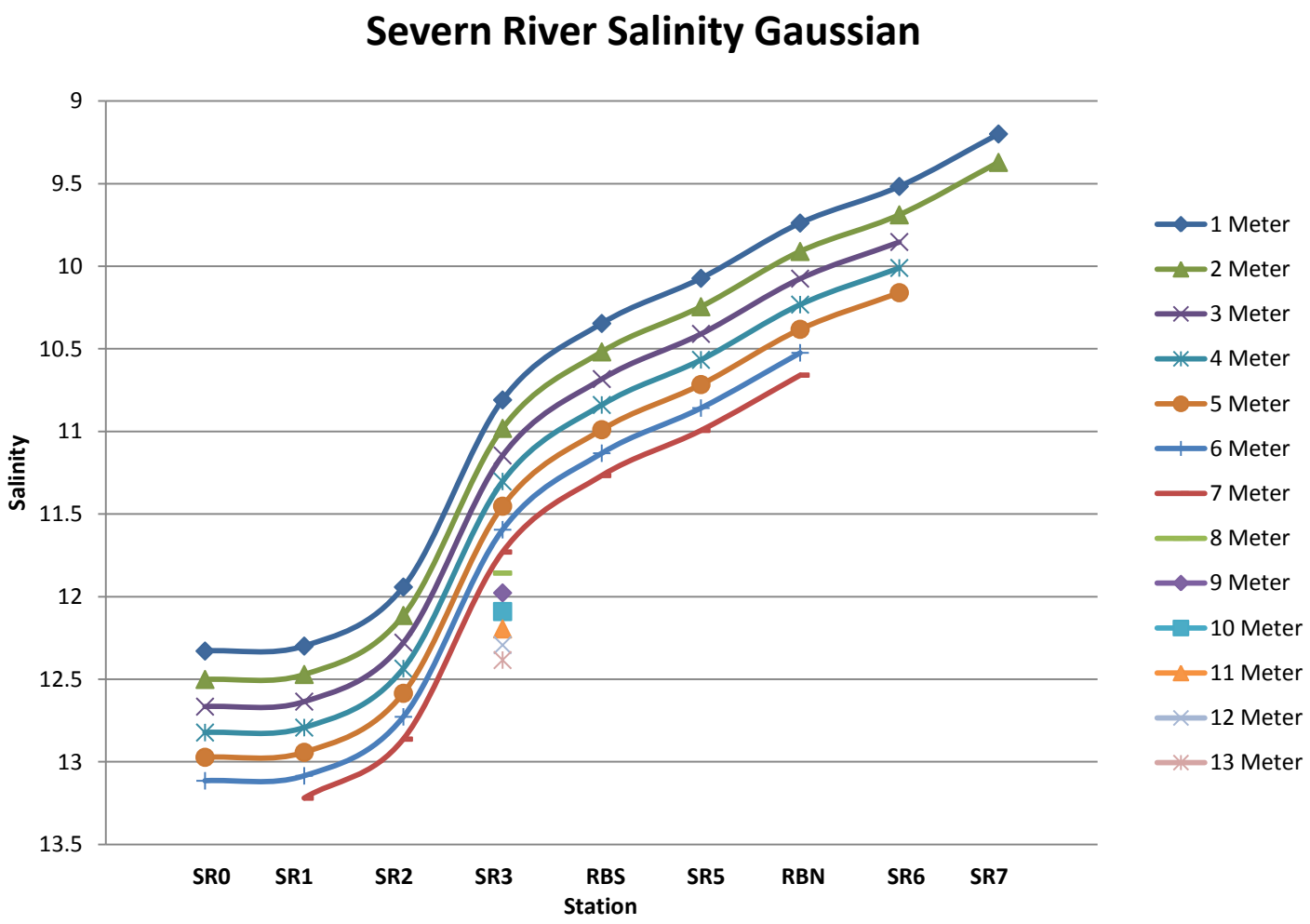
$$T(x) = (T_R - T_M)(e^{-\frac{x^2}{2\sigma_x^2}}) + T_M$$

$$S(x) = (S_M - S_R)(e^{-\frac{x^2}{2\sigma_x^2}}) + S_R$$

- Hindcasting water quality parameters




Severn River Temp Gaussian
29.5
29
28.5
28
27.5
27
26.5
26
Temperature (C)
SR0
SR1
SR2
SR3
RBS
SR5
RBN
SR6
SR7
Station
.3 Meters
1 Meter
2 Meter
3 Meter
4 Meter
5 Meter
6 Meter
7 Meter
8 Meter
9 Meter
10 Meter
11 Meter
12 Meter
13 Meter


Severn River Salinity Gaussian
Salinity
9
9.5
10
10.5
11
11.5
12
12.5
13
13.5
SR0
SR1
SR2
SR3
RBS
SR5
RBN
SR6
SR7
Station
1 Meter
2 Meter
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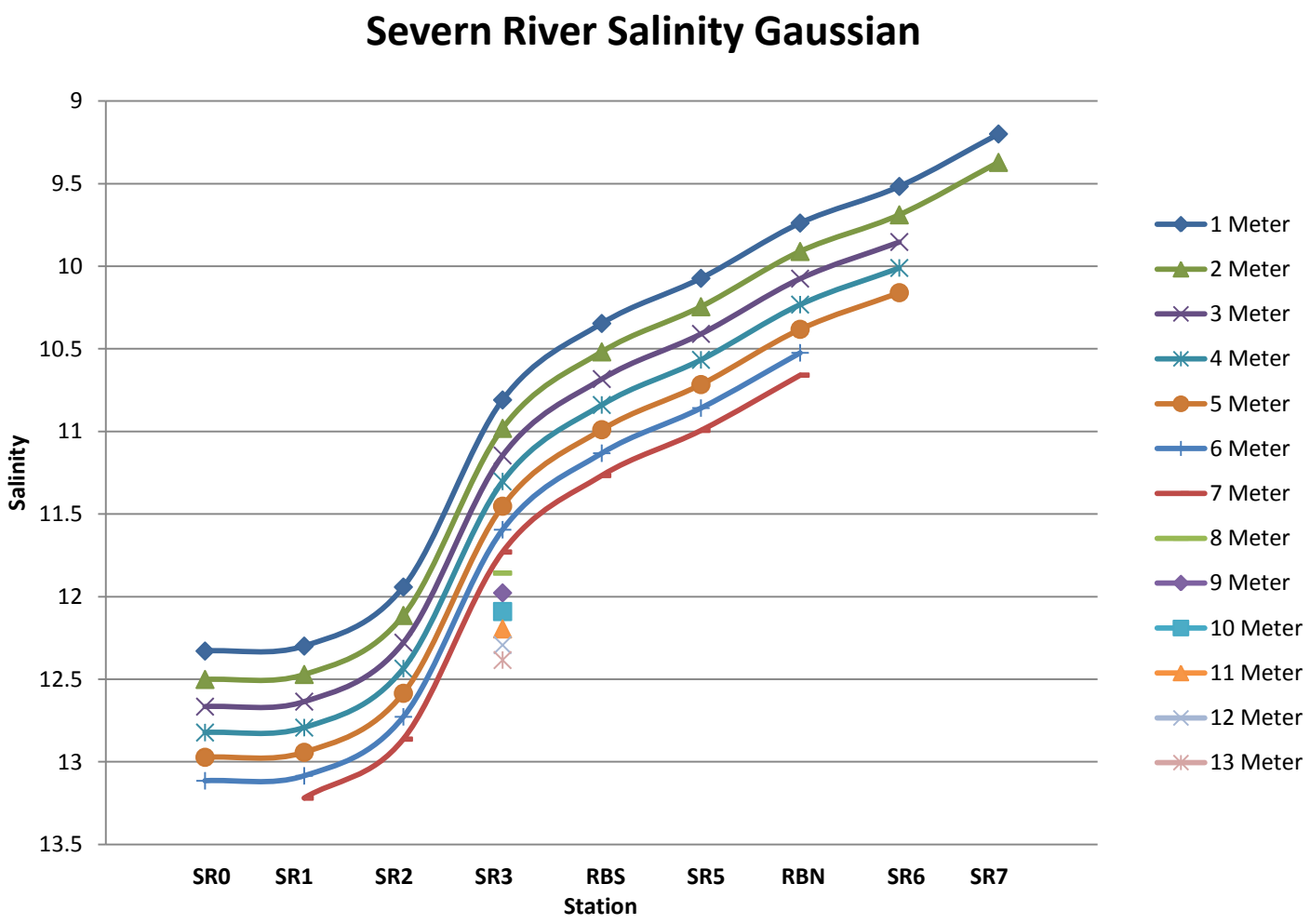
11 Meter
12 Meter
13 Meter


Severn River Salinity Gaussian
Salinity
9
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RBS
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Station
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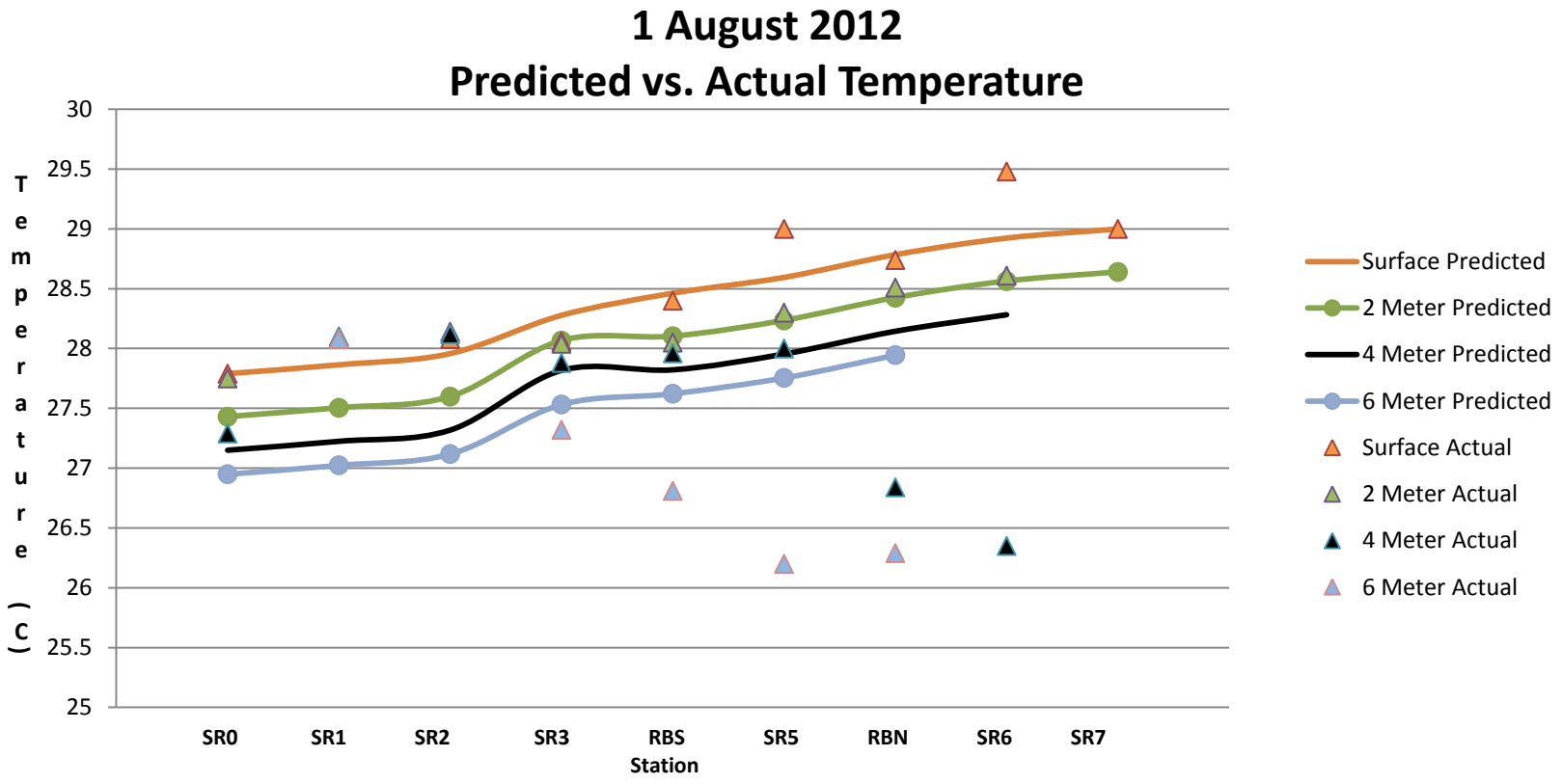
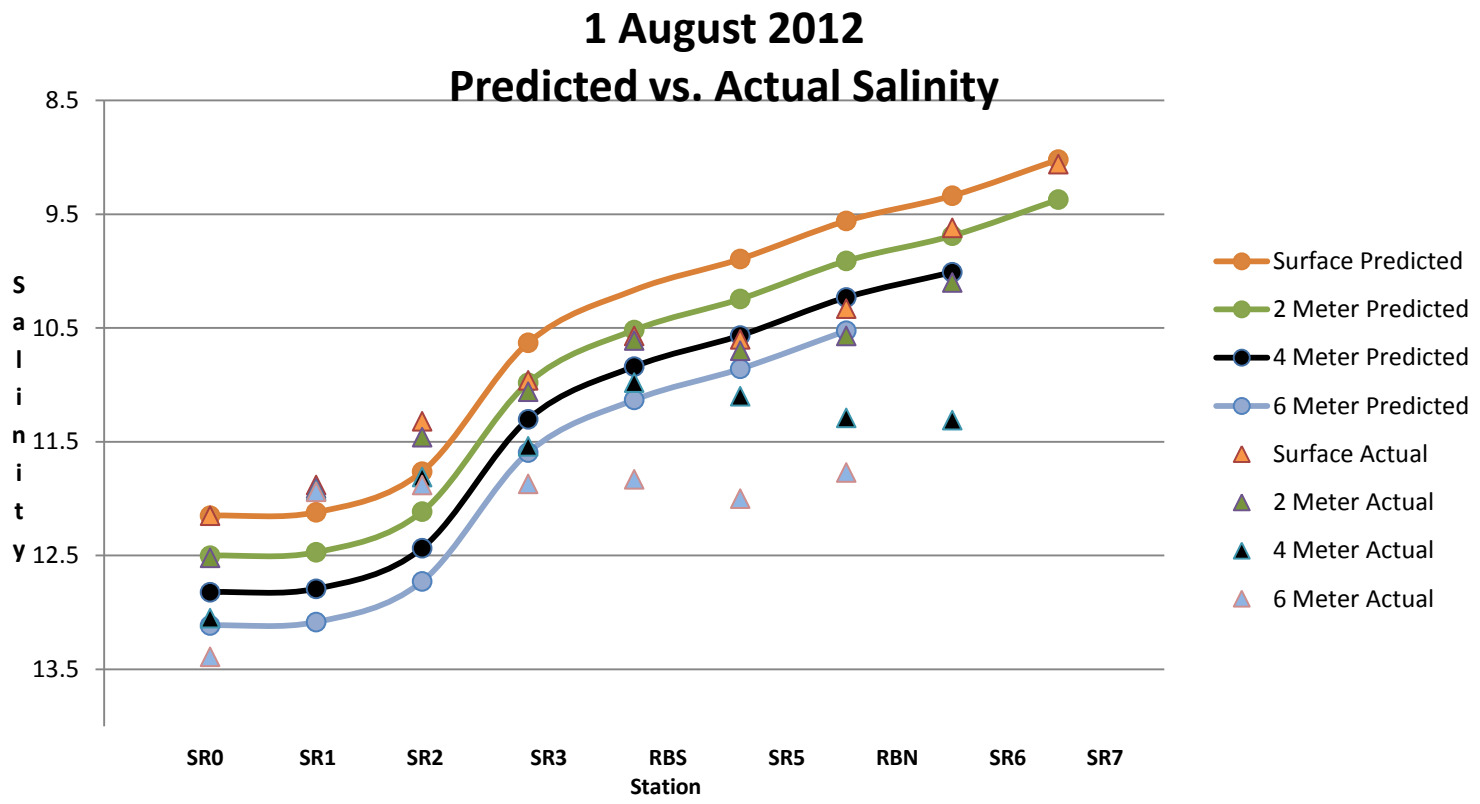
12 Meter
13 Meter


1 August 2012
Predicted vs. Actual Temperature
Temperature (C)
30
29.5
29
28.5
28
27.5
27
26.5
26
25.5
25
SR0
SR1
SR2
SR3
RBS
SR5
RBN
SR6
SR7
Station
Surface Predicted
2 Meter Predicted
4 Meter Predicted
6 Meter Predicted
Surface Actual
2 Meter Actual
4 Meter Actual
6 Meter Actual


1 August 2012
Predicted vs. Actual Salinity
8.5
9.5
10.5
11.5
12.5
13.5
Salinity
SR0
SR1
SR2
SR3
RBS
SR5
RBN
SR6
SR7
Station
Surface Predicted
2 Meter Predicted
4 Meter Predicted
6 Meter Predicted
Surface Actual
2 Meter Actual
4 Meter Actual
6 Meter Actual

Conclusion

- Auv's can be useful in helping to understand the evolution of water quality parameters in estuarine environments with careful consideration of their limitations.
- However in order to fully resolve the spatiotemporal nature of water quality parameters , it will take the coupling of regular monitoring, Auv's and continuous monitoring devices in a dedicated network with multiple partners.