THE WATER INSTITUTE
OF THE GULF

MODEL PERFORMANCE ASSESSMENT

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The Water Institute of the Gulf

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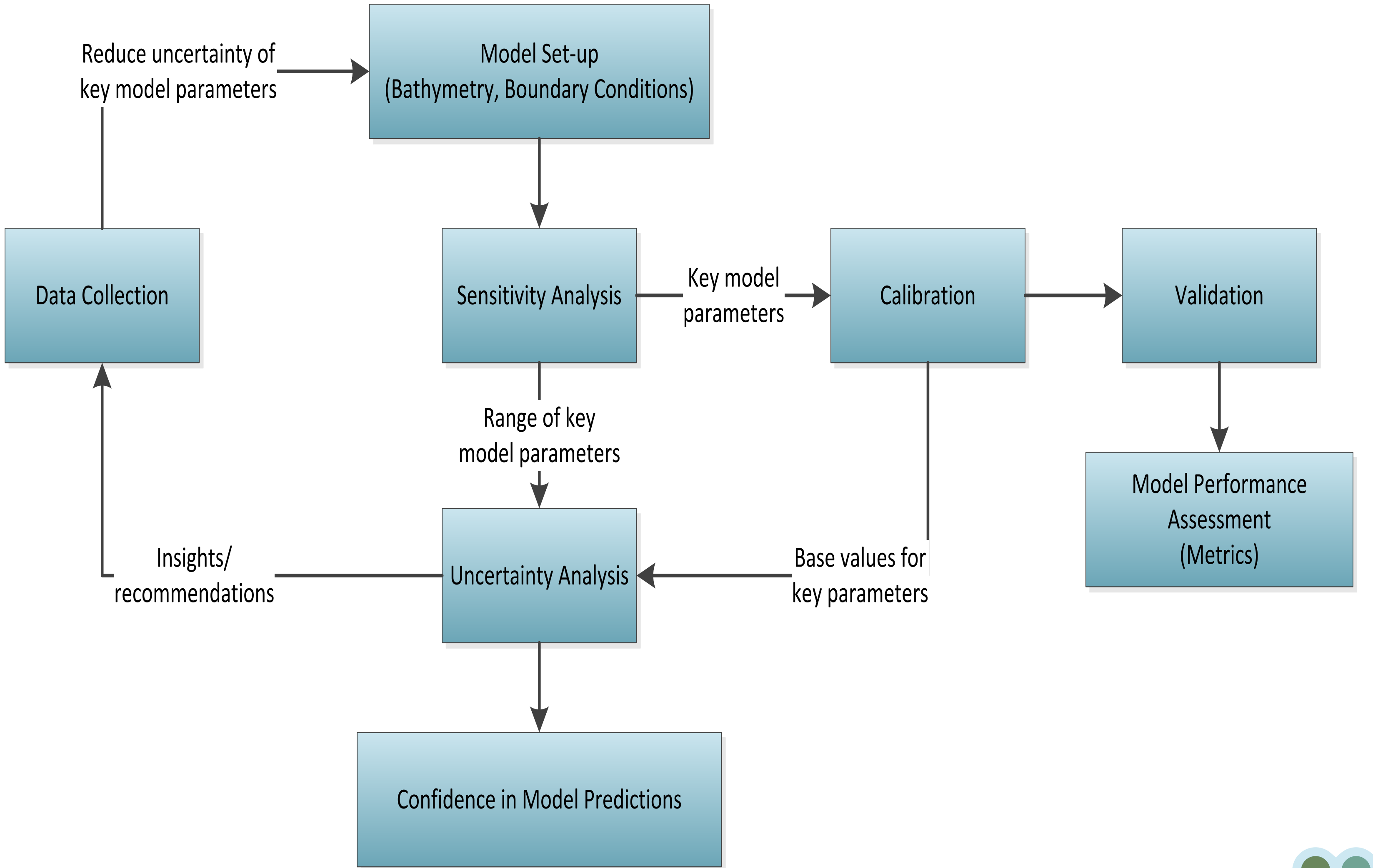
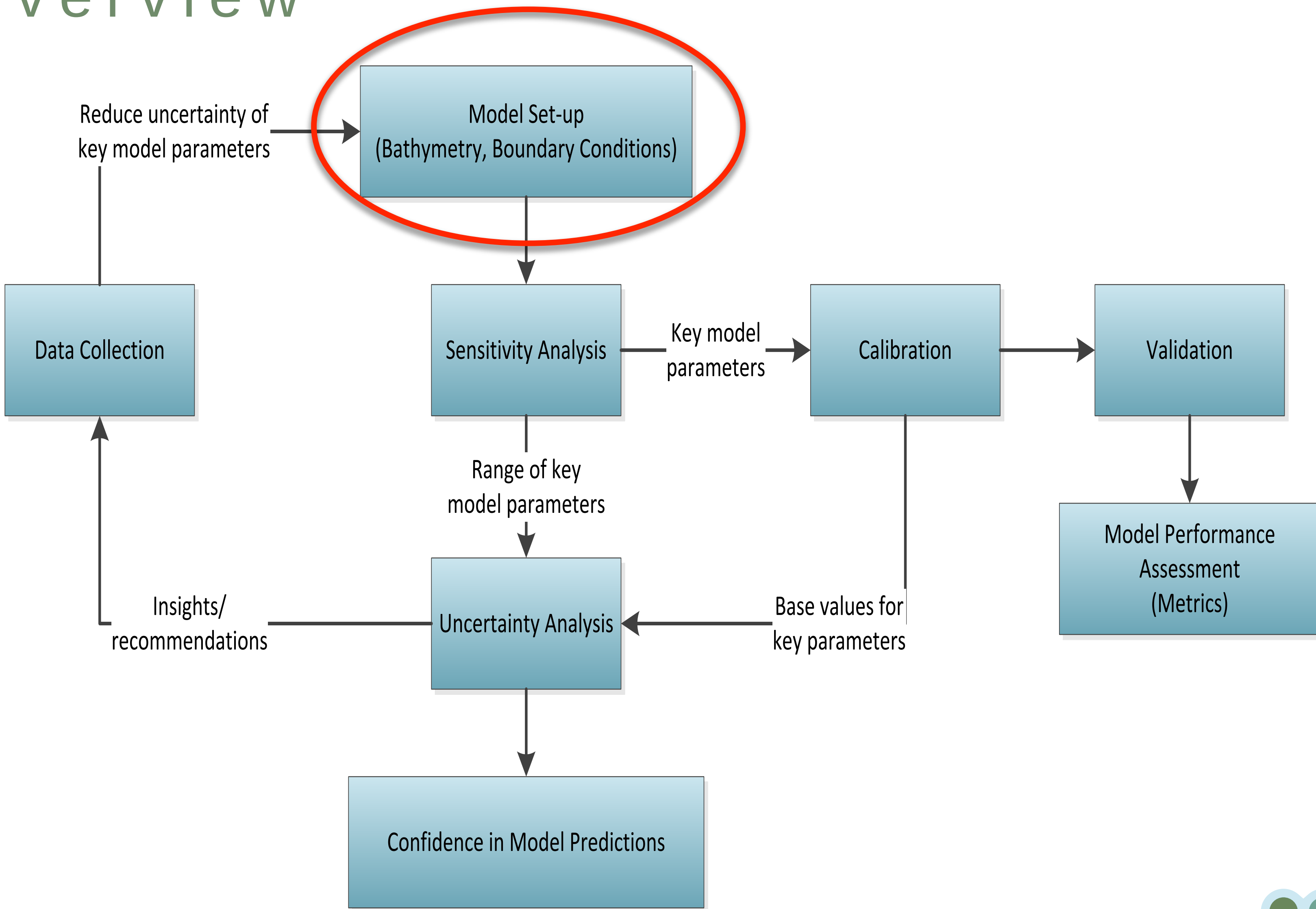
Performance Assessment Overview



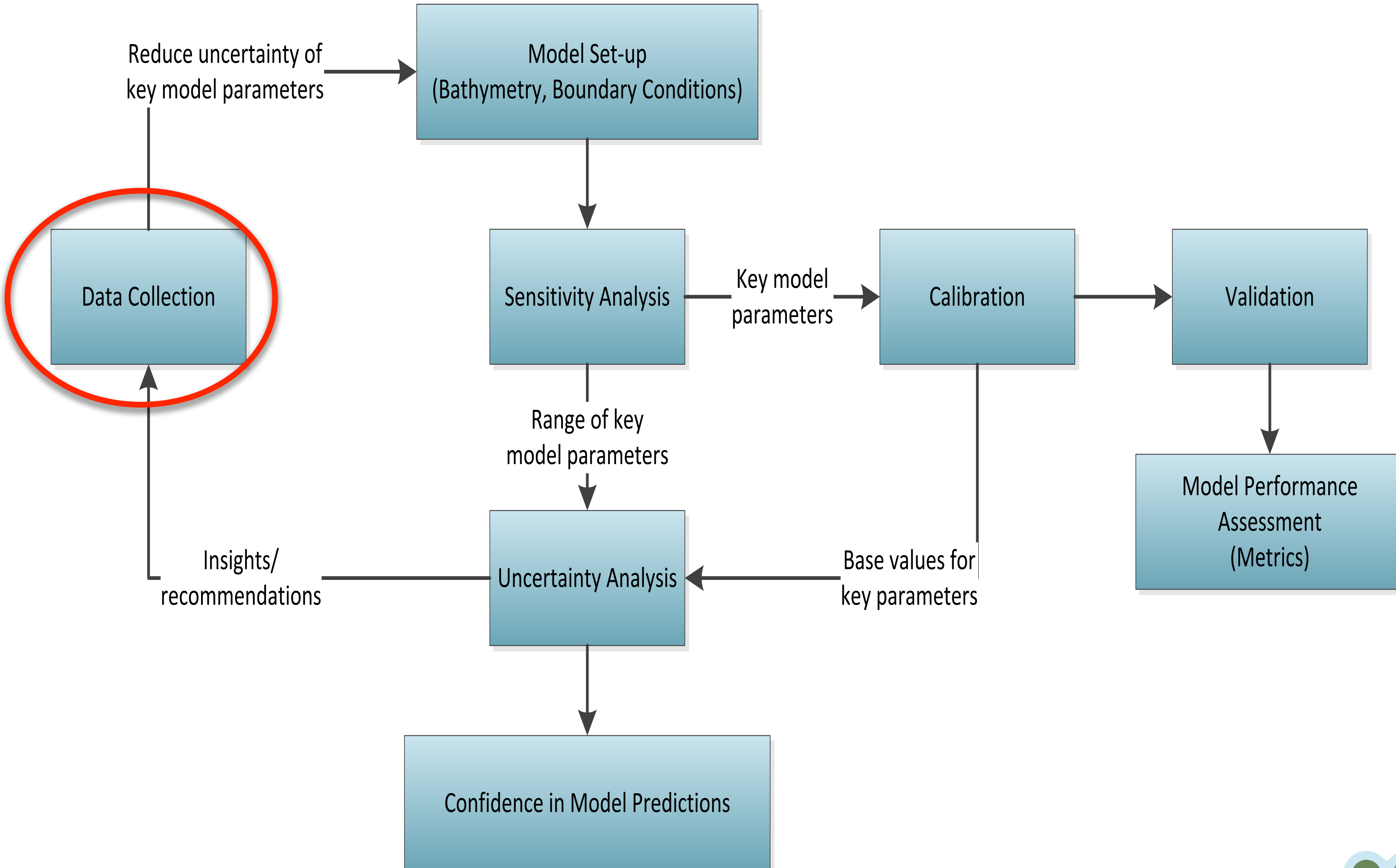
Performance Assessment Overview



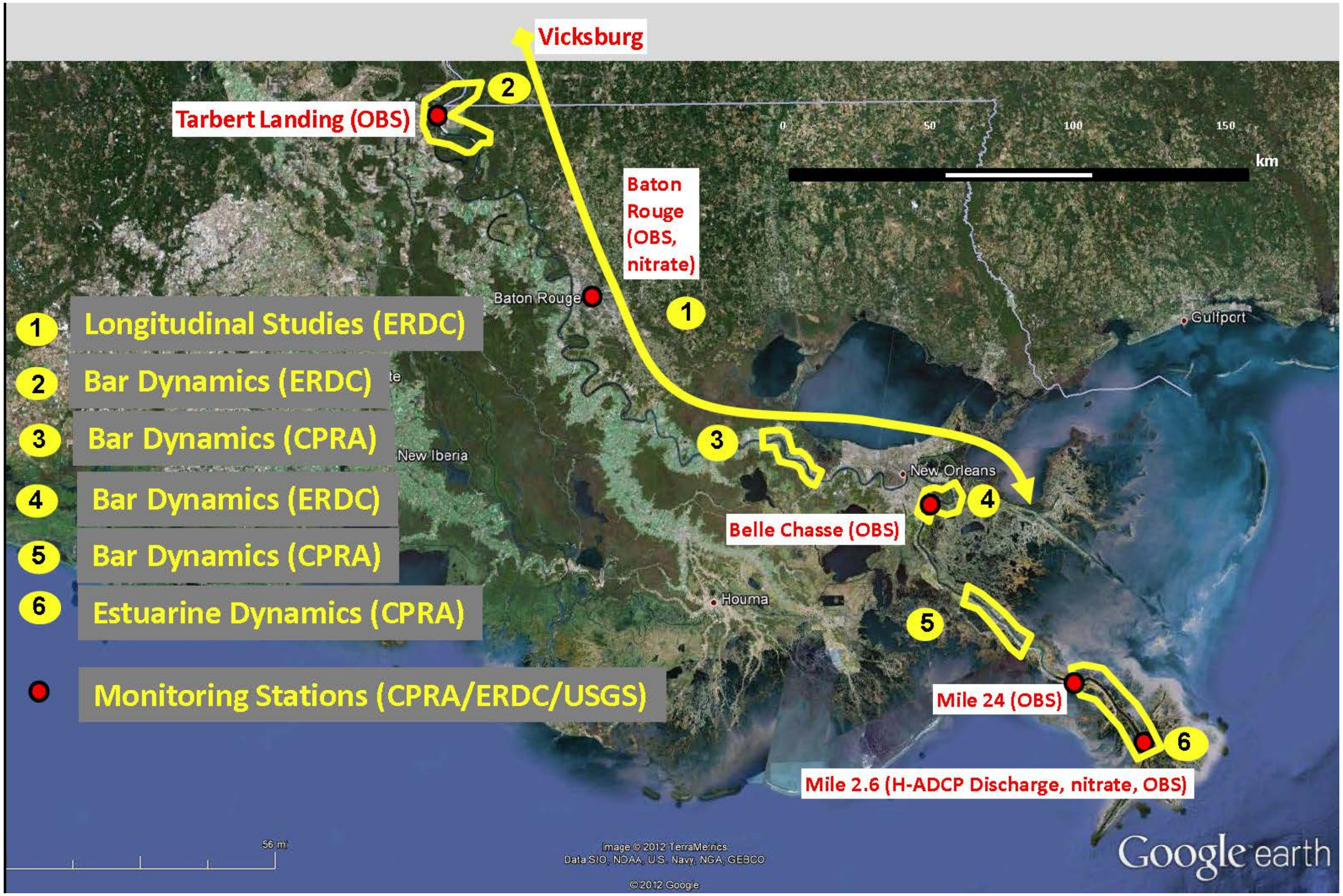
MODEL SETUP: CHALLENGES

- Spatial scales: meters to hundreds of kilometers
- Temporal scales: events (weeks) to decades
- Complexity of physical processes – examples:
  - Water losses through cuts and overbank
  - Riverine bed and suspended sediment material
  - Spatial pattern of relic material
  - Continuous sediment measurements versus rating curves (rising/falling limbs; multi events)
  - Basin side substrate characterization
  - Basin side nutrient dynamics and fisheries

Performance Assessment Overview



MRHDMS Data Collection Study Design



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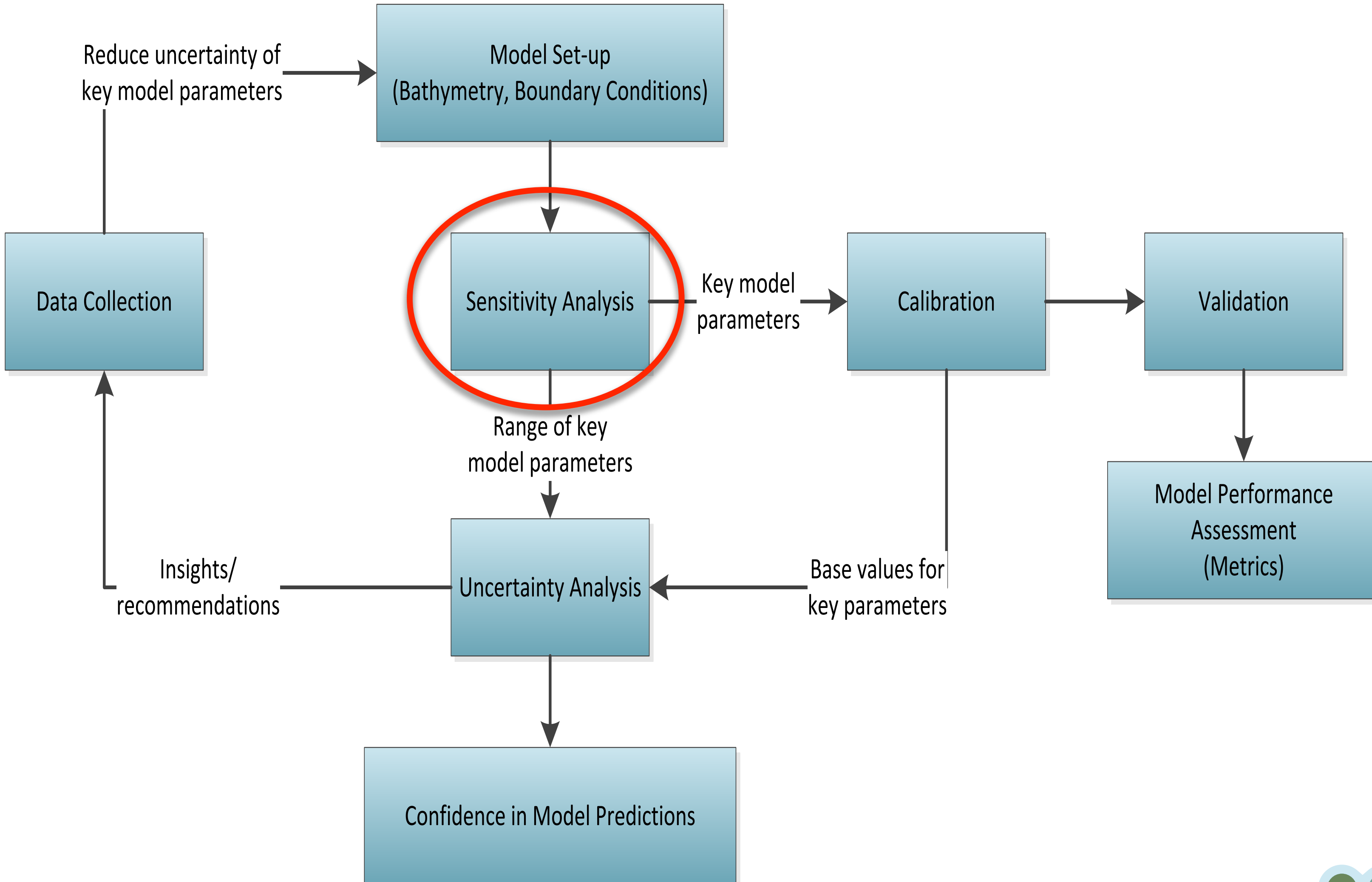
USGS science for a changing world

FENSTERMAKER

MODEL SETUP: PROGRESS

- Extensive data collection program to address:
  - High resolution bathymetry
  - Bed material characteristics
  - Bed and suspended sediment loads
  - Water losses through cuts and overbank
  - Stations for stage, Qw, turbidity, nutrients
  - Basin side substrate characterization
- Spatial/Temporal scales: multi models approach

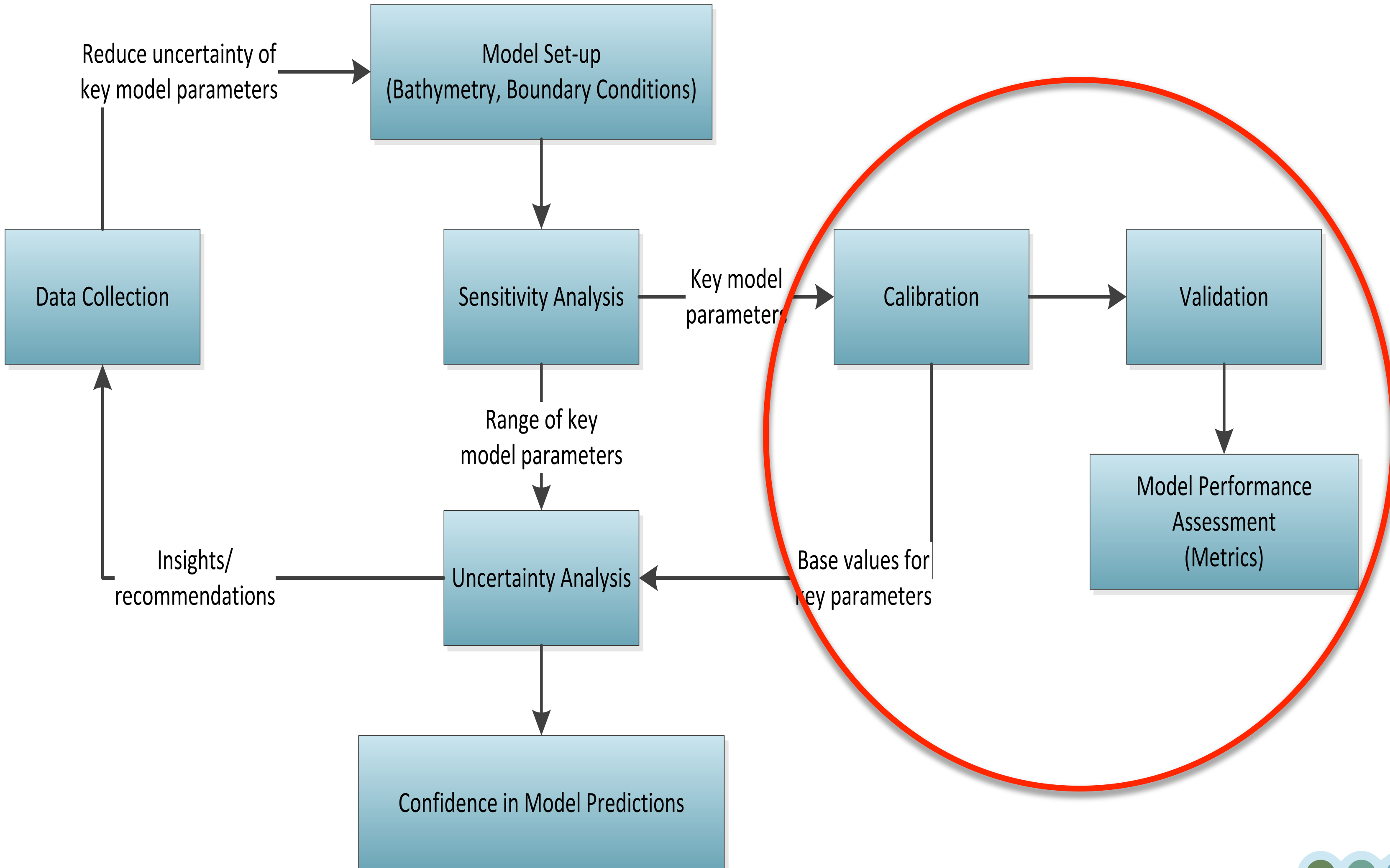
Performance Assessment Overview



SENSITIVITY ANALYSIS

- Environmental Parameters
  - Sea level change
  - Subsidence
  - Water discharge
  - Sediment concentration
  - Nutrients concentration
  - Precipitation/ET
- Model Parameters

Performance Assessment Overview



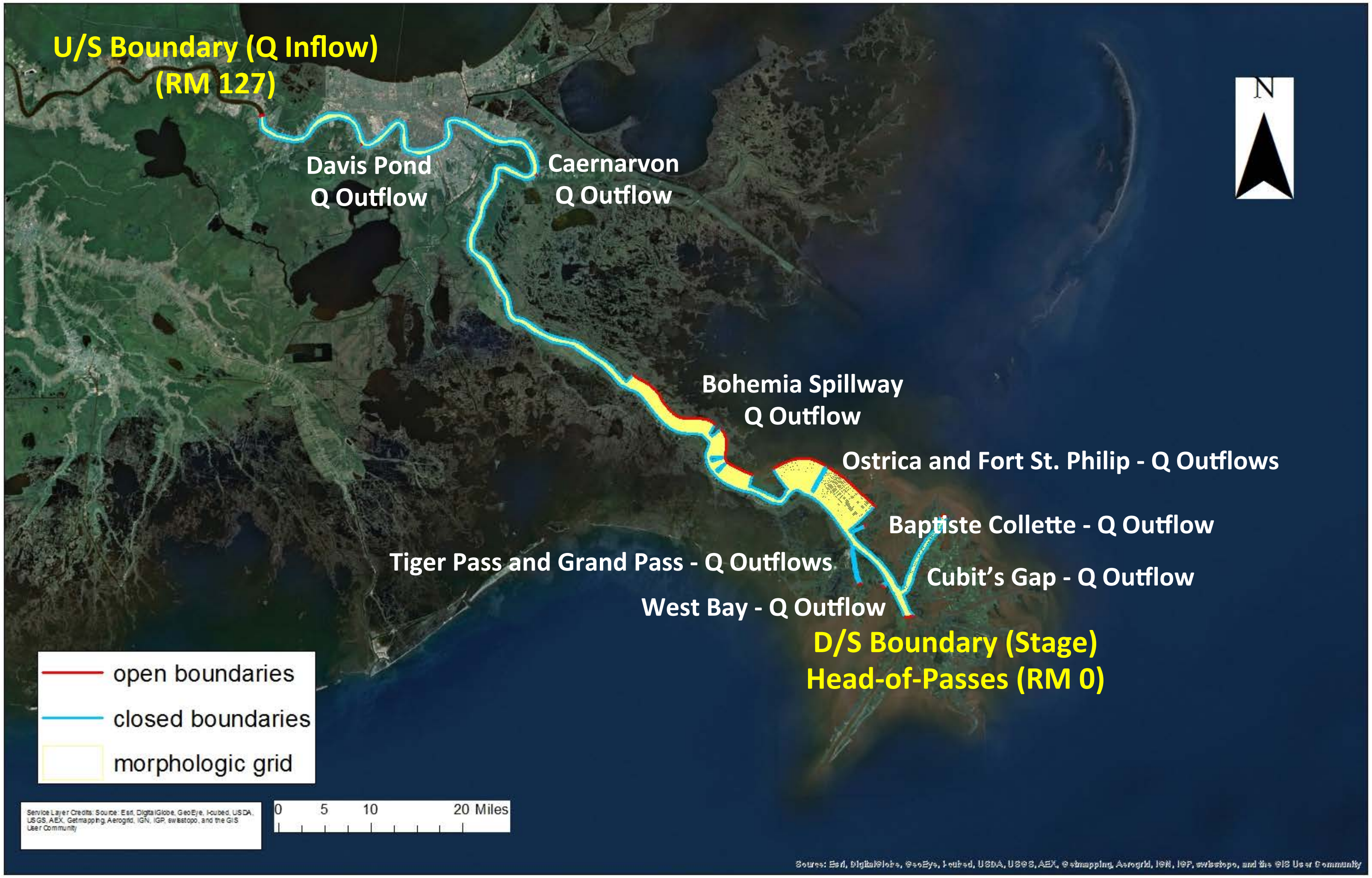
PERFORMANCE METRICS

- Statistics used in the evaluation; e.g. RMSE, Correlation Coefficient, Bias, etc.

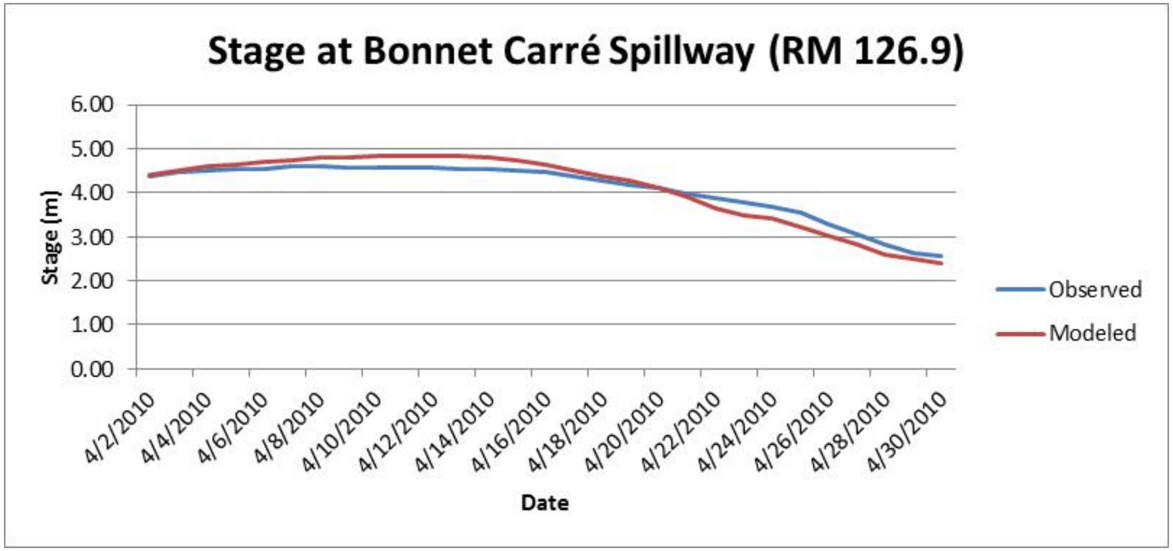
- These statistical tools are guidelines; not pass/fail test

- Identify areas of potential weaknesses and explore strategies to improver performance

Mississippi River Regional Model
Model Domain – Boundaries



Hydrodynamics - Stage



USACE STATIONS:

Bonnet Carre Spillway (RM 127)

New Orleans (RM 103)

IHNC Lock (RM 23)

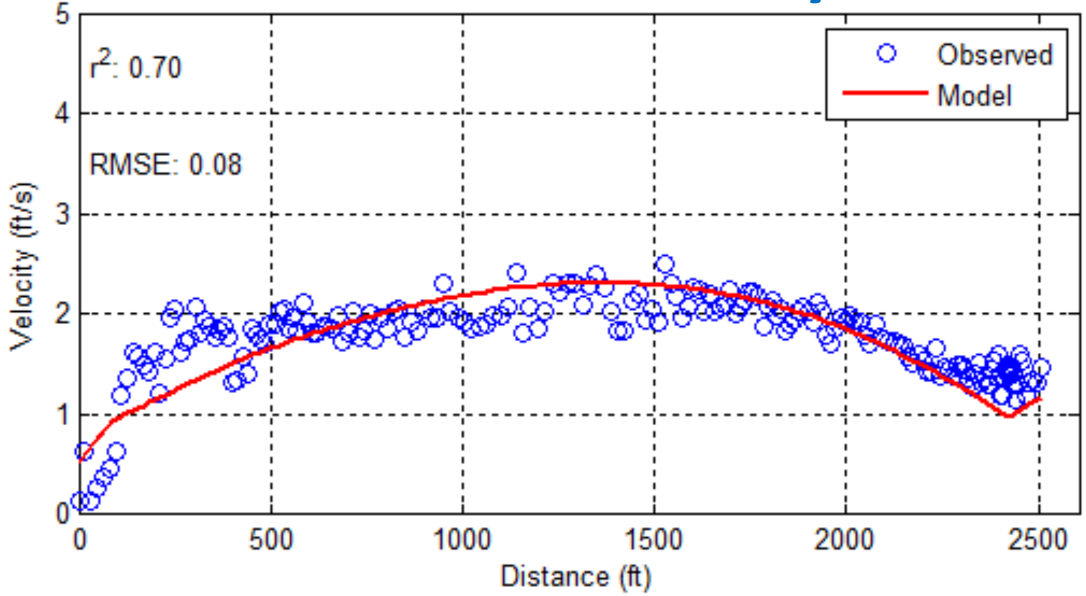
West Pointe A La Hache (RM 49)

Venice (RM 11)

All Stations	March/April 2011	May 2011	May 2009
RMSE (ft)	0.520	0.378	0.470
Bias (ft)	0.225	0.284	-0.220
Efficiency	0.989	0.996	0.992

Hydrodynamics - Velocity Profiles

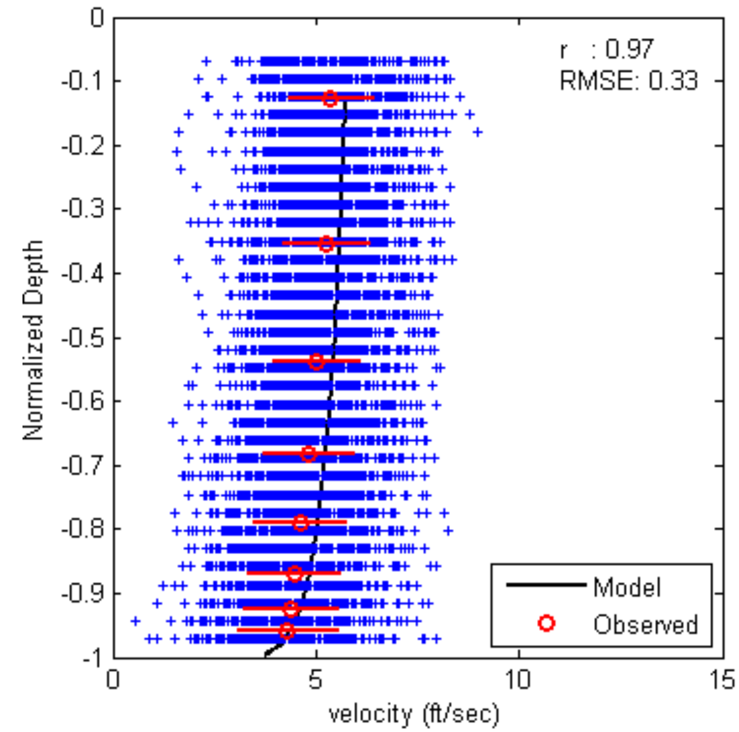
Transect Velocity



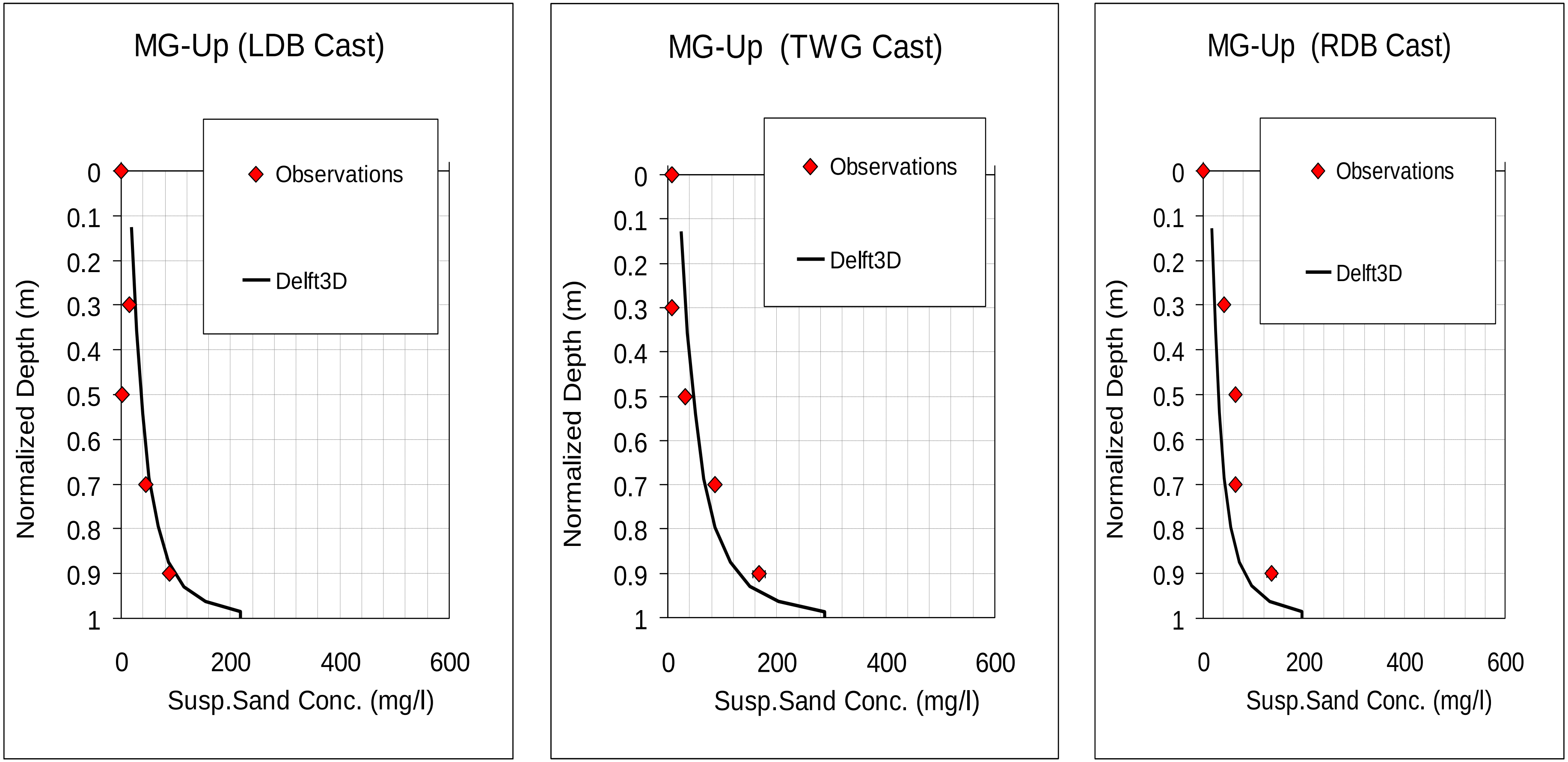
September 21st, 2009
Transect Velocity Profile, RM 31

Vertical Velocity

April 13th, 2010
Vertical Velocity Profile, RM 46

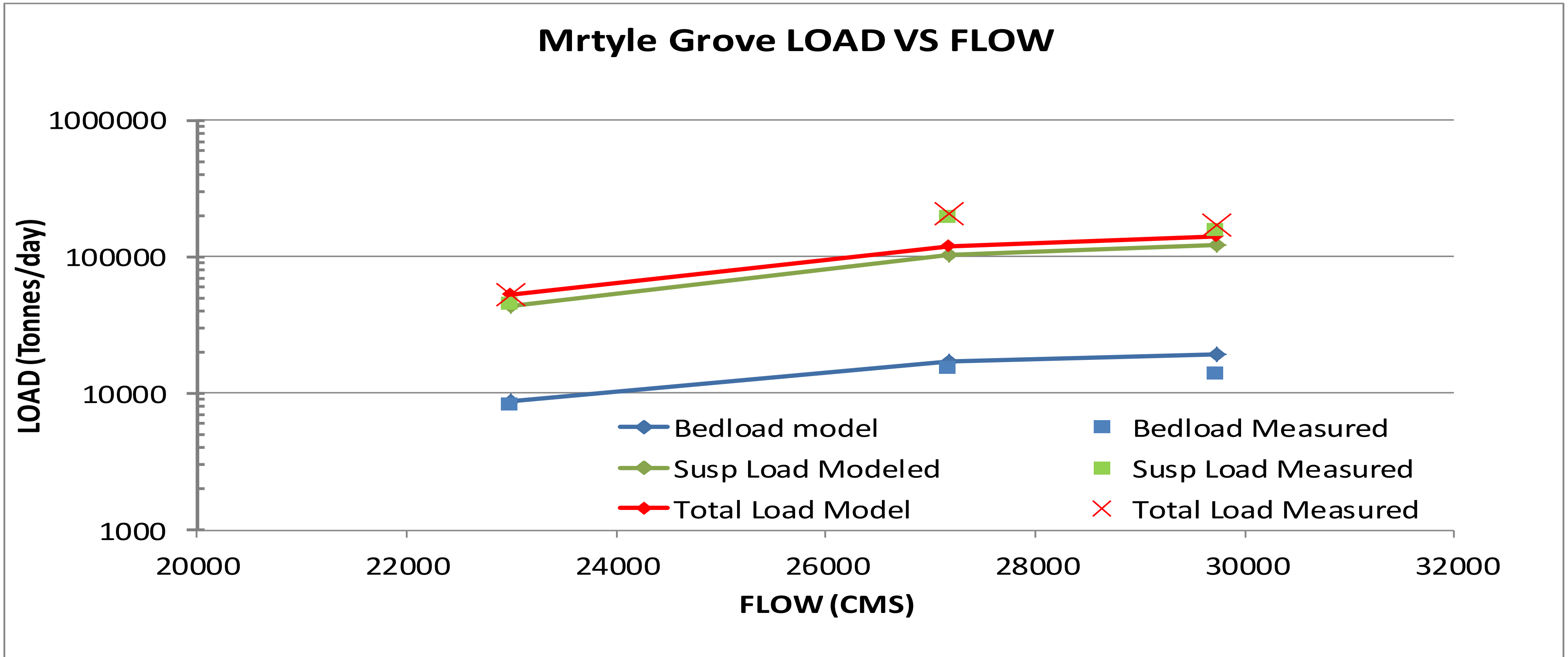


Sand Transport – Suspended Concentrations



Myrtle Grove, RM 61
May 2011

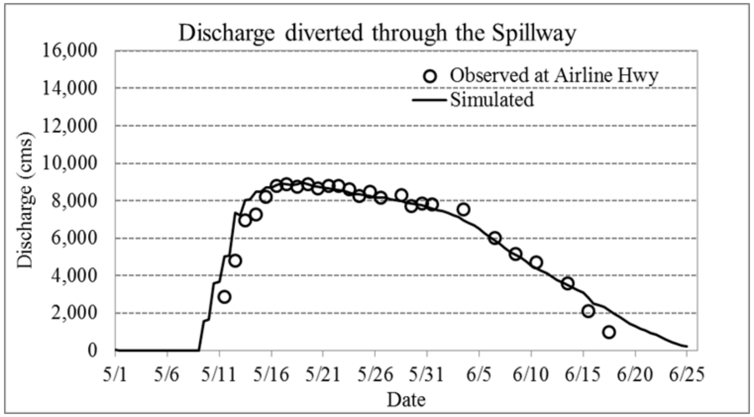
Sand Transport – Loads

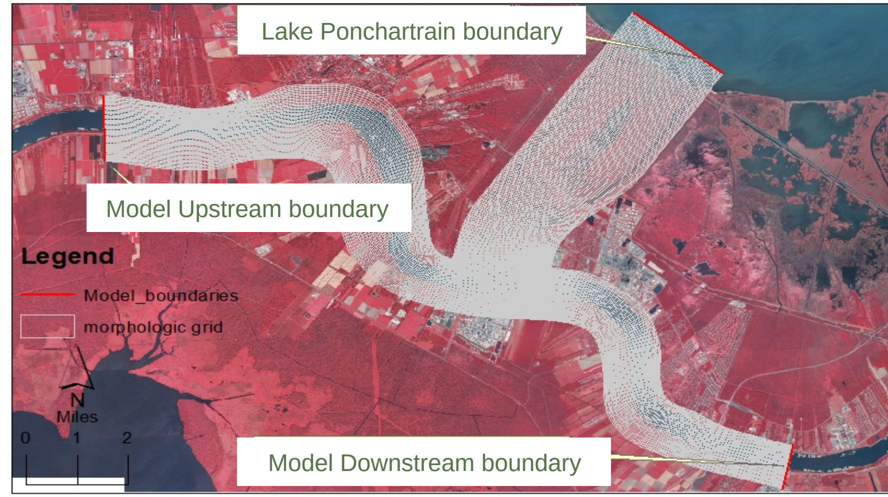


Period	Site	Model Total Load (tonnes/d)	Measured Total Load (tonnes/d)
March/April, 2011	Myrtle Grove (RM 61)	**217,063**	**199,533**
	Magnolia (RM 47)	**199,628**	**190,874**
April, 2010	Myrtle Grove (RM 61)	**110,938**	**44,977**
	Magnolia (RM 47)	**102,445**	**45,272**
May, 2011	Myrtle Grove (RM 61)	**151,400**	**168,700**
	Magnolia (RM 47)	**175,000**	**150,500**

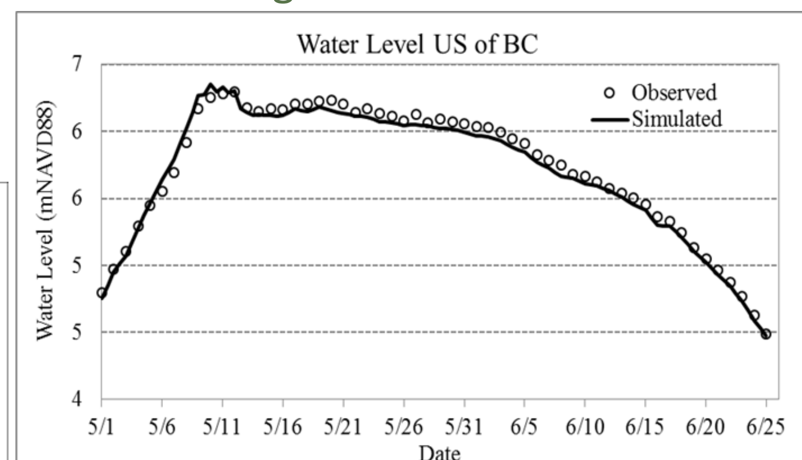
Bonnet Carre Model
(Delft3D)

Discharge Calibration



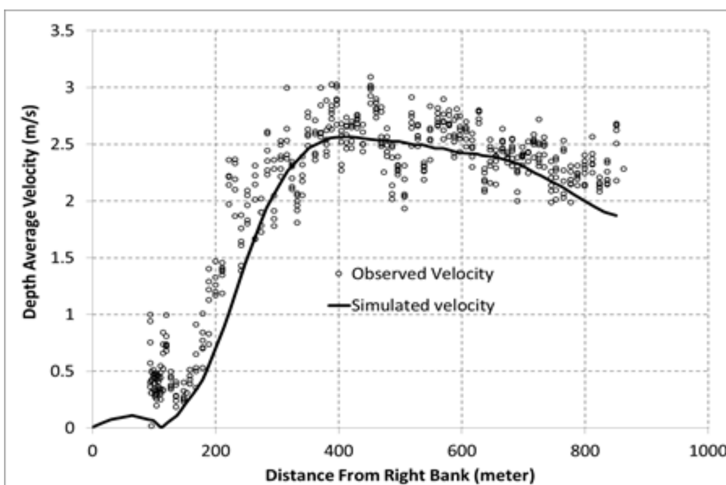


Stage Calibration at RM 129

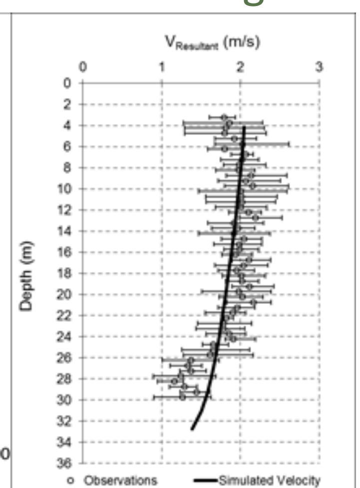


Velocity Calibration at RM 128

Depth Average

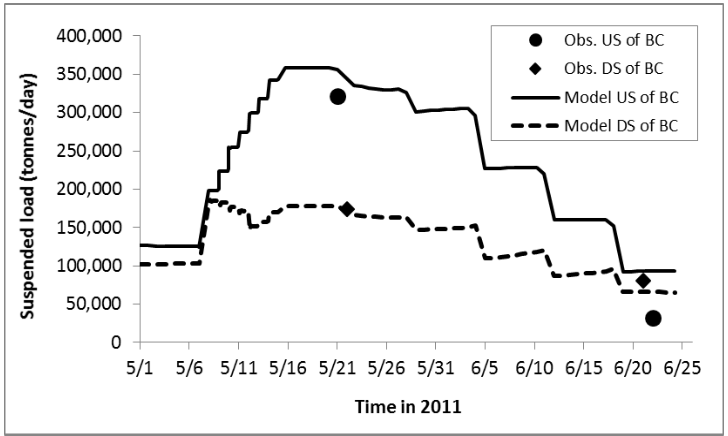


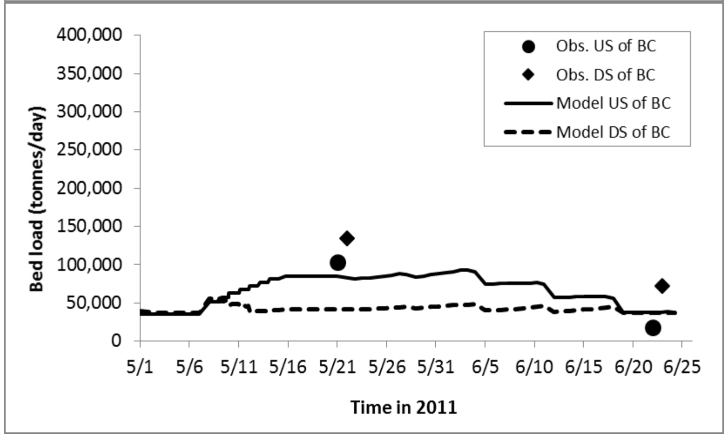
Thalweg



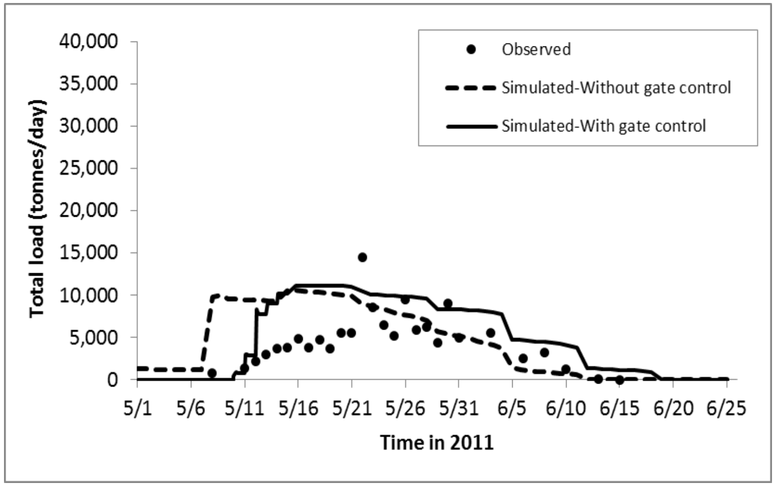
Bonnet Carre Model (Contd.)

Sediment Load Calibration in the River

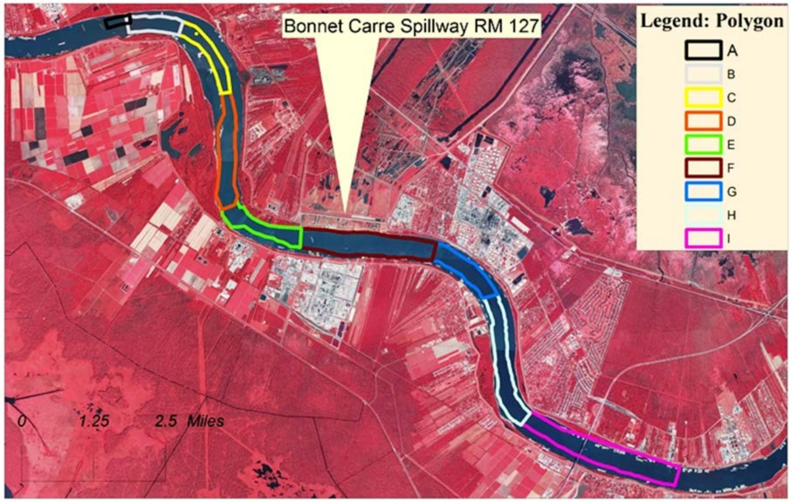


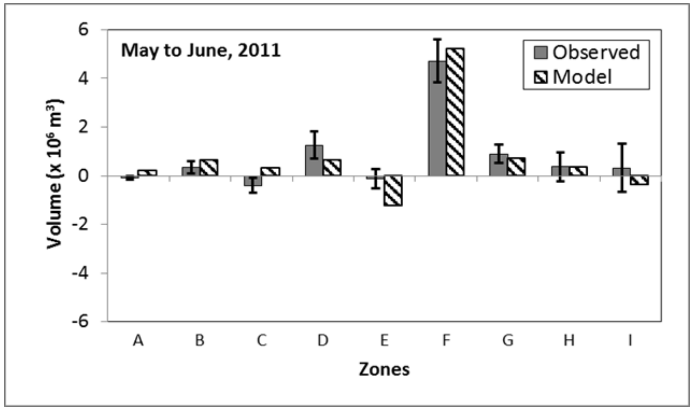


Sediment Calibration at Airline Hwy



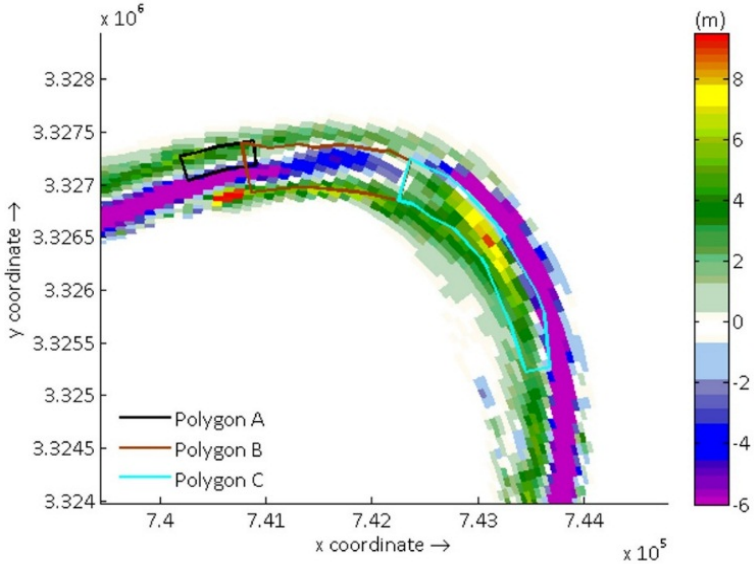
Erosion and Deposition Volume in the 2011 Flood

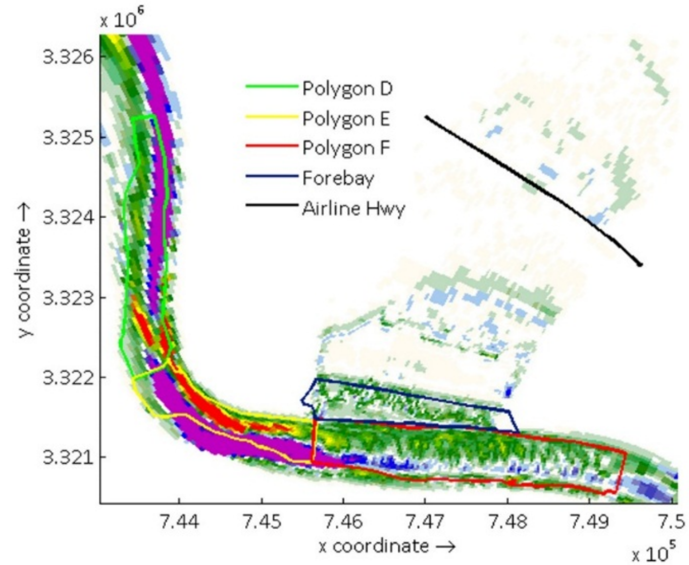


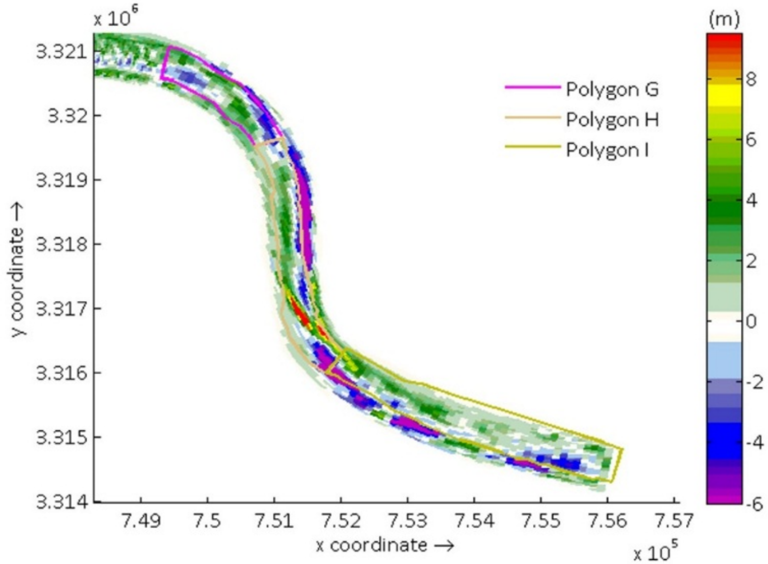


Bonnet Carre Model (Contd.)

Erosion and Deposition Pattern during May-June 2011



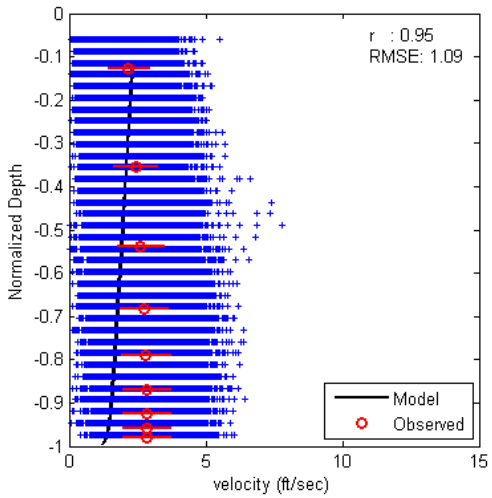




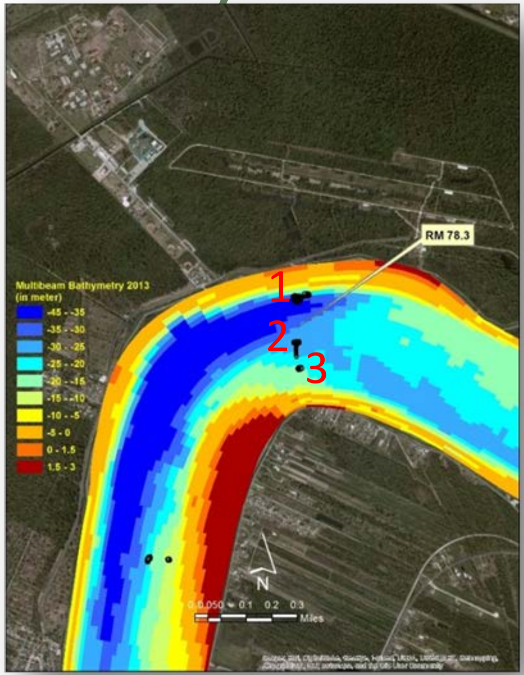
Sediment Budget during May-June 2011

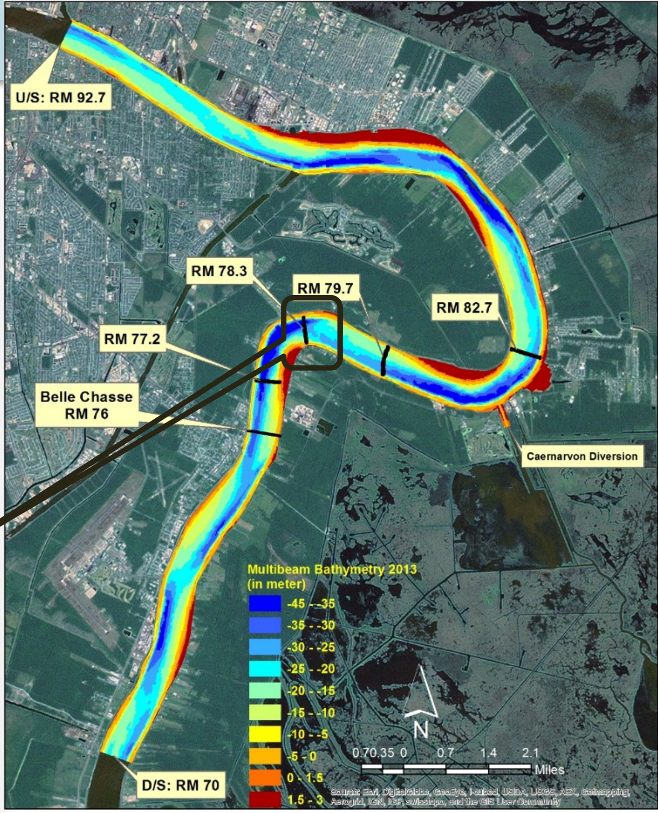
UPPER BRETON SOUND (UBS)

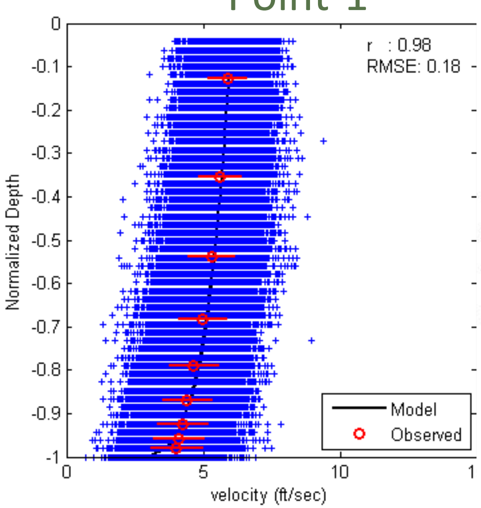
Model (Delft3D)



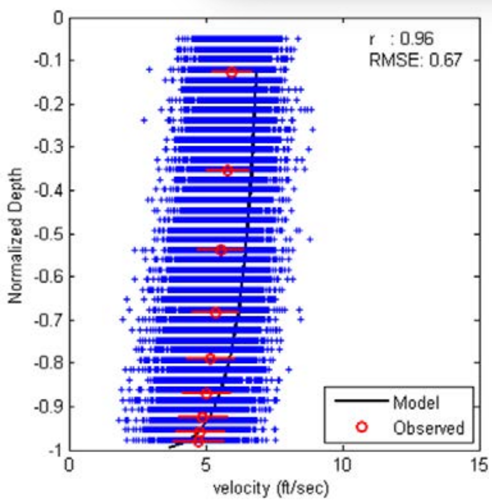
Point-1



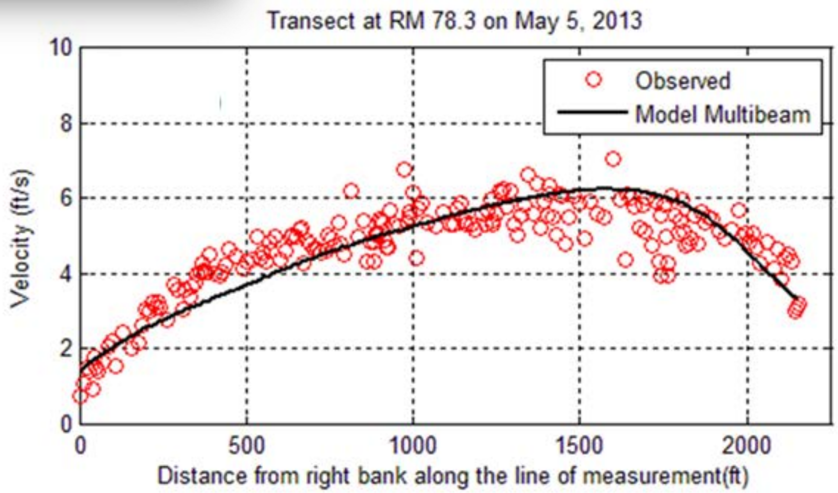




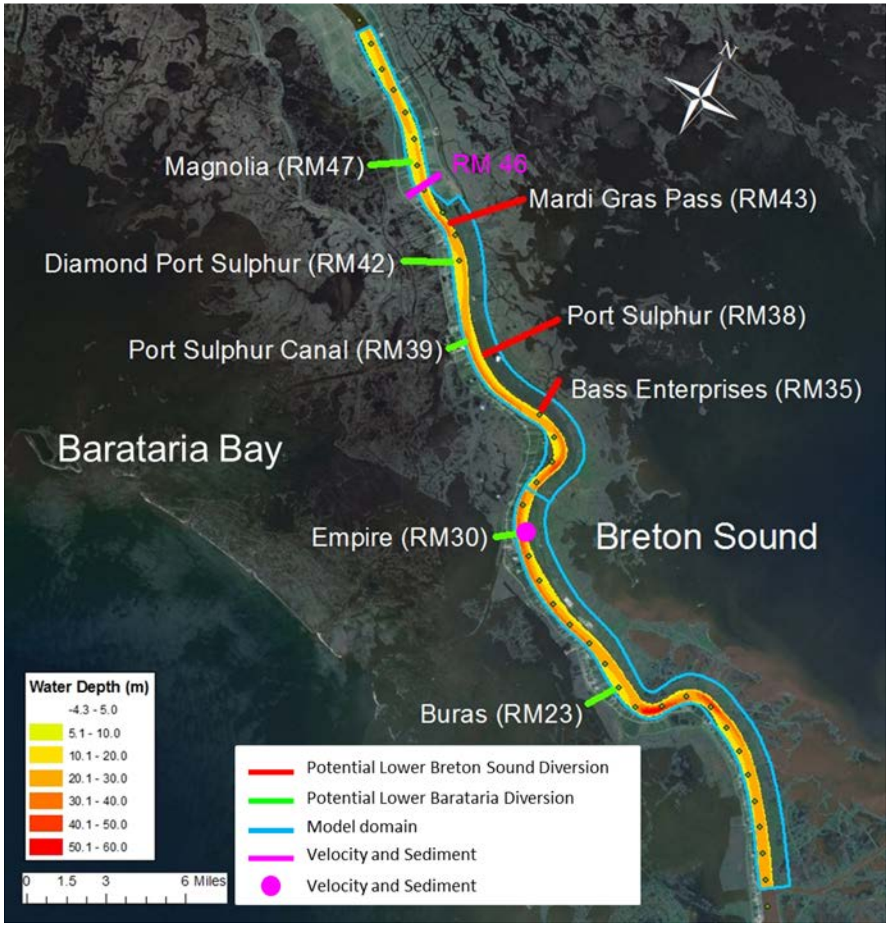
Point-2



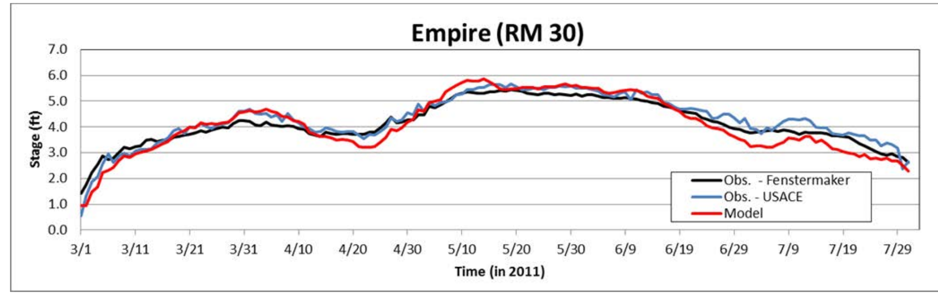
Point-3



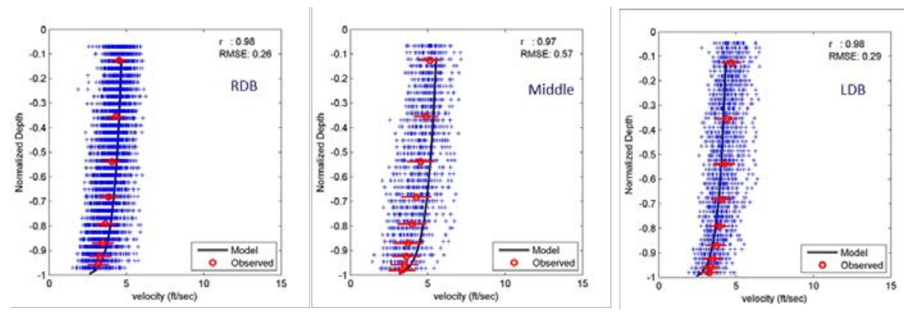
Lower Barataria/Breton Sound



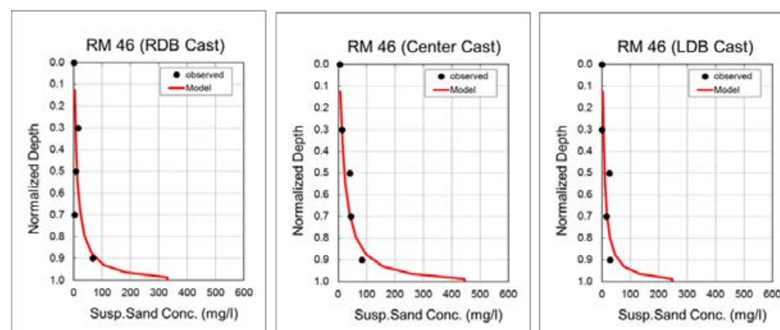
Model Domain



Water stage comparison at Empire (RM 30)

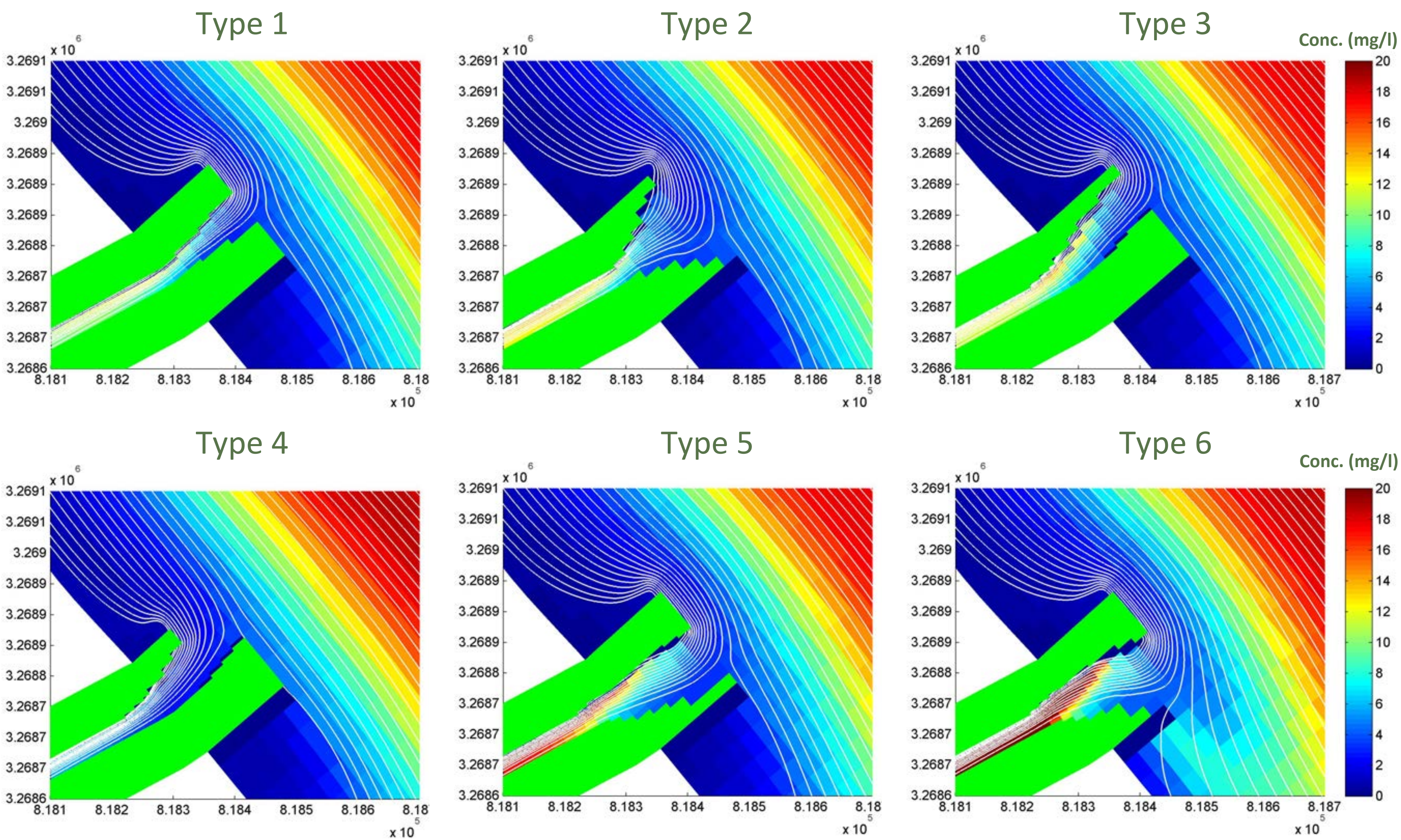


Vertical velocity profile comparison (RM 46)



Vertical sand concentration comparison (RM 46)

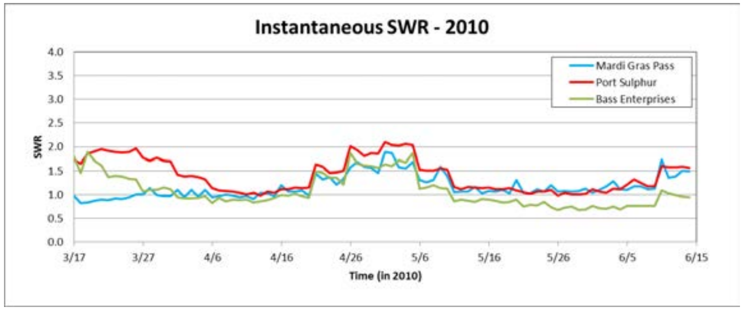
Streamlines and Surface Concentration for 6 different Intake types at Diamond Port Sulphur

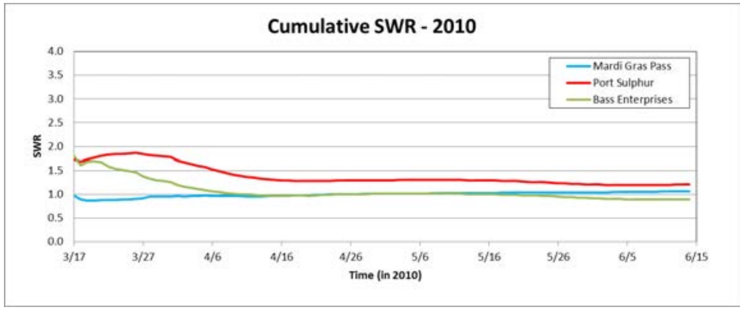


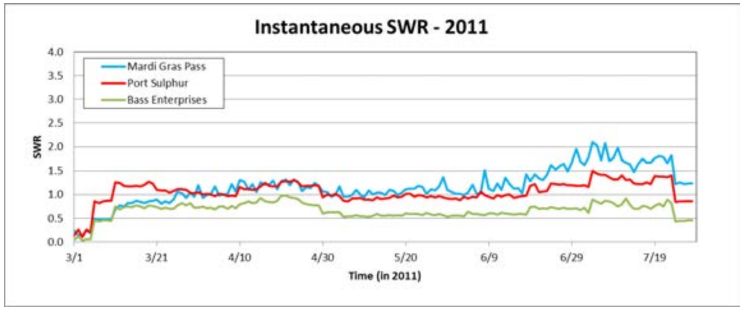
Lower Barataria/Breton Sound

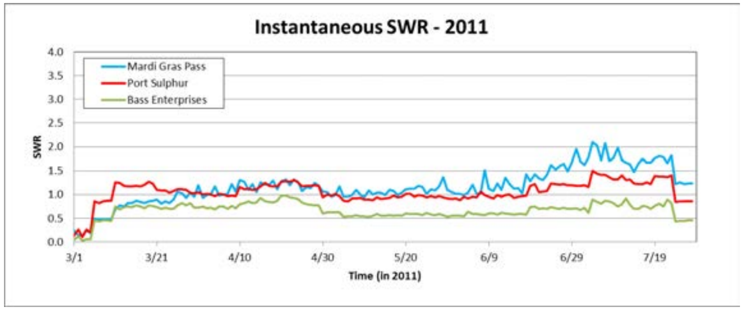
Event Simulation Runs

Lower Breton Sound

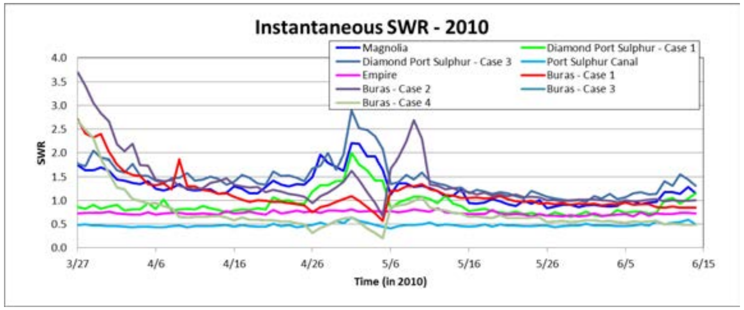


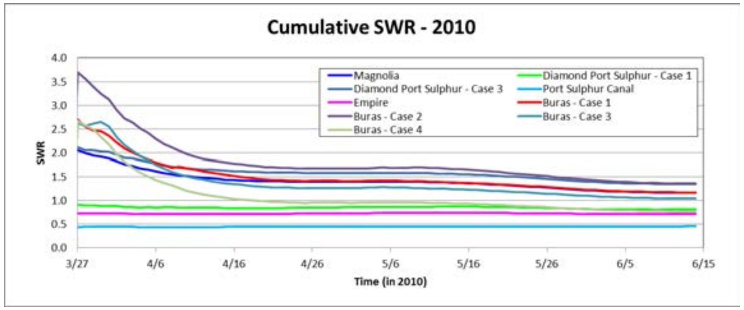


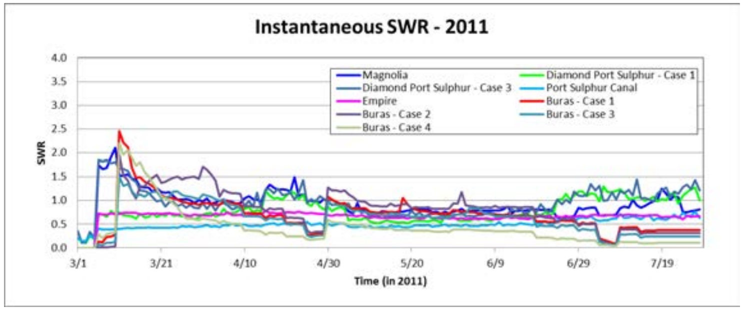


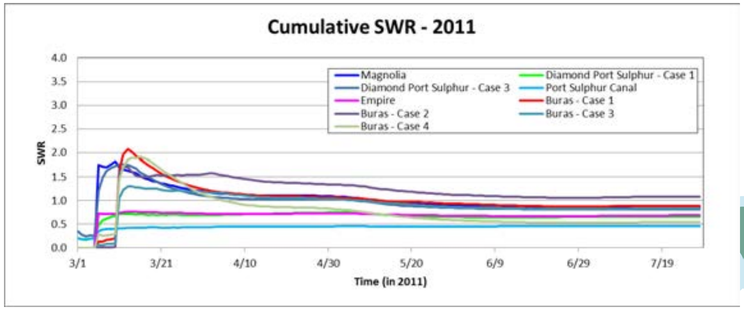


Lower Barataria

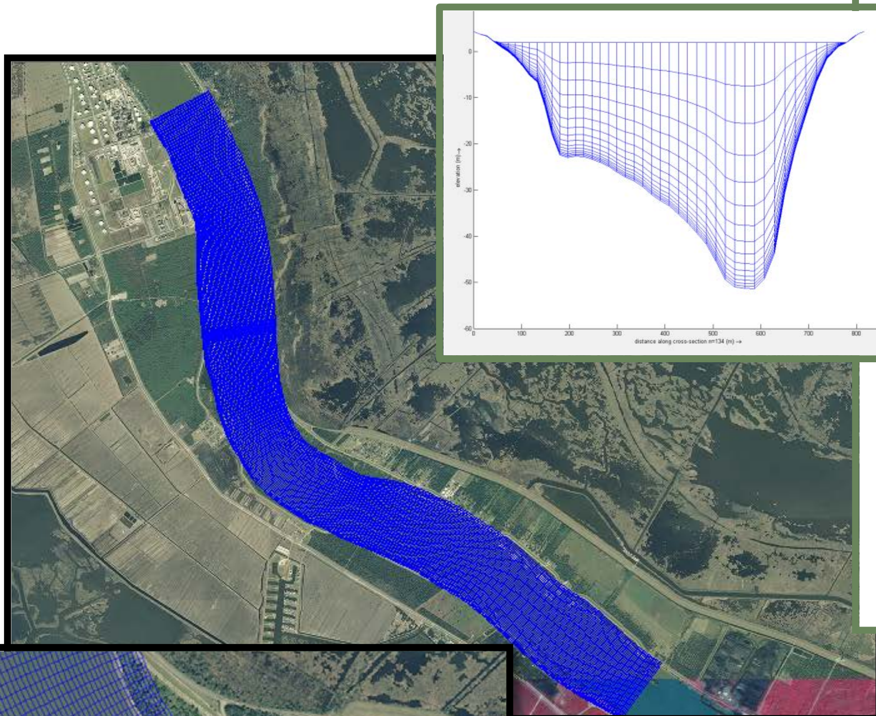


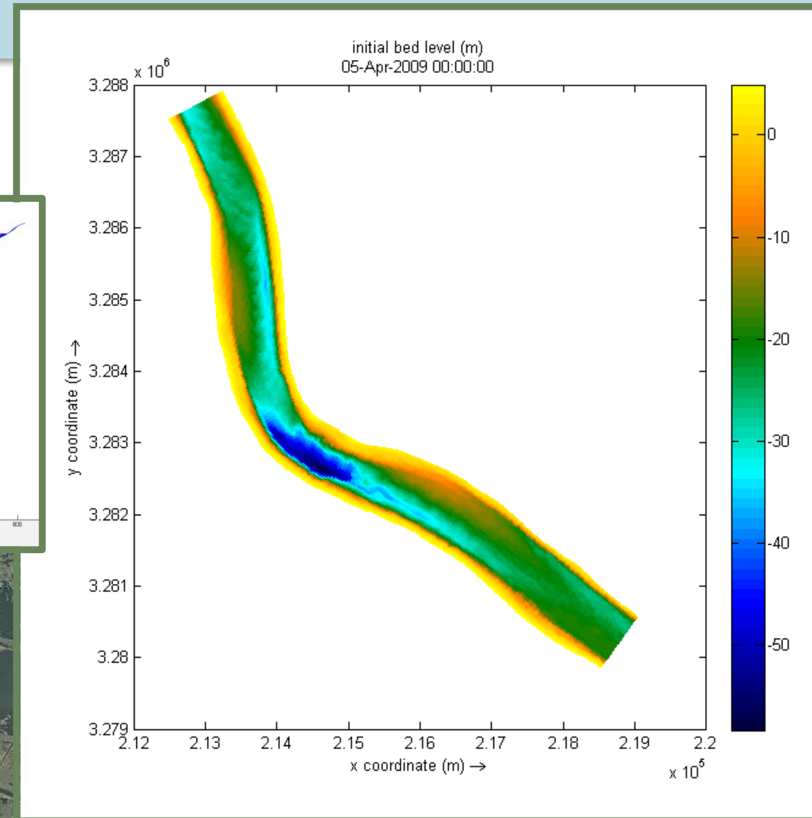






Myrtle Grove

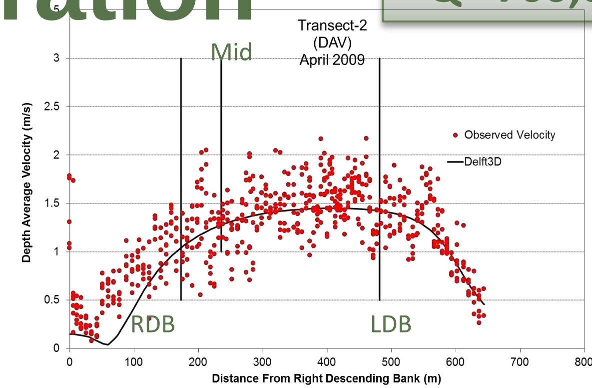


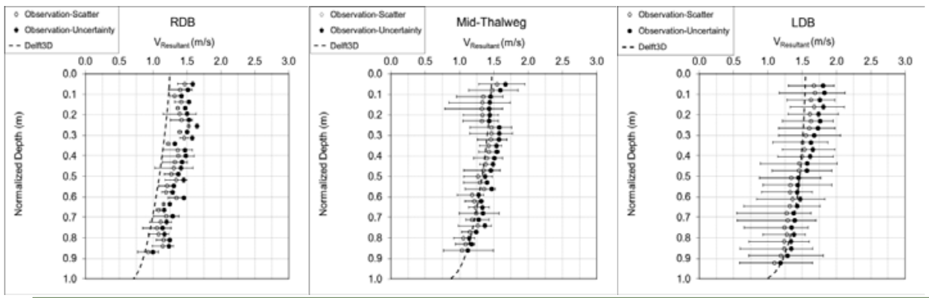


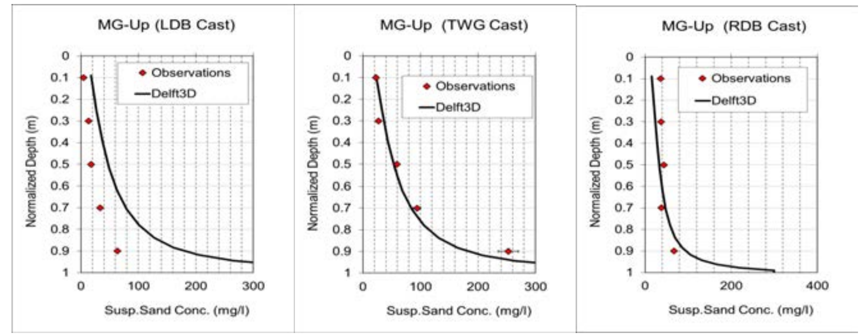
Modeled domain	:	RM 62.7 - RM 56.3
Grid Type	:	Ortho-Curvilinear
Avg. Resolution	:	40 X 20 m
No. of Cells	:	12,220
# of 3D Sigma Layers	:	15-Parabolic
Δt (time step)	:	6 sec
Manning's n	:	0.024

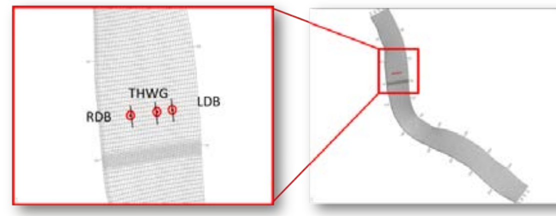
Calibration

Q= 700,000 cfs, April 2009

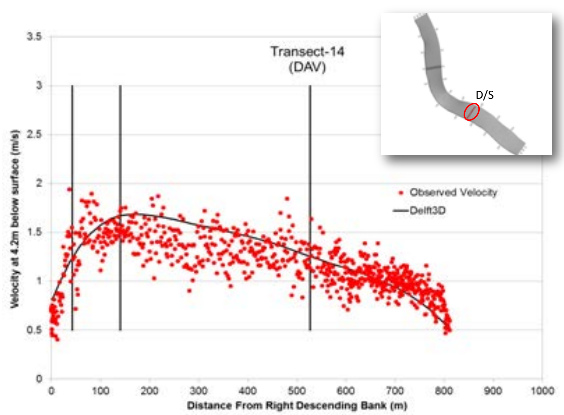






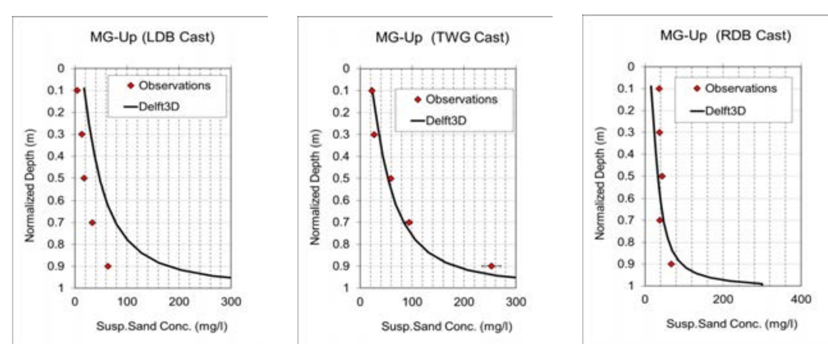


Validation

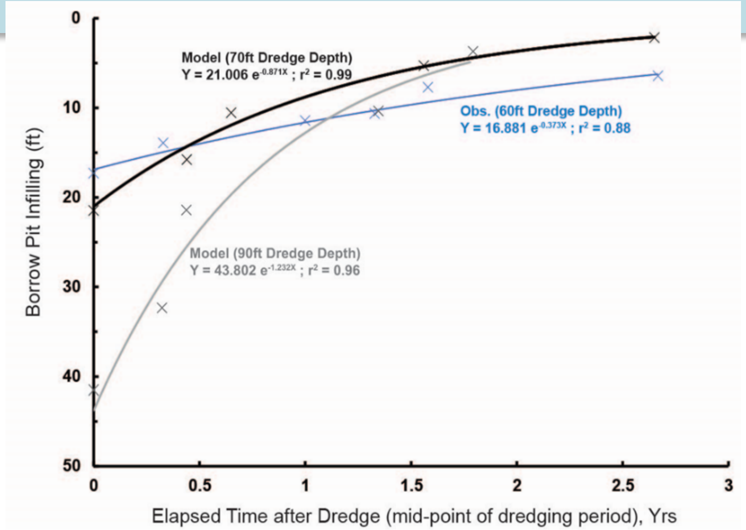


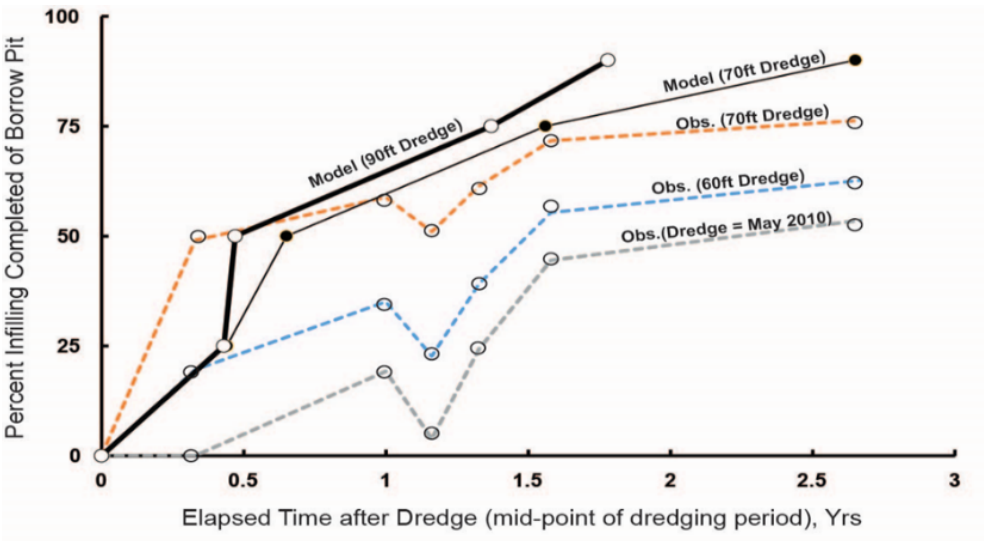
Q= 831,000 cfs, April 2010

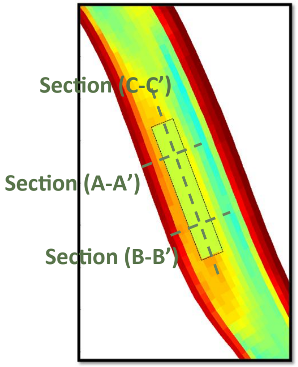
Q= 700,000 cfs, April 2009

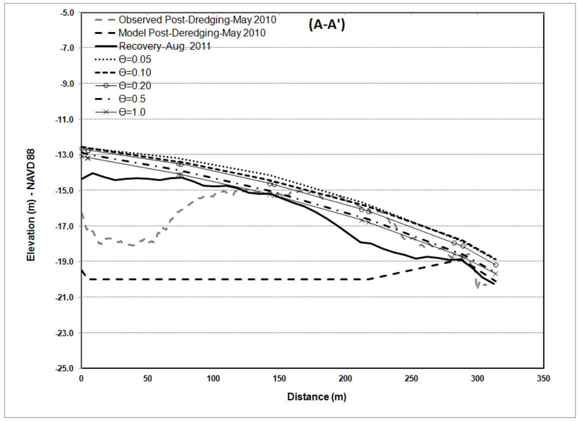


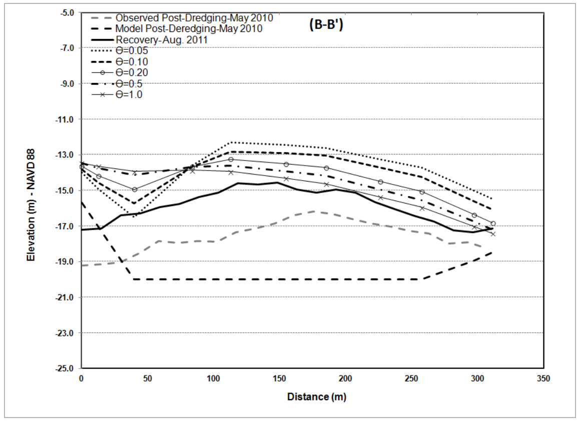
Bar Recharge

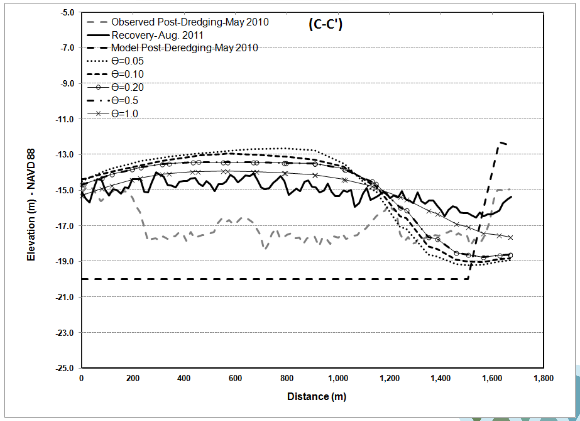




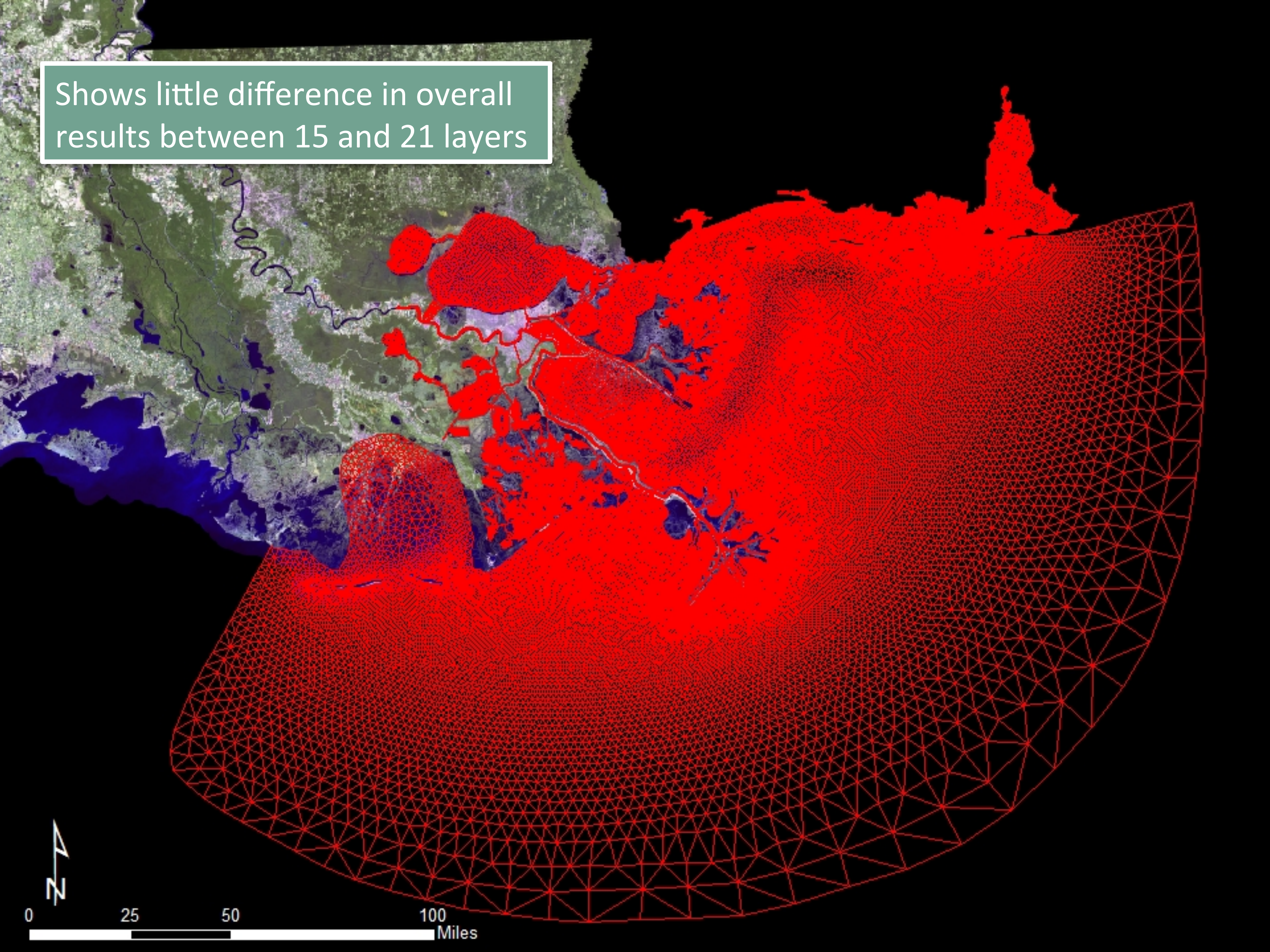


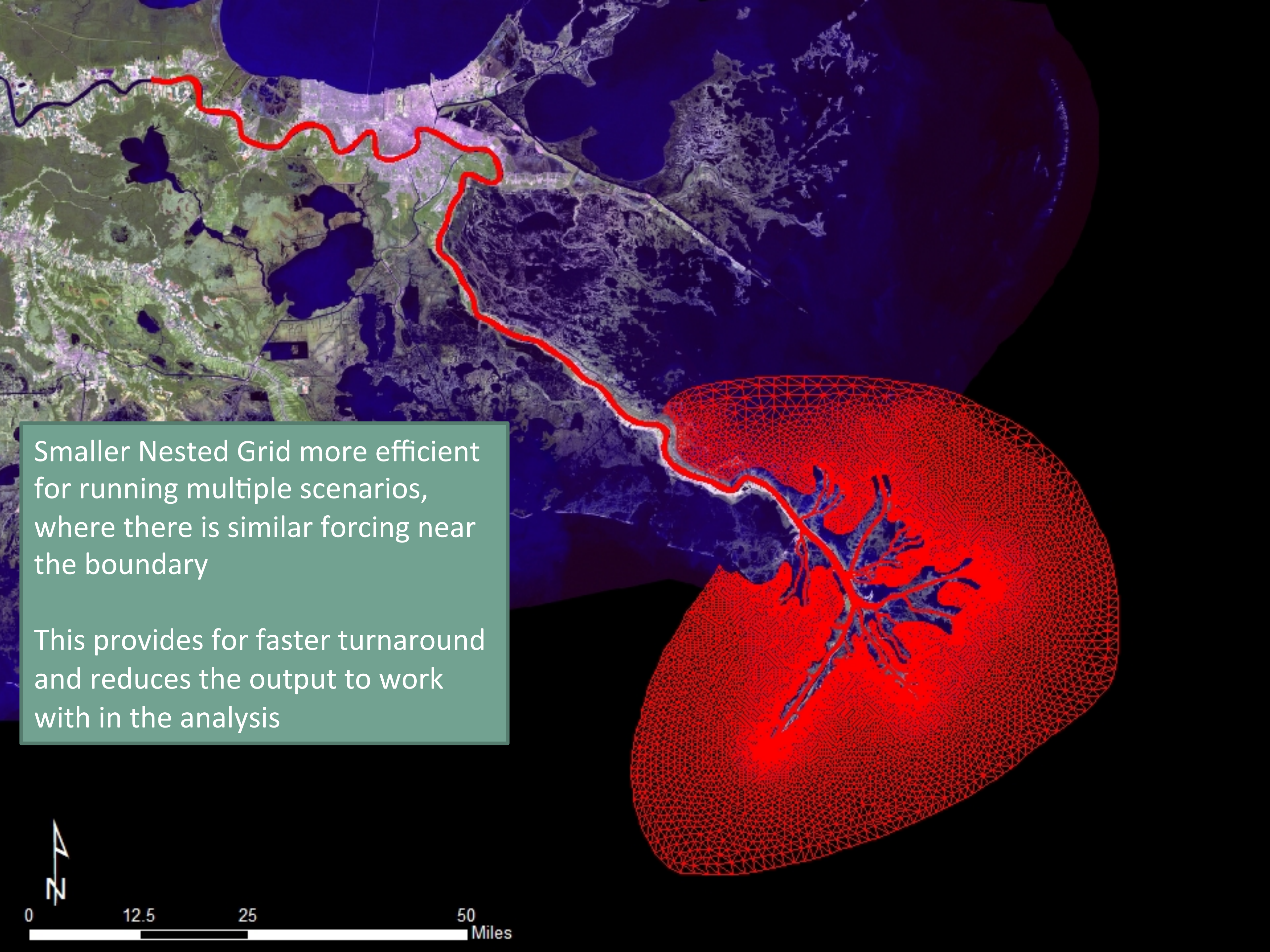






Shows little difference in overall results between 15 and 21 layers





Smaller Nested Grid more efficient for running multiple scenarios, where there is similar forcing near the boundary

This provides for faster turnaround and reduces the output to work with in the analysis

Calibration field data (hydrodynamics - tides) August 2012

Location	RMSE (%)	r	NSE
Grande Isle	10.77	0.93	0.78
Southwest Pass (east Jetty)	8.27	0.90	0.76
Head of Passes	12.98	0.80	0.63
Venice	12.77	0.88	0.74
Empire	17.76	0.95	0.69
Alliance	19.96	0.94	0.62
Carrolton	25.51	0.92	0.25

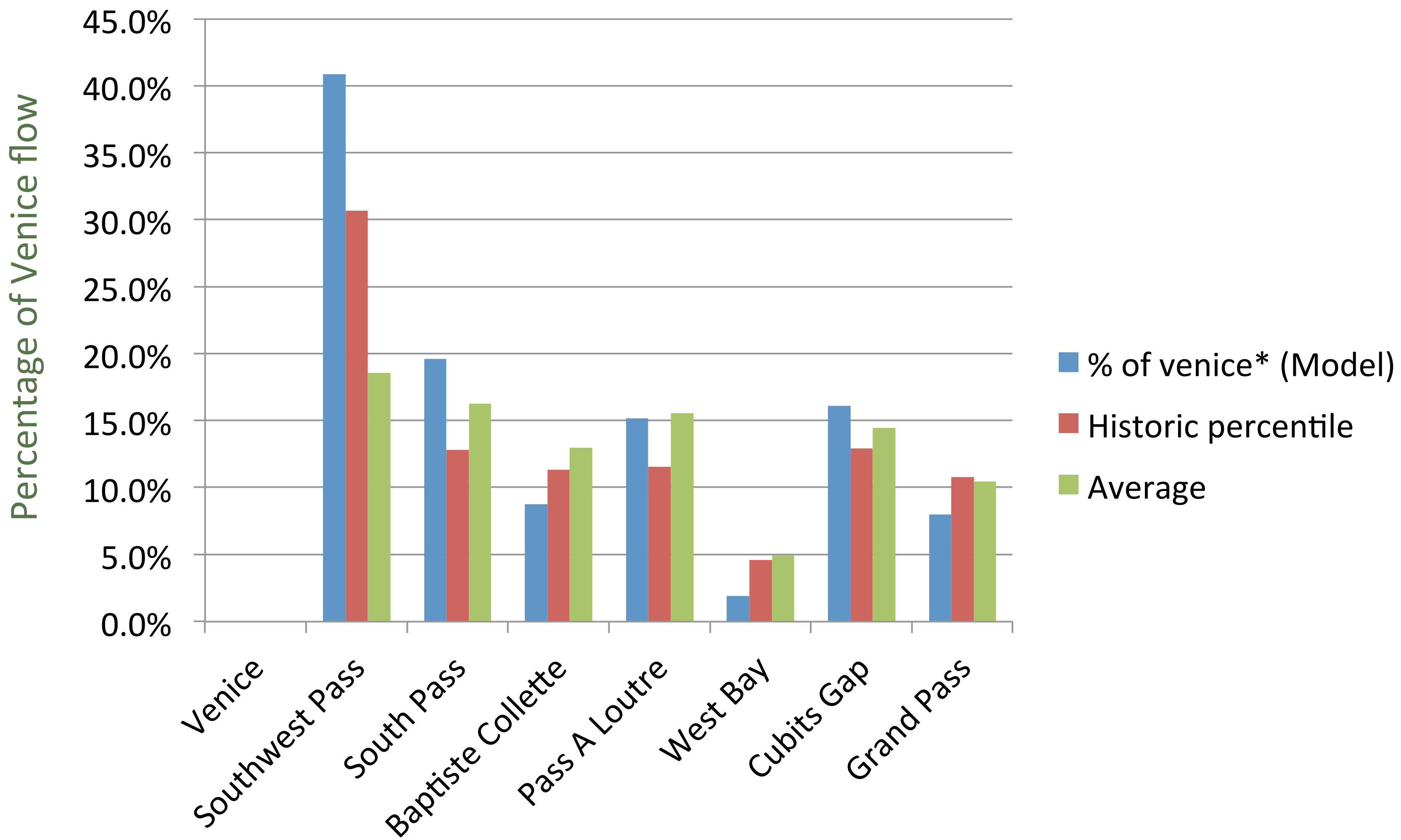
Calibration (Flow in main stem)

	Model (at max ebb tide)		Observations	
Model summary	Q (cms)	Q (cfs)	Q (cms)	
Venice	4,580 (±700)	165,261	4,254 (±800)	RM10
Myrtle Grove (up)	4,804	169,664		
Myrtle Grove (down)	4,841	170,946		
Venice plus Baptiste Collette	5,080	179,387	4,578 (±1200)	RM14

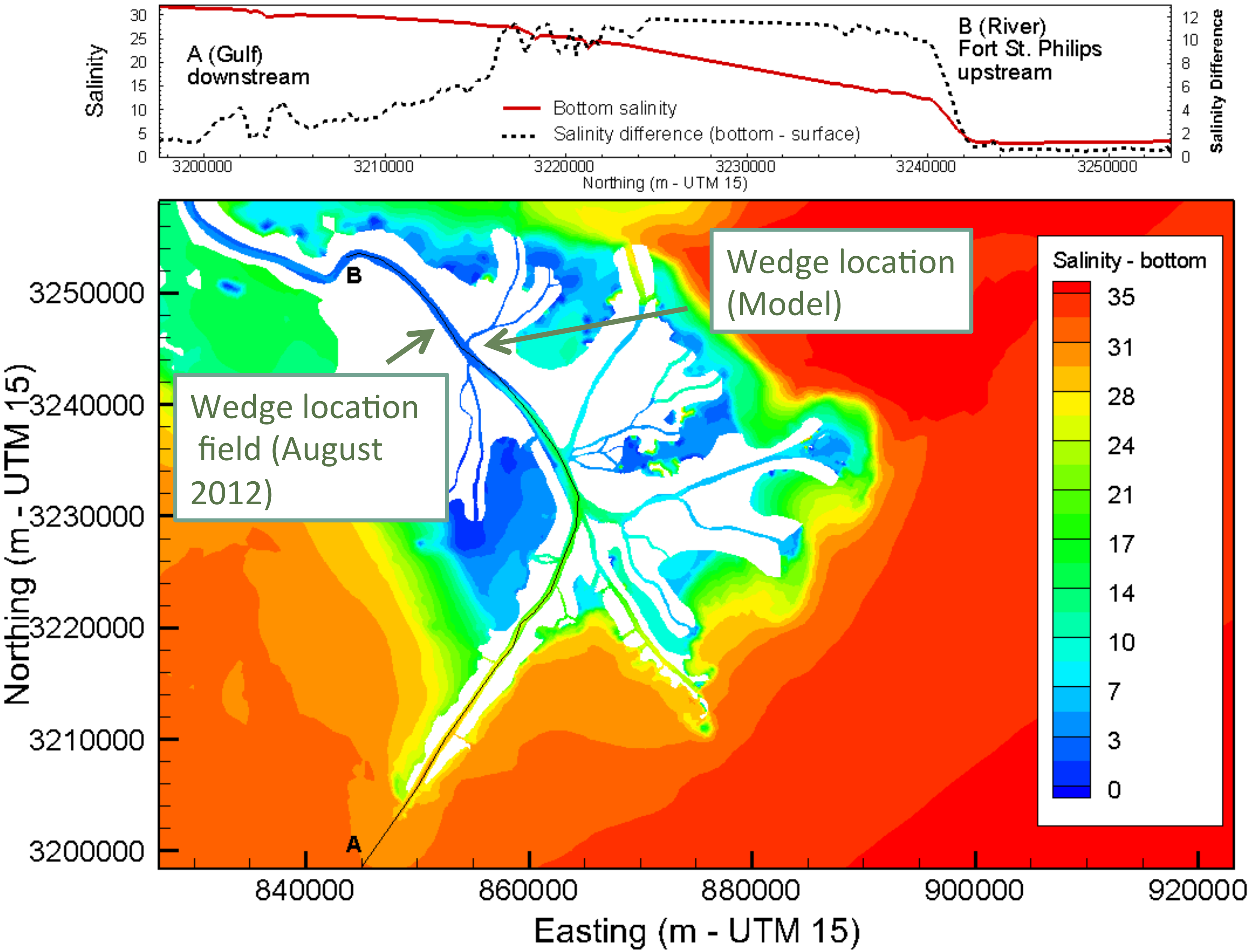
Generally good agreement, considering some variance in the model/field observations

(in parenthesis we show flow variance between ADCP transects, while for model predictions parenthesis shows tidal variability in flow)

Calibration - Flow distribution (% of Venice)

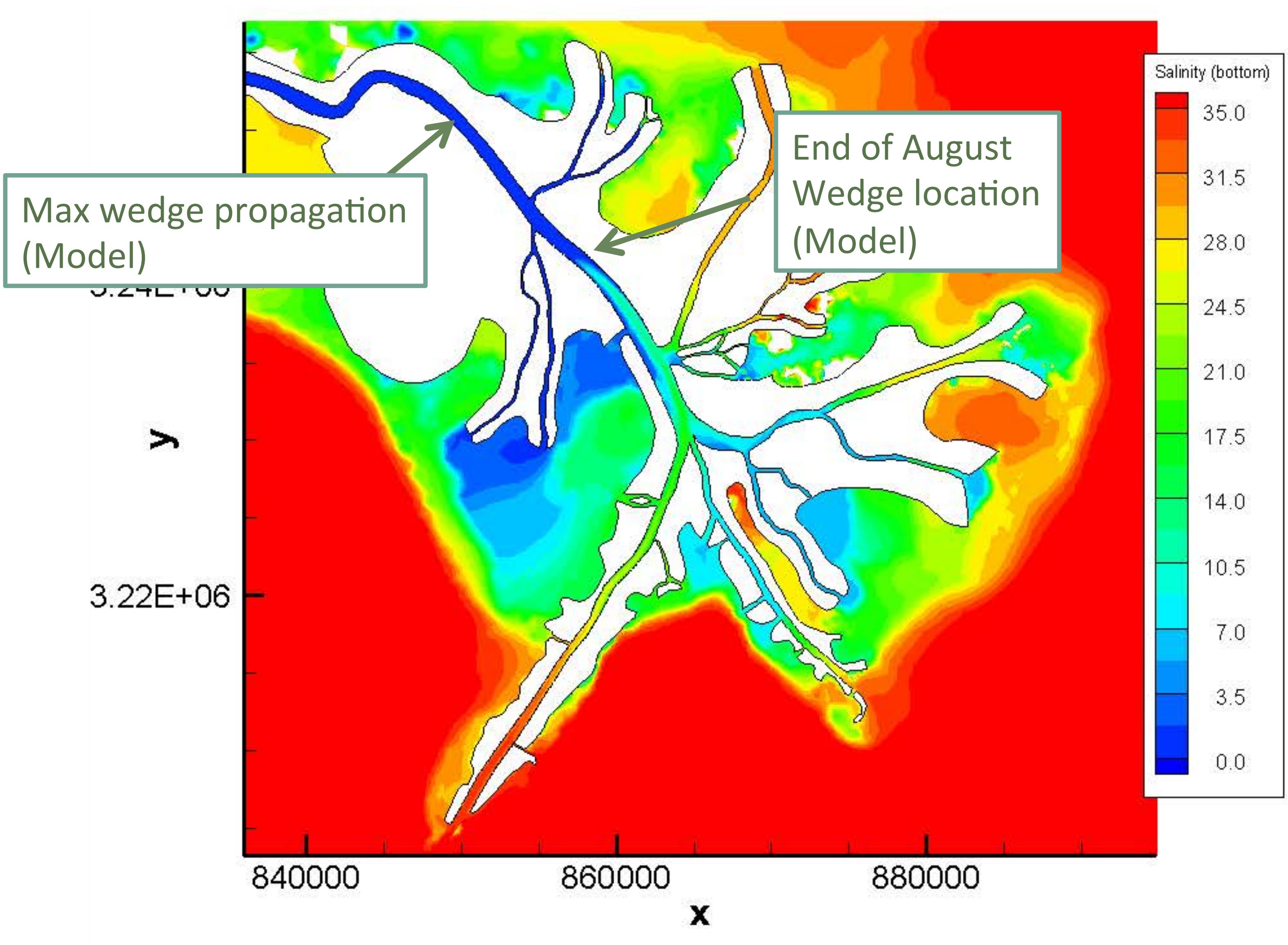


Historic percentage represents all measurements including higher flows, while the ***average*** only represents flows less than 300,000 cfs

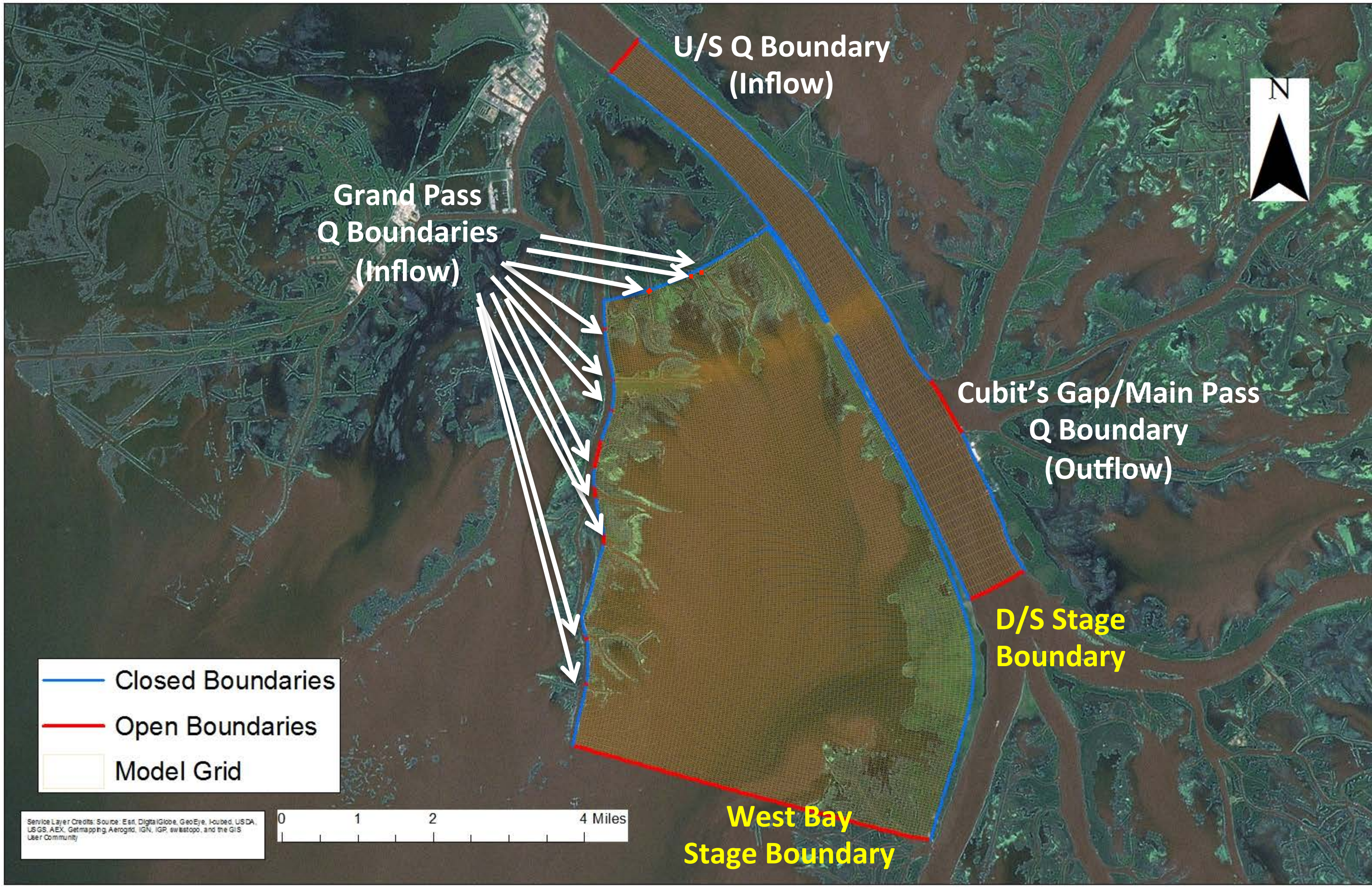


Salinity
A (Gulf)
downstream
B (River)
Fort St. Philips
upstream
Bottom salinity
Salinity difference (bottom - surface)
Salinity Difference
Northing (m - UTM 15)
B
A
Wedge location (Model)
Wedge location field (August 2012)
Salinity - bottom
Northing (m - UTM 15)
Easting (m - UTM 15)

Contraction of the wedge to below Venice in late August 2012



Water Institute – West Bay Model Domain – Boundaries



UNCERTAINTY ANALYSIS

- Environmental scenarios are addressed through direct simulations
- Use only mature & accepted models: assume that model assumptions/approximations/schemes have been verified
- We are **FOCUSING** on: Imperfect characterization of numerical and physical parameters in the formulations utilized in the models

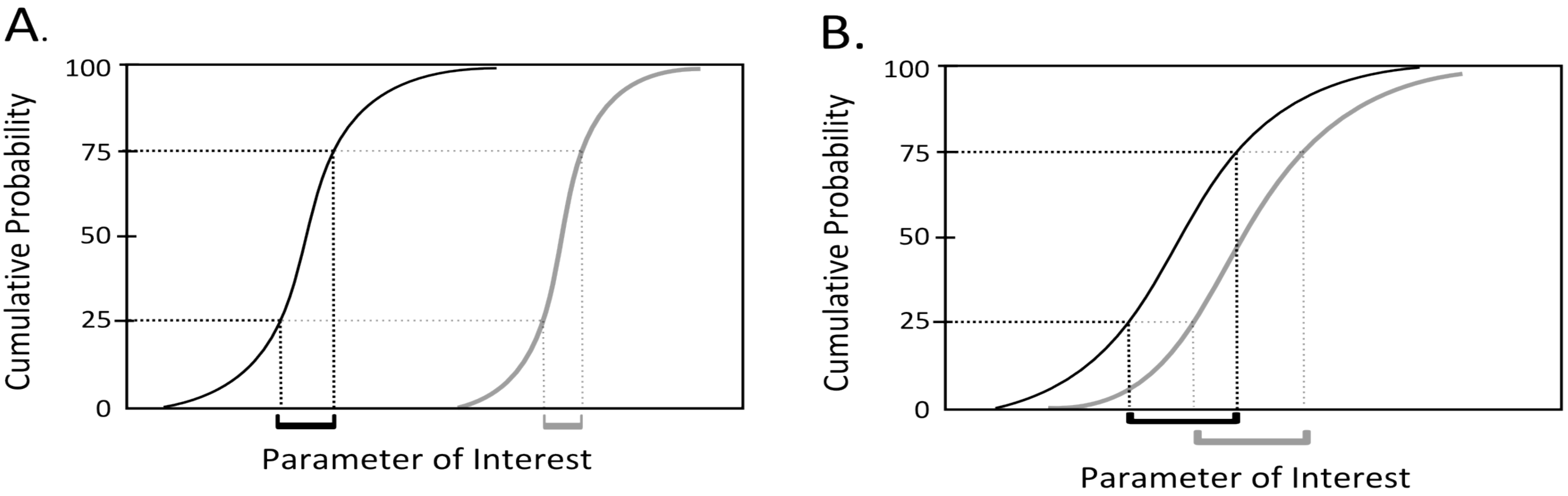
Example of Key Model Parameters:

Output	Parameter with Uncertainty
Stage	Bed Roughness
Salinity	Bed Roughness
	Diffusion Coefficient
Sediment	Settling velocity
	Sediment formulations coefficients
	Sediment substrate parameters
	Morphological parameters
Velocity	Bed Roughness
	Turbulence model parameters

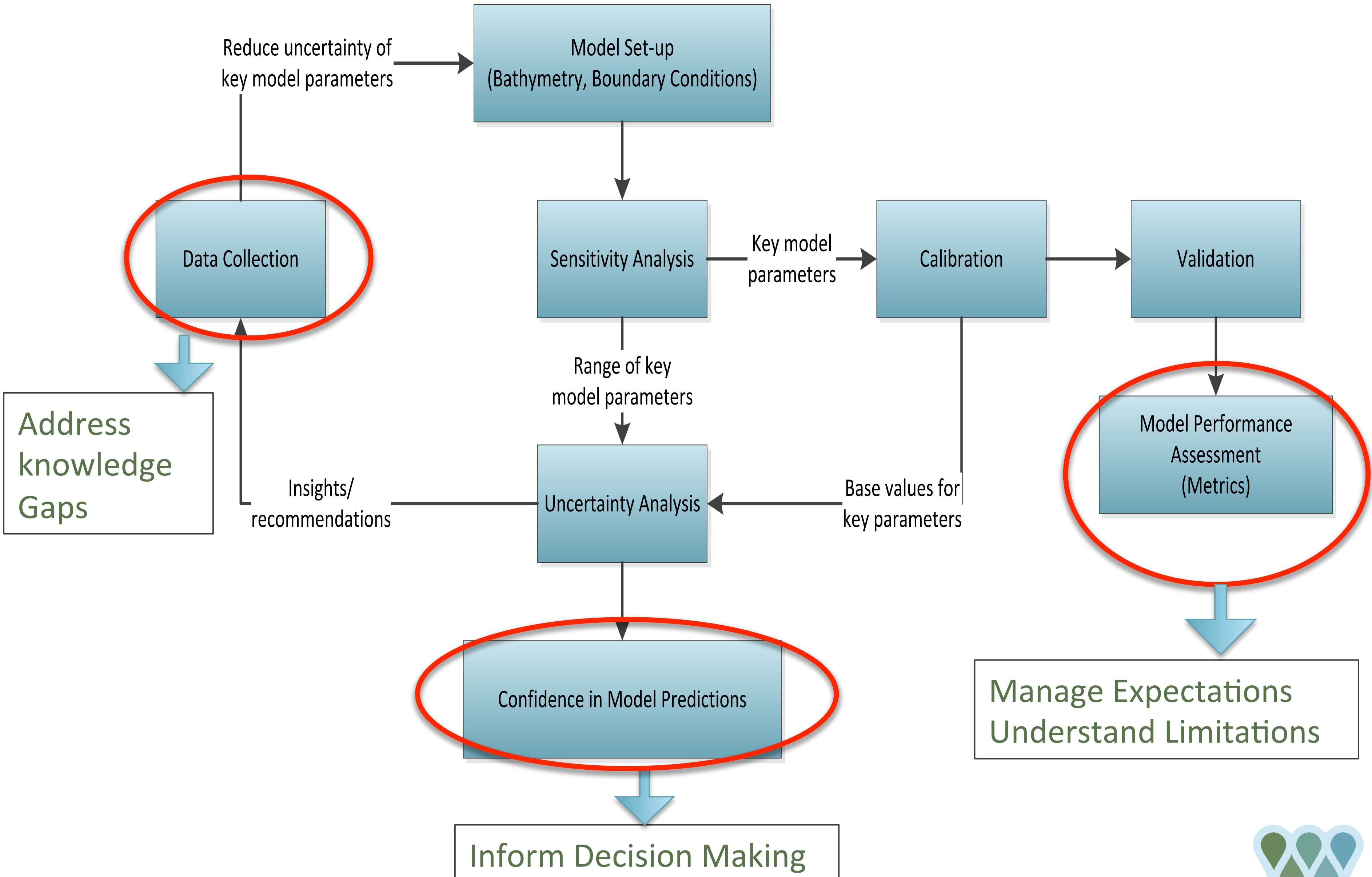
Range of Key Model Parameters

	Parameter Setting				
Key Model Parameters	**Low**	**Medium Low**	**Base**	**Medium High**	**High**
Bed roughness					
Diffusion coefficients					
Sediment settling velocity					
Sediment formulations coefficients					
Sediment bulk density					
Turbulence model parameters					

Uncertainty Analysis: predictions presented within context of confidence bounds.



Summary


Reduce uncertainty of
key model parameters
Model Set-up
(Bathymetry, Boundary Conditions)
Data Collection
Sensitivity Analysis
Key model
parameters
Calibration
Validation
Address
knowledge
Gaps
Range of key
model parameters
Model Performance
Assessment
(Metrics)
Insights/
recommendations
Uncertainty Analysis
Base values for
key parameters
Confidence in Model Predictions
Manage Expectations
Understand Limitations
Inform Decision Making

Closing Remarks

- Models provide valuable insights and inform the decision making process
- Multiple models reduce risk and provide multiple-line-of-evidence
- Models coupled with data collection significantly improve our understanding of the Lower River and the receiving basins
- Perfect science/models is not attainable. Adequate science coupled with efficient management are sufficient to implement restoration strategies.
- Post project monitoring is critical