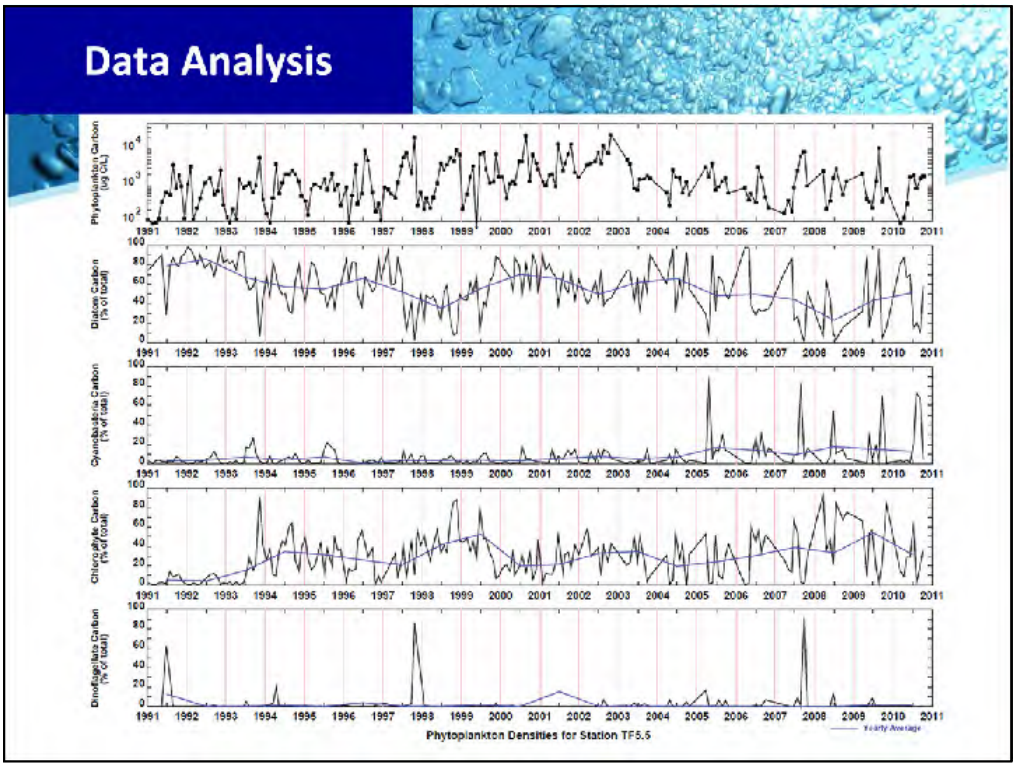
Status Report on the James River HAB Model

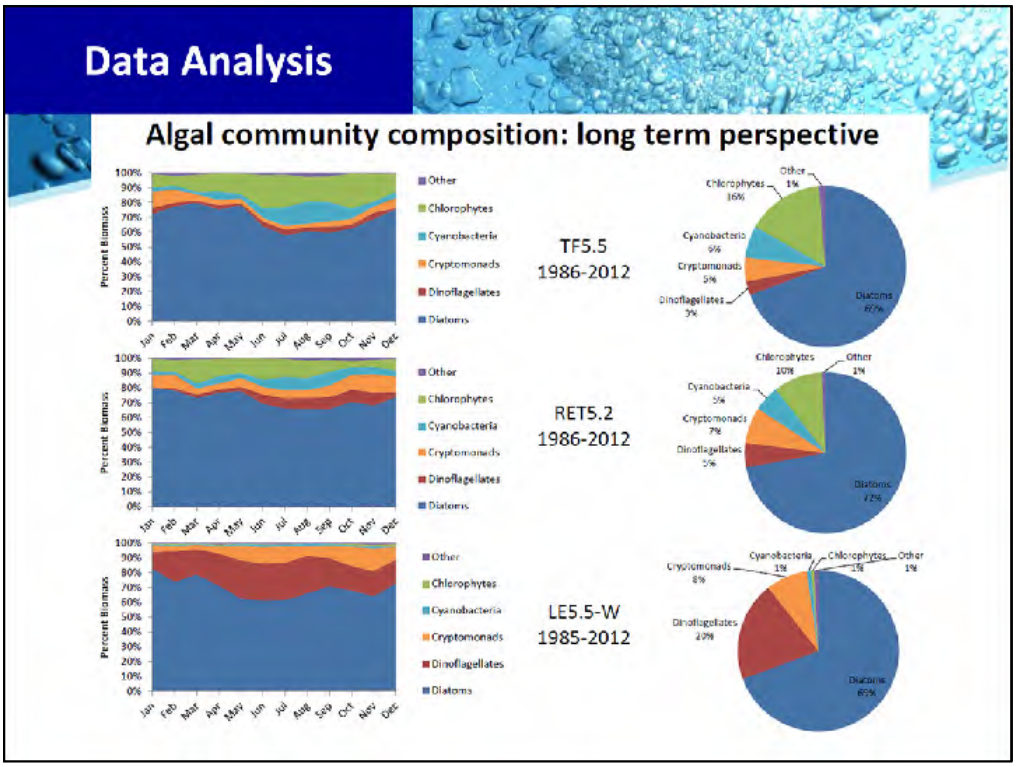
Jim Fitzpatrick
Nataliya Kogan
Mahwah, NJ

Outline

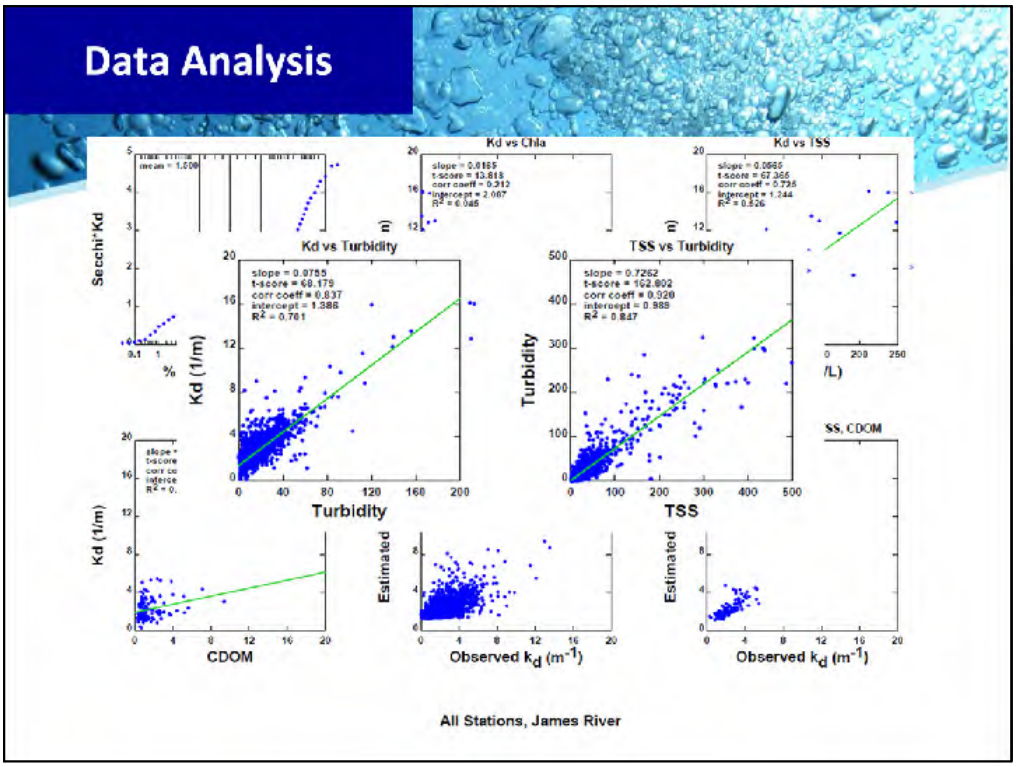
1. Data Analysis
2. Model Formulation
3. Calibration Status
4. Moving Forward



These data provided guidance into the selection of the algal groups to model, as well as provided calibration data (Thanks to Harold Marshall and Todd Egerton)



"borrowed" from Todd's presentation at the March 2014 SAP meeting



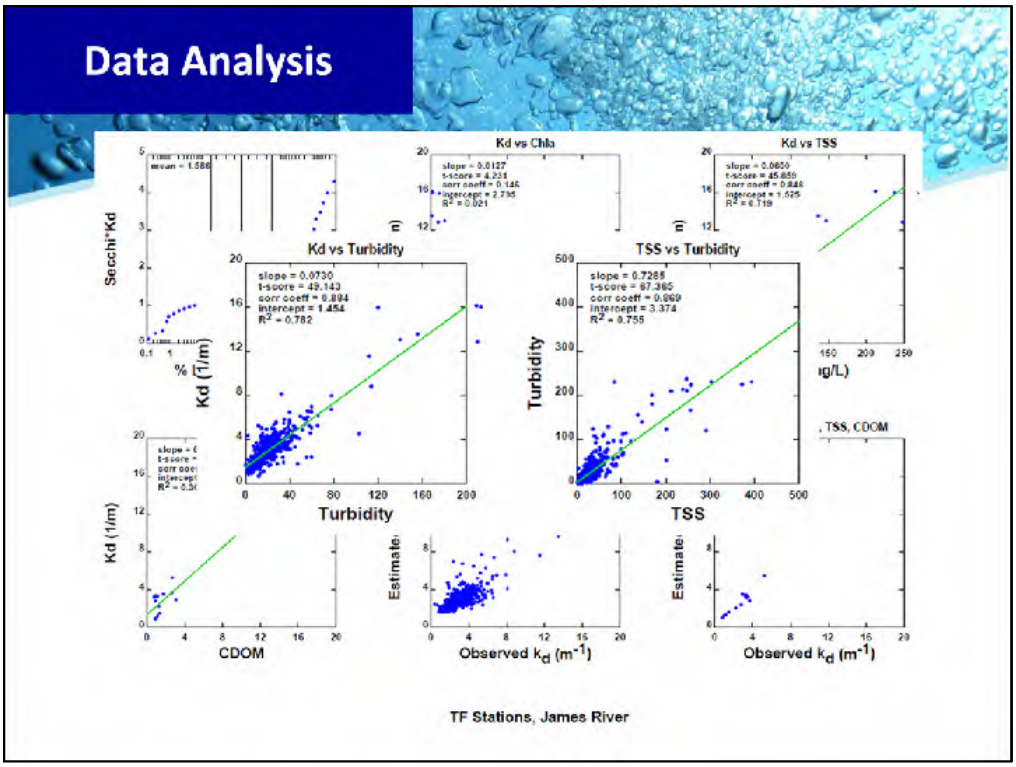
Challenges in developing light attenuation relationships as a function of water quality variables.

Want to check Poole-Atkins coefficient – Kd = P.A./SDD -> P.A. = Kd*S.D.D. = note variability – mean value of 1.5

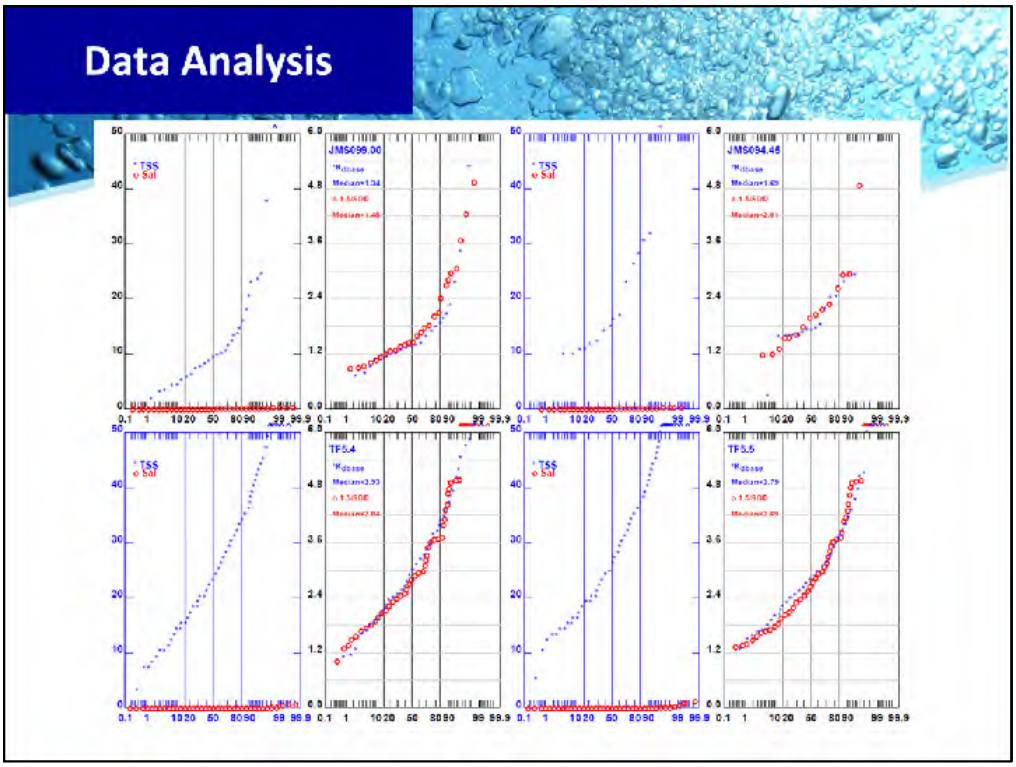
Regression slope for Kd = f(Chla) = 0.0165 (models usually 0.010-0.025 – I've used 0.017 pretty consistently), but low R2

Regression slope for kd = f(TSS) = 0.0565 R2=.526 Multiple linear regression for Chla (0.0133), TSS (0.0528), CDOM (0.243) yields R2=0.6

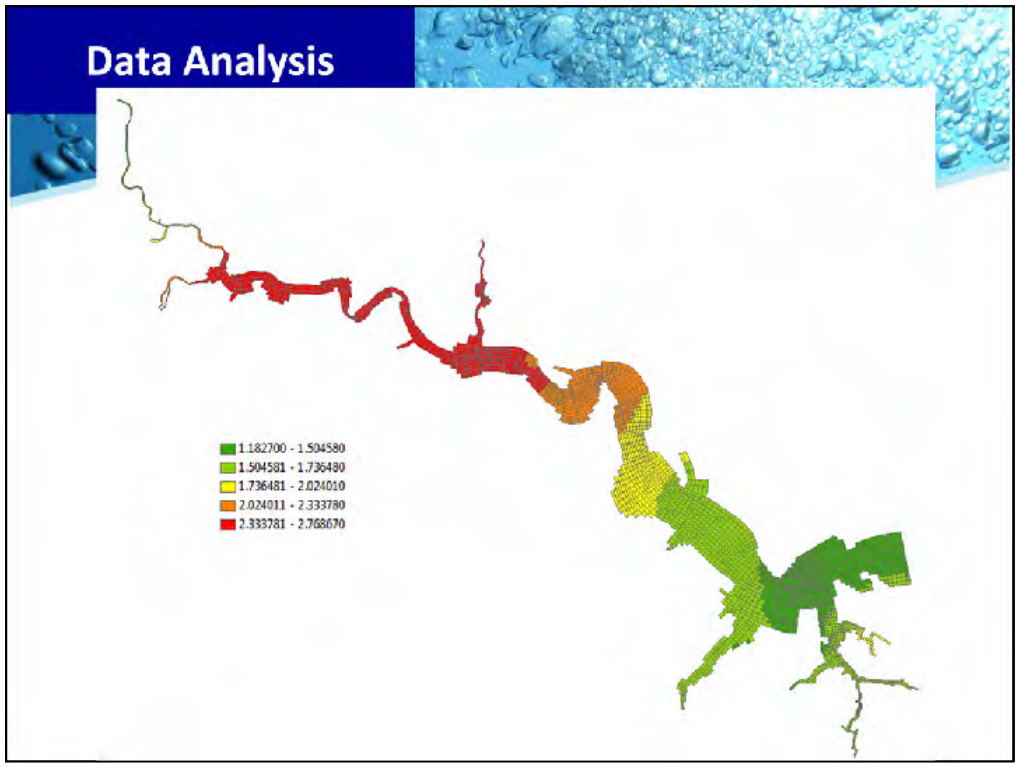
Good R2 for Kd vs. Turbidity and TSS vs. Turbidity, but note the product of the regression slopes 0.0755 * 0.726 = 0.055 which is similar to slope for Kd vs TSS



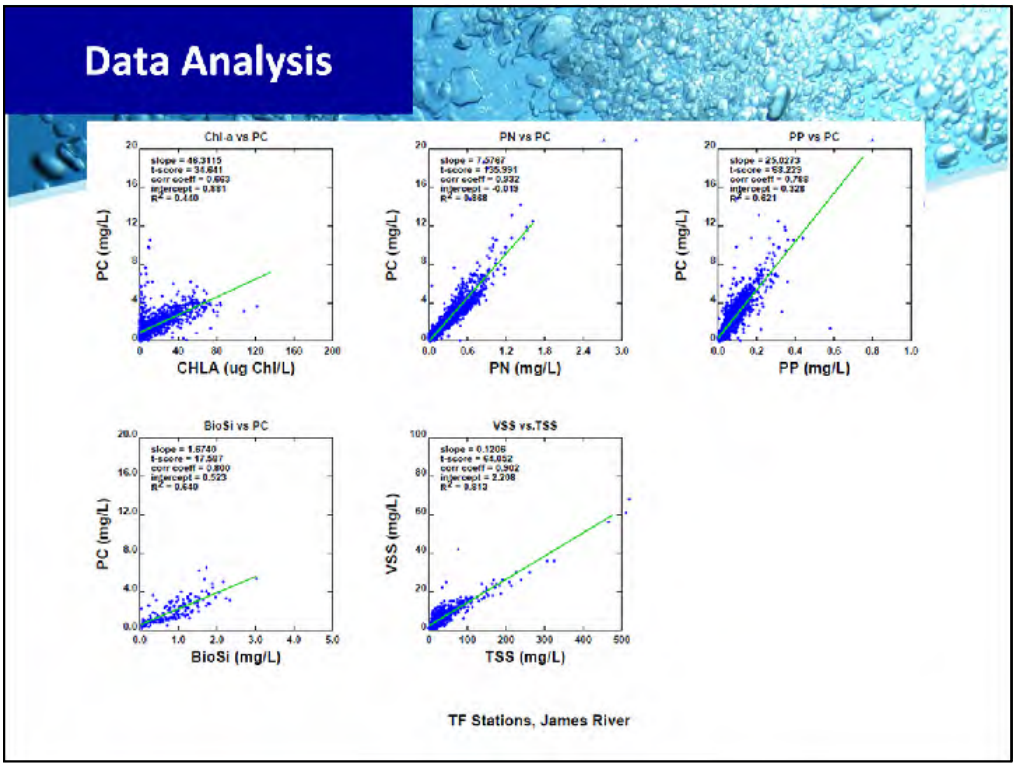
We performed similar regressions for each salinity regime – similar type of results



As will be presented in the calibration section, the spatial/temporal distribution of light attenuation data (based on monthly grab samples) were quite variable and made calibration of challenging. If the river was sampled just after a storm event with high light attenuation do you use that high value for the entire month. Decision was made to use median Kd data. We looked at both available Kd and Kd estimated using 1.5/SDD. First, however, the observed Kd were "corrected" for chla -> Kdbase = obs Kd – 0.017*Chl-a

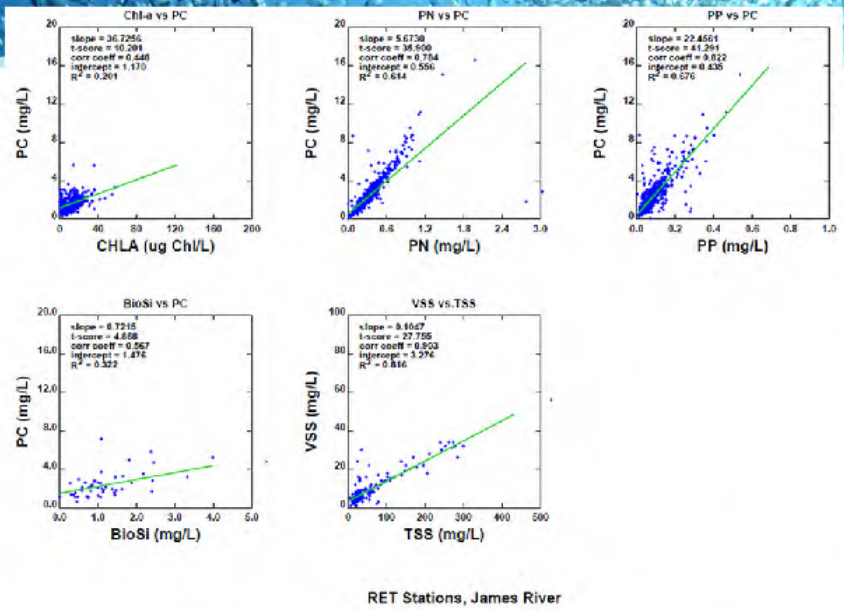


Plot of Kdbase – spatially variable, but constant in time



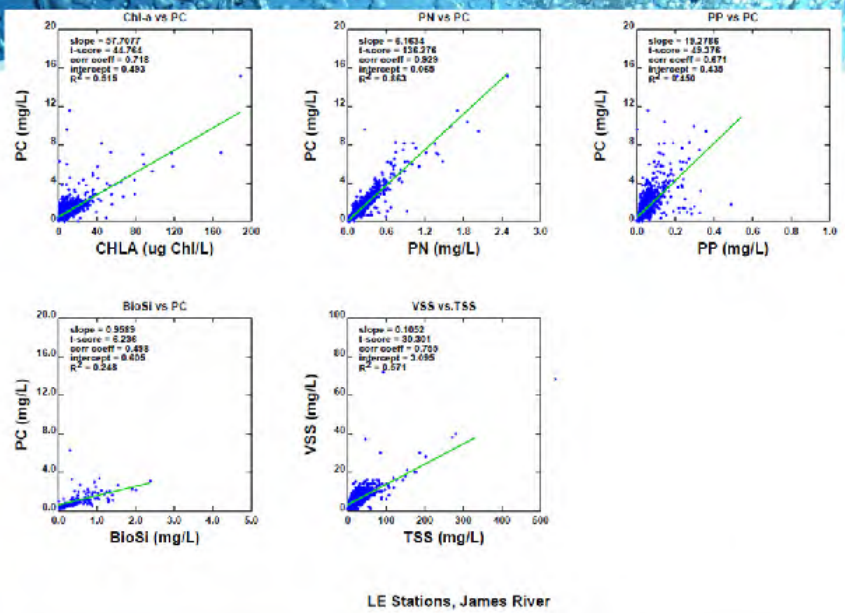
Looked C:Chla ratios and C:N, C:P and C:Si ratios by river segment

Data Analysis



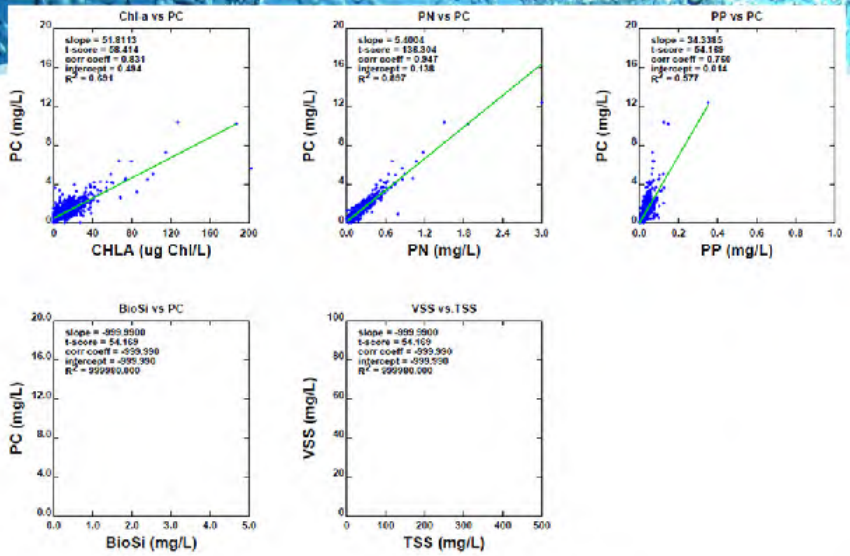
RET Stations, James River

Data Analysis

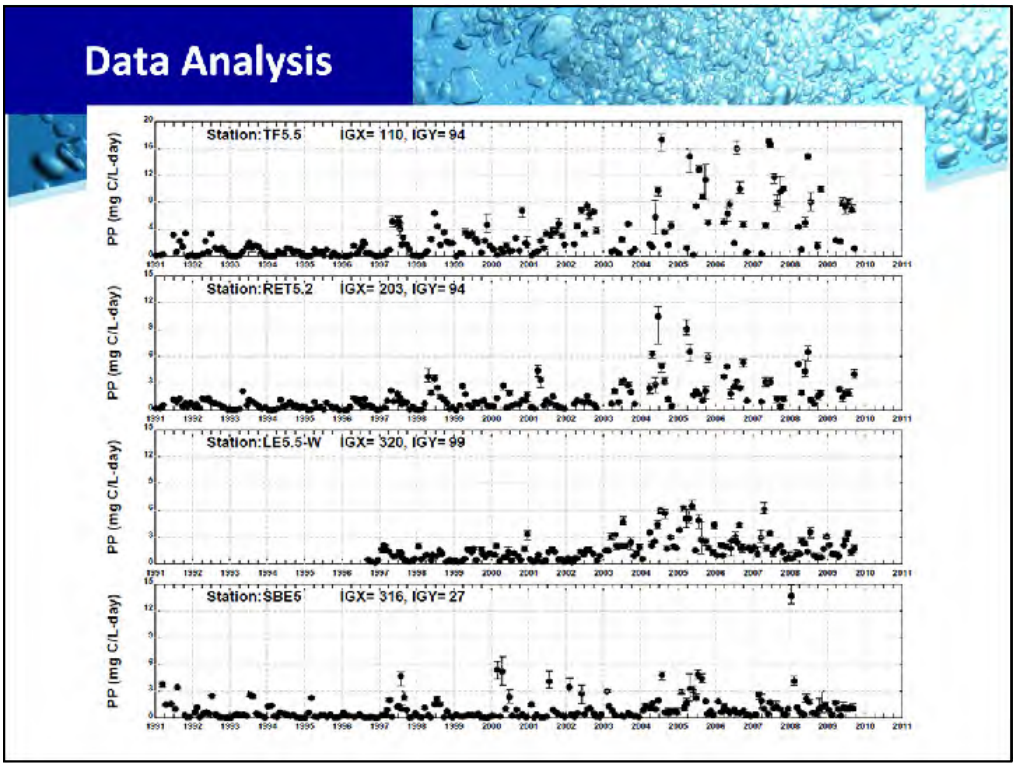


LE Stations, James River

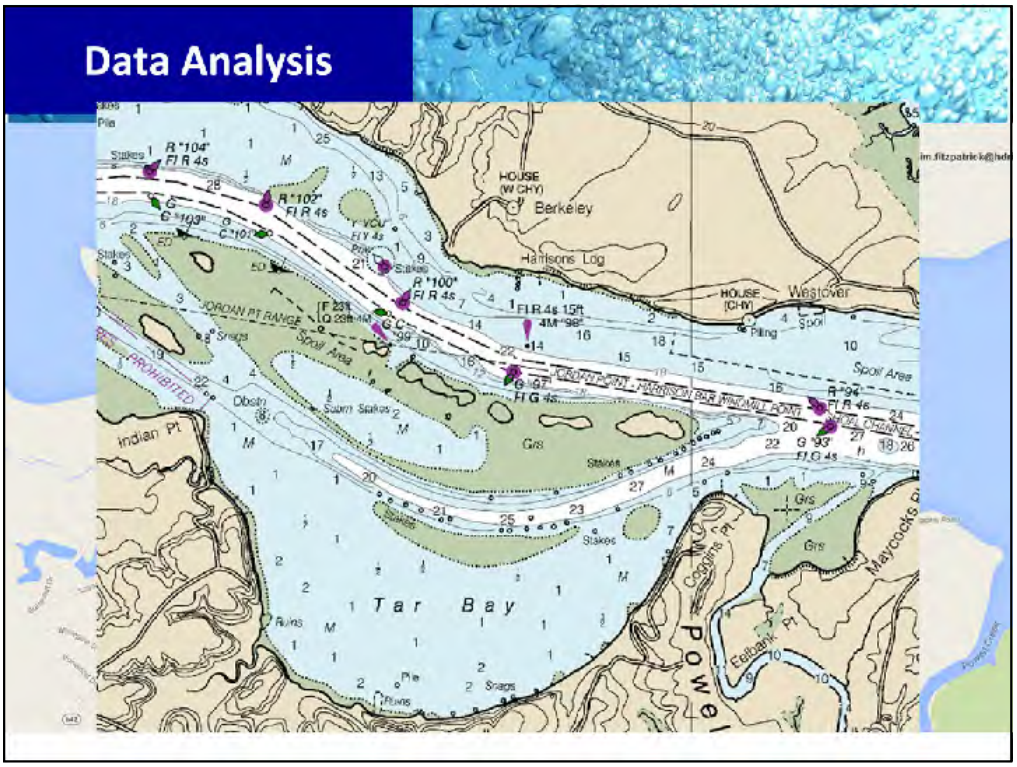
Data Analysis



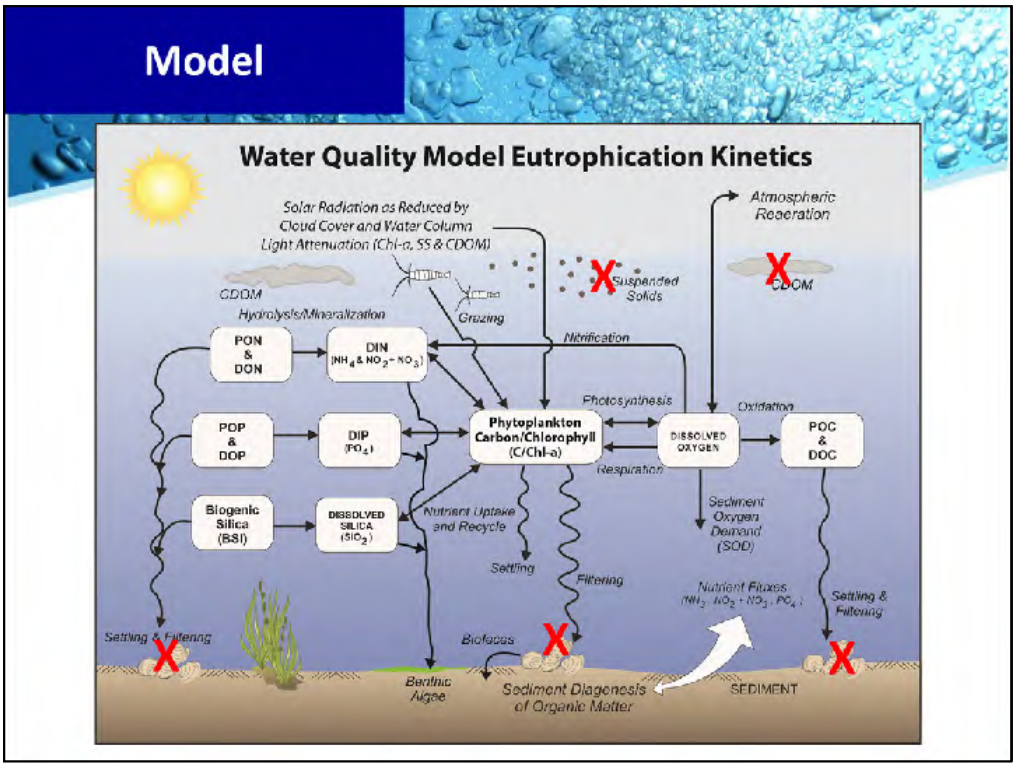
Elizabeth Stations, James River



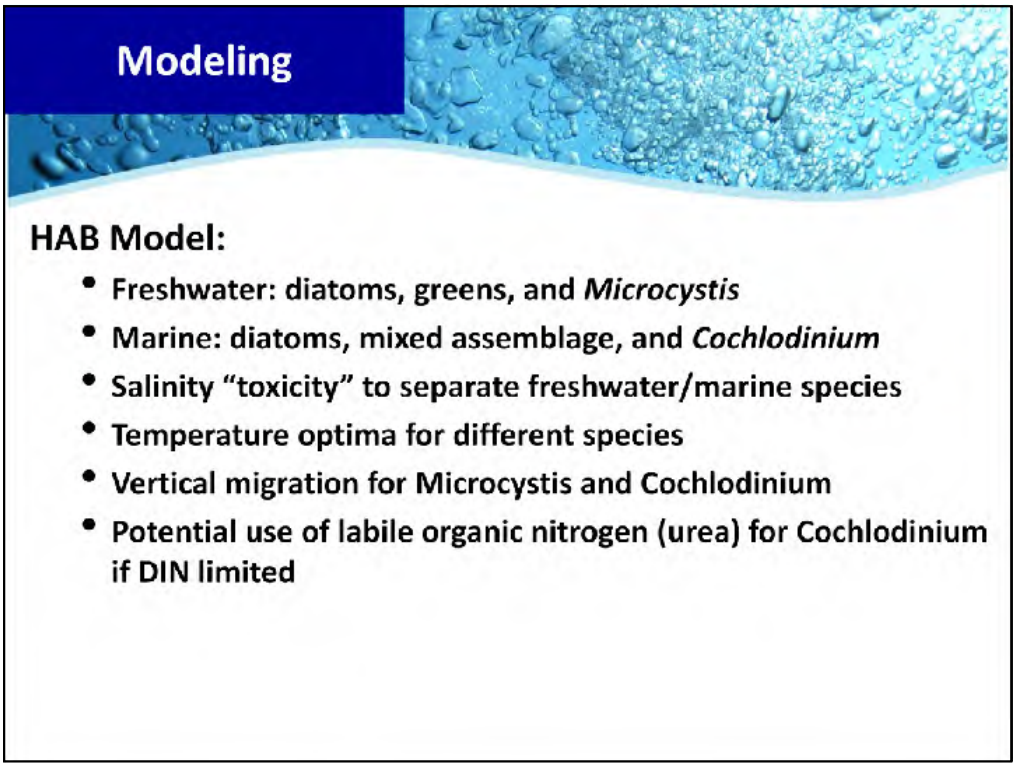
What caused the change in PP in the upper freshwater portion of the James R.? Change in methodology?



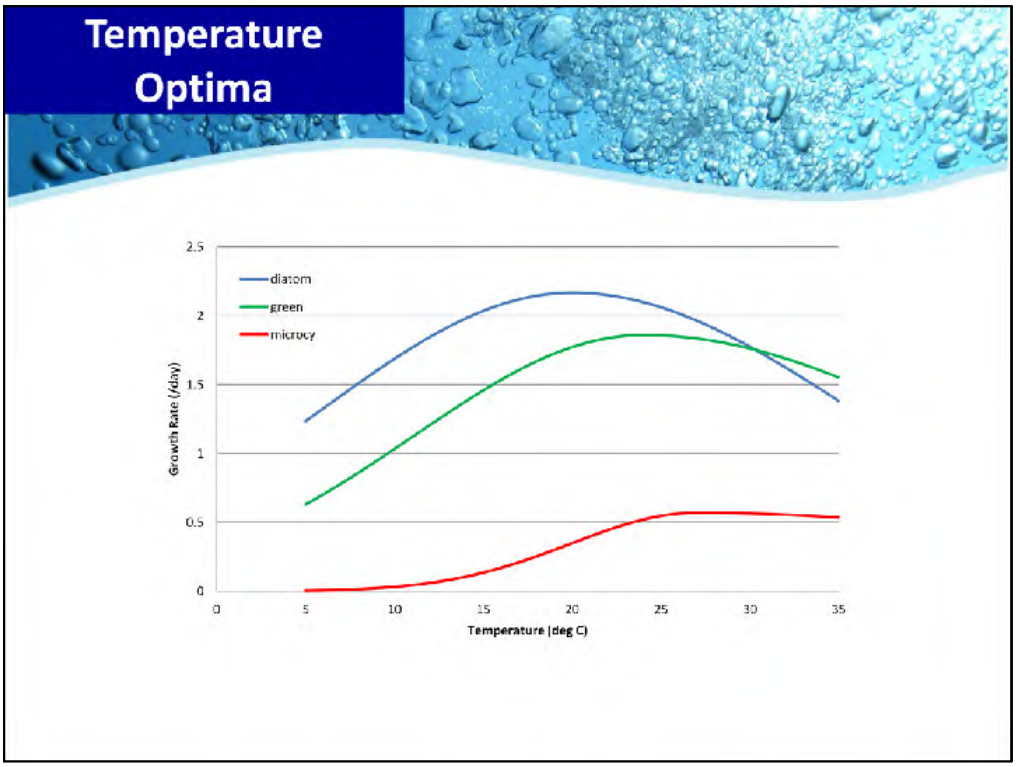
Google map under the USGS Nav chart, shows the locations of two of Iris Anderson's sediment flux stations – located in 1 and 2 m of water. However, model grid includes channel and model depths are 3 m. Therefore, not good for model vs data comparisons, since light attenuation limits light reaching bottom and precludes development of benthic algae. Will consider using nearby model segment in Tar Bay



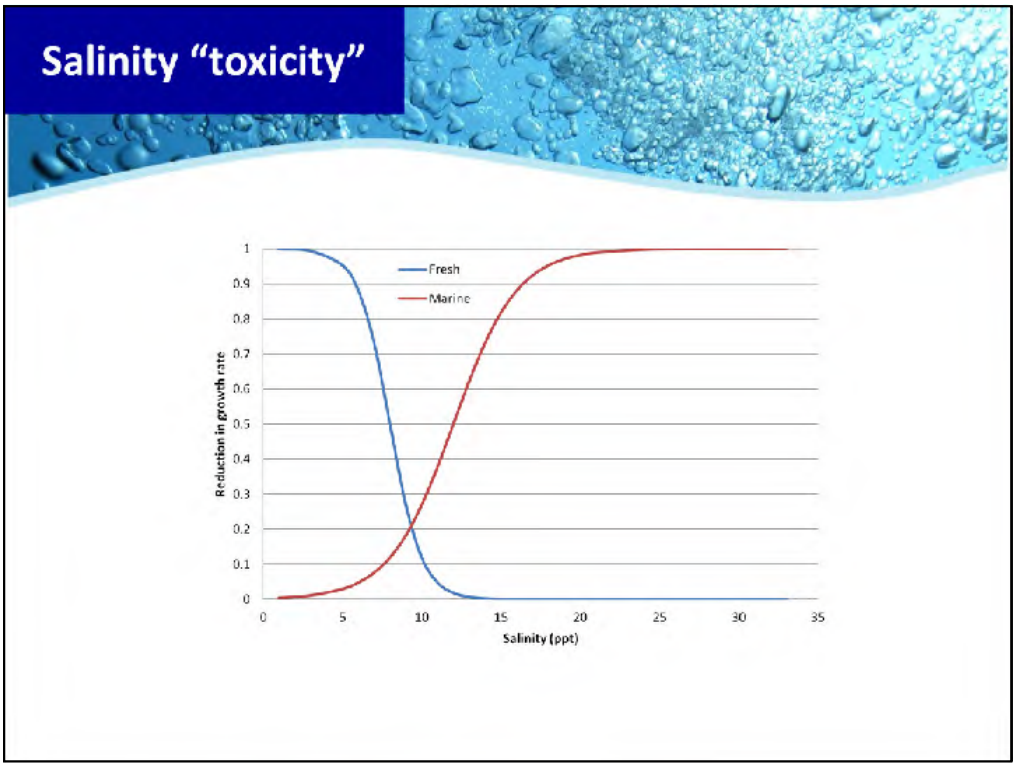
Overview of RCA eutrophication model structure. Very similar to USACE/CBP CE-QUAL-ICM, but we are not directly modeling CDOM, TSS, not benthic filter feeders



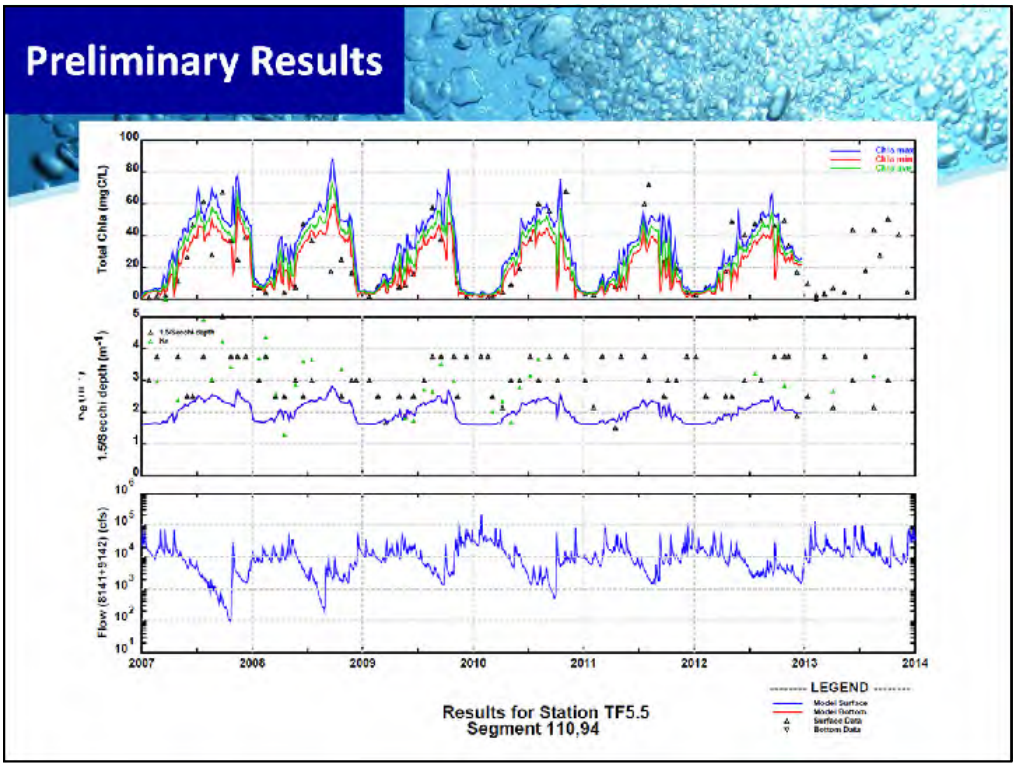
Overview of structure of the HAB model



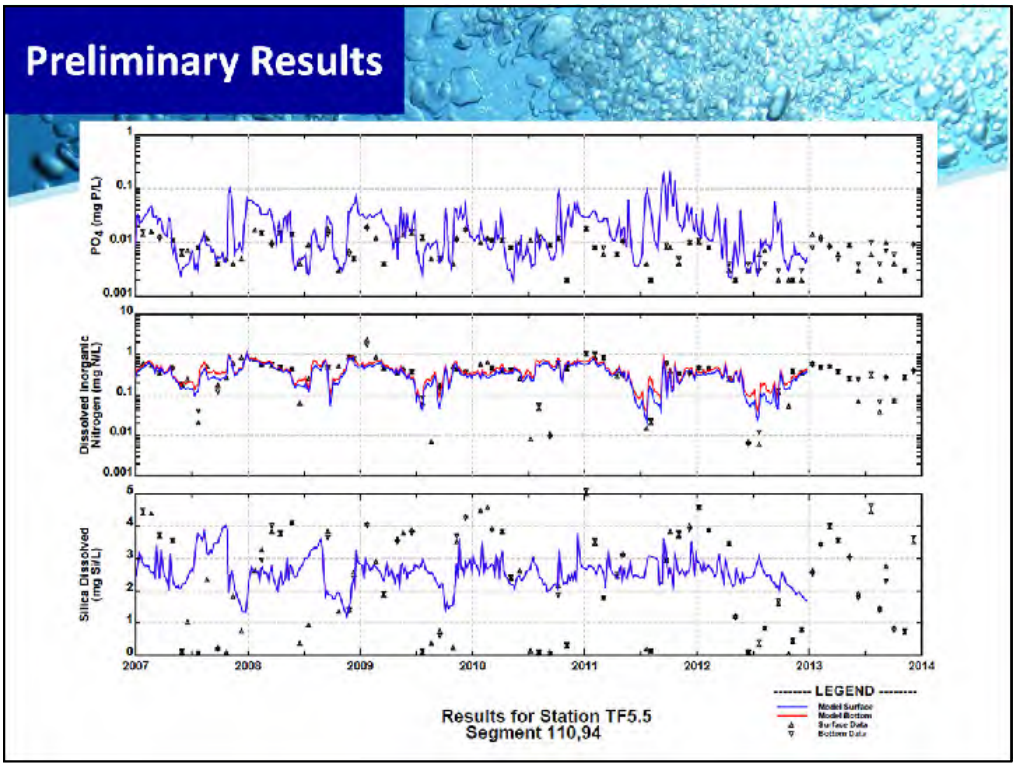
Algal growth rates as a function of temperature with current model coefficients



Effect of salinity on reducing freshwater and marine algal growth rates

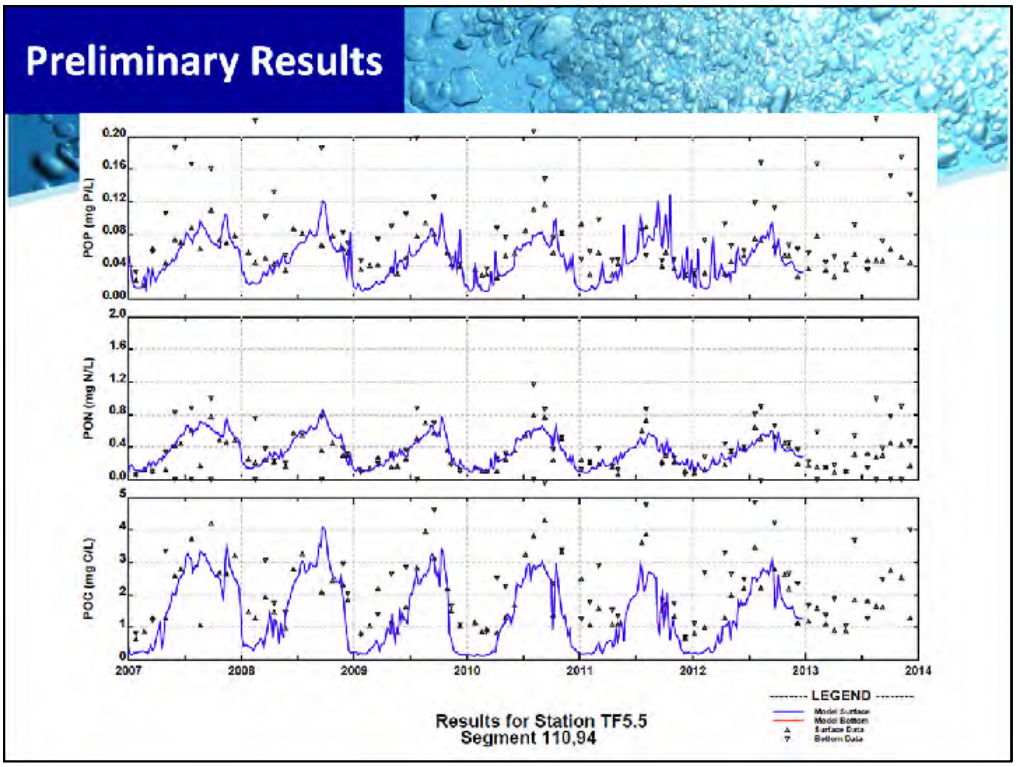


Some calibration results. Top panel: green is 5-day average Chl-a, blue is max chla computed within the 5-day period and red is the min computed within the 5-day period. Revisiting Kd story. Note: low Kd values in spring 2009 despite high flows and high values of Kd in late summer and fall 2009 despite lower flows. Led to decision to use “average” Kd rather than time-variable Kd

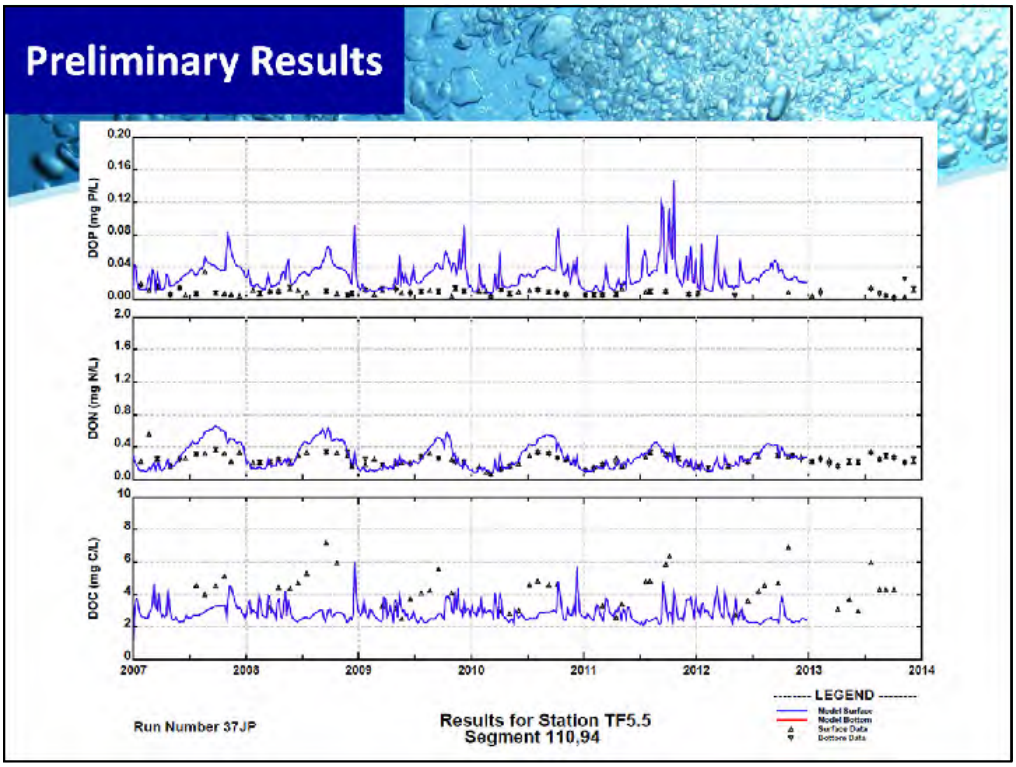


Plot PO4 and NH4 using logs in order to better see if nutrient limitation is occurring) Michaelis-Menton coefficients for PO4 are about 0.001 mgP/L and for NH4 are about 0.010 mgN/L. If PO4 concentrations are 0.004 mgP/L then you have a 20% reduction in growth rate -> PO4/(KmP+PO4) = 0.004/(0.001+0.004) = 0.80

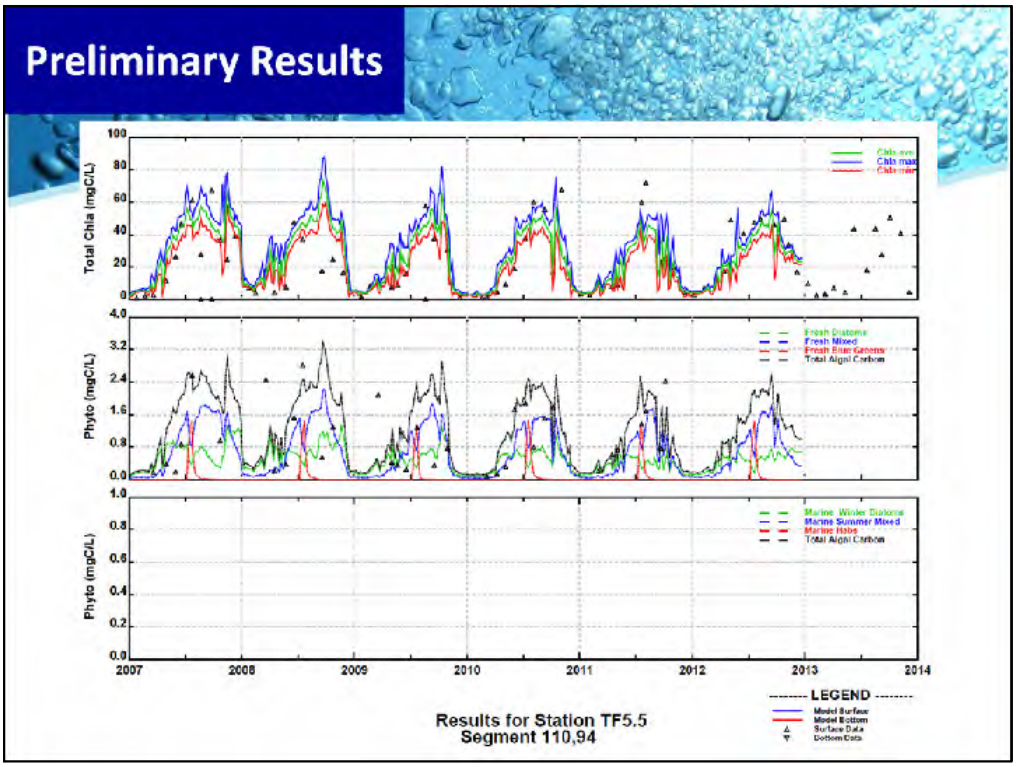
Data suggest some P limitation in upper tidal James



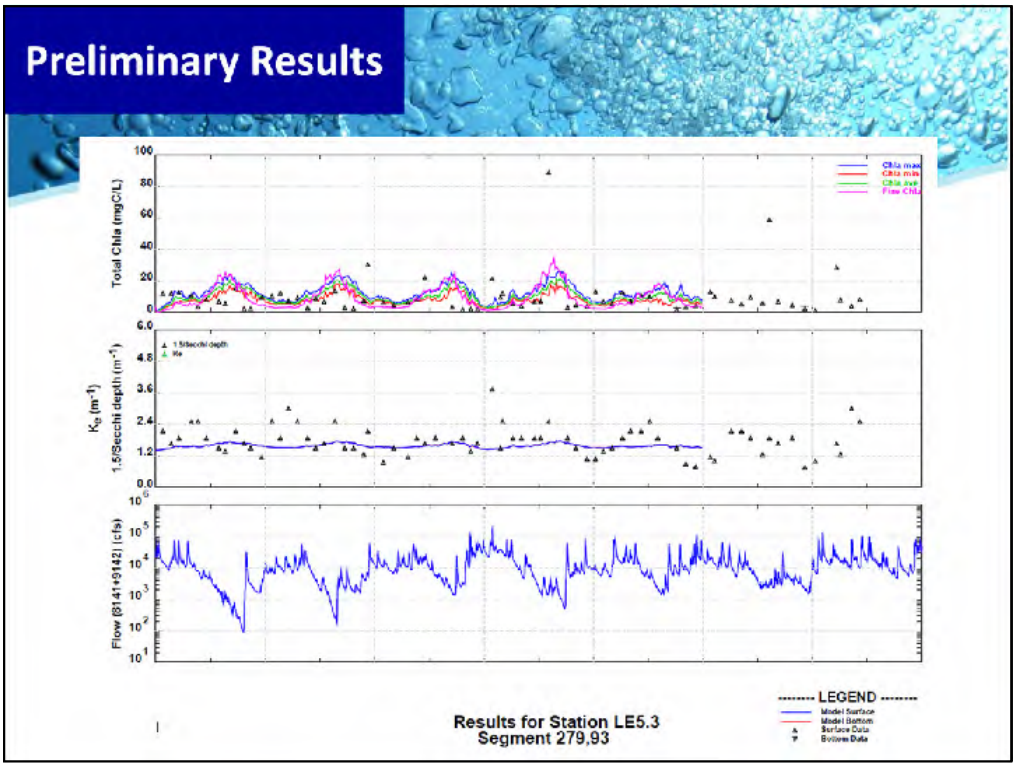
Looking to complete WQM calibration/validation in Q1 of 2015.



Looking to complete WQM calibration/validation in Q1 of 2015.

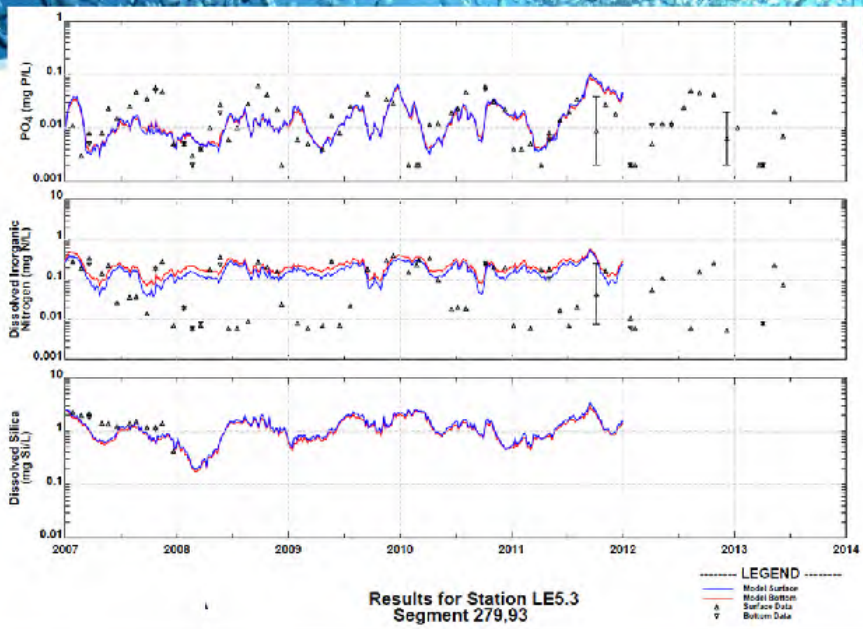


Top panel – same as earlier. Middle panel: black is total phyto C, green is diatom C, blue is greens C, red is Microcystis and black triangles are observed algal C based on Todd estimates



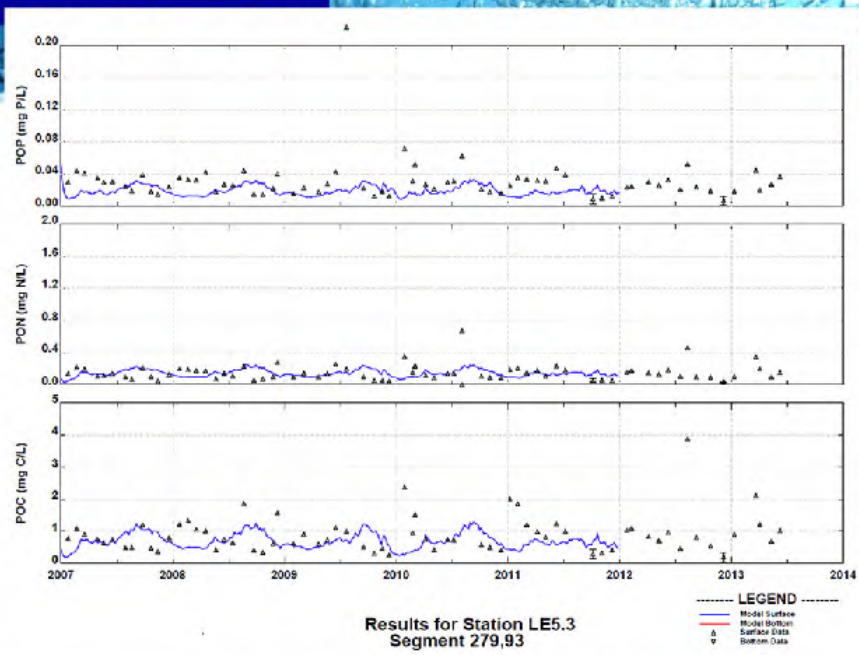
Similar analysis for lower estuary (ignore purple line – was exploring an alternative method for determining algal Chla based on a paper by Finenko et al.)

Preliminary Results

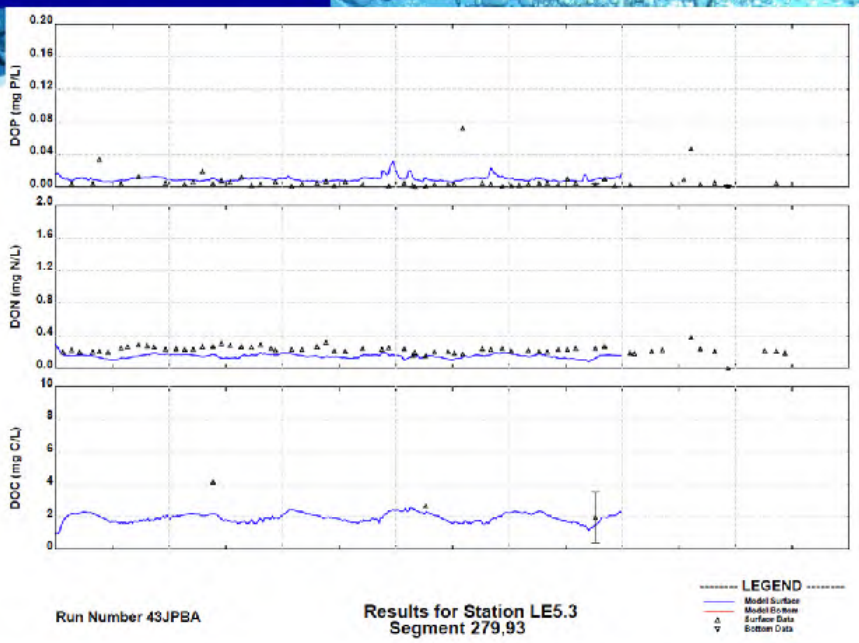


Results for Station LE5.3
Segment 279,93

Preliminary Results

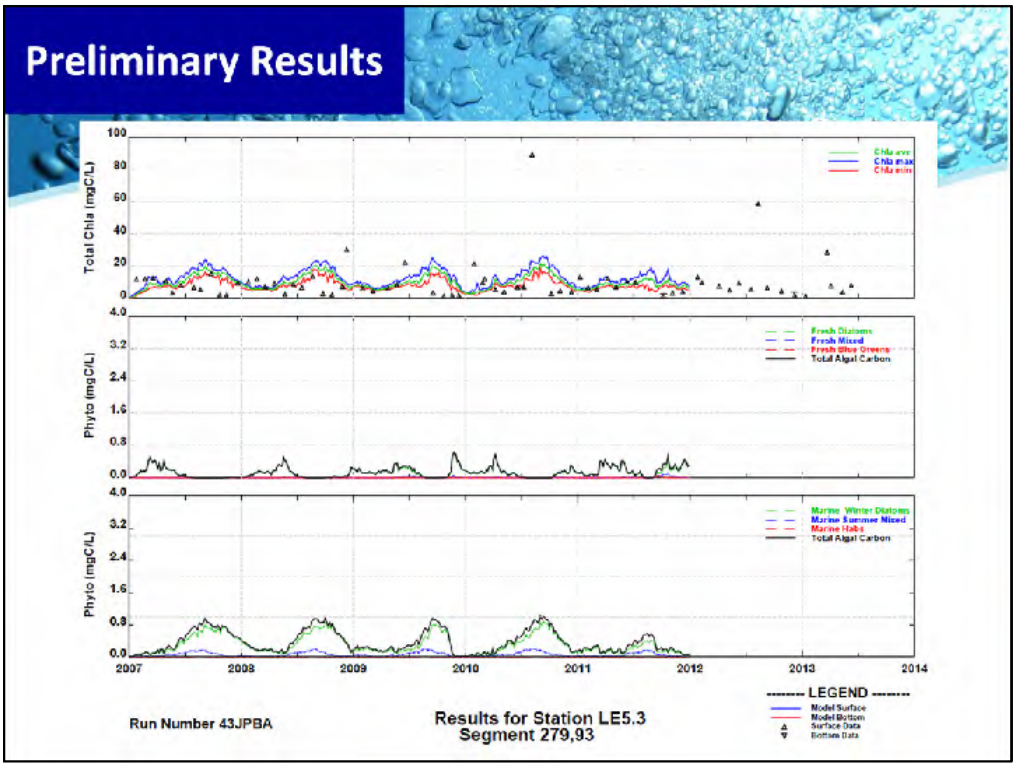


Preliminary Results

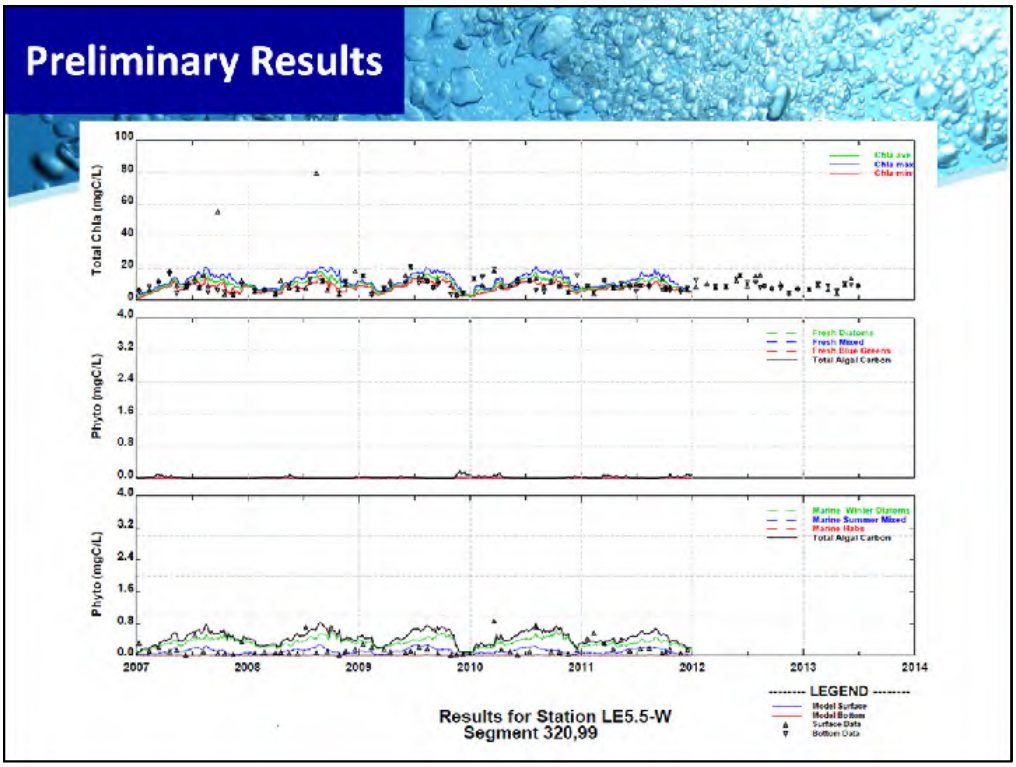


Run Number 43JPBA

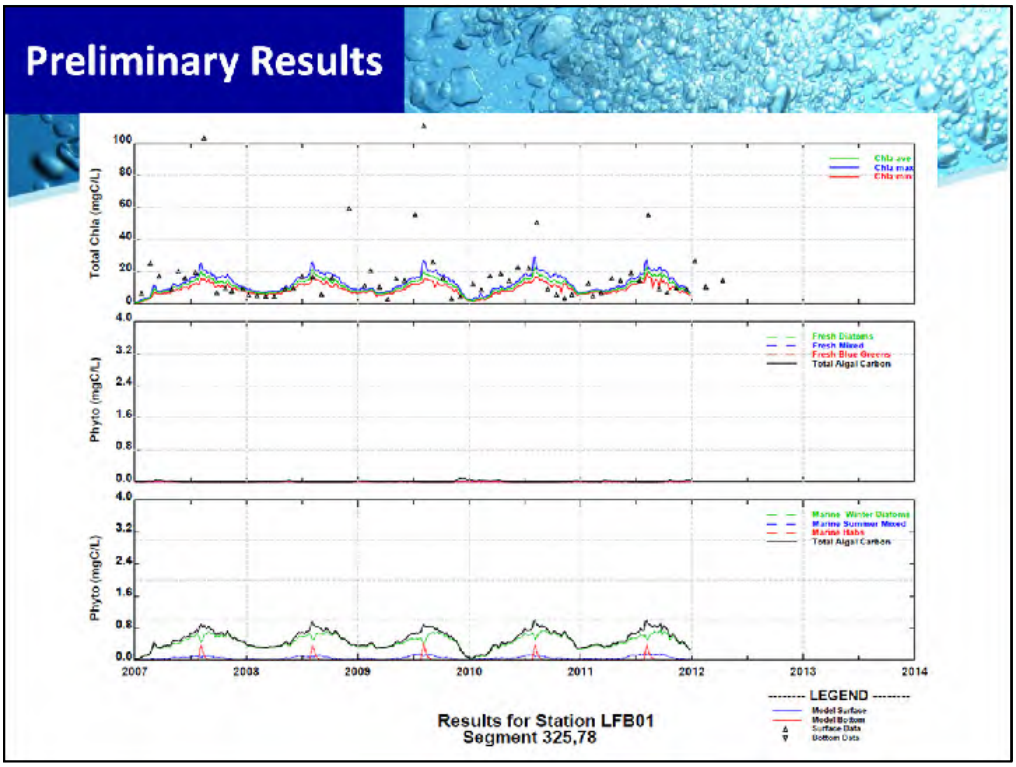
Results for Station LE5.3
Segment 279,93



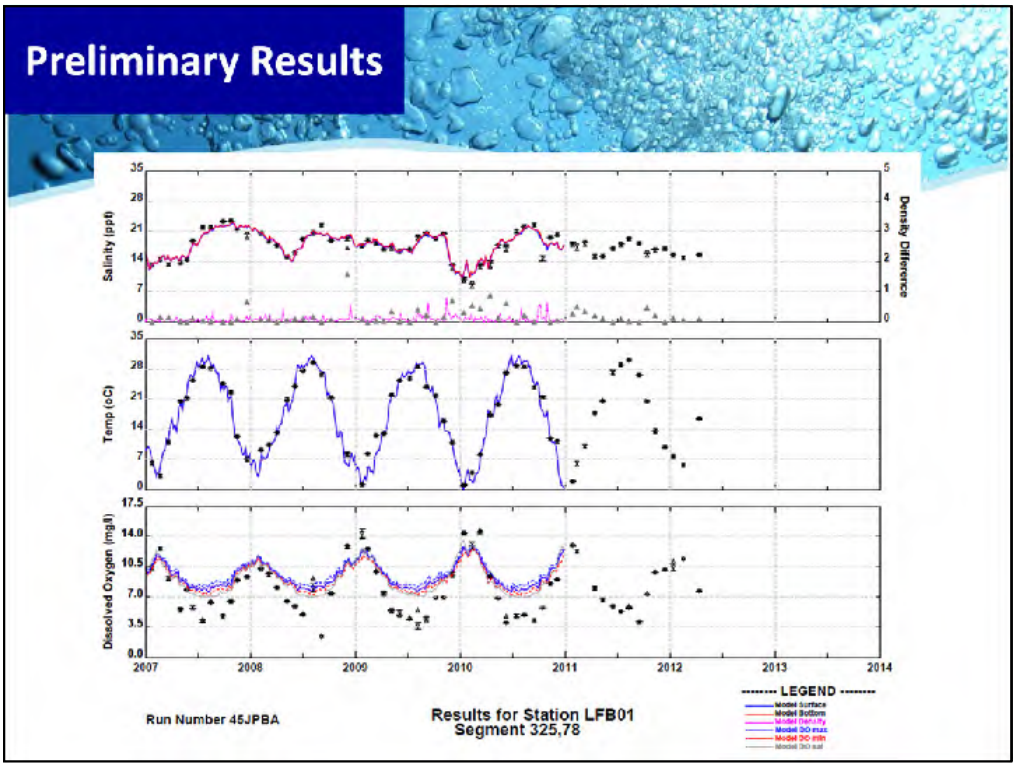
Looking to complete WQM calibration/validation in Q1 of 2015.



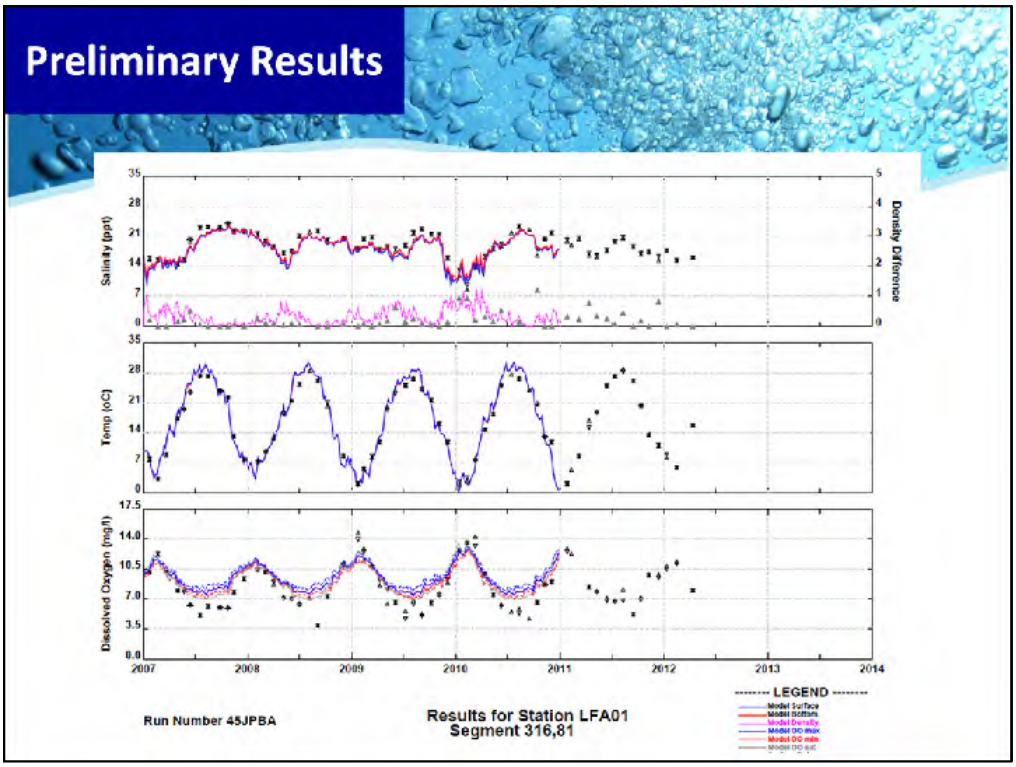
Similar analysis for LE5.5-W – here we have phyto C estimates from Todd. Question – do we believe phyto C based on biovolume and cell counts? Note how low phyto C estimates are despite reasonable fit to chl-a. Would have to have much lower C:Chla ratio to fit both chla and phyto C.



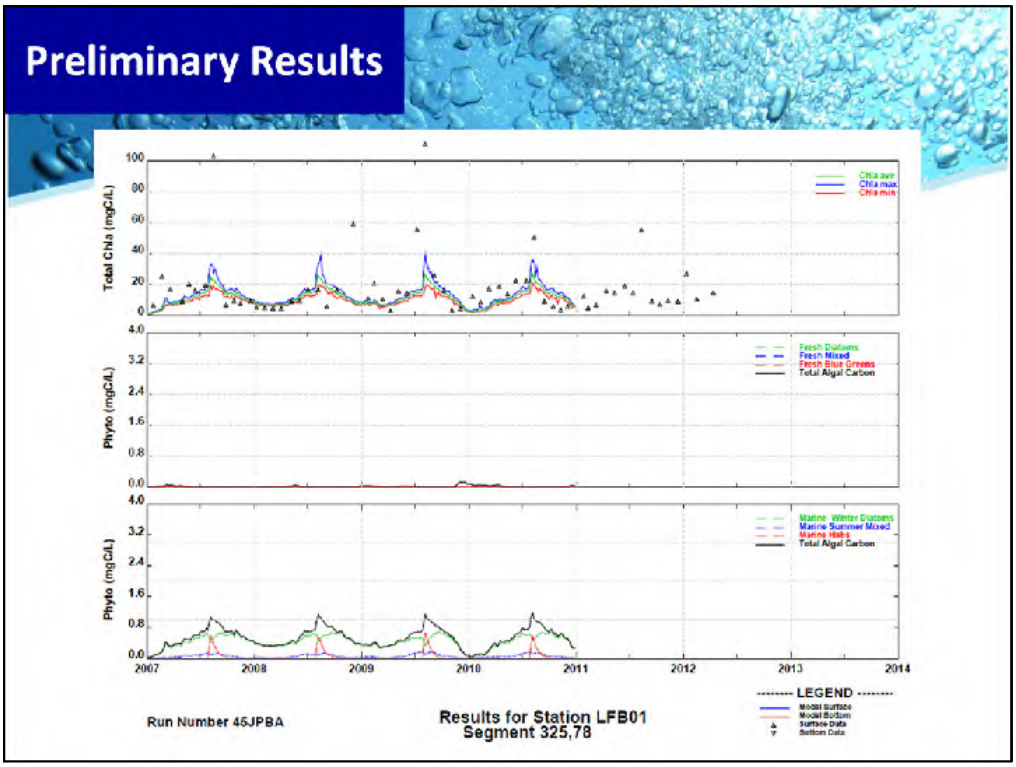
Area needing work – very low cochlodinium (red)



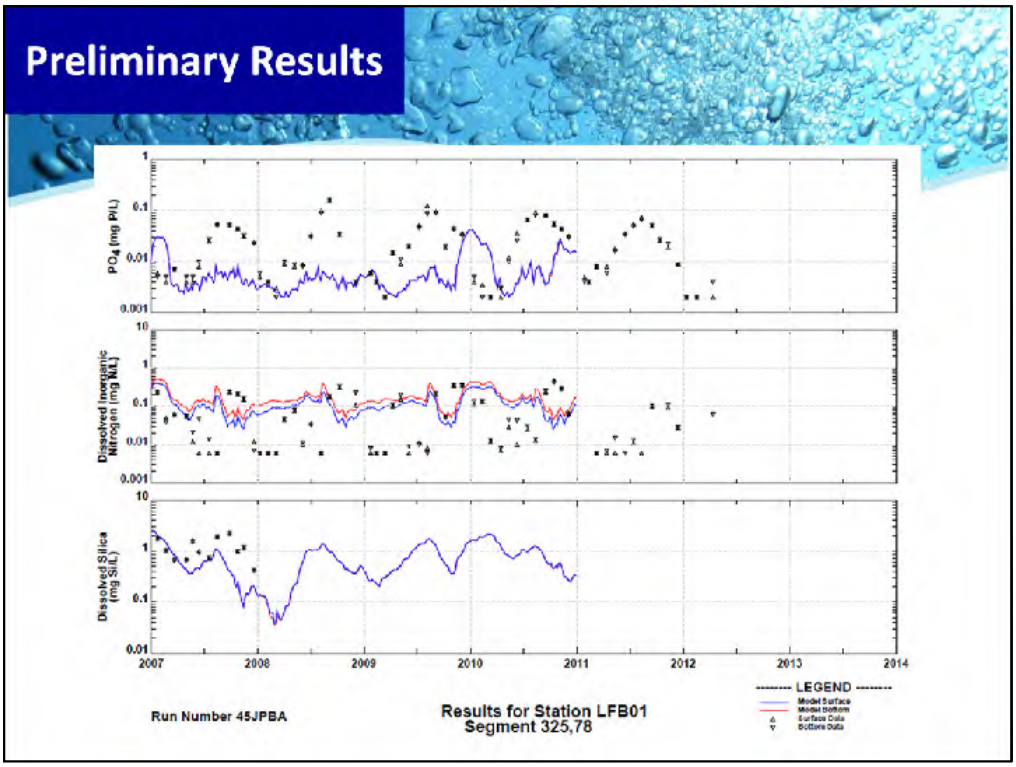
Another issue in Lafayette – low DO not captured by model. Where is O2 demand coming from?



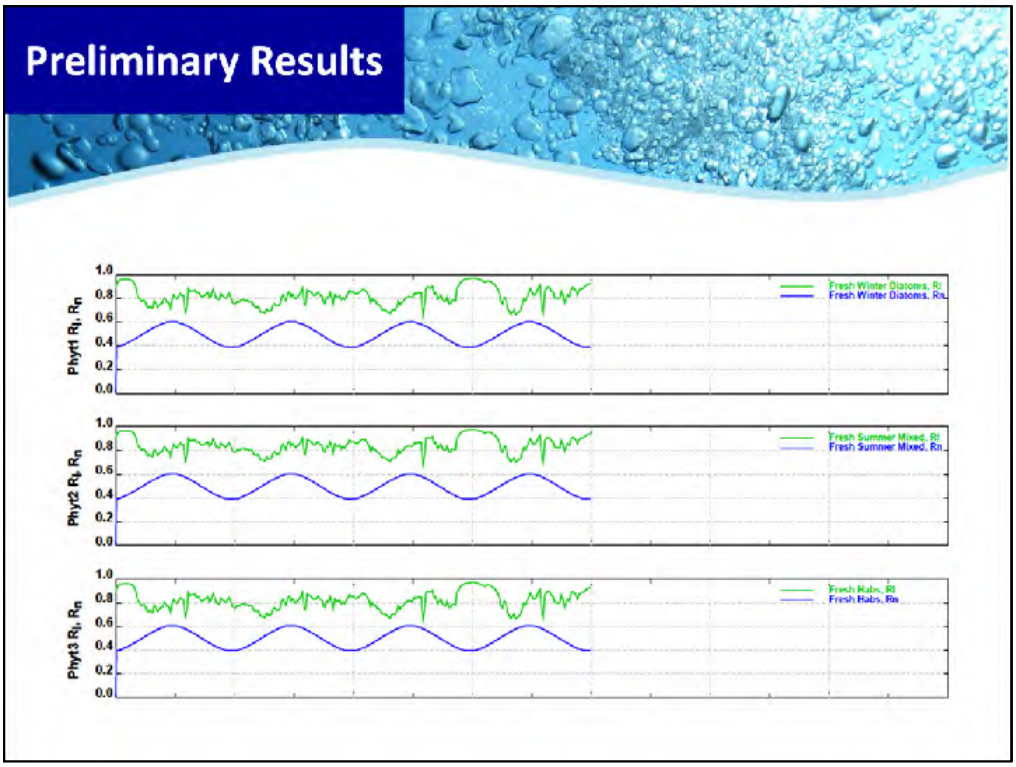
Looking to complete WQM calibration/validation in Q1 of 2015.



Looking to complete WQM calibration/validation in Q1 of 2015.



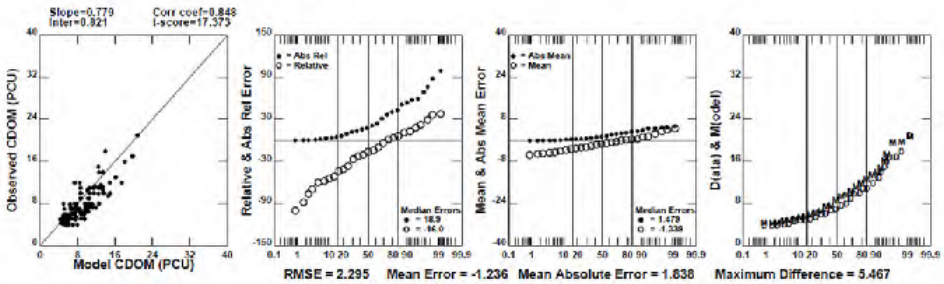
Can low DO be driving PO4 release from the sediment – note increase in summer. Likely not due to loads since flows would be low, but maybe due to low DO



Model output can show if algal growth is light or nutrient limited. Above plot show model output for a surface layer segment. Blue line is reduction in algal growth rate due to light limitation (low solar radiation in winter, high in summer), hence sinusoidal shape. Green line is reduction in algal growth rate due to nutrient limitation. This needs to be depth integrated to get true reductions in growth rate for a segment

Skill Assessment

1. Linear Regression (slope, intercept, r^2)
2. Relative and Absolute Relative Error
3. Mean and Absolute Mean Error
4. Root Mean Square Error
5. Monthly or Seasonal Basis



Type of skill assessment we are looking to perform

Moving Forward

1. Include 2013 in calibration analysis
2. Improve hydrodynamics
3. Improve Cochlodinium calibration
4. Perform Skill Analysis and Sensitivity Analysis
5. Develop Model Report

What needs to be done

Questions

Questions