Assessment of Criteria Attainment for SAV-Water Clarity

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MW Meeting
April 26, 2016

SAV – Water Clarity Criteria Attainment Assessment

Does SAV acreage reach Restoration Goal?
(in any year of 3-rolling-year)

Yes

No

Does Water Clarity meet the Criteria?
in other than SAV area >=
2.5 (SAV Goal area – SAV acre) ?

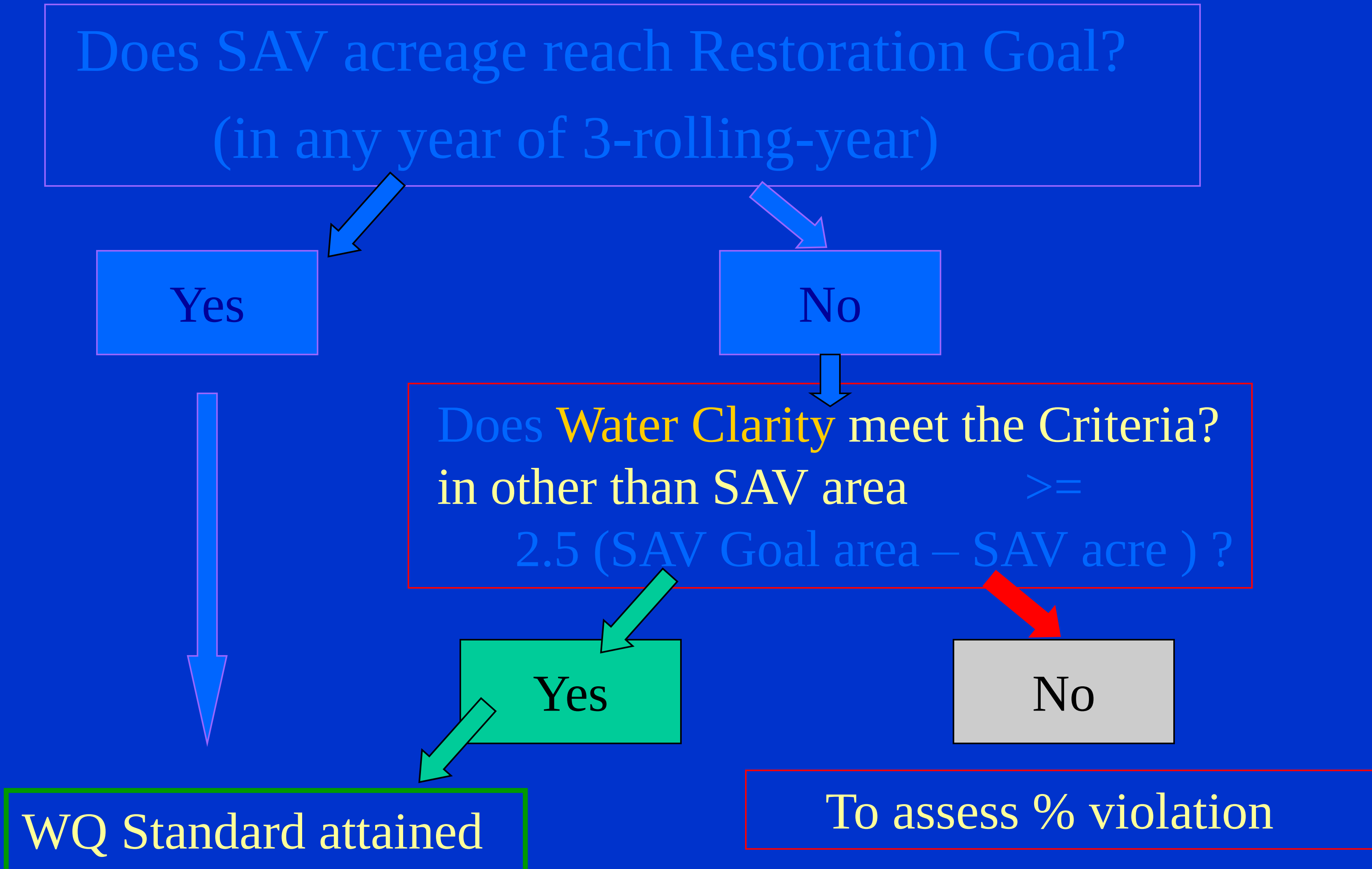
Yes

No

WQ Standard attained

To assess % violation

Water Clarity (only) Criteria Attainment Assessment

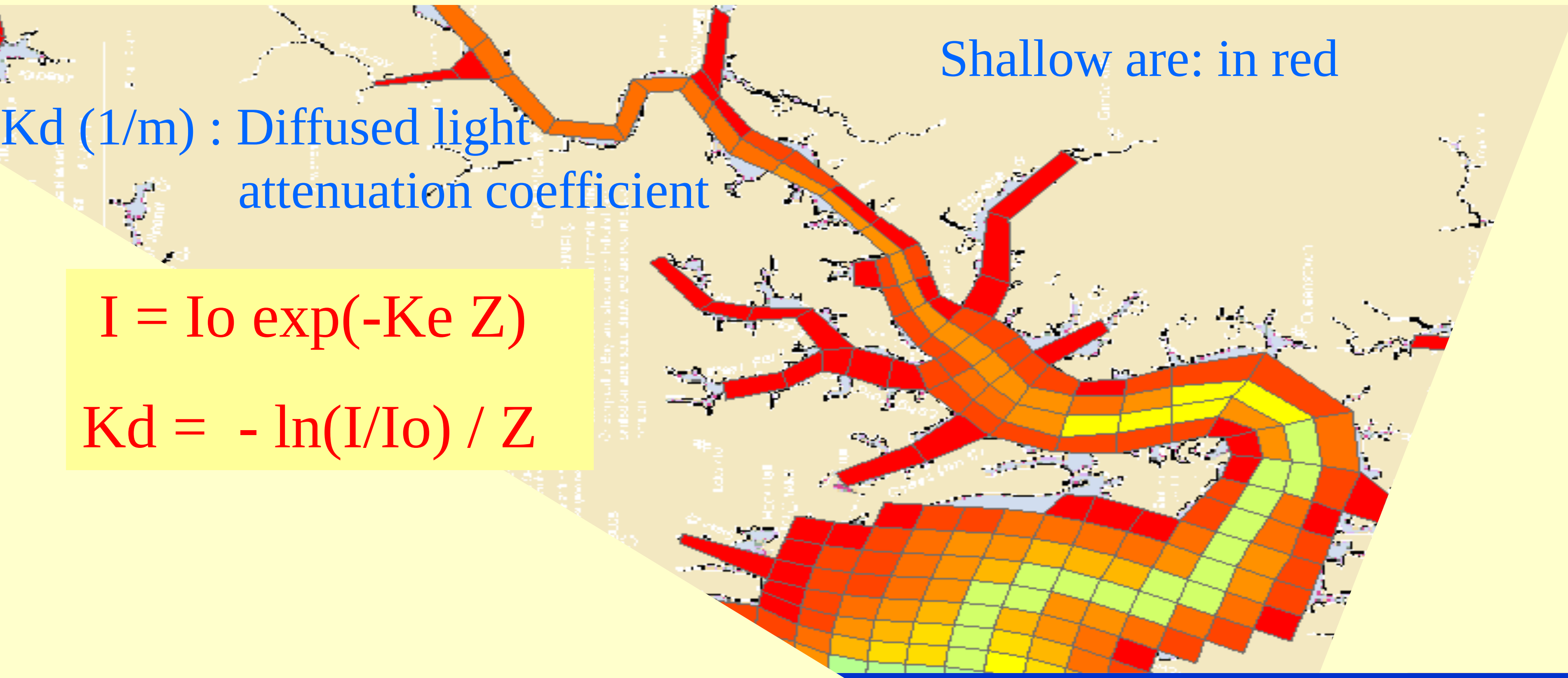


The task becomes to access the area of Kd attainment in each CB segments

- Sum up the area (of model cells in the shallow region) that meets Kd criteria in a specific (WIP) scenario – against the required acreage for a segment.

Shallow are: in red

Kd (1/m) : Diffused light attenuation coefficient



$$I = Io \exp(-Ke\ Z)$$

$$Kd = -\ln(I/Io) / Z$$

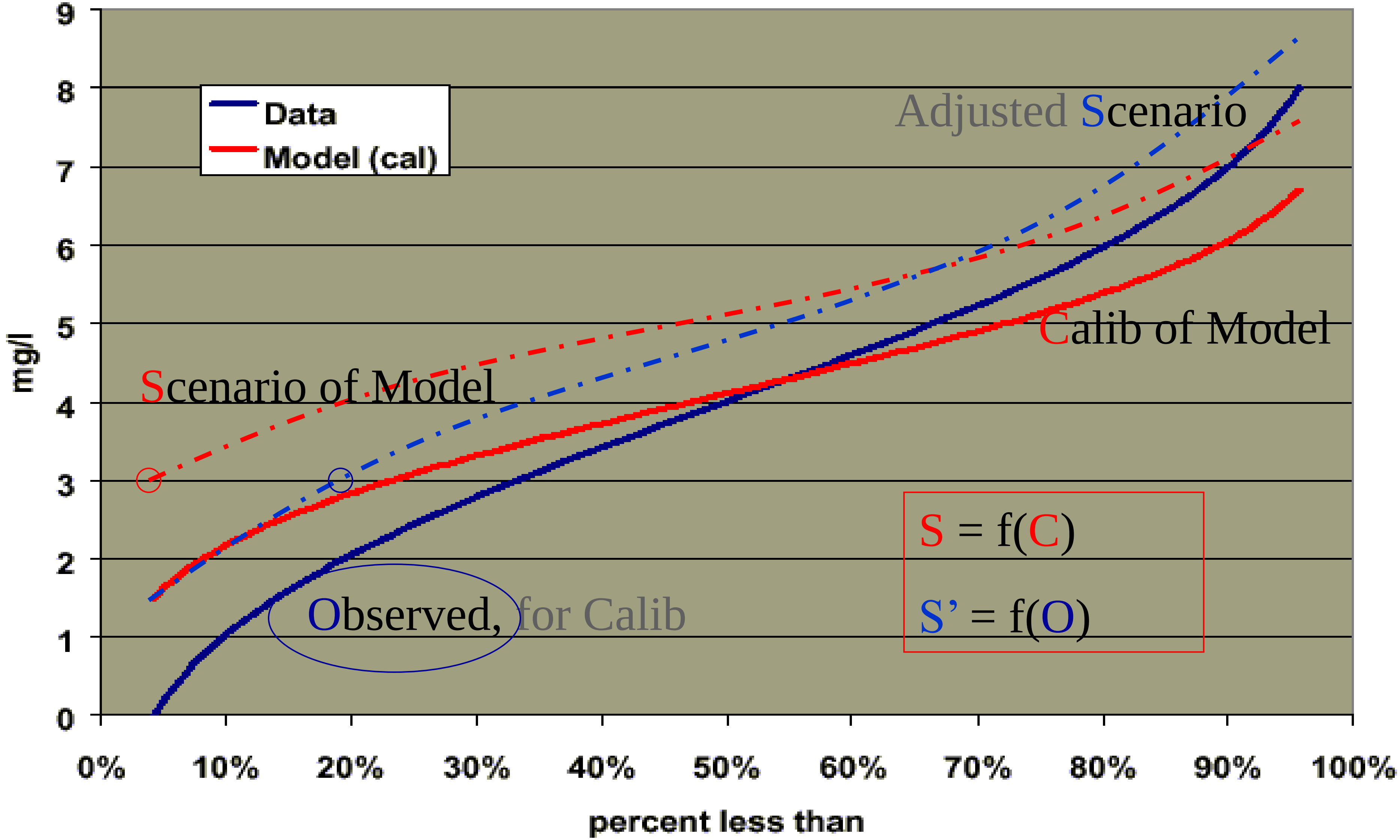
Salinity Regime	Water Clarity Criteria as Percent Light through Water	Water Clarity Criteria Application Depths (meters)			
		0.5	1.0	1.5	2.0
		Kd (1/m) Equivalents for Criteria Application Depth			
Tidal Fresh & Oligohaline	13%	Kd<4.08	Kd< 2.04	Kd<1.36	Kd<1.02
Mesohaline & Polyhaline	22%	Kd< 3.03	Kd< 1.51	Kd<1.01	Kd<0.76

Use computer model of Kd to assess criteria attainability in management

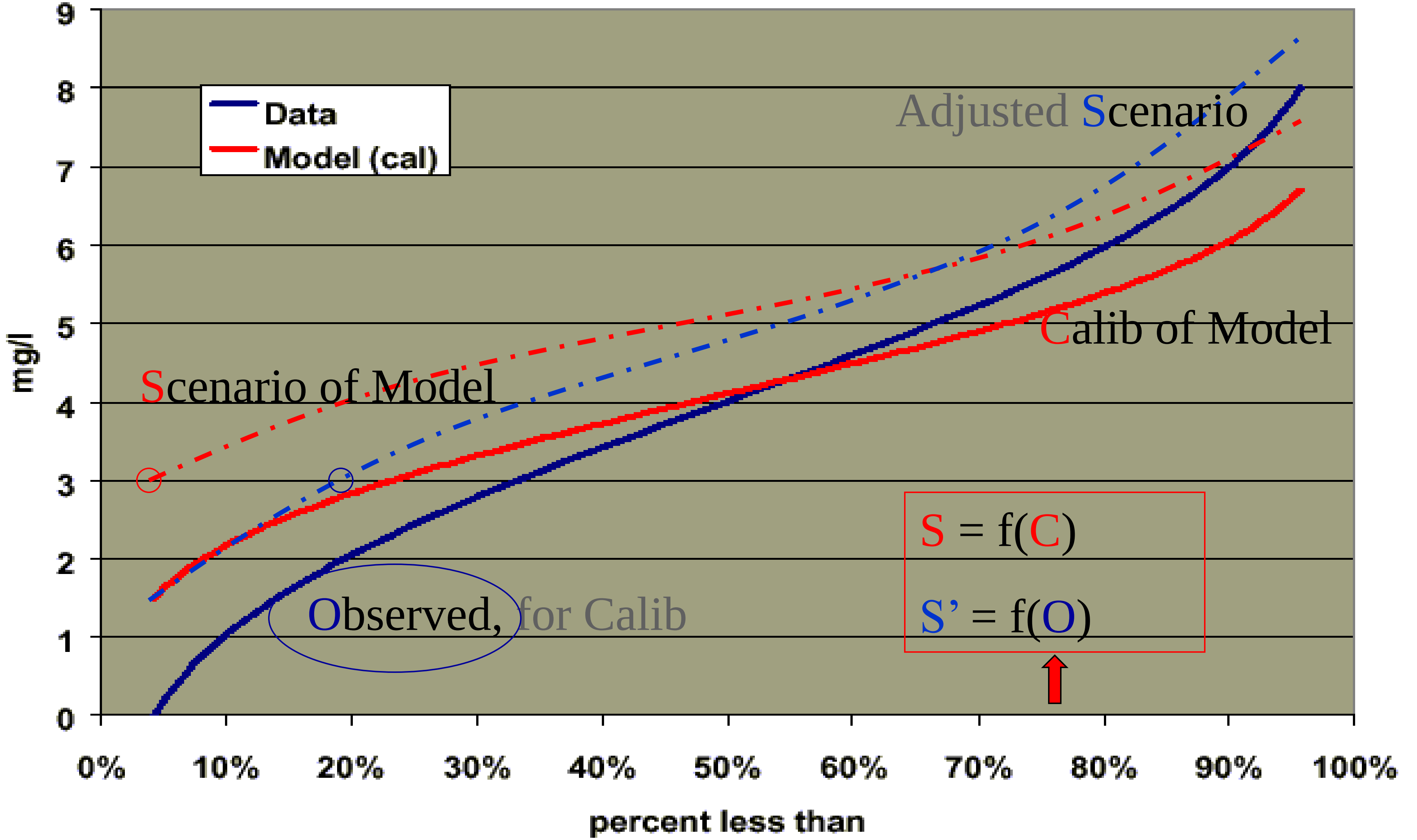
Accessing acreage of Kd attainment in CB segments (using model)

- Sum up the area (of model cells) in shallow areas that meets Kd criteria in a specific (WIP) scenario.
- However, a data correction is needed to modeled Kd, because the model estimates deviate from the actual (observed) values. When using a numerical water quality standard, the variation could lead to wrong conclusions of water quality standard achievement or violation.
- Data correction requires the model be well calibrated with reasonable responses to seasonal change and load changes and that there are sufficient representative observations.

Scenarioing modeled data

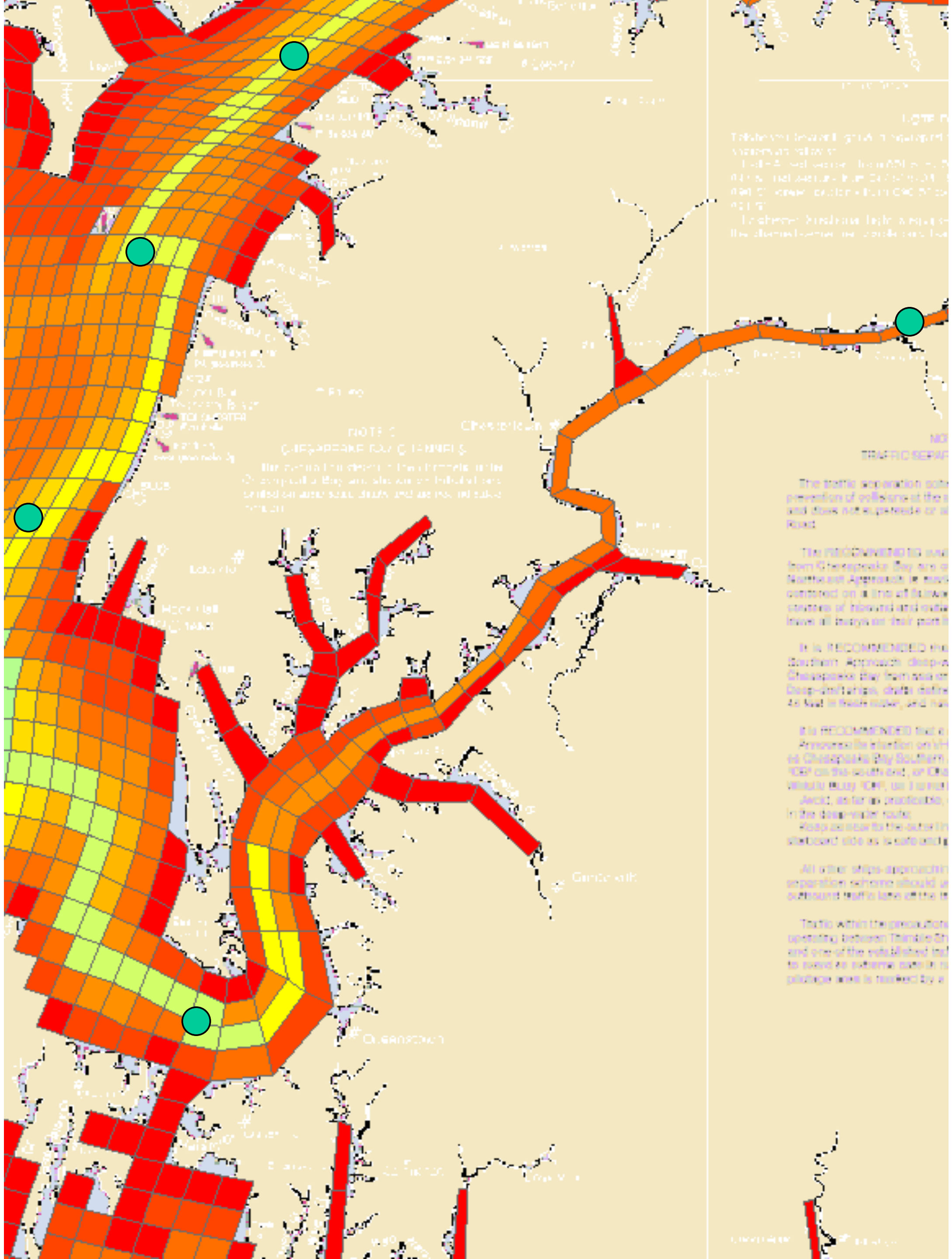


Scenarioing modeled data



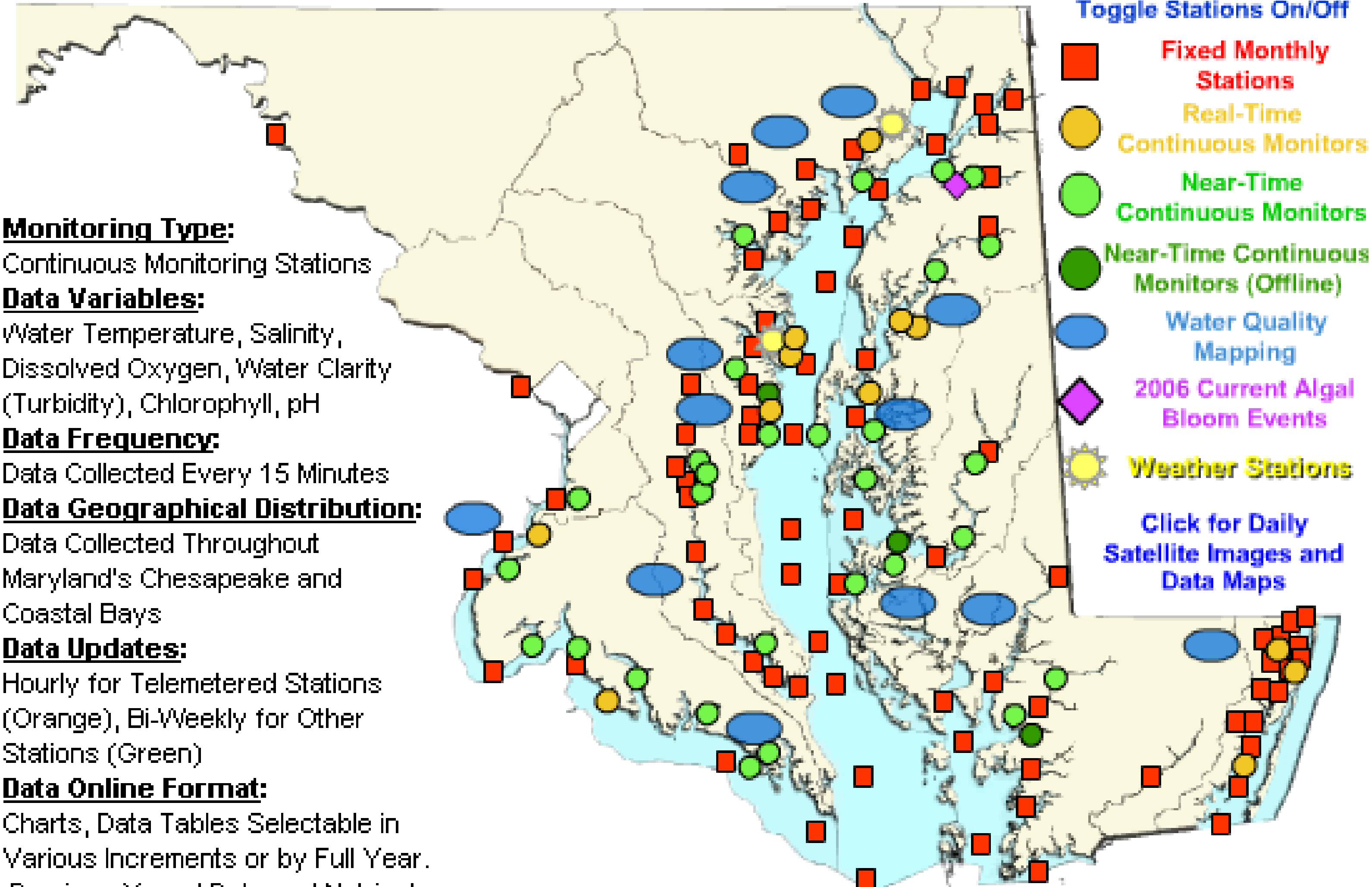
The Key to data correction is to have Observed Kd

In the criteria assessment, we use model results from 1991-2000 average hydrology.



We don't have enough observed Kd in shallow water in 1991-2000, but in channel.

The key is to get likely "observed Kd" in shallow in 1991-2000



Monitoring Type:
Continuous Monitoring Stations
Data Variables:
Water Temperature, Salinity, Dissolved Oxygen, Water Clarity (Turbidity), Chlorophyll, pH
Data Frequency:
Data Collected Every 15 Minutes
Data Geographical Distribution:
Data Collected Throughout Maryland's Chesapeake and Coastal Bays
Data Updates:
Hourly for Telemetered Stations (Orange), Bi-Weekly for Other Stations (Green)
Data Online Format:
Charts, Data Tables Selectable in Various Increments or by Full Year. Previous Years' Data and Nutrient Data Available.

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Shallow water monitoring started in 2003, and switch tributaries among years.

Optional Views:
Full Screen Map
Text Only Station Menus

Note: *Fixed Monthly Monitoring stations depicted on map are representative of Maryland's Water Quality Monitoring Program and do not include all monitored stations.*

To get likely observed Kd in 1991-2000

- Based on observed & modeled Kd in shallow and in channel in 2003-2014(?) to establish a relationship.
- Substitute observed Kd in channel in 1991-2000 to get "likely observed Kd" in shallow in 1991-2000".

Data-correct of modeled Kd

- Based on modeled Kd in shallow in Base and in a management scenario, to establish a relationship:

  Shallow Kd in manage sce = f (shallow Kd in Base) .

- Substitute the "likely observed Kd" in shallow in 1991-2000" to the right-hand side, to get data-corrected shallow Kd in a management scenario in 1991-2000.

Alternative methods in to get the “Likely Observed Kd” in 1991-2000

A) Simple ratio method:

$$\frac{\text{mod\_shallow}}{\text{mod\_channel}} = \frac{\text{obs\_shallow}}{\text{obs\_channel}}$$

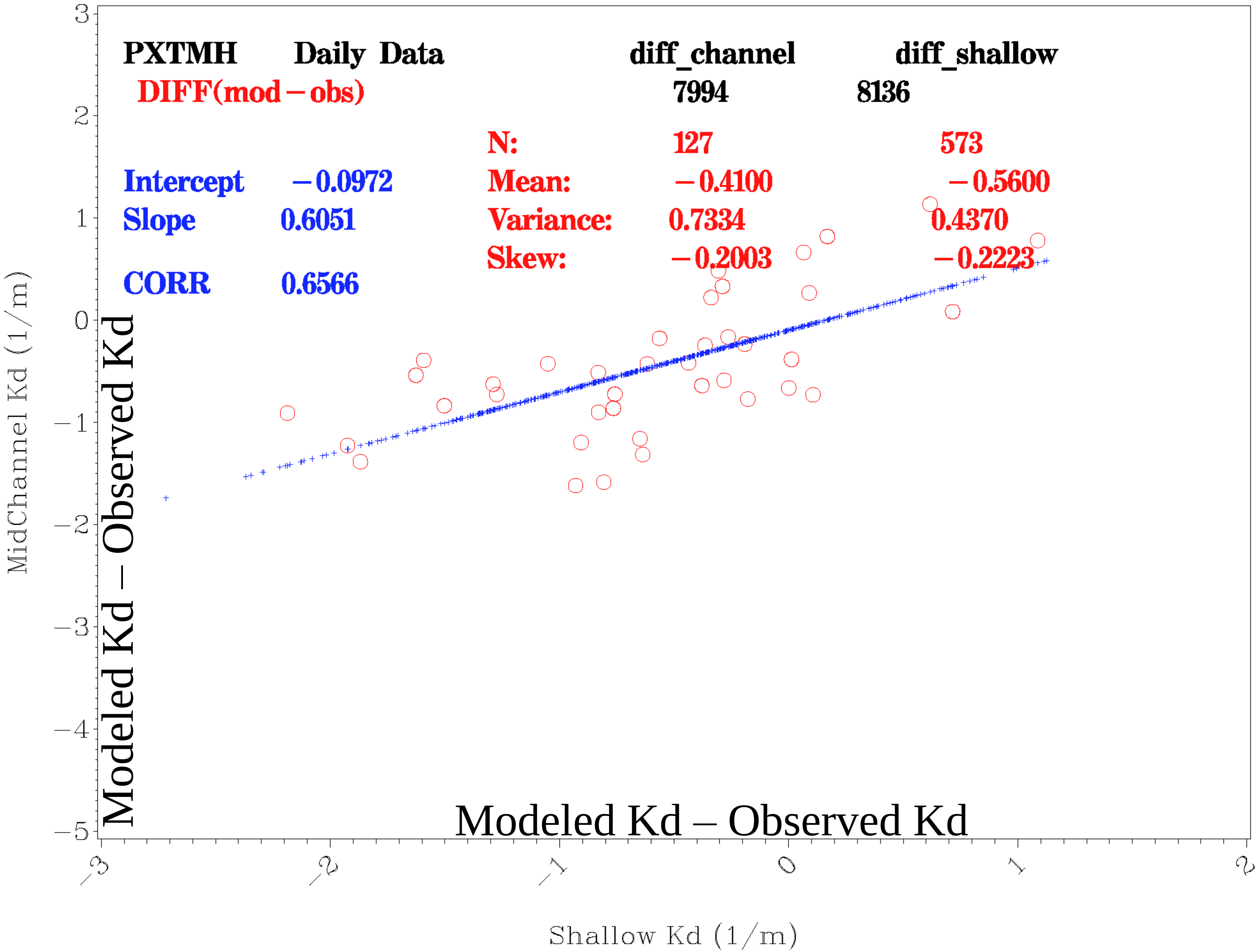
B) Simple regression:

Mkd_shlw = f(Mkd_cntr) => Okd_shlw = f(Okd_cntr)

C) Multi-var regression:

Okd_shlw = f(Okd_cntr, Mkd_cntr, Mkd_shlw, physics_shlw)

D) Other better method?



PXTMH Daily Data
diff_channel
diff_shallow
DIFF(mod – obs)
7994
8136
N:
127
573
Intercept –0.0972
Mean:
–0.4100
–0.5600
Slope 0.6051
Variance:
0.7334
0.4370
Skew:
–0.2003
–0.2223
CORR 0.6566
MidChannel Kd (1/m)
Modeled Kd – Observed Kd
Modeled Kd – Observed Kd
Shallow Kd (1/m)

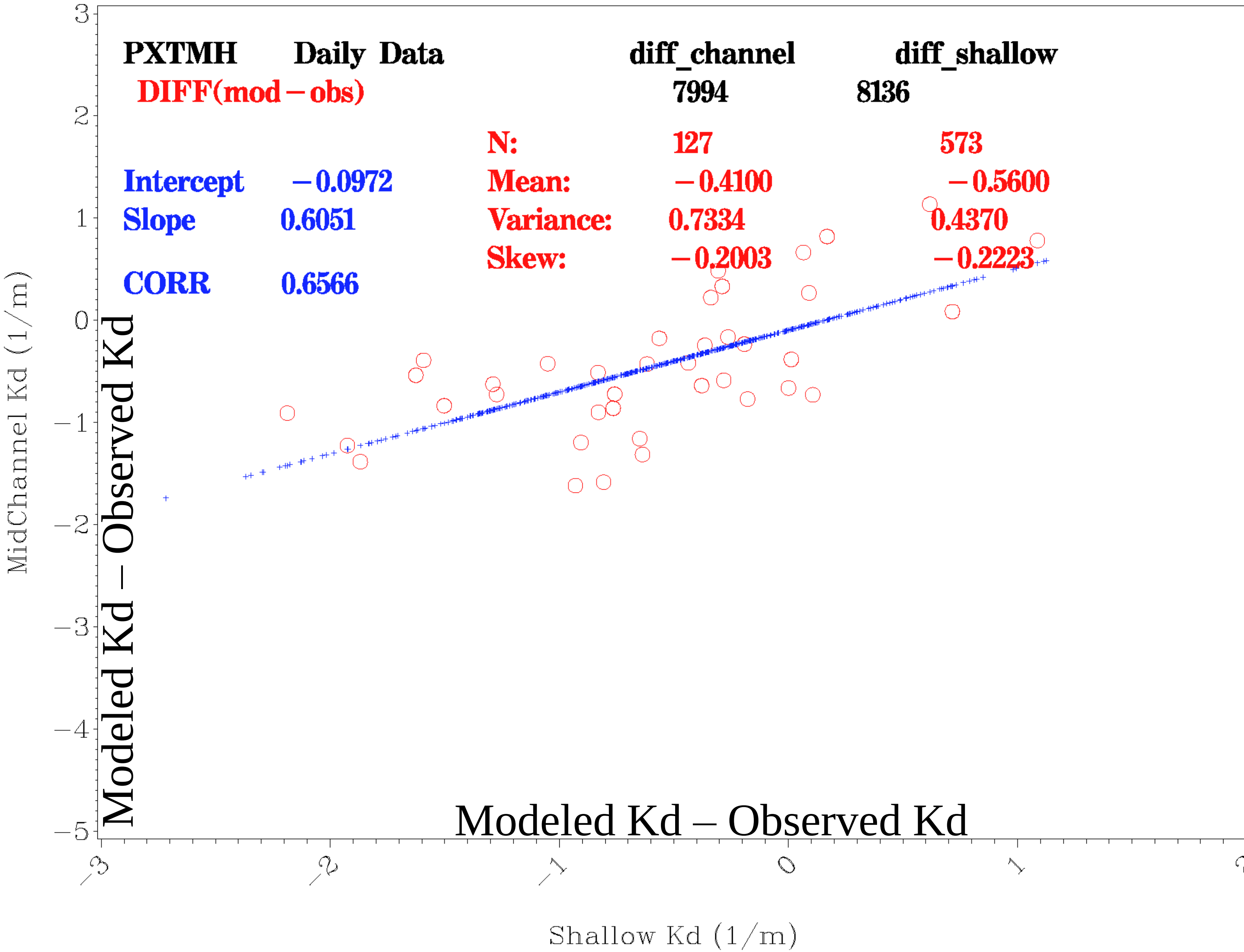
Simple Ratio Method

A) Use modeled shallow Ke & modeled center Ke . To get a relationship

mod_shlw_Ke = f (mod_cntr_Ke)

B) Use observed center Ke, and the above relationship in 1991-2000, to get the likely ”observed” shallow Ke in 1991-2000 .

How good the method is? Use 2003-2005 modeled ke and observed center Ke to derive ”observed” shallow Ke, then compare observed shallow Ke for verification.



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Modeled Kd – Observed Kd
Modeled Kd – Observed Kd
MidChannel Kd (1/m)
Shallow Kd (1/m)
3
2
1
0
–1
–2
–3
–4
–5
–3
–2
–1
0
1
2

Simple Regression Method

A) Use modeled shallow Ke & modeled center Ke . To get a relationship

mod_shlw_Ke = Slope * mod_cntr_Ke + Intercept

B) Use observed center Ke, and the above relationship in 1991-2000, to get the likely observed shallow Ke in 1991-2000 .

How good the method is? Use 2003-2005 modeled ke and observed center Ke to derive observed shallow Ke, then compare observed shallow Ke for verification.

Alternative methods in to get the “Likely Observed Kd” in 1991-2000

A) Multi-var regression: Sophisticate, but may not be applicable in some cases. – will try.

Okd_shlw = f(Okd_cntr, Mkd_cntr, Mkd_shlw, physics_shlw)

B) Simple regression: May not be applicable in some cases.

Mkd_shlw = f(Mkd_cntr) =>   Okd_shlw = f(Okd_cntr)

C) Simple ratio method: as a backup for the cases if the above regression methods fail to yield reasonable result.

D) Other better method?

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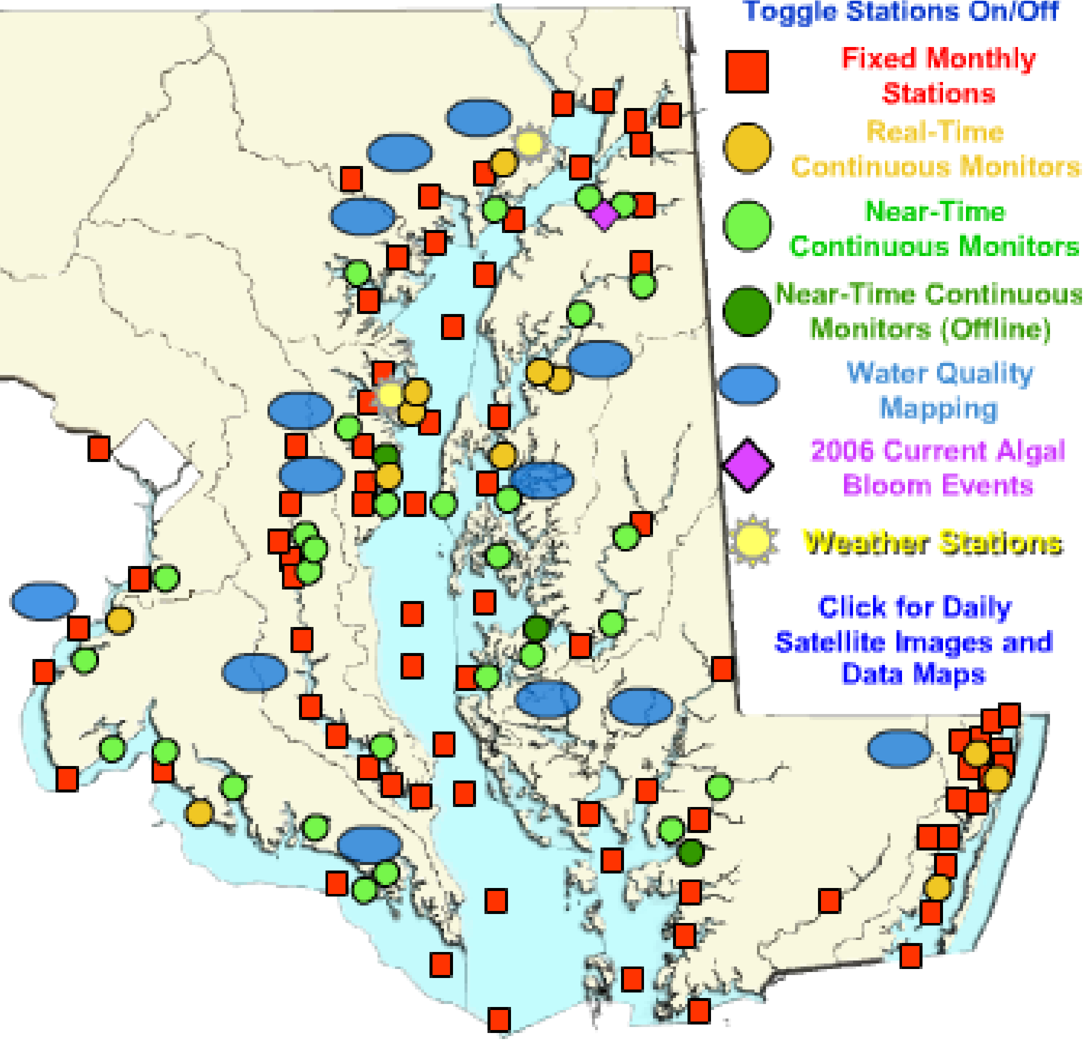

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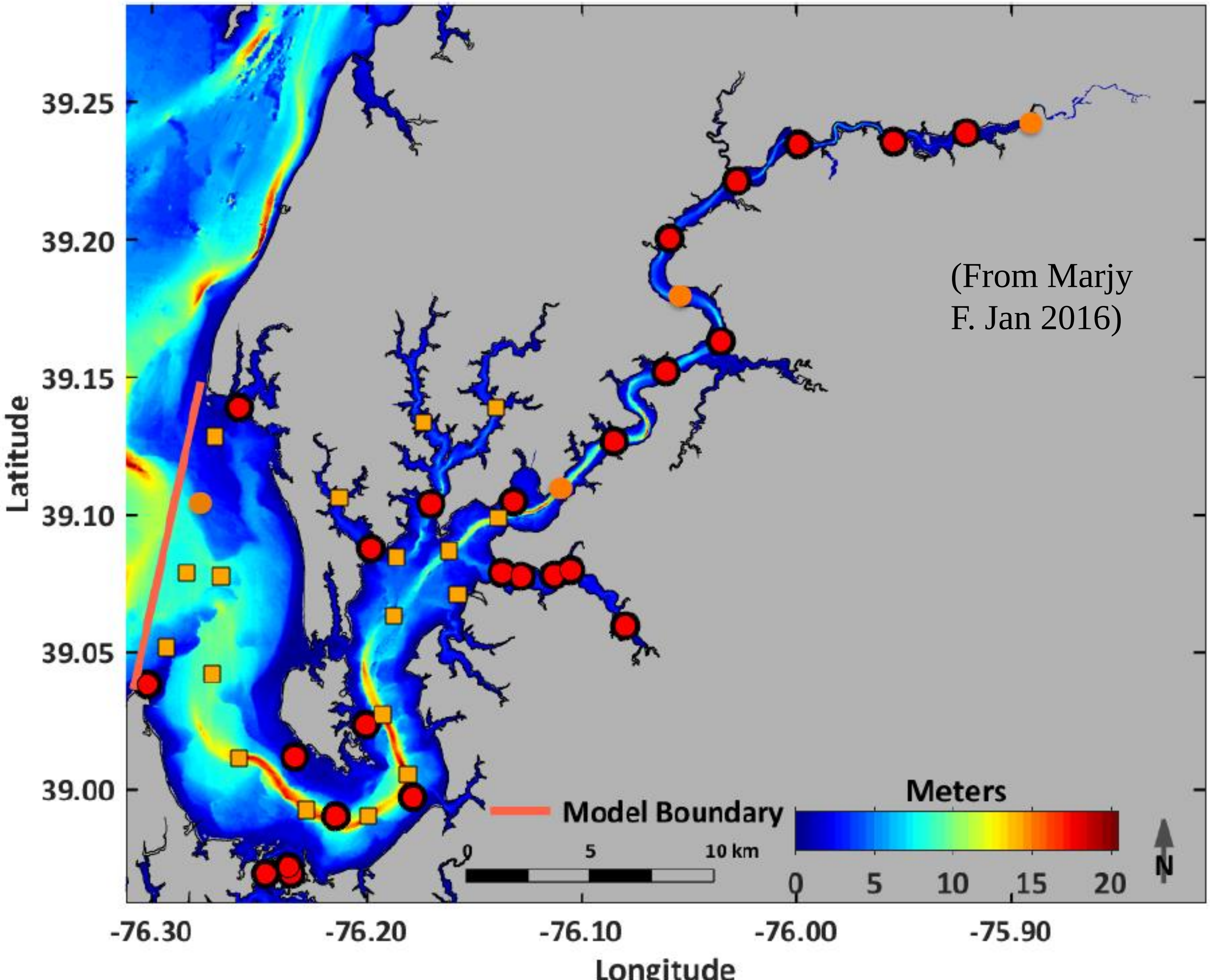
New Station Set



(From Marjy F. Jan 2016)

- Use Chester River as a prototype to conduct SAV-Clarity water quality standard assessment throughout the tidal Bay.

- Identify criteria for SAV-Clarity acres in the application depth for CHSTF, CHSOH and CHSMH.

- Identify stations in the Chester R. with observed kd, secchi, or equivalent light attenuation metric.

- Identify how to spatially weight the light attenuation observations in each year at 1) the application depth, 2) each CB segment CHSTF, CHSOH and CHSMH, and 3) each SAV-Clarity standard season.

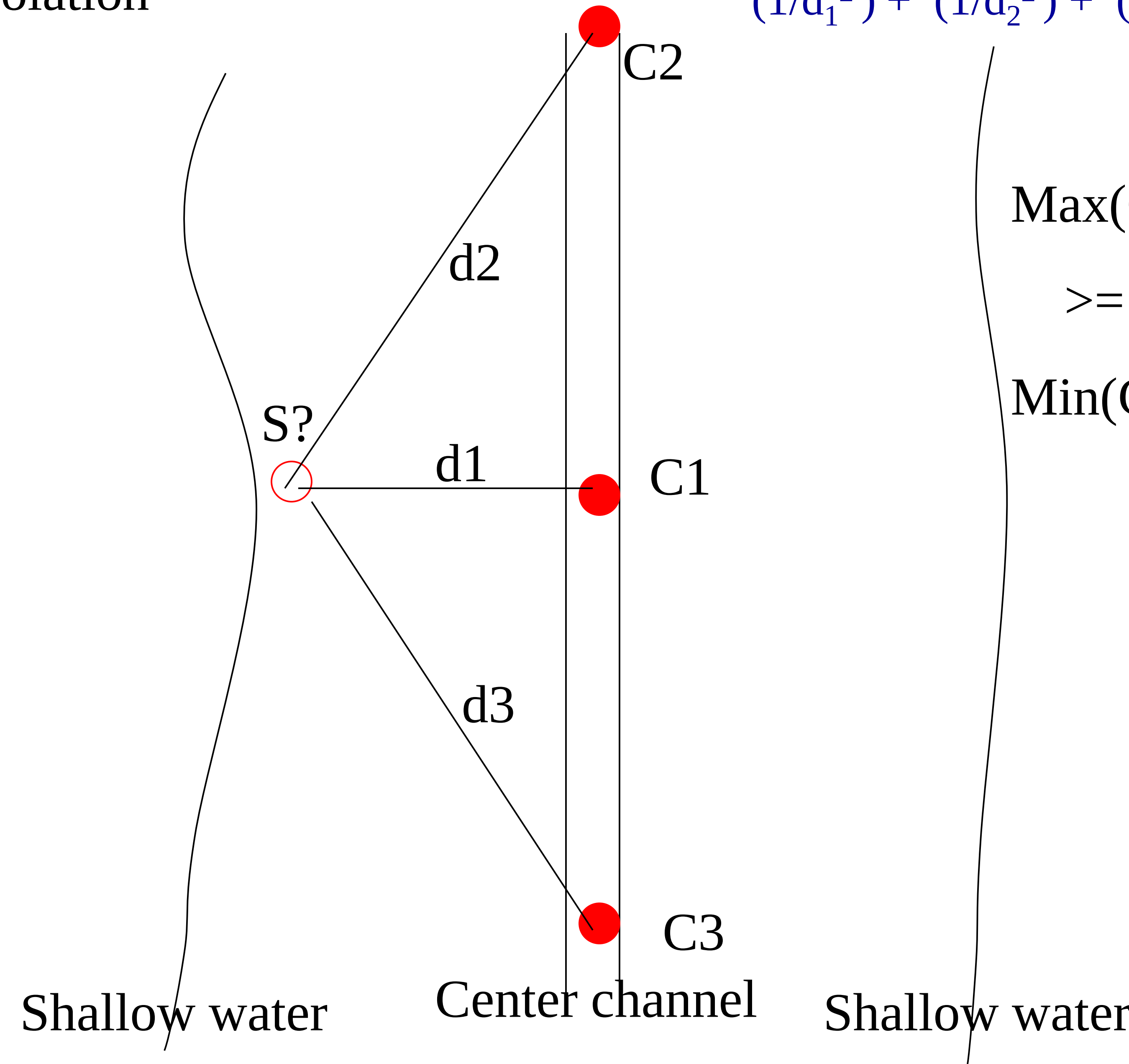
- Data correction: Adjust spatially averaged light availability at the appropriate application depth based on a relative difference of scenario to the base calibration over the water quality season.

- Use Base, 1985, 2009, TMDL and All forest scenarios.

Thank you

Weighted Invert distance Interpolation

$$S = \frac{C_1 * (1/d_1^2) + C_2 * (1/d_2^2) + C_3 * (1/d_3^2)}{(1/d_1^2) + (1/d_2^2) + (1/d_3^2)}$$



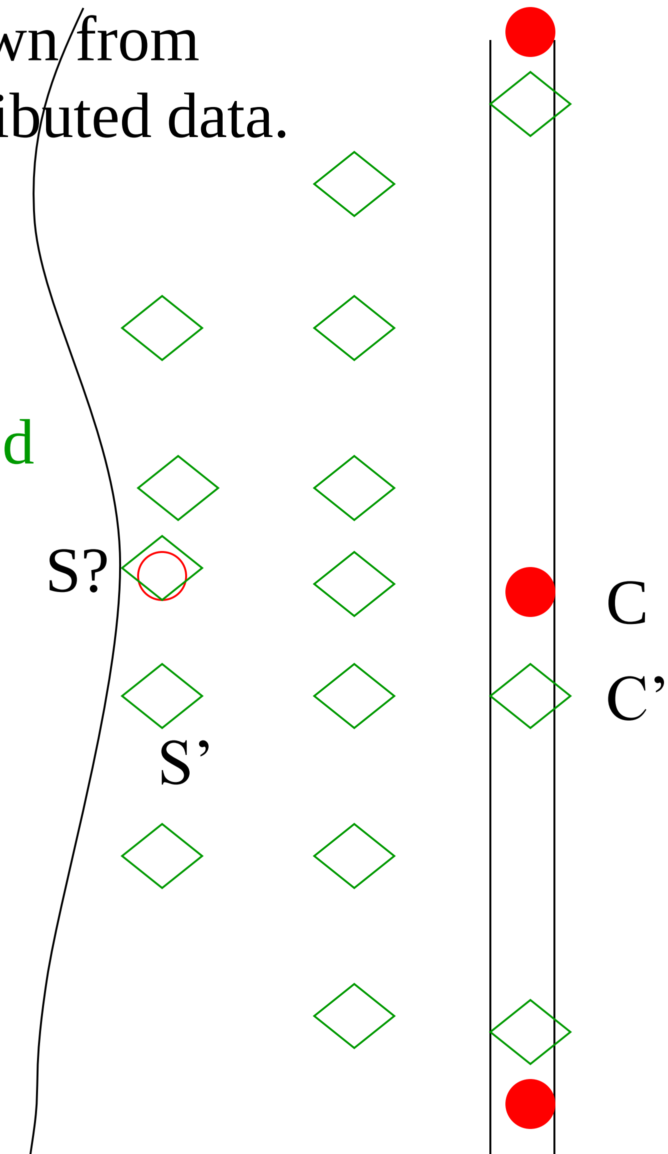
Max(C1, C2, C3)

>= S >=

Min(C1, C2, C3)

Geostatistic method to derive unknown from spatially distributed data.

Using modeled as covariant



- Using spatial observed channel Ke and the relation of Concentration change with Distance change

$S = f(C)$

to predict observed at shallow.

- In addition, may use the modeled as covariant in the derivation.

$S = f(C, C', \ldots\ldots, S')$

● Observed Ke at Center channel
○ Observed Ke at Shallow

◆ Model Ke at Center channel
◇ Modeled Ke at Shallow