Overview of Recent DSM2 Recalibration for BDCP

DSM2 Users Group Meeting

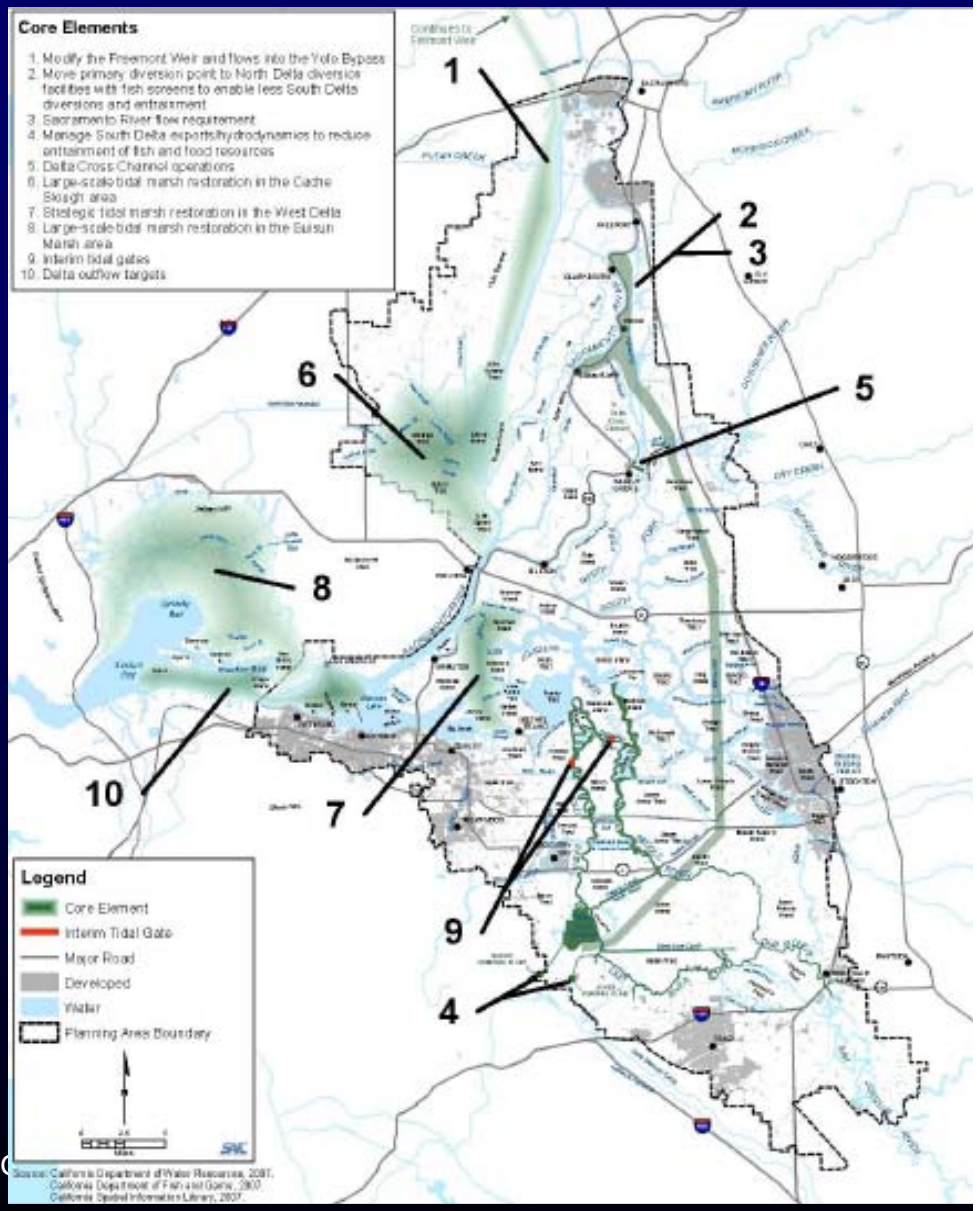
October 28, 2009

Bay-Delta Conservation Plan (BDCP)

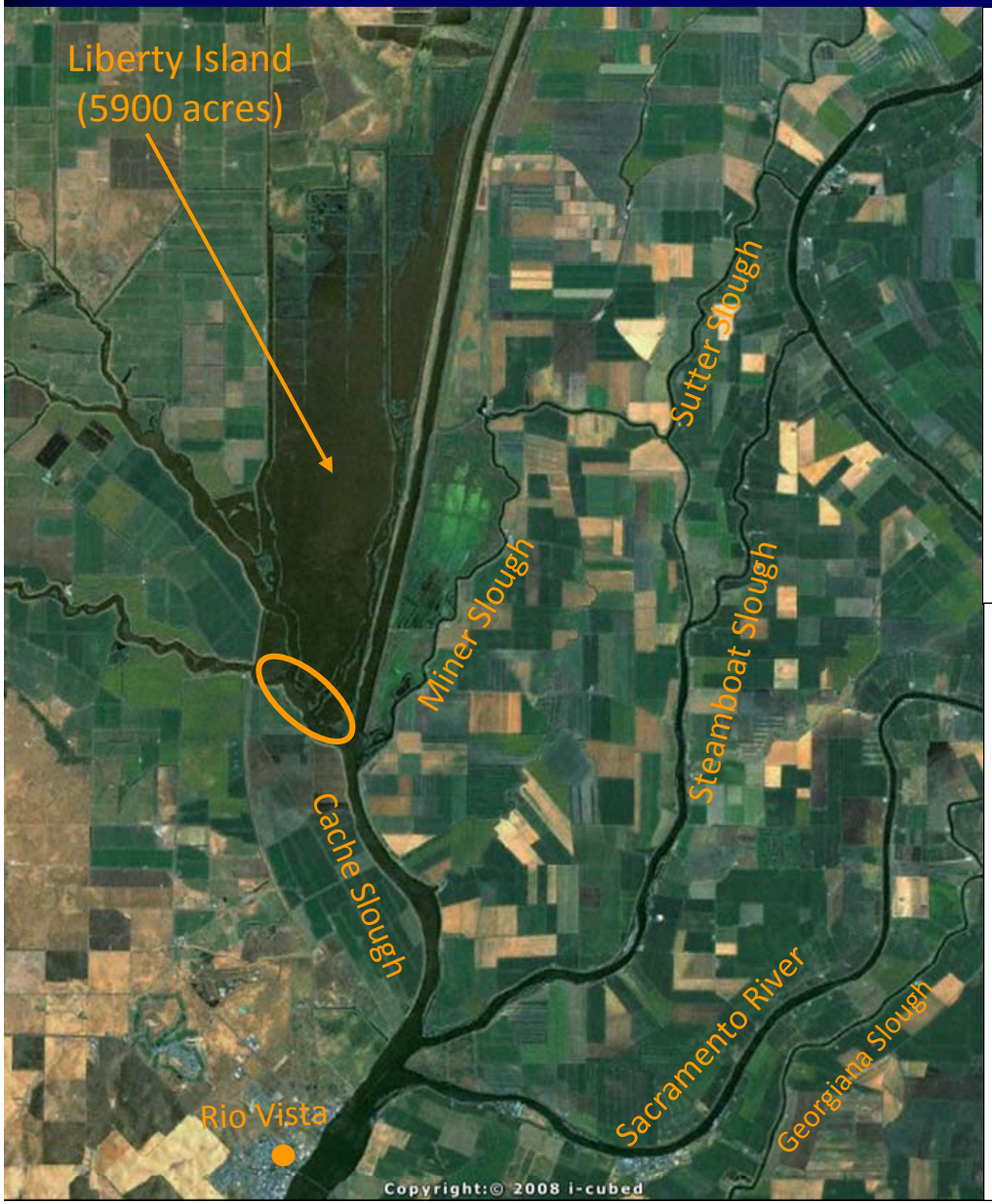
- BDCP is considering several conservation strategies to restore habitat for Delta fisheries while continuing reliable water supply.
- Federal and state agencies, environmental organizations, and other stakeholders are working together to develop the Plan.
- DSM2 is one of the core analytical tools considered to evaluate the changes in Delta hydrodynamics and water quality associated with the elements of the BDCP.

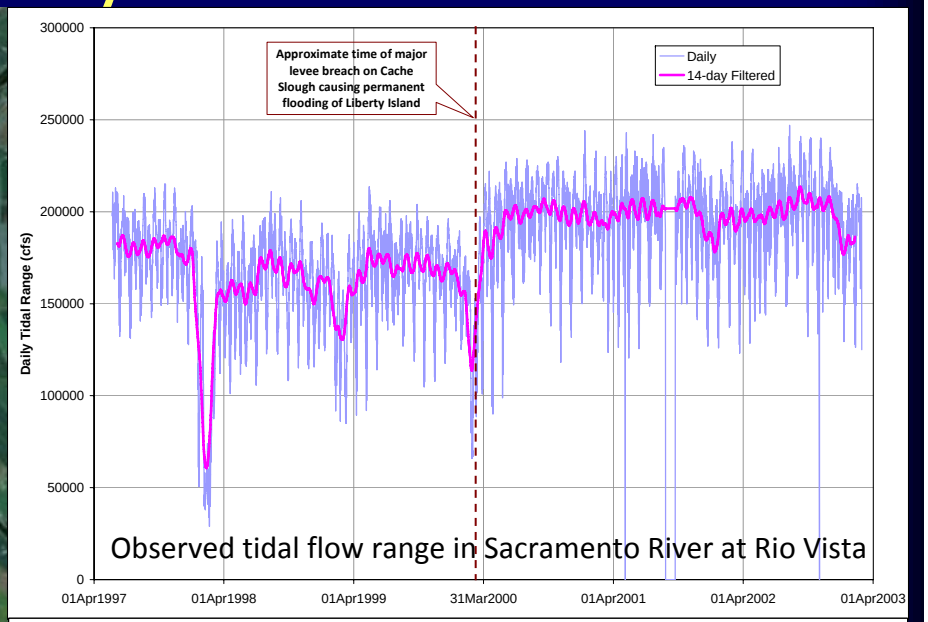
BDCP Core Elements of Draft Conservation Strategy

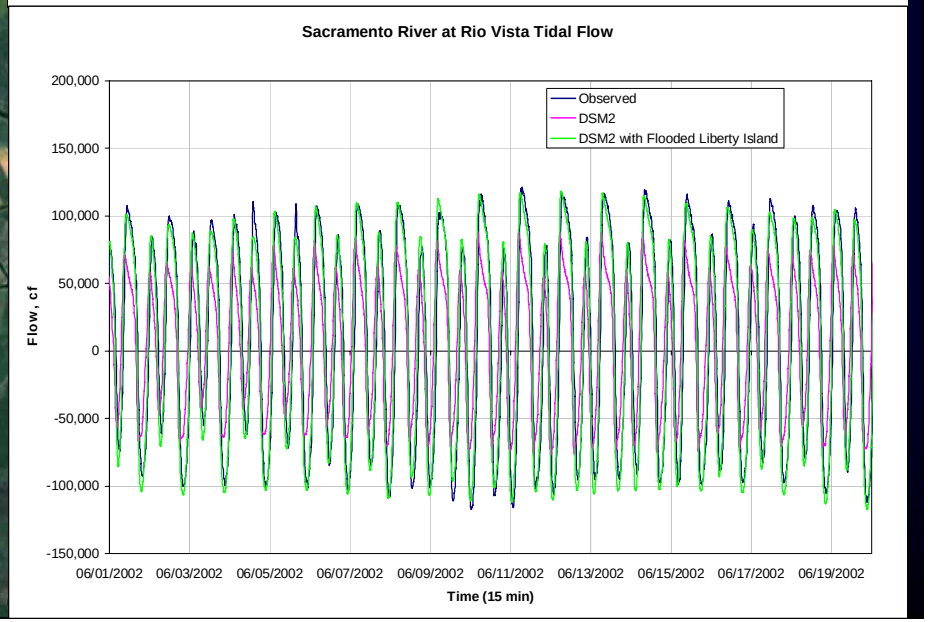
- Fremont Weir modifications for more frequent inundation
- North Delta diversion and associated bypass flows
- Delta Cross Channel operations
- Old and Middle River flow restrictions
- Large-scale tidal marsh restoration in Cache Slough, Suisun Marsh, West Delta, East Delta, and South Delta



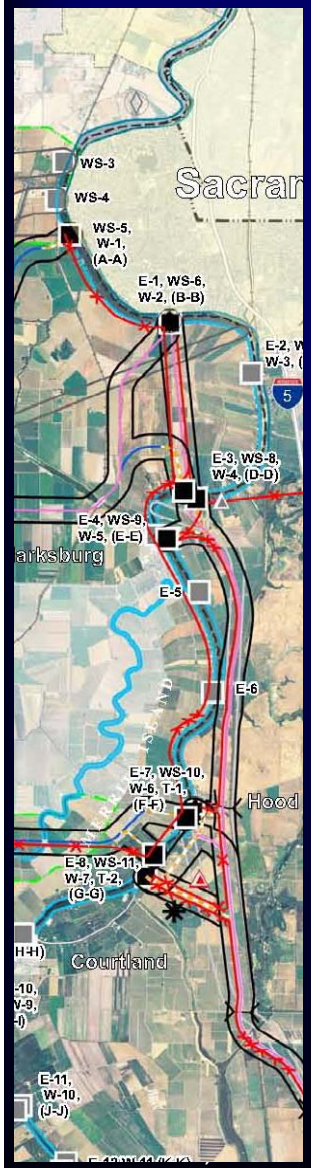
Motivation for Recalibration of DSM2 Flooded Liberty Island

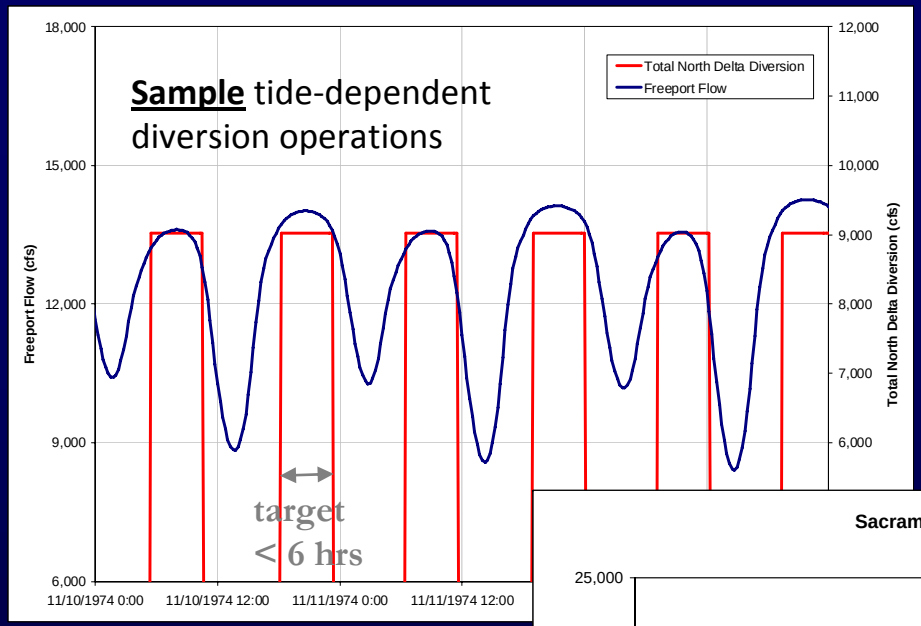


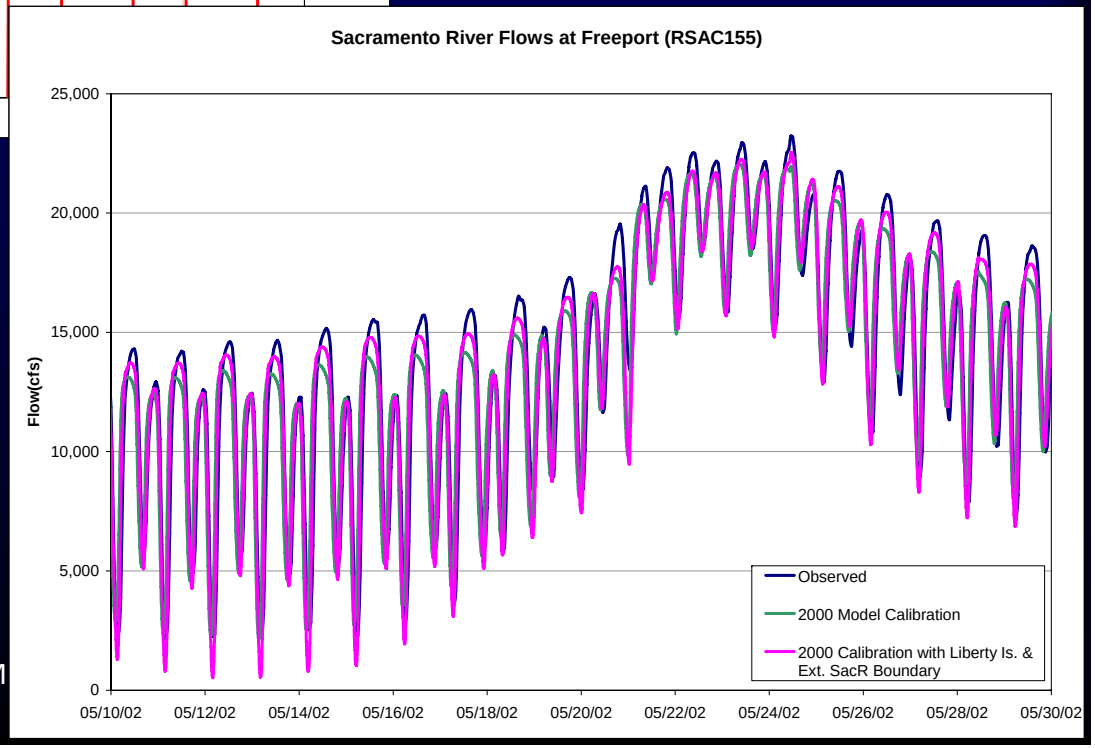




Motivation for Recalibration of DSM2 Attenuated Peak Tidal Flows at Freeport

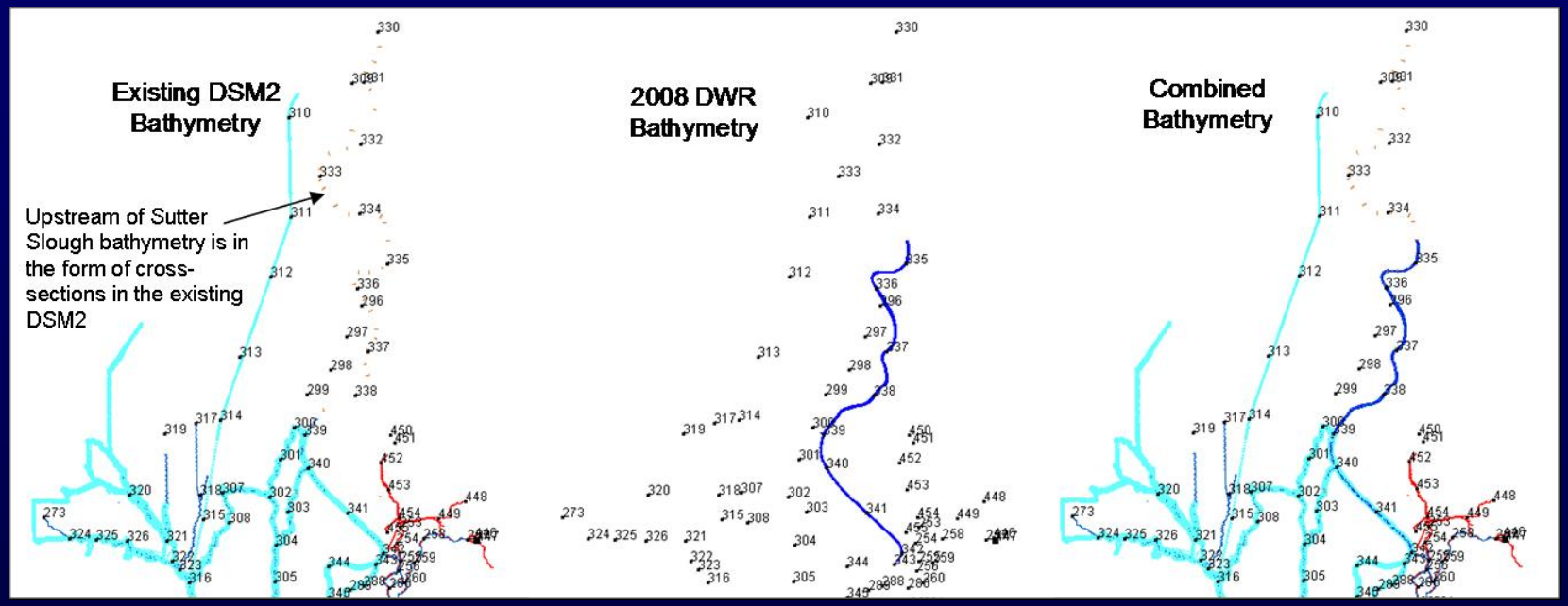


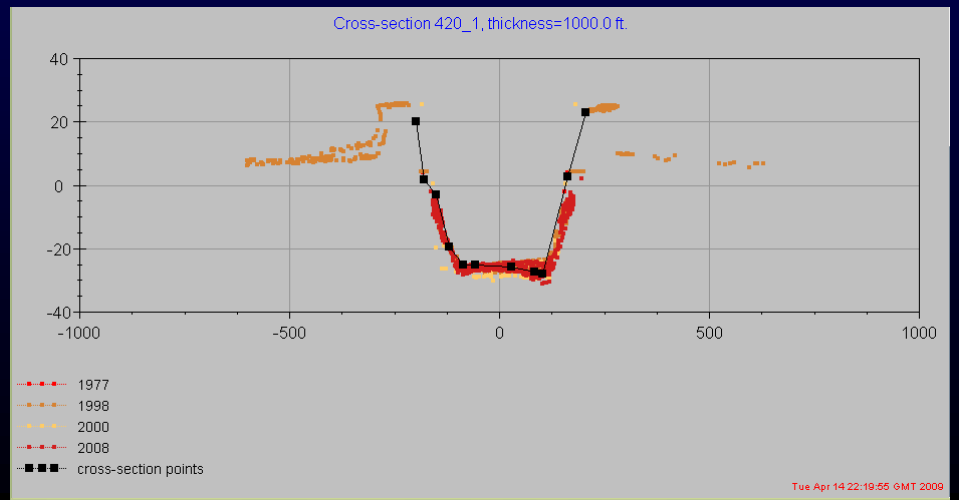




DSM

Motivation for Recalibration of DSM2 Updated Sacramento River Bathymetry





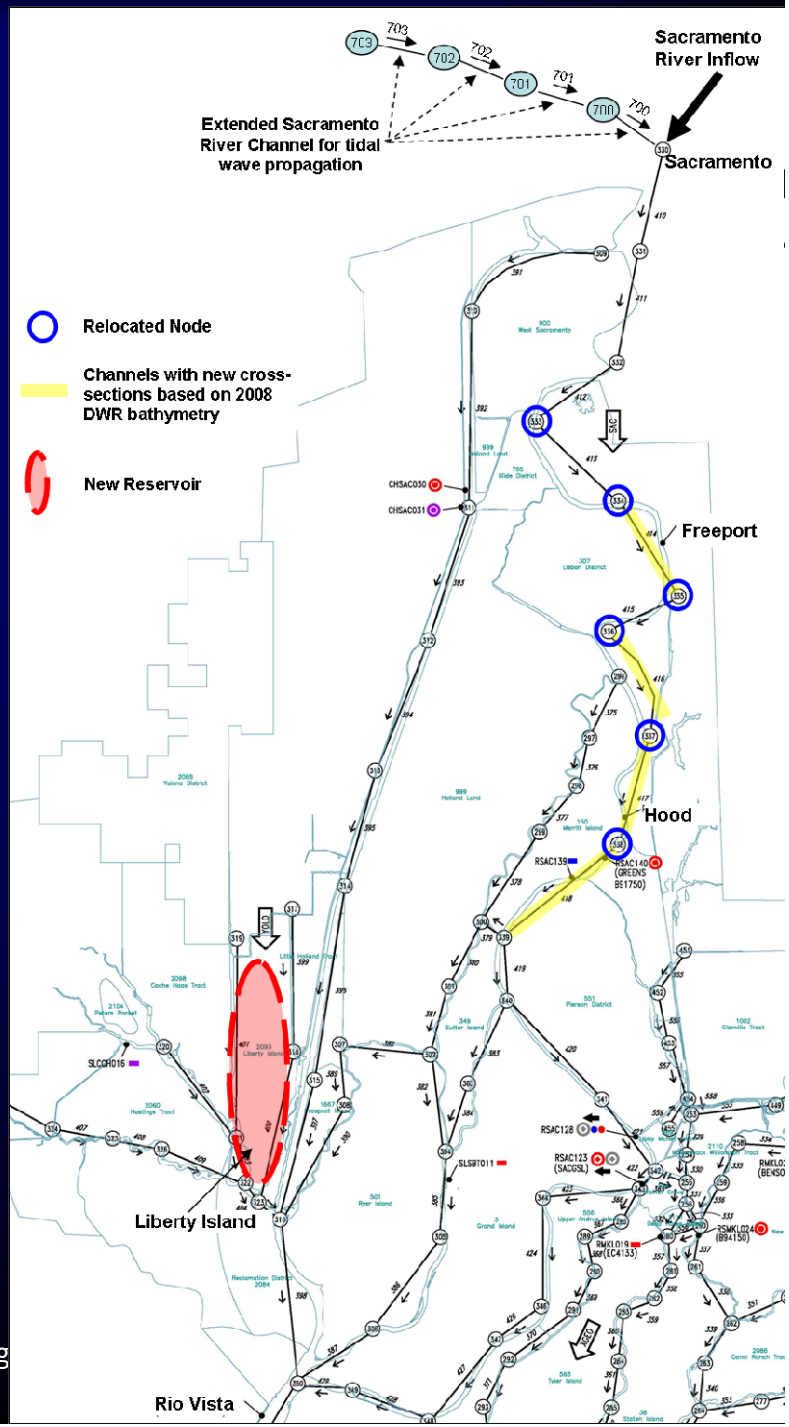
Scope of Recalibration

The scope is mainly focused on these primary objectives:

- Accurate representation of tidal prism in DSM2 under the current physical conditions in the Delta
- Accurate simulation of tidal flows at Rio Vista, Jersey Point and Threemile Slough, in terms of magnitude and phase
- Adequate simulation of EC at Collinsville, Emmaton, Jersey Point, Rio Vista and Rock Slough

Model Grid Changes in the North Delta

- Inclusion of flooded Liberty Island
- Extension of Sacramento River grid
- Updated Sacramento River bathymetry
- Grid setup for potential diversion intakes



Boundary Condition Review

- All boundary conditions were reviewed
- Minor corrections to flow and stage boundaries
- Delta island consumptive use and drainage EC boundaries were not reviewed – requires a much broader effort

Criteria for Period Selection for Calibration and Validation of DSM2

- **Current physical conditions**: Liberty Island flooding in early 2000.
- **Hydrology**: Low flow periods are desirable for calibration of hydrodynamic and water quality models in estuaries.
- **Exports**: Variable export regimes would provide contrast in terms of the hydrodynamics and water quality in the South and Central Delta.
- **Availability of observed data**: The availability of observed flow, stage, and EC data at various locations in the Delta is critical for the calibration.

Selection of Calibration Period Based on Hydrology, Exports, and Observed Data Availability

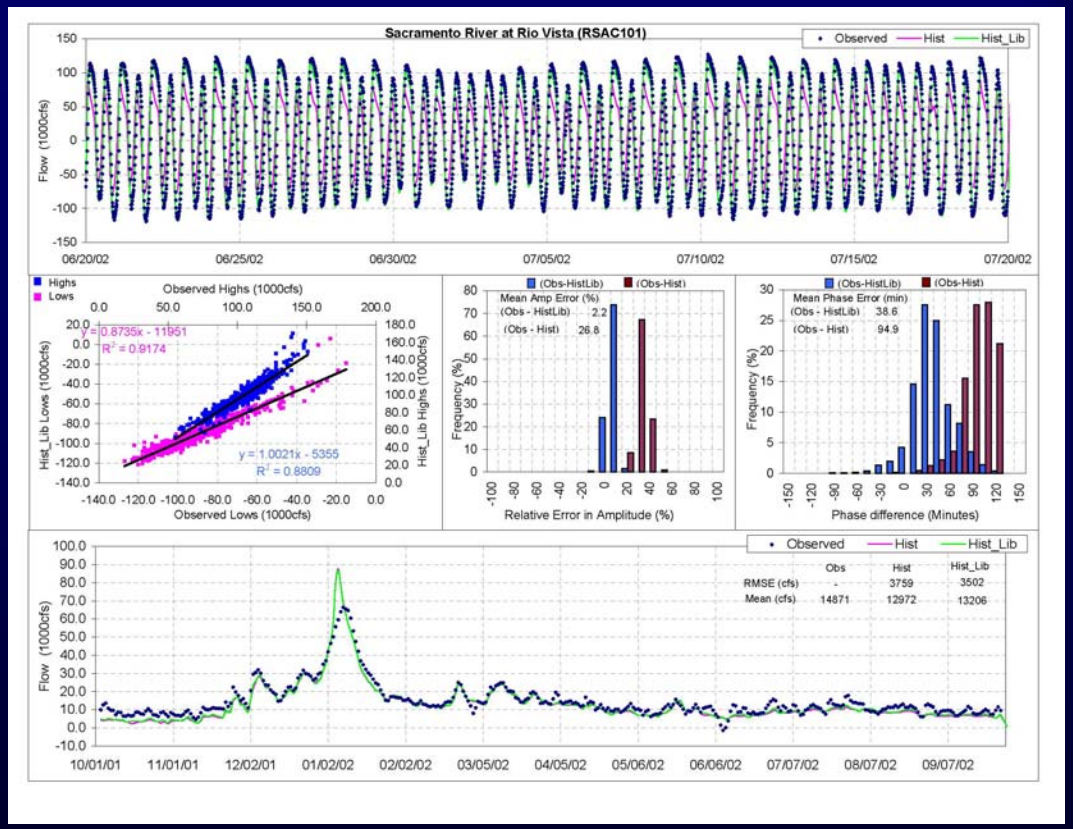
Water Year	Sacramento Valley[a]	Annual Exports (cfs)[b]	Data Availability[c]		
			Flow	Stage	EC
2001	D	7,067	Sparse	Sparse	Good
2002	D	7,698	Good	Good	Good
2003	AN	8,734	Good	Good	Good
2004	BN	8,464	Fair	Fair	Good
2005	AN	8,936	Fair	Fair	Good
2006	W	8,722	Fair	Fair	Good
2007	D	8,020	Good	Good	Good
2008	C	5,146	Good	Good	Good

[a] Based on CDEC data (http://cdec.water.ca.gov/cgi-progs/iodir/WSIHIST)
[b] Based on DAYFLOW data from IEP website (http://www.iep.water.ca.gov/dayflow/output/index.html)
[c] Based on data availability from IEP, CDEC and USGS at several locations in the Delta

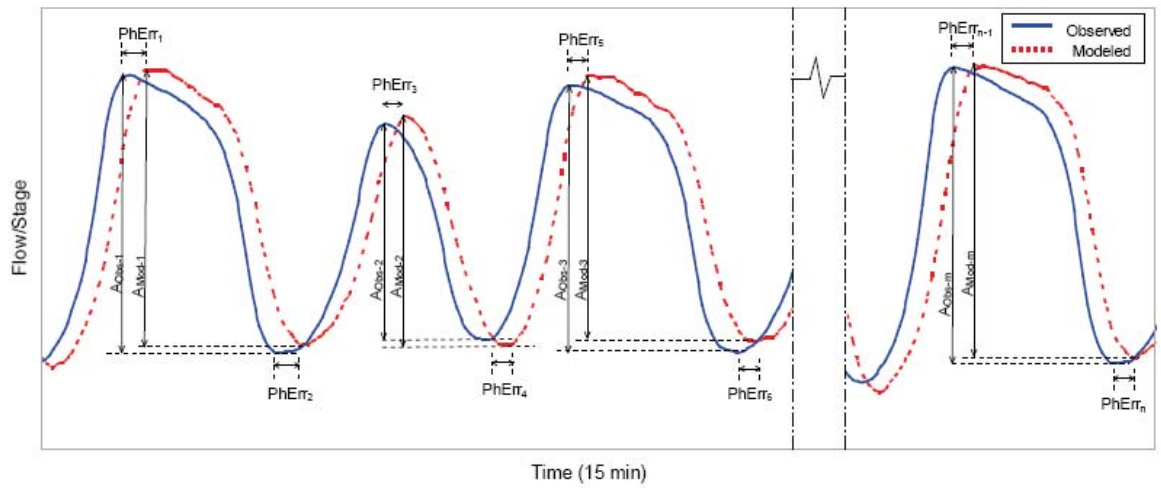
- **HYDRO was calibrated for one year period, using the data from WY 2002.**
- **HYDRO was validated for 8 year period from WY 2000 to WY 2008.**
- **QUAL was calibrated for 8 year period from WY 2000 to WY 2008.**

HYDRO Calibration and Validation Metrics

- Time series inspection of tidal flow and stage
- Bias in simulated peak ebb and peak flood
- Error in Tidal amplitude
- Error in Tidal phase
- Time series inspection of tidally-averaged flow and stage
- Mean Error in tidally-averaged flow and stage
- Root Mean Squared Error (RMSE) in tidally-averaged flow and stage



Definition of Average Amplitude Error and Average Phase Error

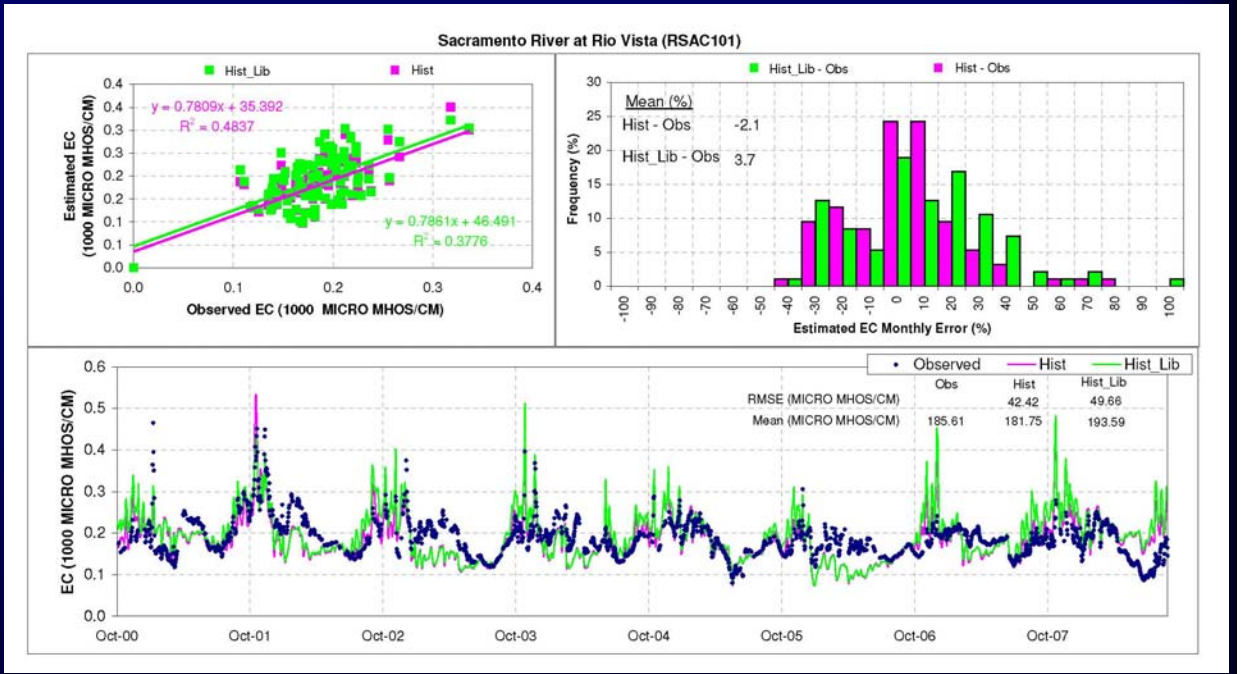


$$AvgAmplitudeError = \left\{ \frac{(A_{MOD-1} - A_{OBS-1}) + (A_{MOD-2} - A_{OBS-2}) + (A_{MOD-3} - A_{OBS-3}) + \ldots (A_{MOD-m} - A_{OBS-m})}{m} \right\}$$

$$AvgPhaseError = \left\{ \frac{PhError_1 + PhError_2 + PhError_3 + \ldots PhError_{n-1} + PhError_n}{n} \right\}$$

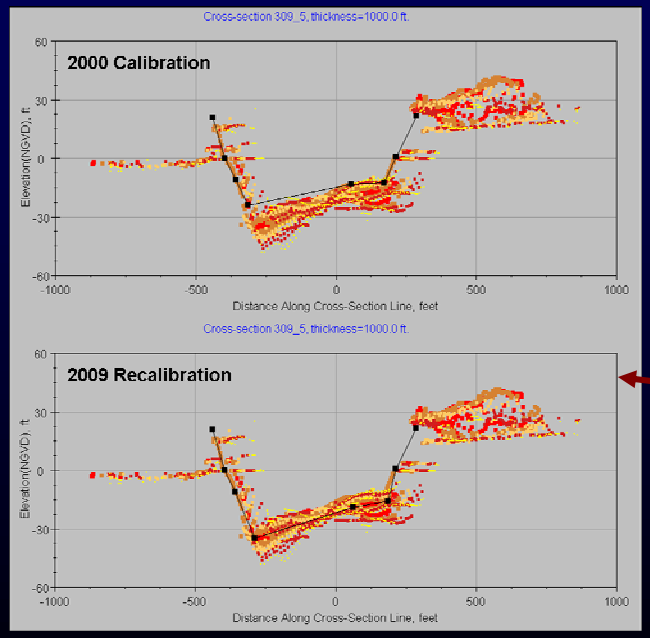
QUAL Calibration Metrics

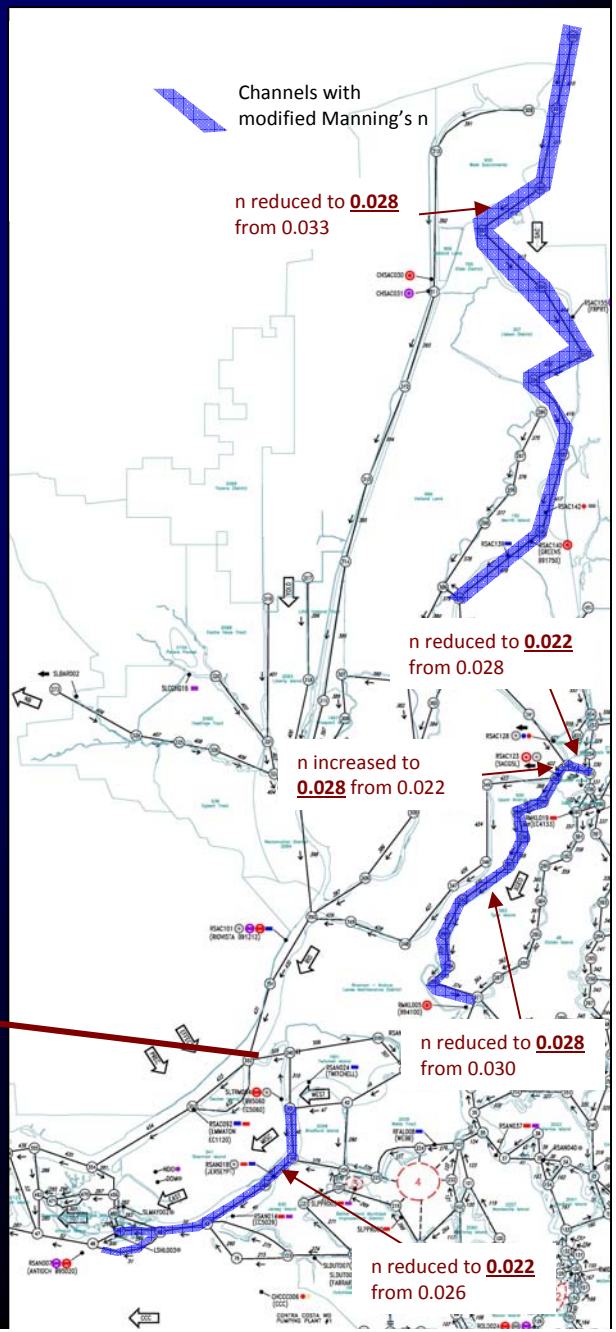
- Bias in simulated monthly averaged EC
- Error in monthly averaged EC
- Time series inspection of tidally-averaged EC
- Mean Error in tidally-averaged EC
- Root Mean Squared Error (RMSE) in tidally-averaged EC



HYDRO Calibration

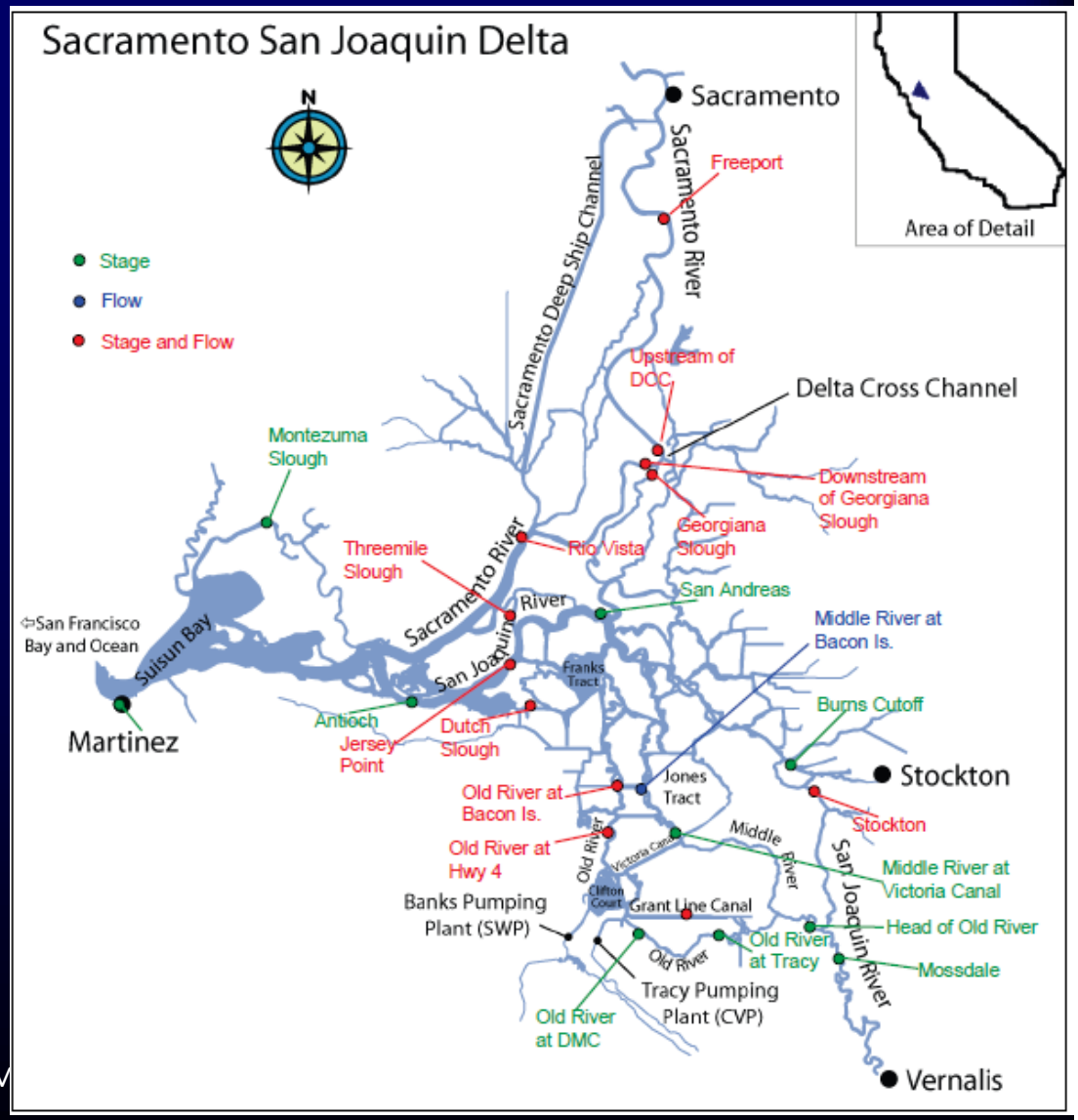
- Physical changes were first incorporated
- Manning's n modified in select channels
- Minor bathymetry corrections near Threemile Slough
- Metrics evaluated for flow and stage



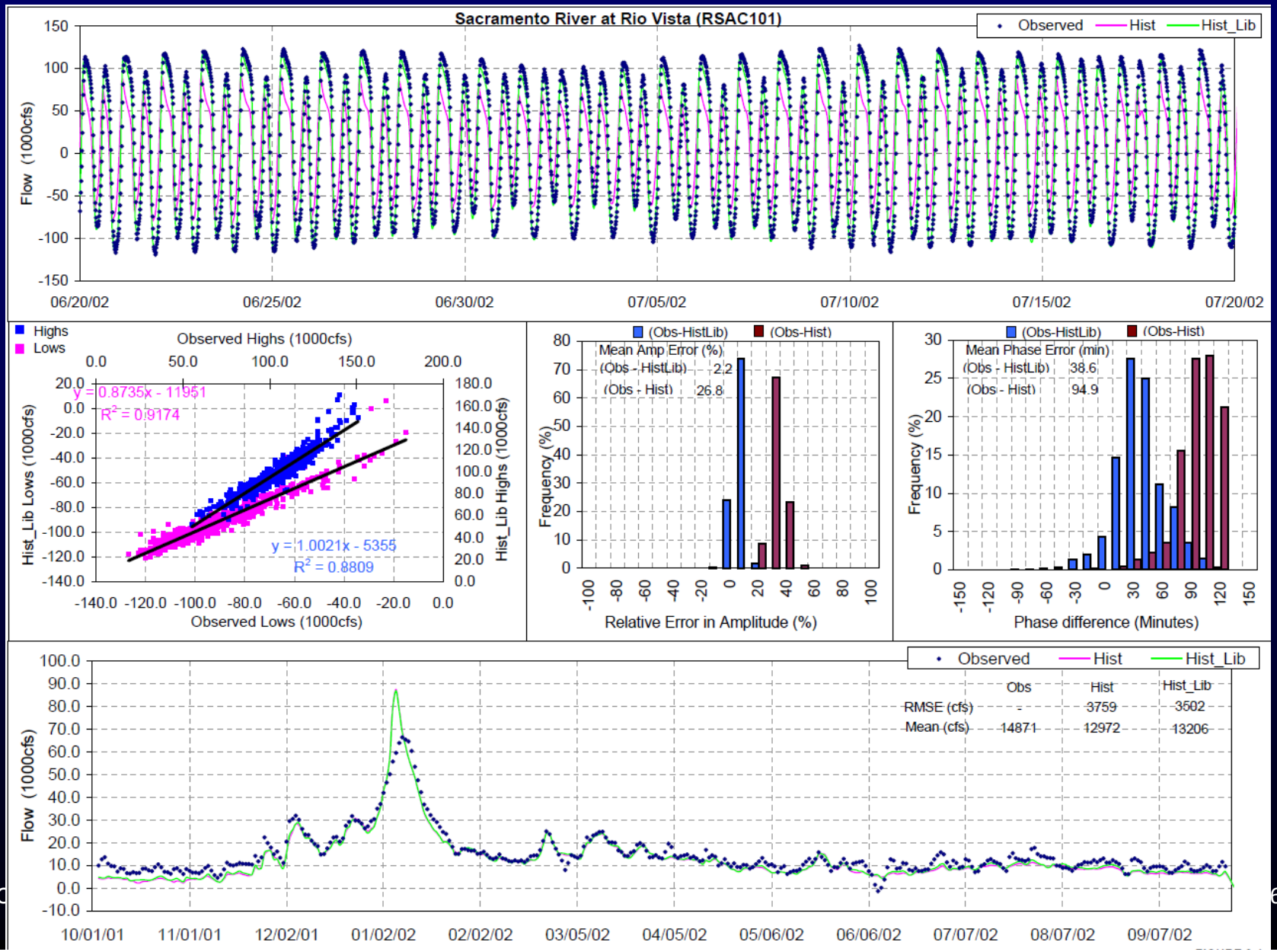


HYDRO Calibration Locations

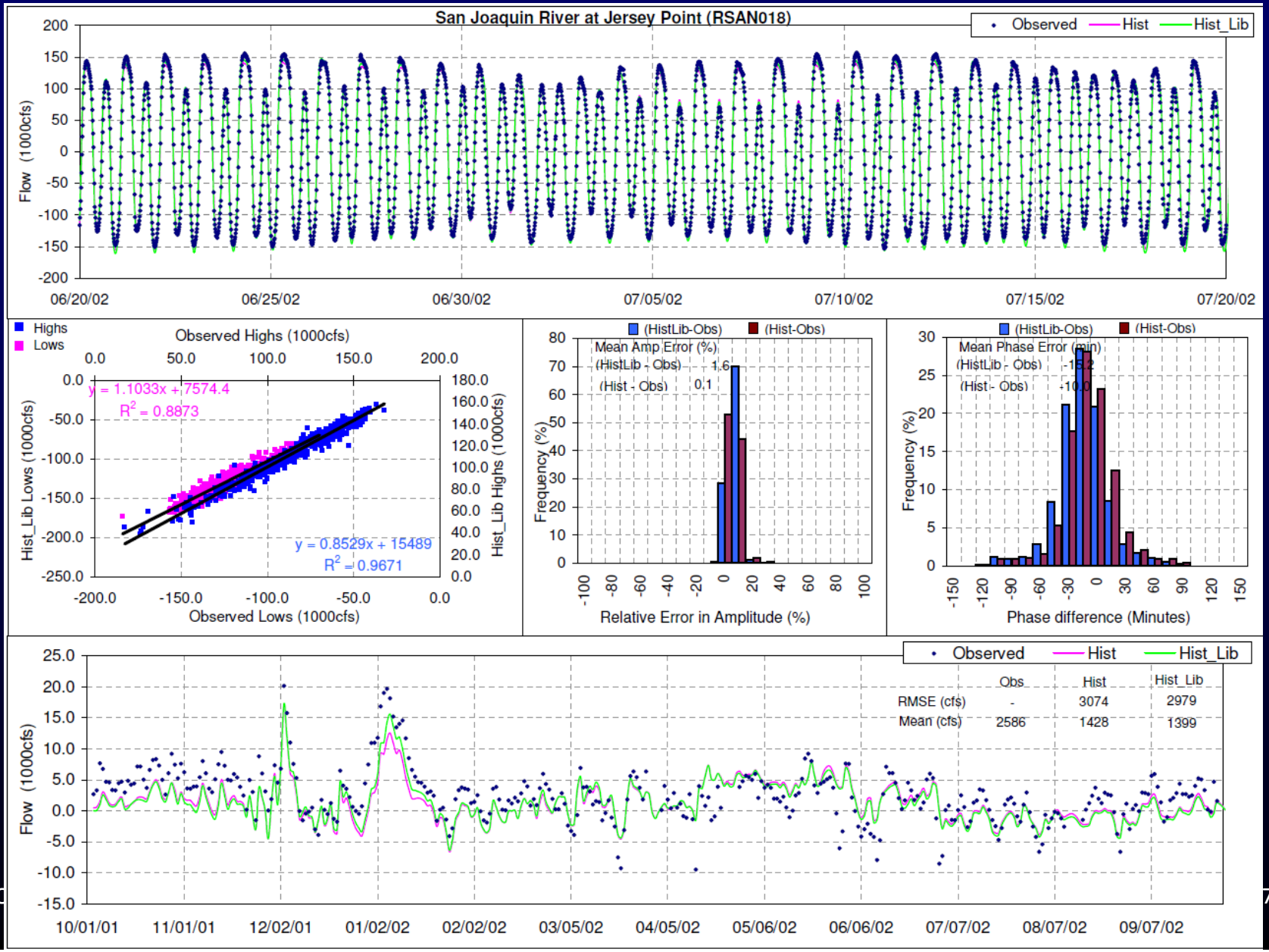
- Broad coverage of flow and state locations
- Flow and stage compared to observed
  - Tidally-averaged
  - 15-min time series
  - Tidal range
  - Amplitude error
  - Phase error



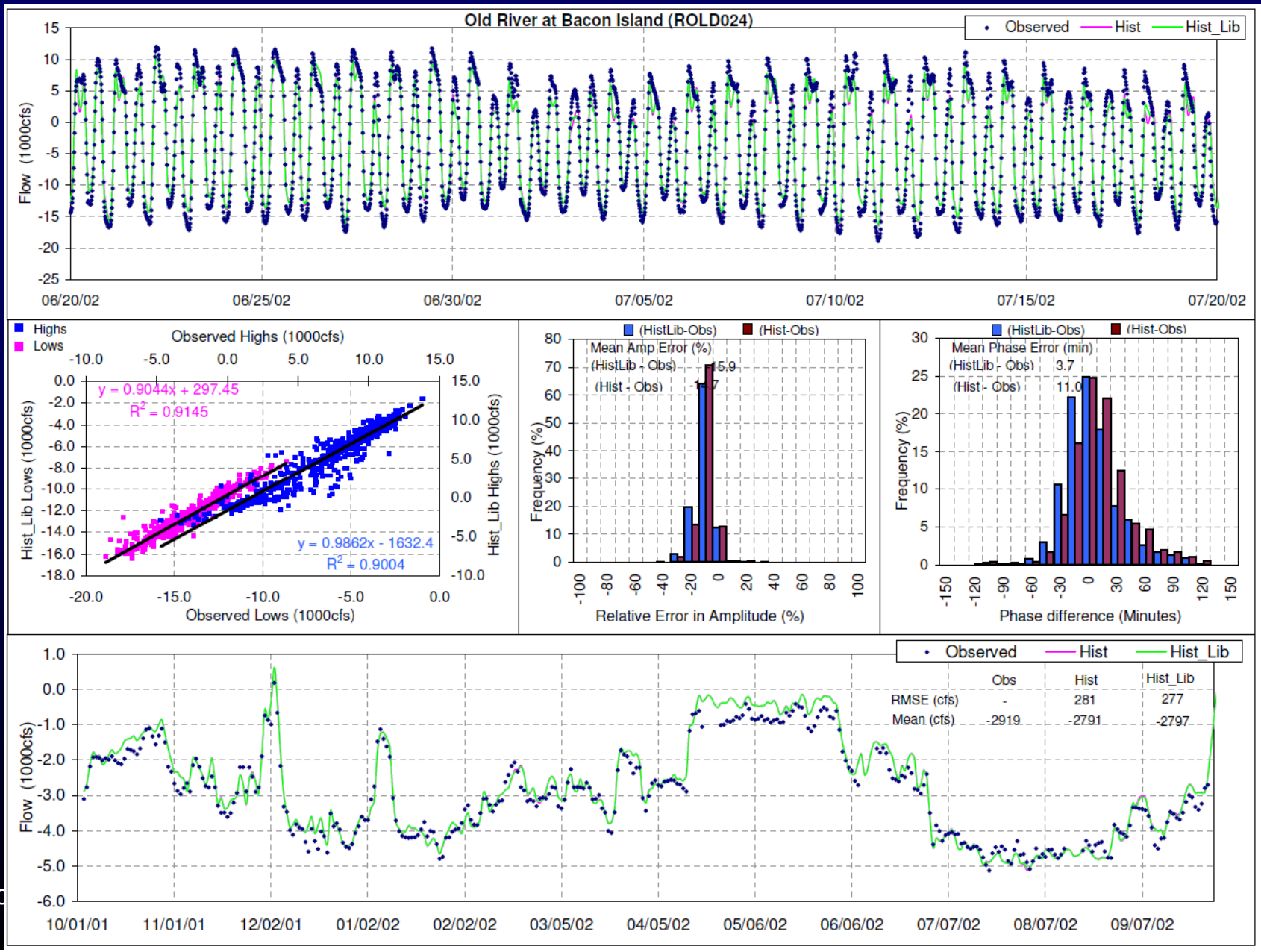
Sacramento River at Rio Vista



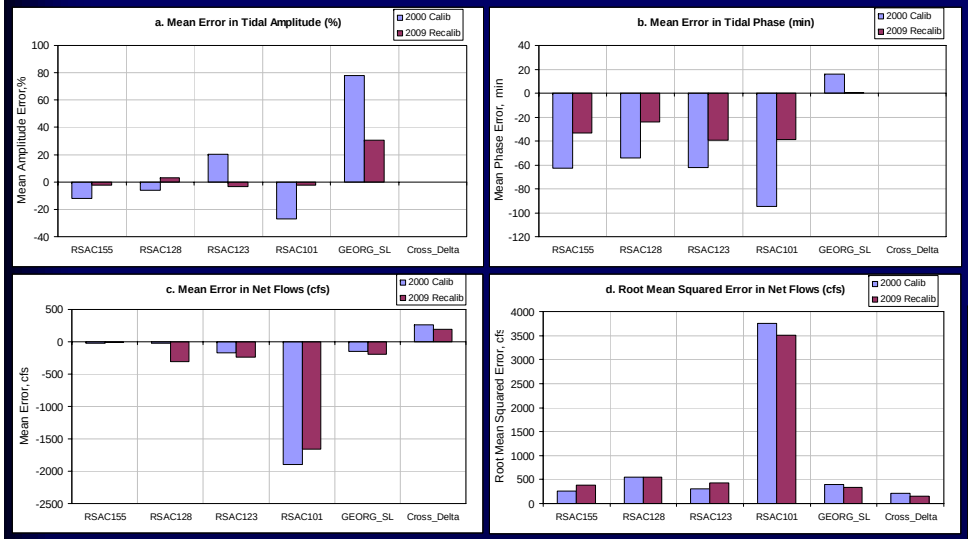
San Joaquin River at Jersey Point



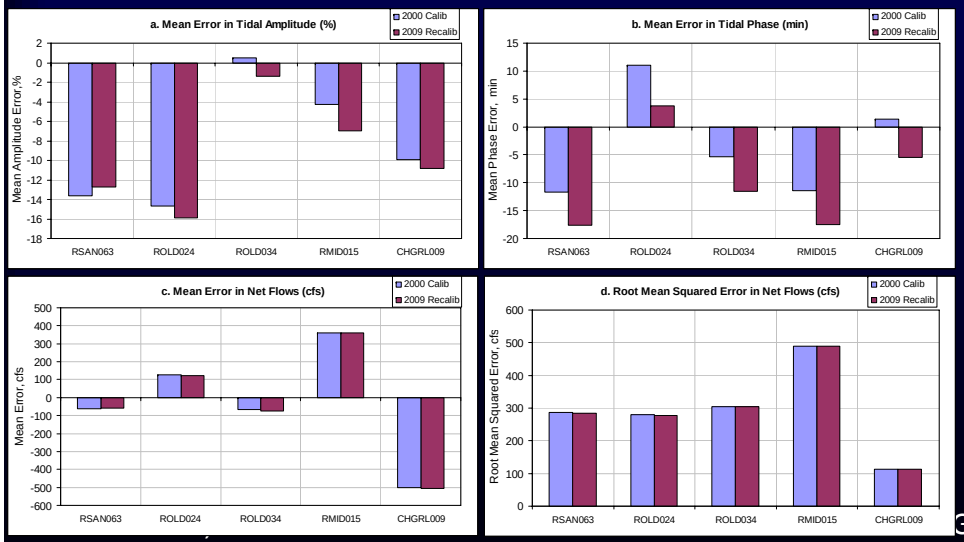
Old River at Bacon Island



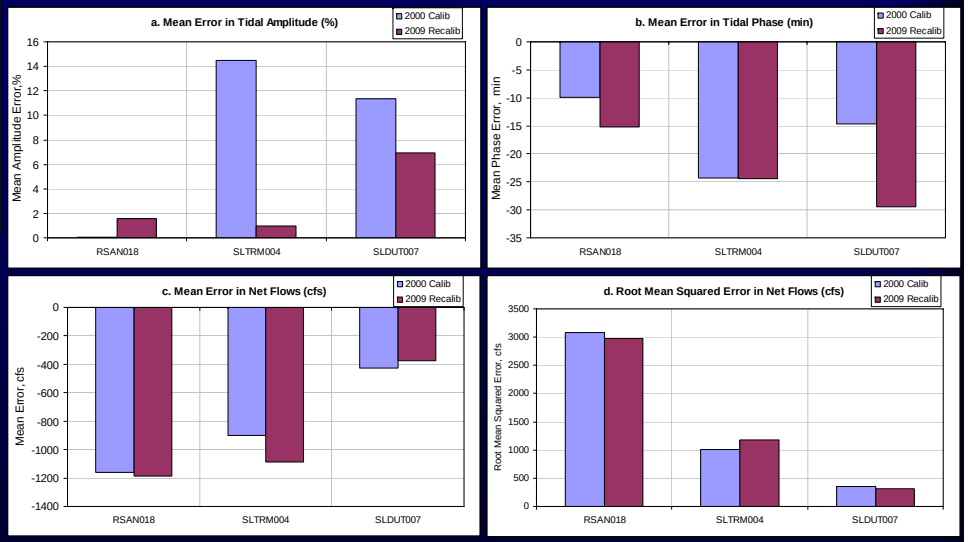
Flow Calibration Summary



North Delta

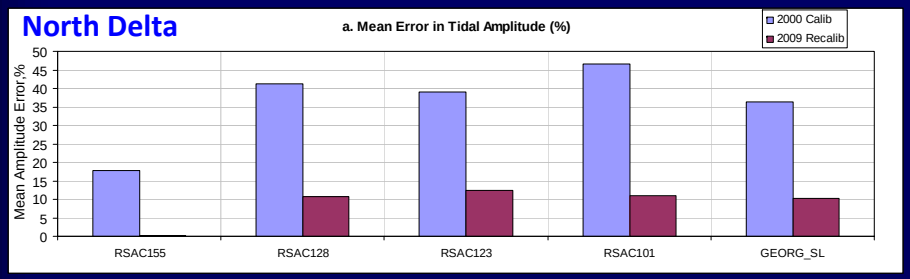


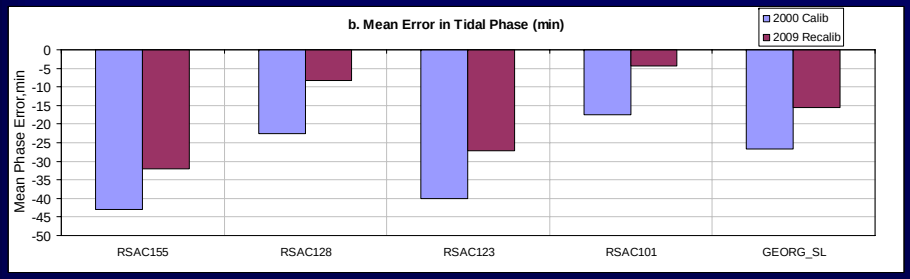
South Delta

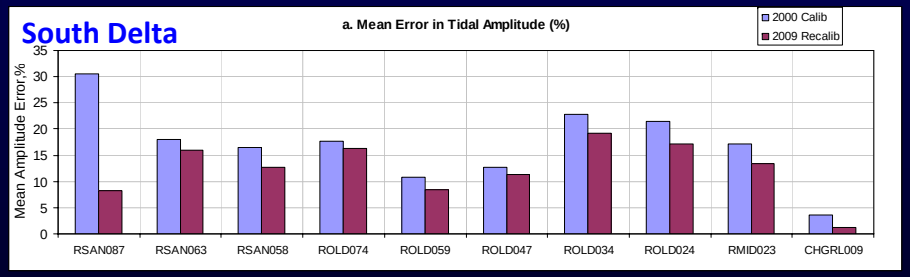


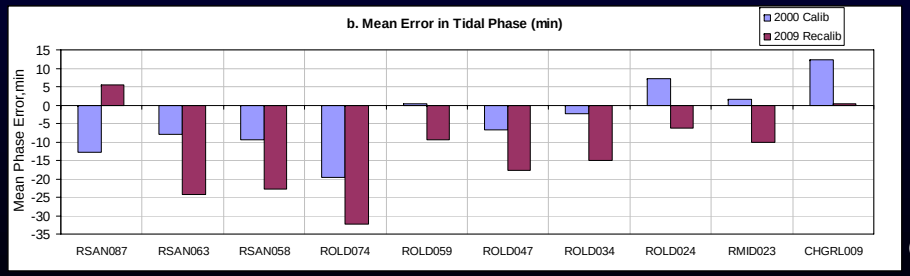
Central/ Western Delta

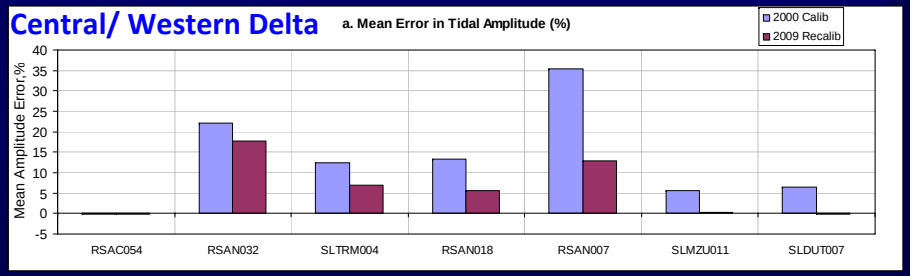
Stage Calibration Summary

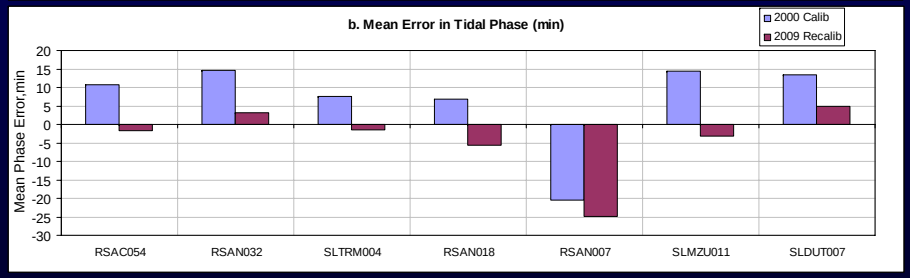




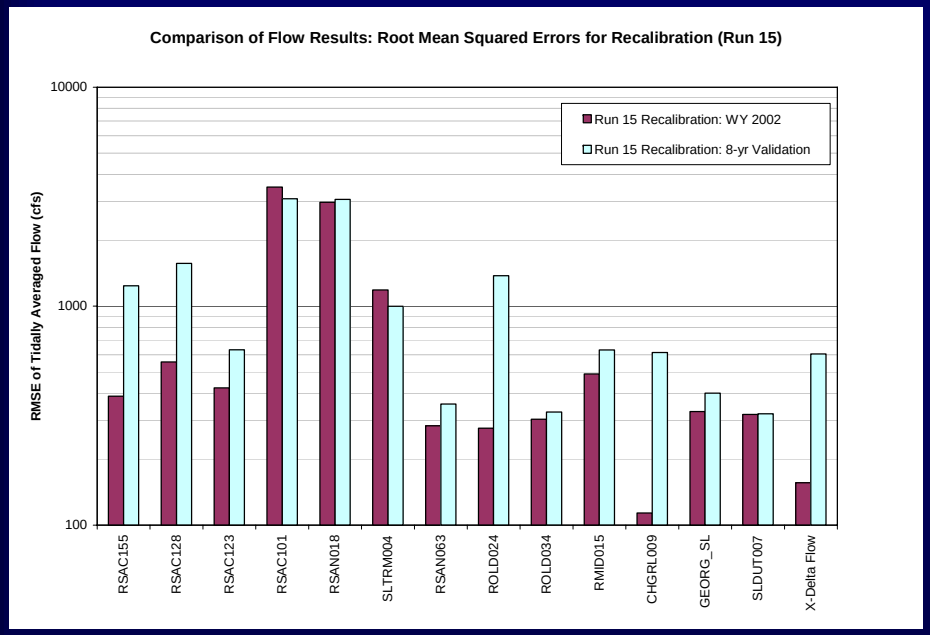


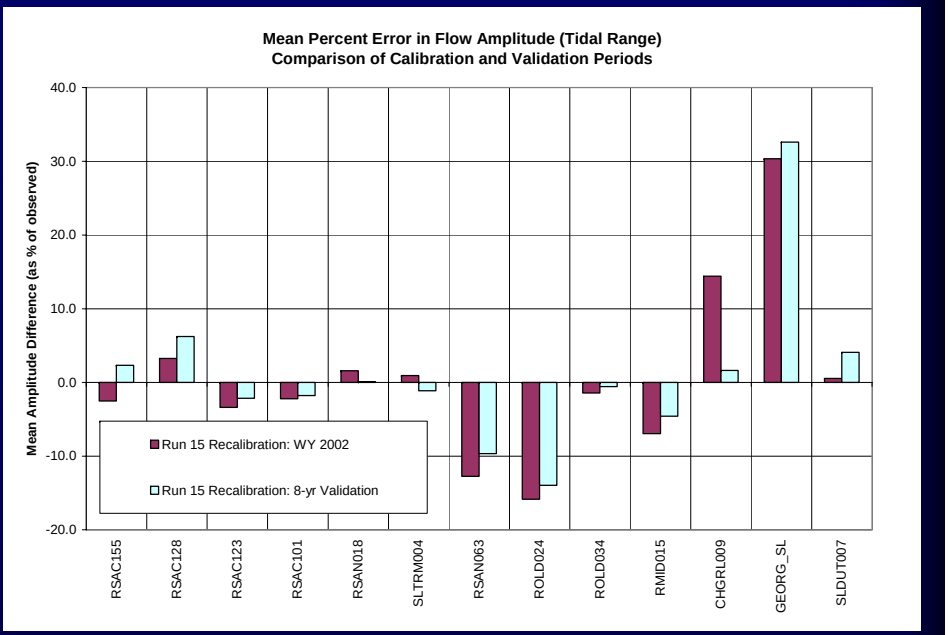


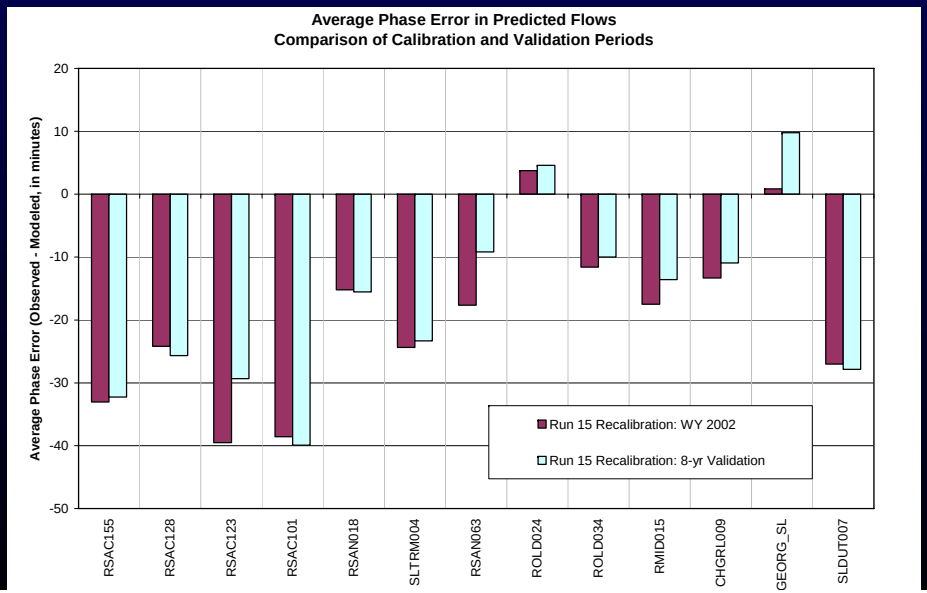




Hydrodynamics Validation Summary







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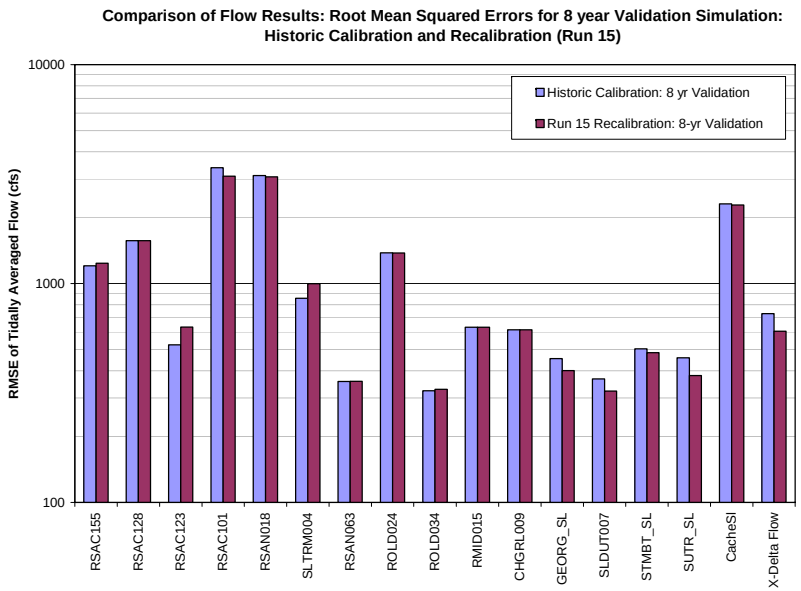
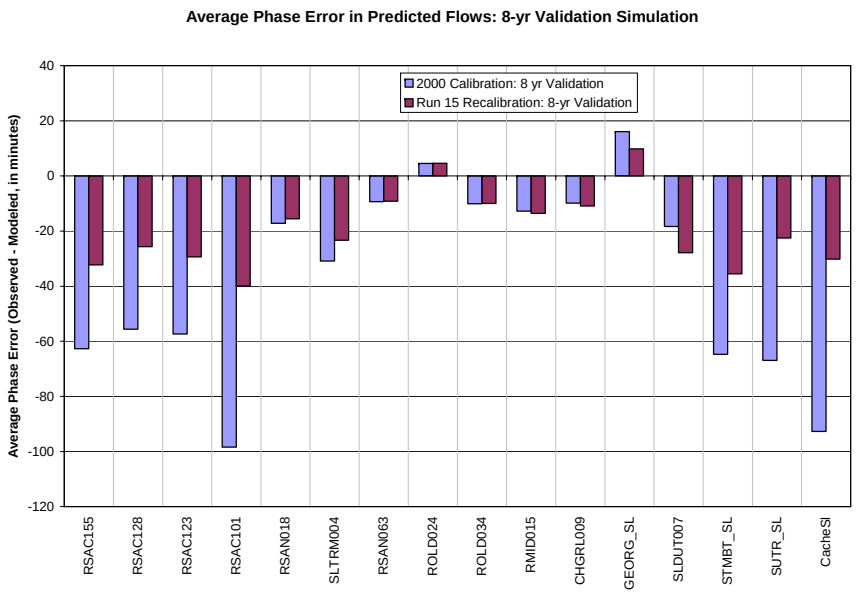
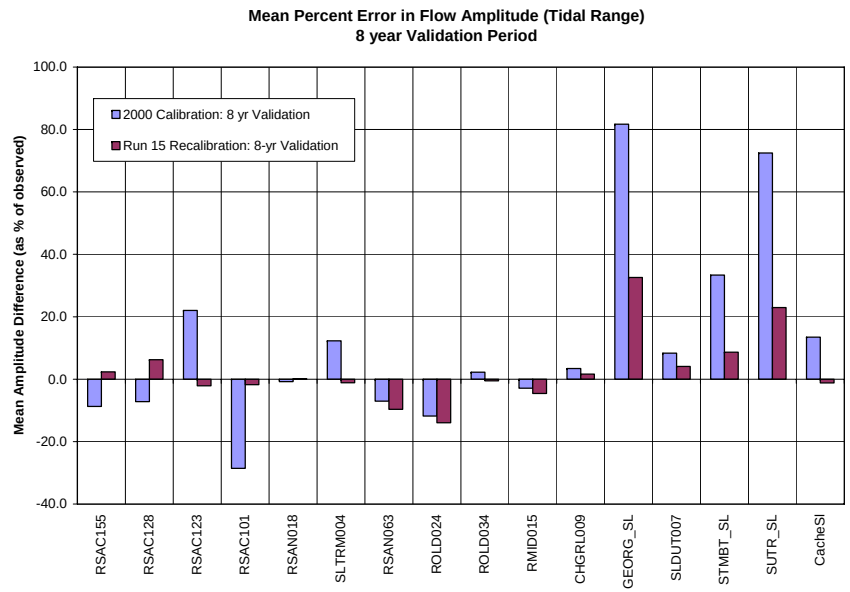
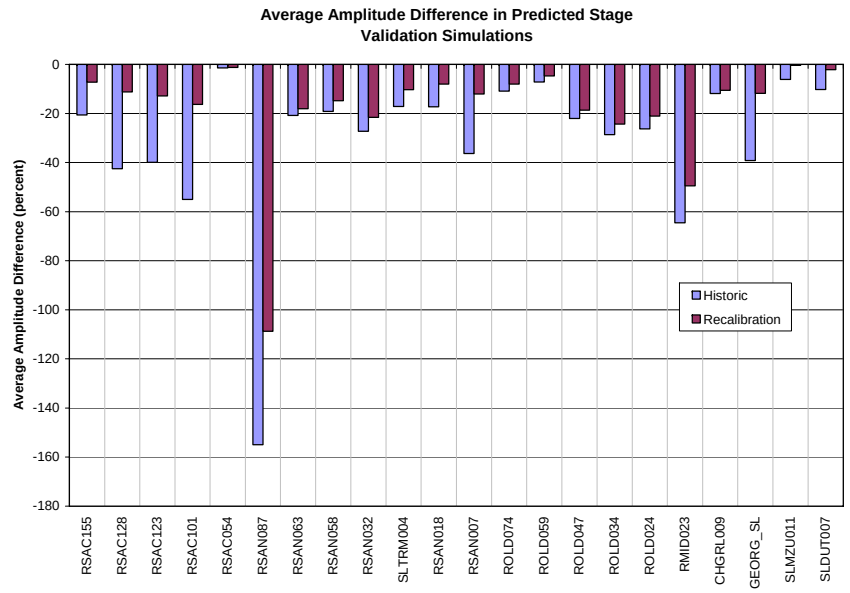


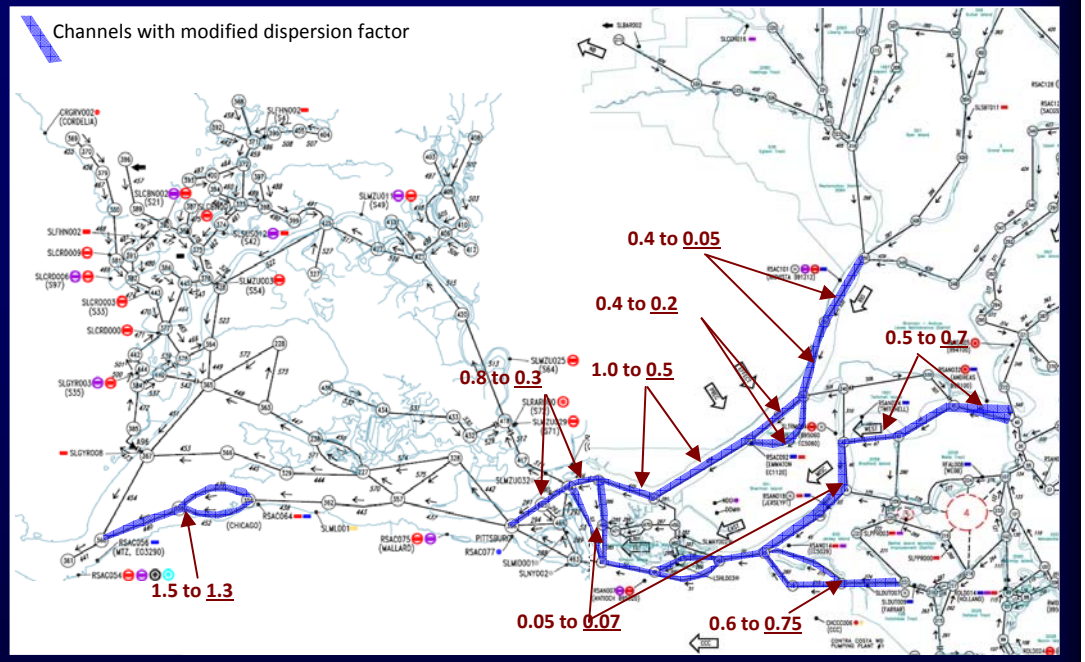






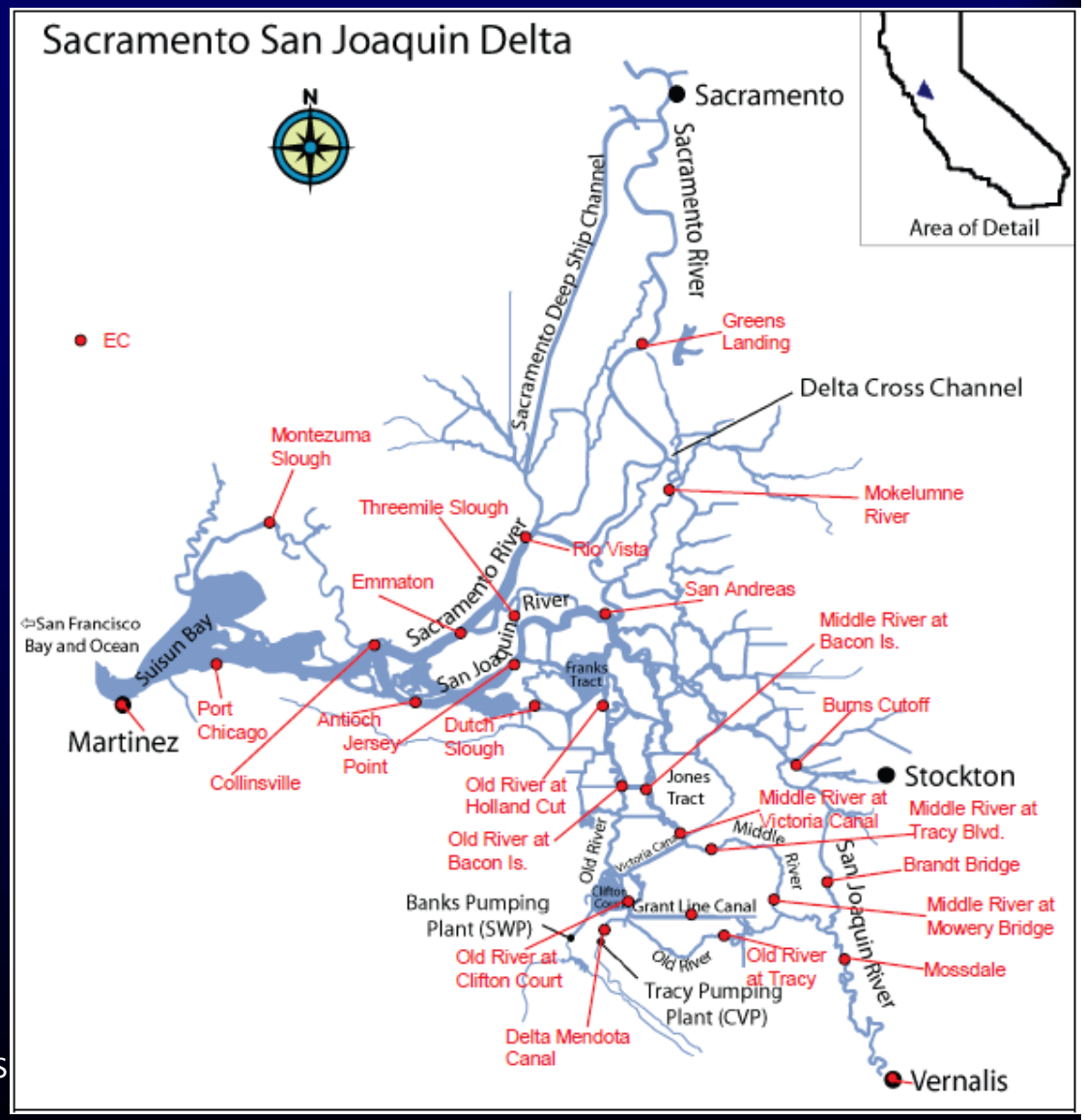
QUAL (EC) Calibration

- Used results from DSM2-HYDRO Validation Simulation
- Dispersion factors adjusted to tune salt transport
- Metrics evaluated for monthly EC

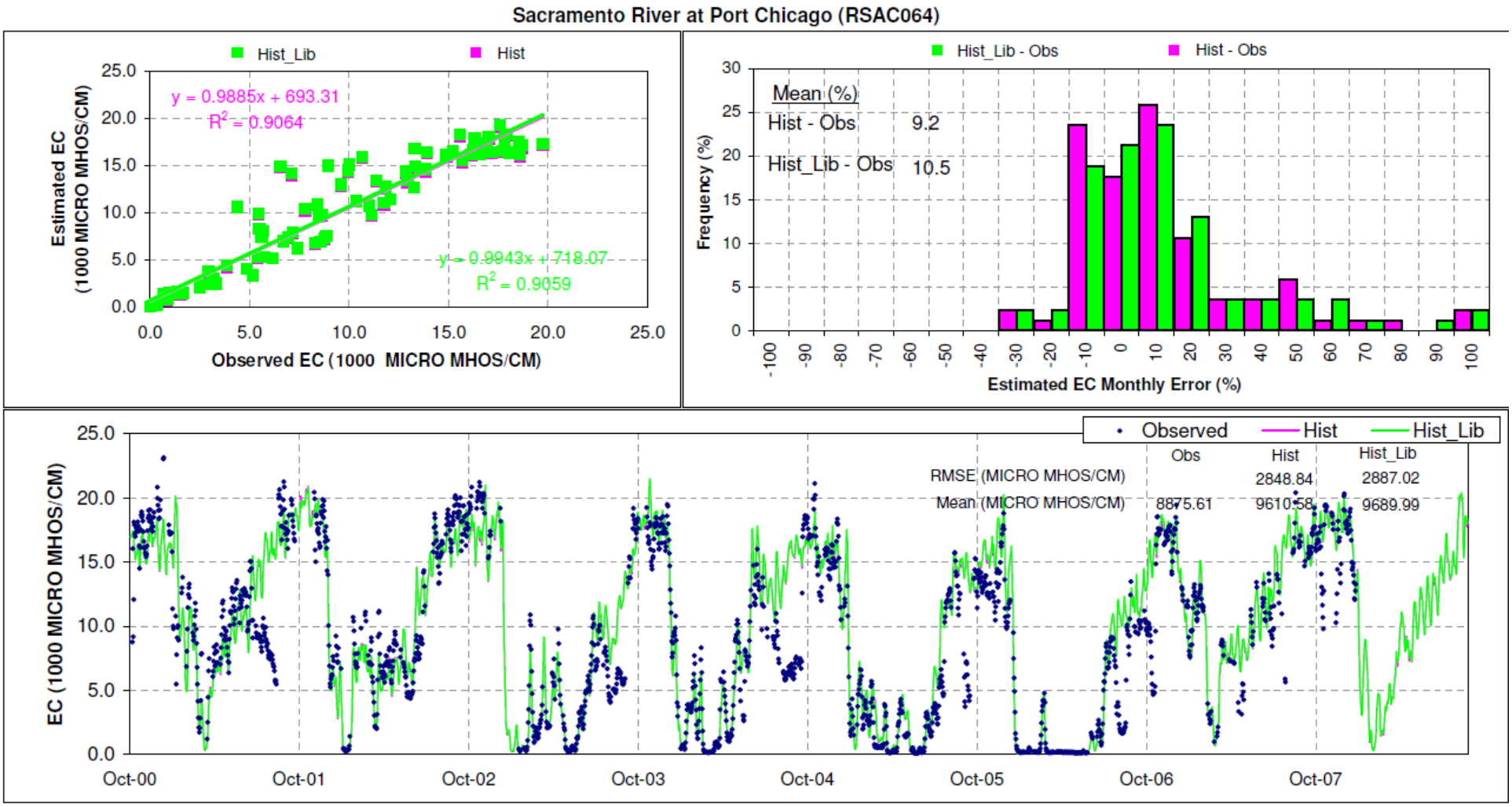


QUAL Calibration Locations

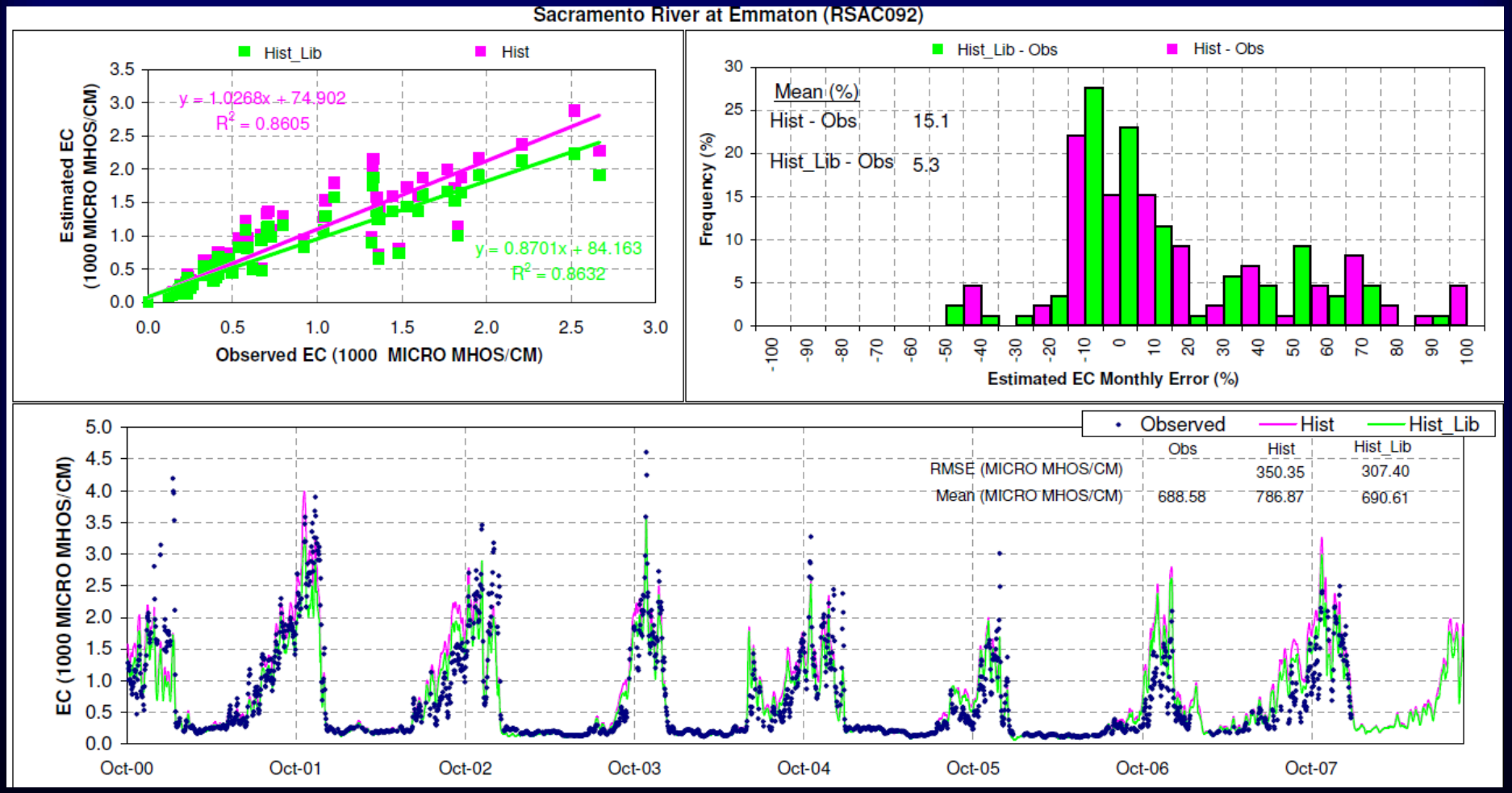
- Broad coverage of EC locations
- EC compared to observed
  - Tidally-averaged
  - Monthly average



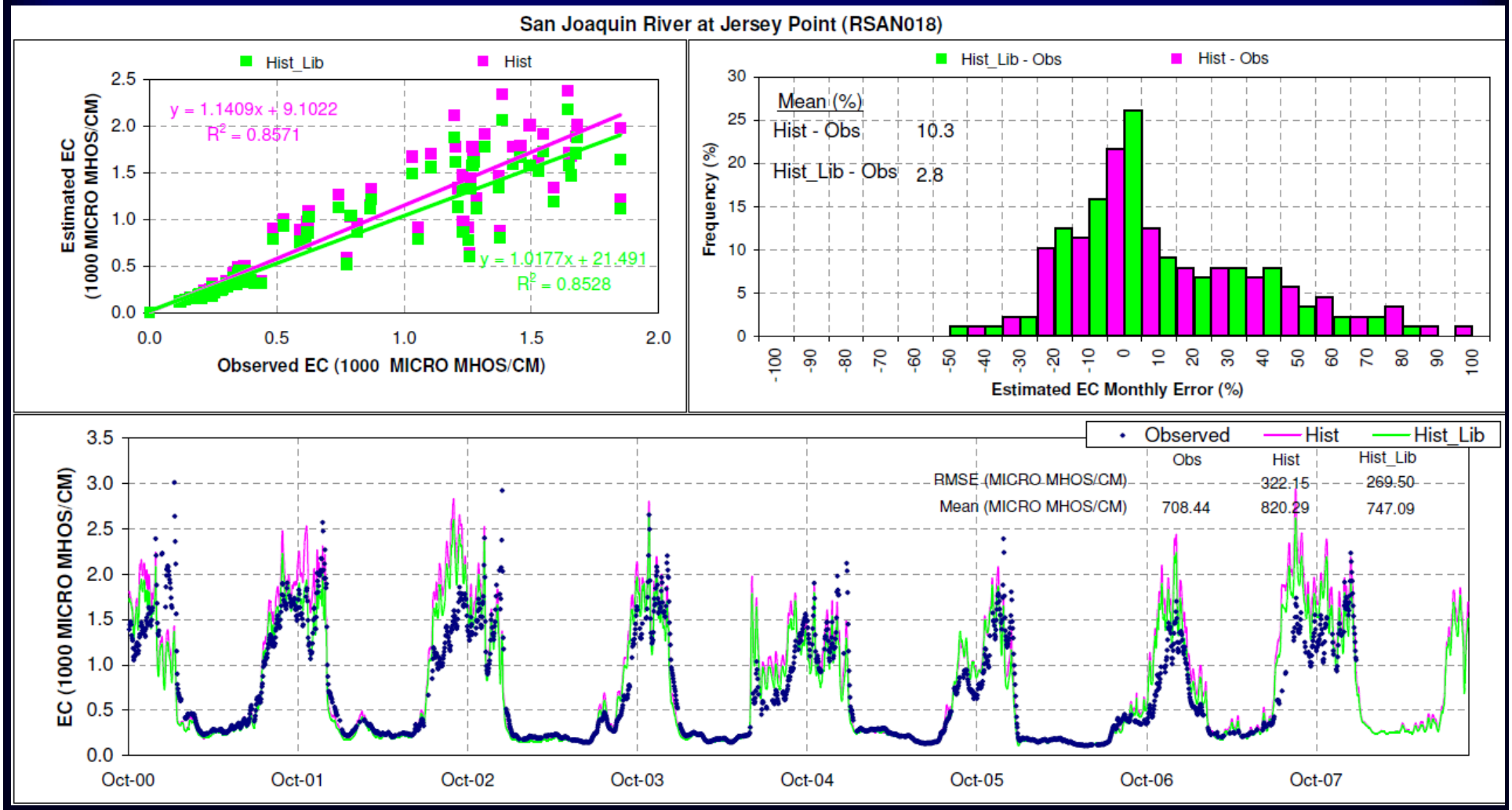
Sacramento River at Port Chicago



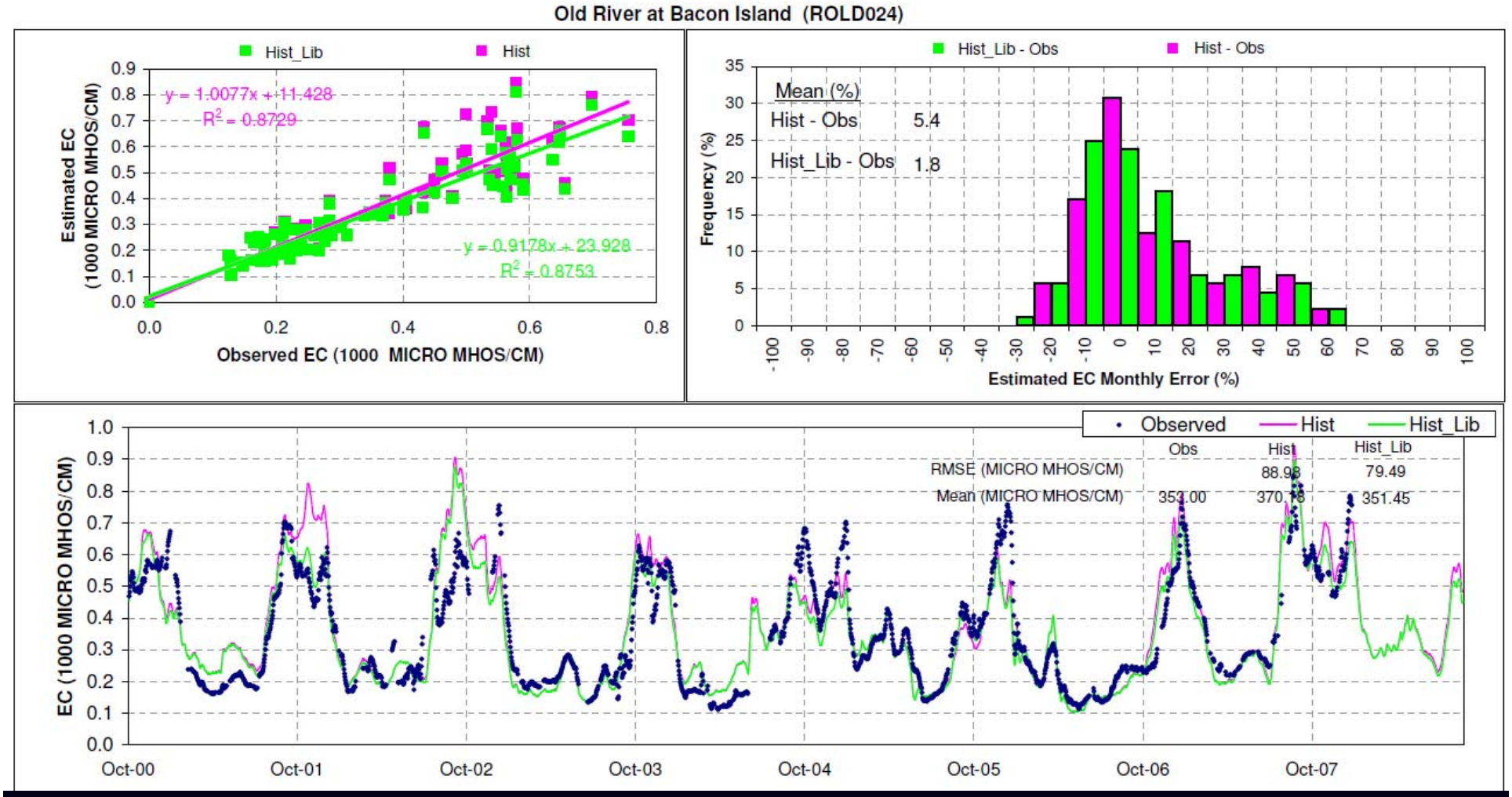
Sacramento River at Emmaton



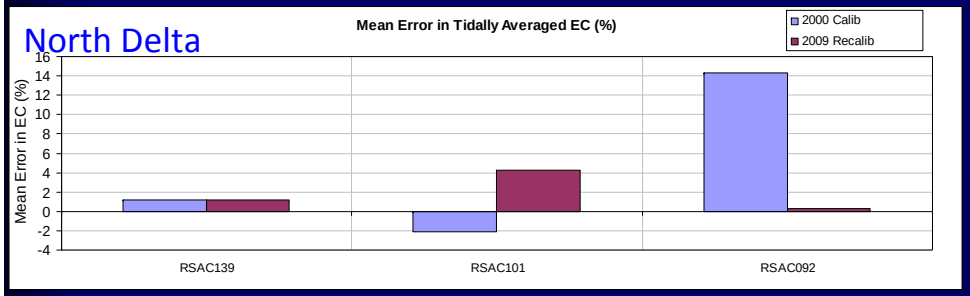
San Joaquin River at Jersey Point

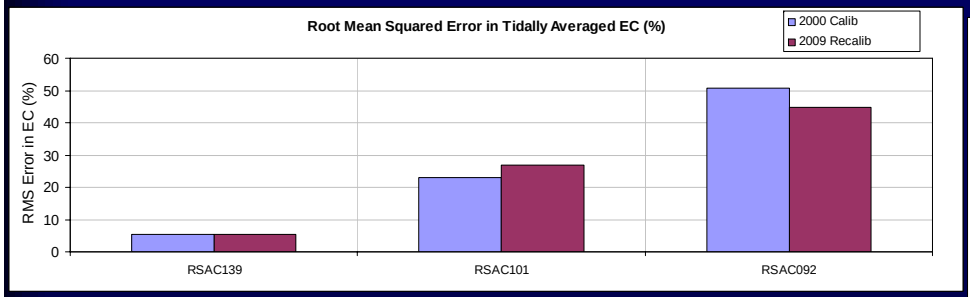


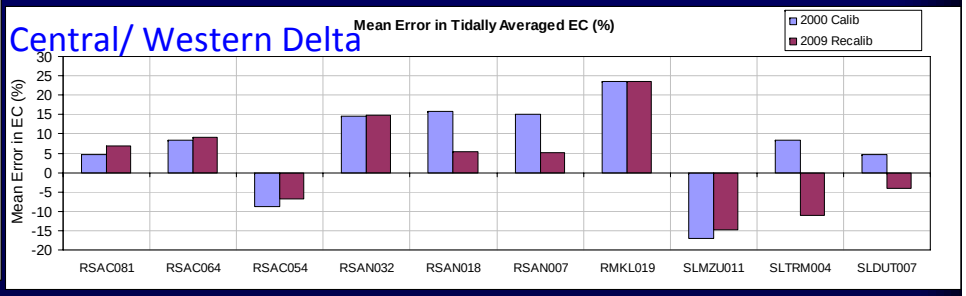
Old River at Bacon Island

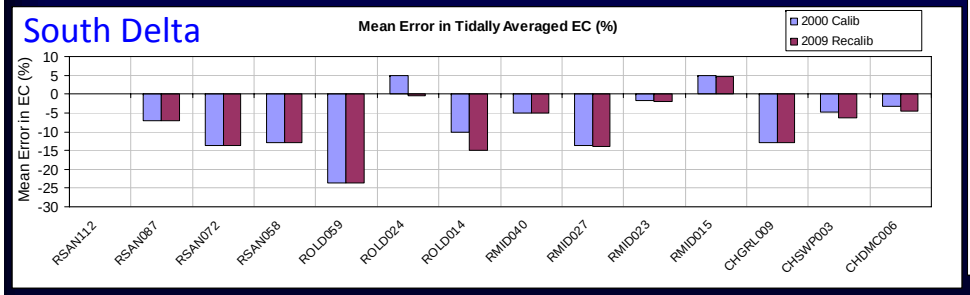


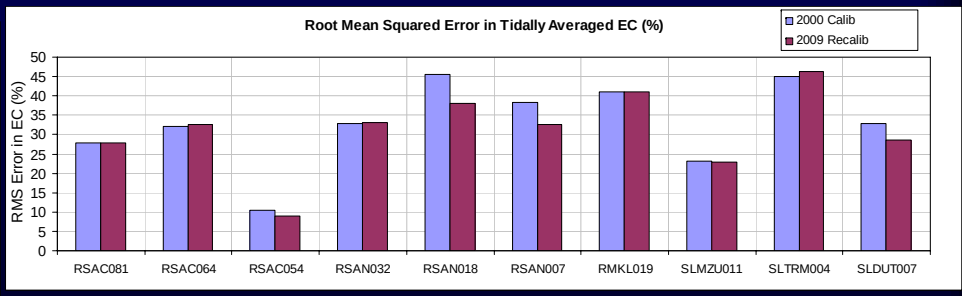
QUAL Calibration Summary

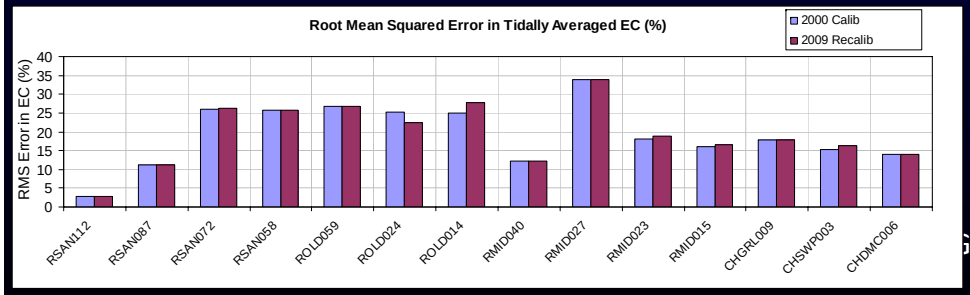




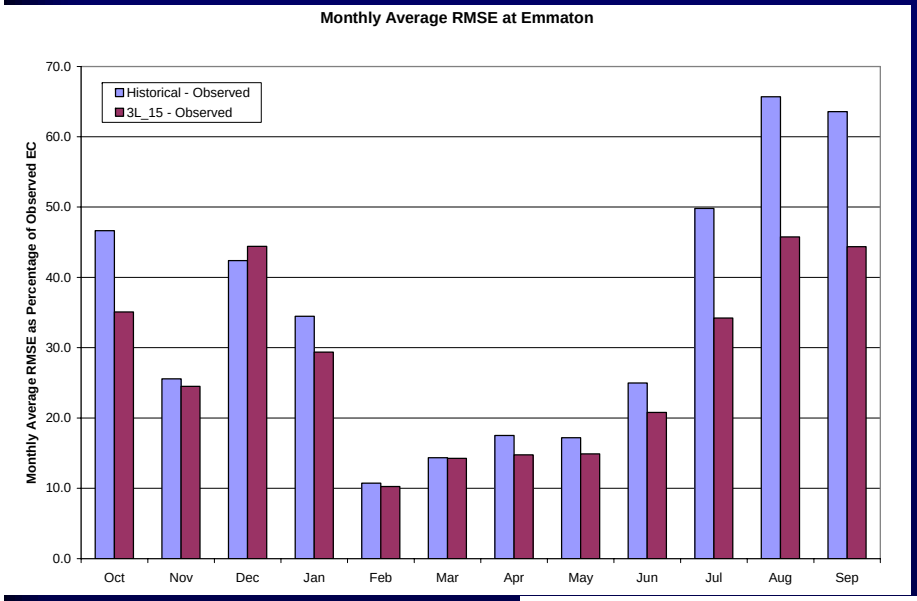


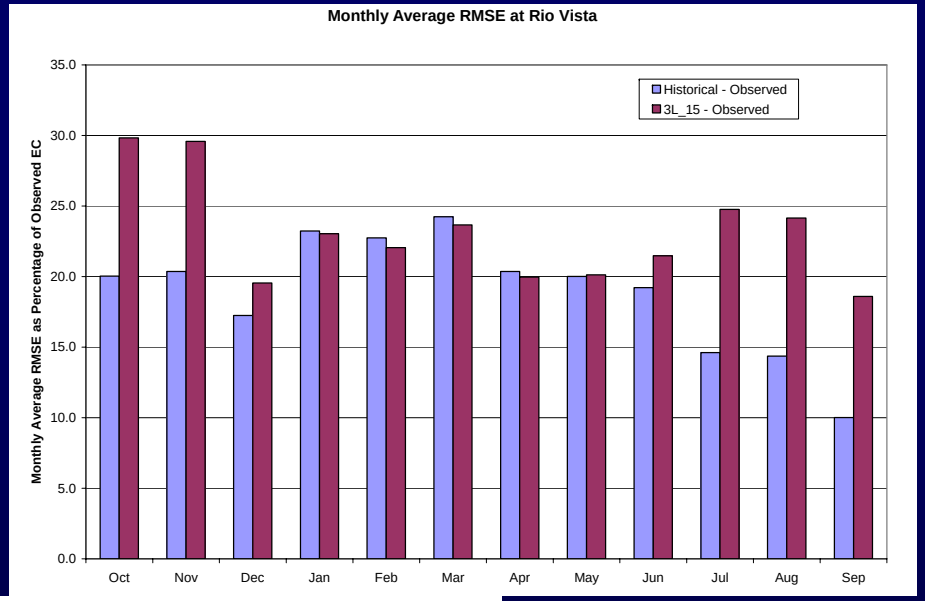


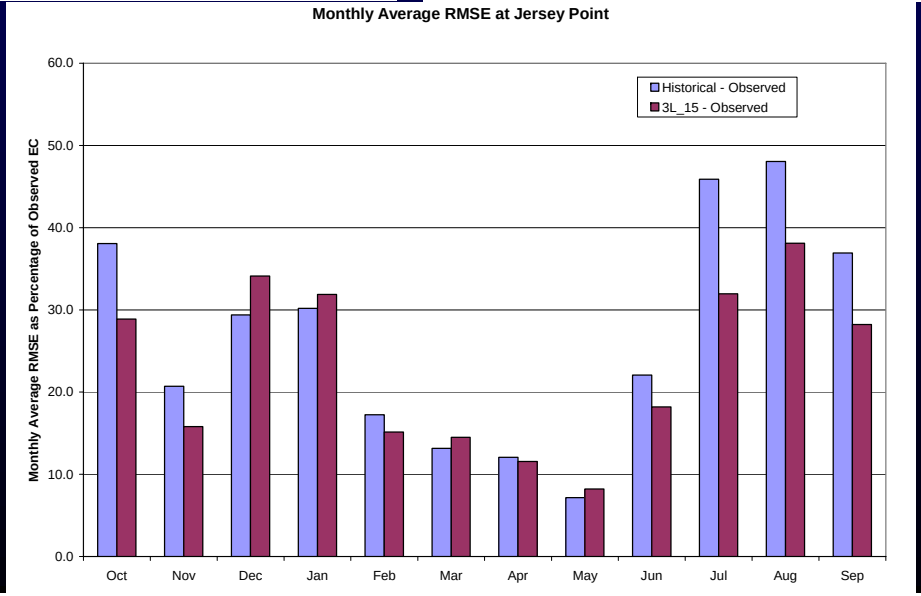




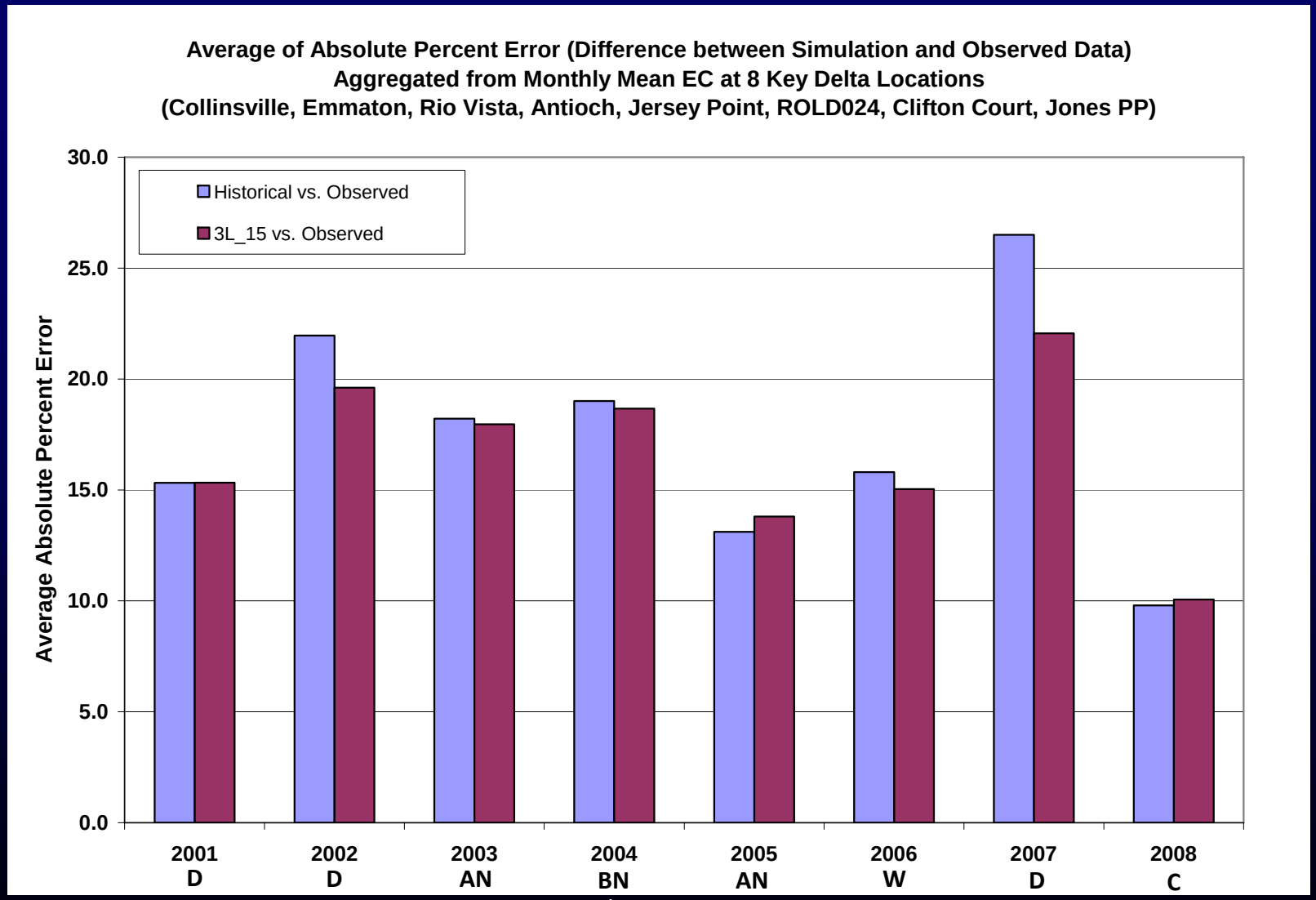
Monthly Average RMS Errors in EC







Model EC Performance by Water Year



Conclusions

- Inclusion of physical changes and modified parameters have resulted in improved calibration over the previous calibration (2000)
- North delta hydrodynamics are significantly improved
  - particularly for Rio Vista, Steamboat Slough, and Cross-Delta flows
  - Threemile Slough and Dutch Slough continue to be problematic
- EC calibration is also improved
  - particularly at Jersey, Emmaton, and Old River at Rock Slough
  - during summer and fall salinity intrusion months
  - in dry and critical years
- Delta island consumptive use and drainage continues to be an area of uncertainty

Recommendations

- One source of verified observed data with metadata is needed. Consistent corrections to the observed stage data are needed.
- Converting DSM2 bathymetry and other elevation inputs to NAVD88 will minimize the need for modifying observed data.
- Differences in the DSM2 historical model boundary conditions and the gage records indicate the need for documenting any changes made to gage records for use in DSM2 for future reference.
- There were indications that dispersion values are too high during periods of low flow and vice versa. The ability to use a variable dispersion coefficient may improve model predictions.
- The targeted adjustments of dispersion values to improve the calibration indicate that other factors such as DICU are controlling the errors. In future, it is recommended that the Delta agricultural diversion and drainage flow data be obtained from a more realistic model than DICU.
- Modifications to DSM2 should be considered to allow simple physical information such as (elevation vs. surface area) curves for the open water body and (elevation vs. cross-sectional area) lookup tables for the inlets to improve hydrodynamics in and around reservoirs.