CHENIER PLAIN RESEARCH ACTIVITIES

University of Louisiana at Lafayette
University of New Orleans
C.H. Fenstermaker & Associates

Acknowledgment

- Funds from CREST, LDNR, and COE

- Data Sources
  - USGS
  - COE
  - NOAA/NOS/NDBC
  - WAVCIS – Coastal Studies Institute
  - TCOON
  - LSU/GIS Atlas

Team

- Emad Habib
- Joao Rego
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- Jeanne Arceneaux
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- Karim Kheiashy
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- Ioannis Georgiou
- Robert Twilley
- Ehab Meselhe
- Mark Fenstermaker
- Shankar Gautam

Presentation Layout

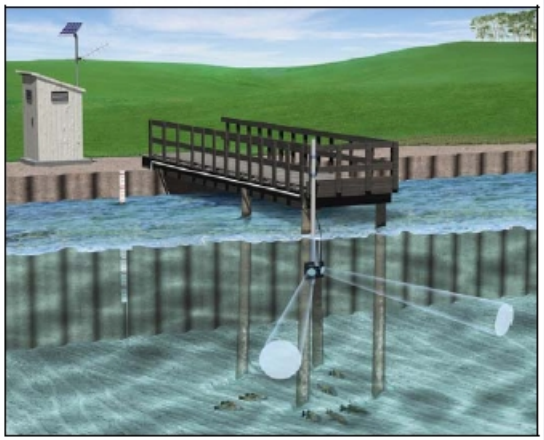
- Field Data
- Modeling/Analysis
  - SHELF model
  - Regional model
  - Water budget analysis
  - Sediment budget analysis
- LACPR Chenier Plain project

Field Data Activities

- The Chenier Plain's most important features are 5 inflow rivers and 5 major outlets connecting to the Gulf of Mexico

Hydrologic Measurements: Field Equipment

An important component of this study is supplementing the existing monitoring network with sensors to quantitatively determine the volumes needed to conduct the budget analysis.



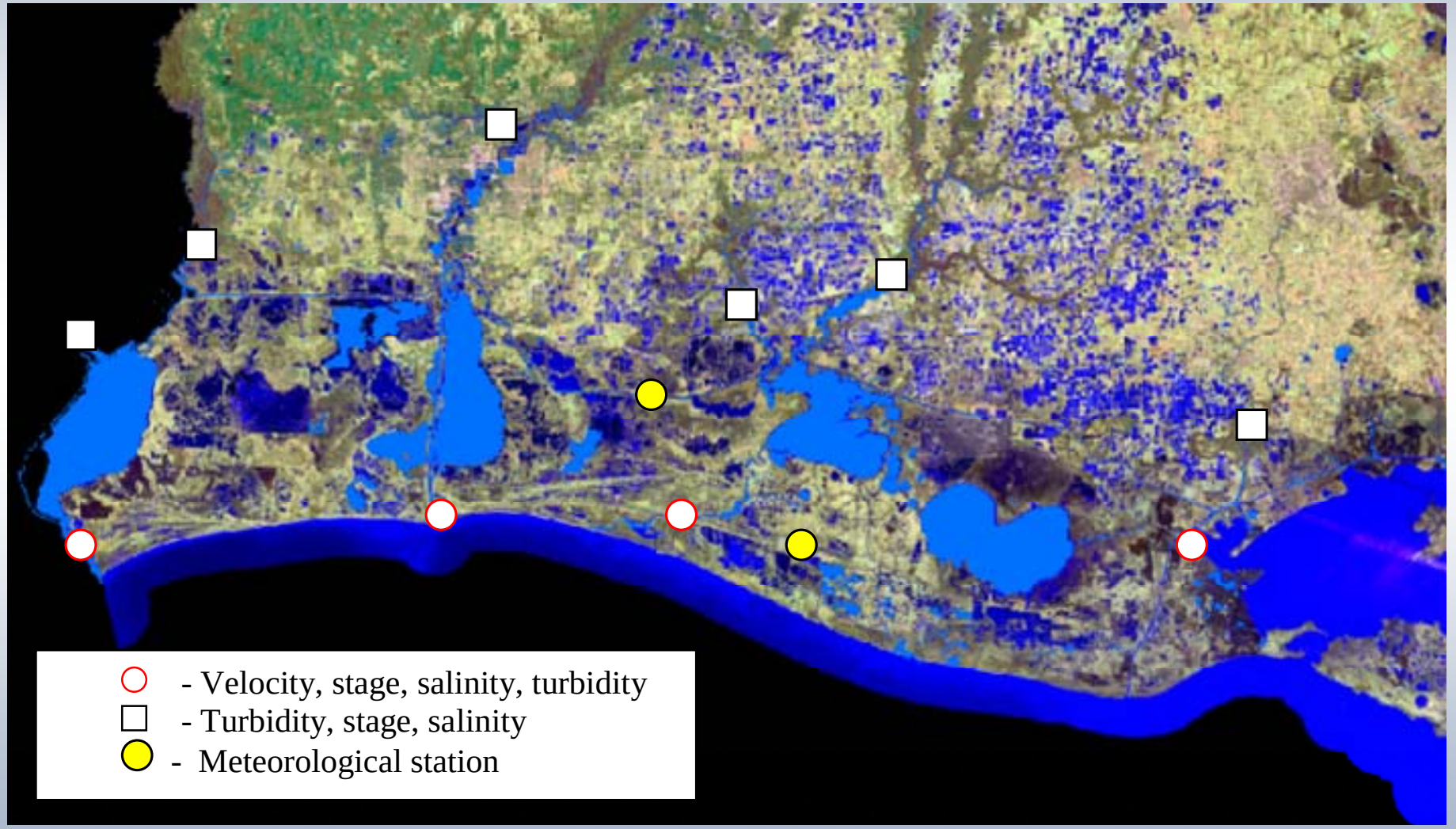
Current profilers: SonTek Argonaut-SL (500 kHz), measuring:

- Horizontal, multi-cell velocity;
- Water level;
- Water temperature.

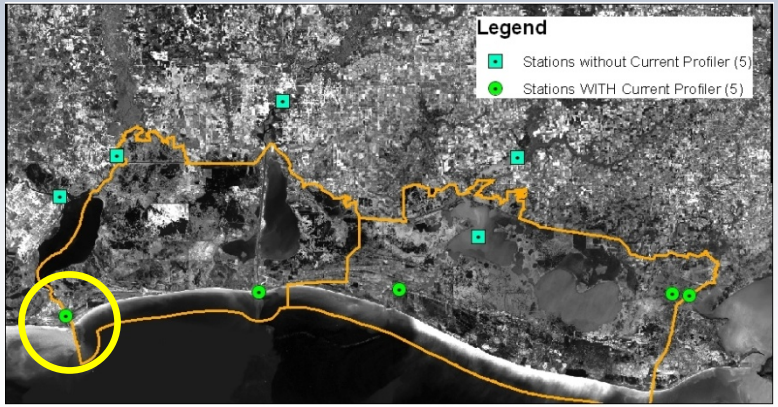
YSI 600 Optical Monitoring System, measuring:

- Turbidity;
- Salinity;
- Water level;
- Water temperature.

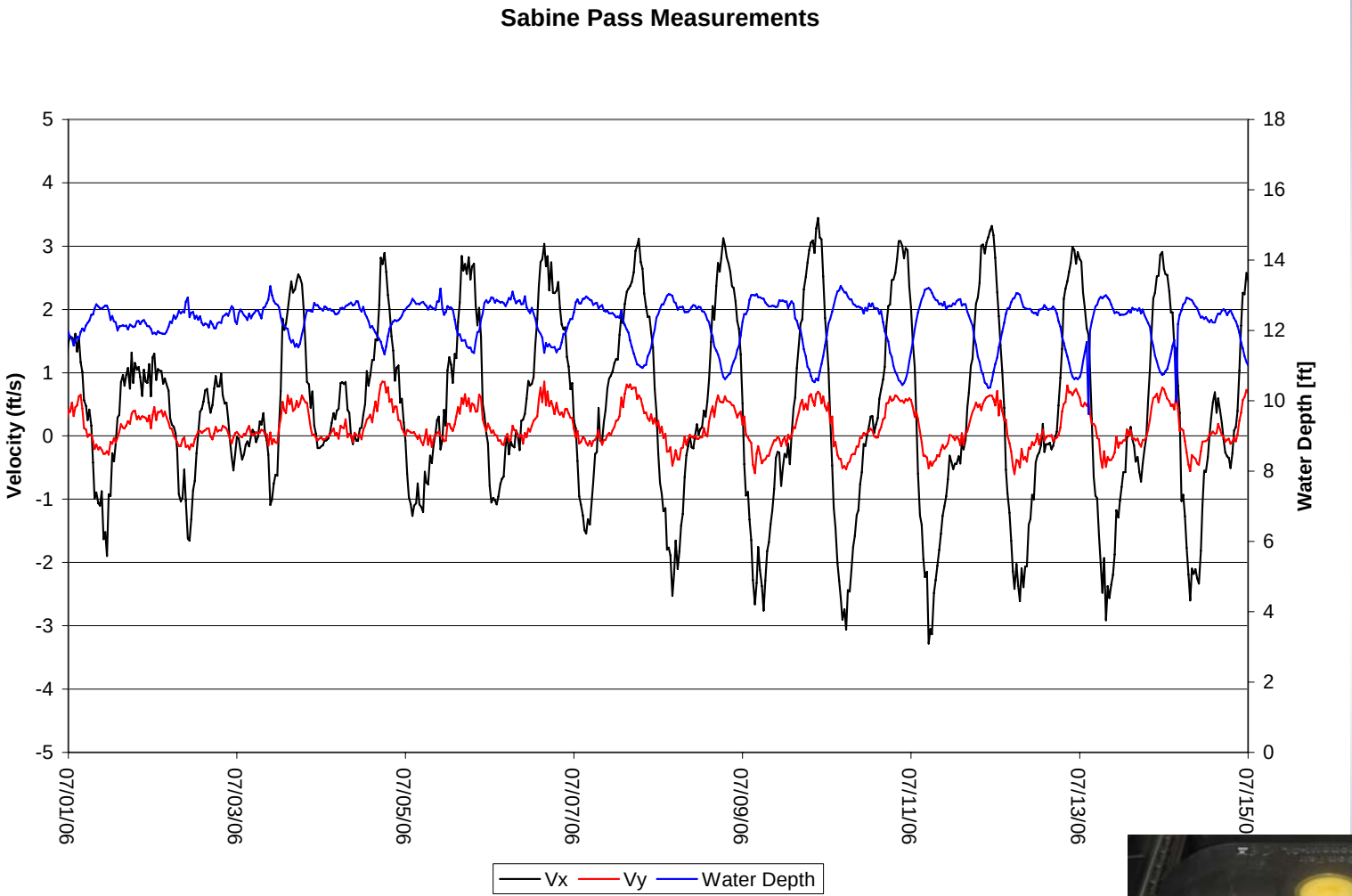
Hydrologic Stations on the Chenier Plain



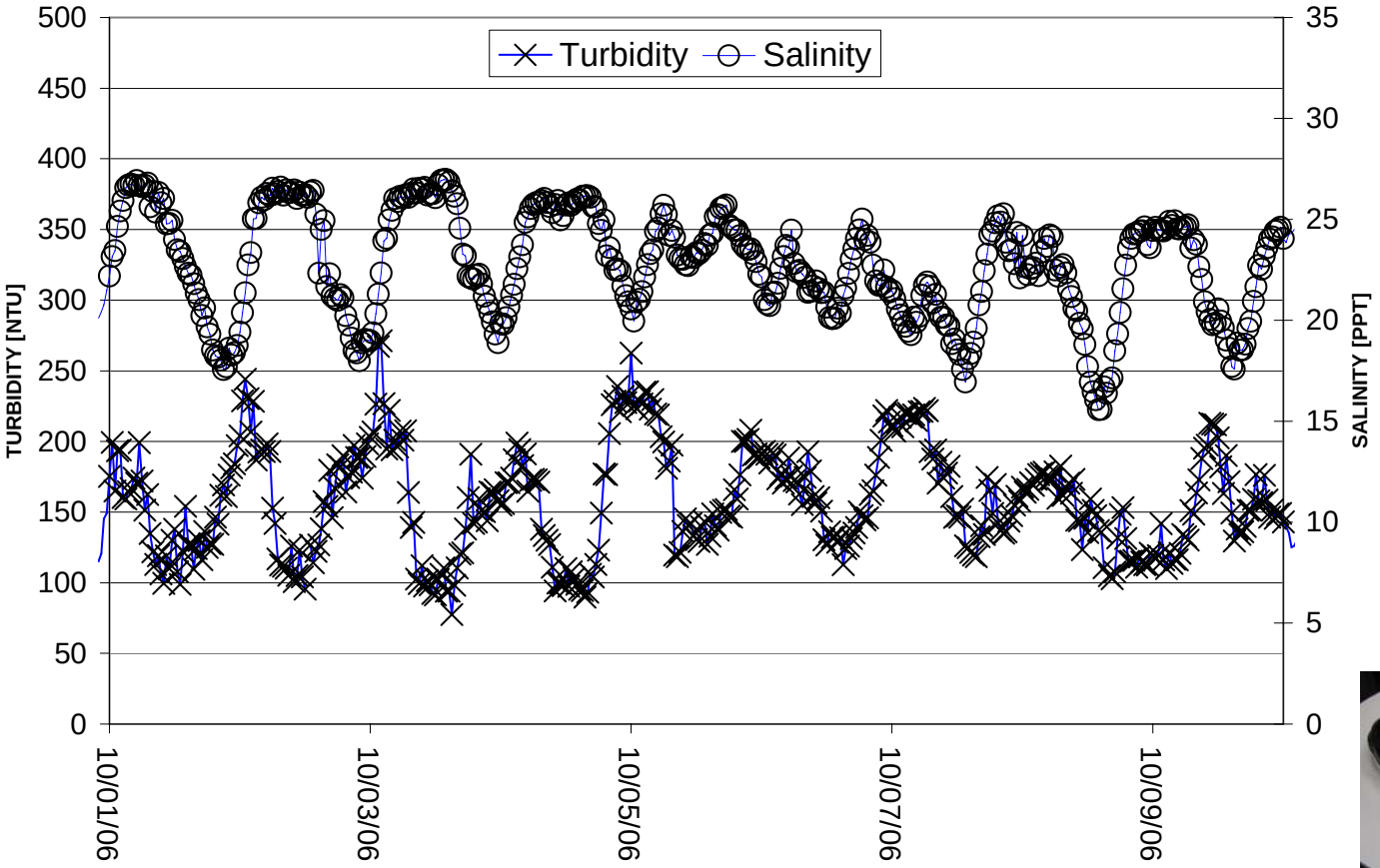
Sabine Pass Hydrologic Station



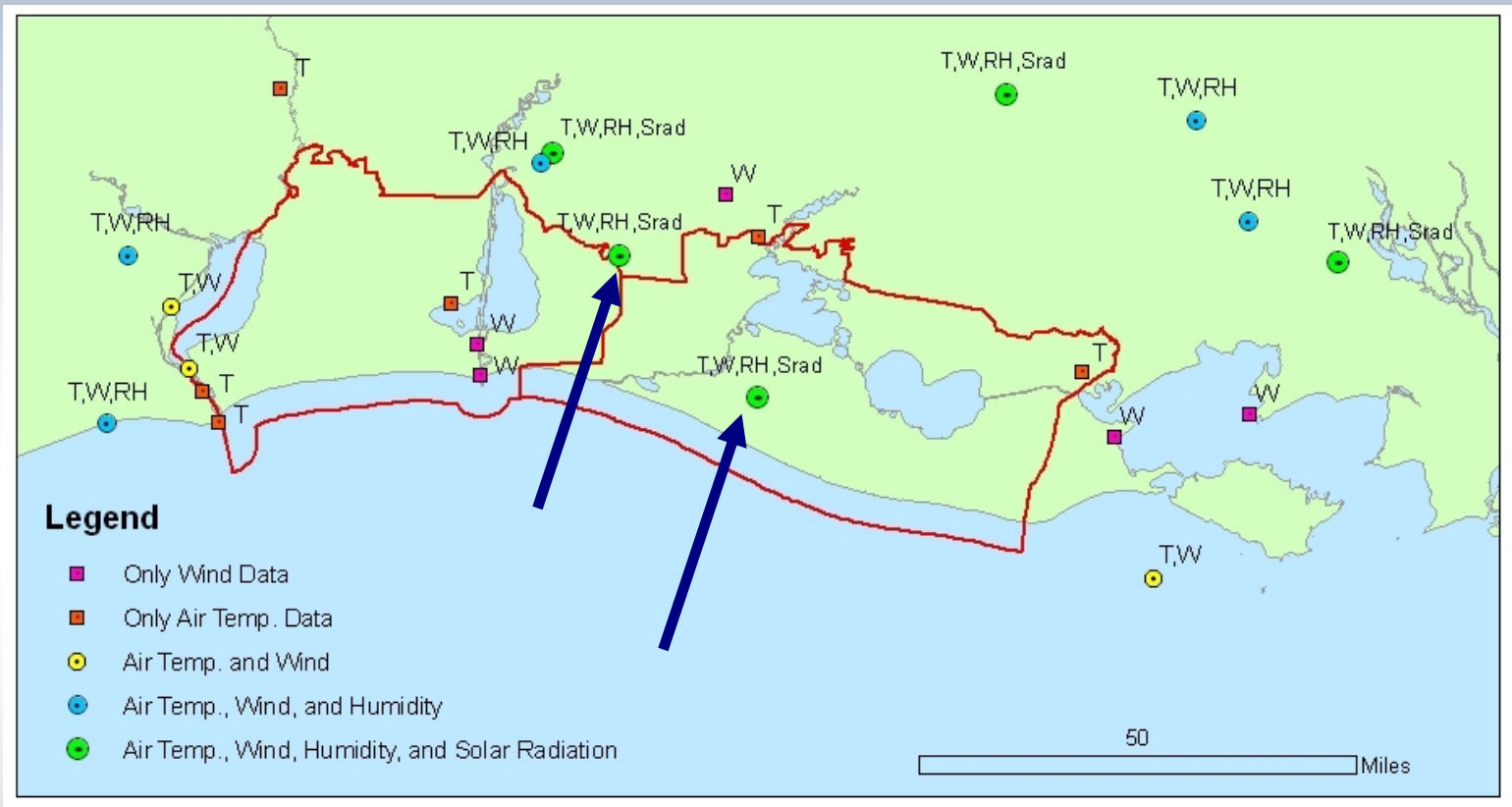
Sample Data


Sabine Pass Measurements
Velocity (ft/s)
Water Depth [ft]
5
4
3
2
1
0
-1
-2
-3
-4
-5
18
16
14
12
10
8
6
4
2
0
07/01/06
07/03/06
07/05/06
07/07/06
07/09/06
07/11/06
07/13/06
07/15/0
Vx
Vy
Water Depth

Sample Data

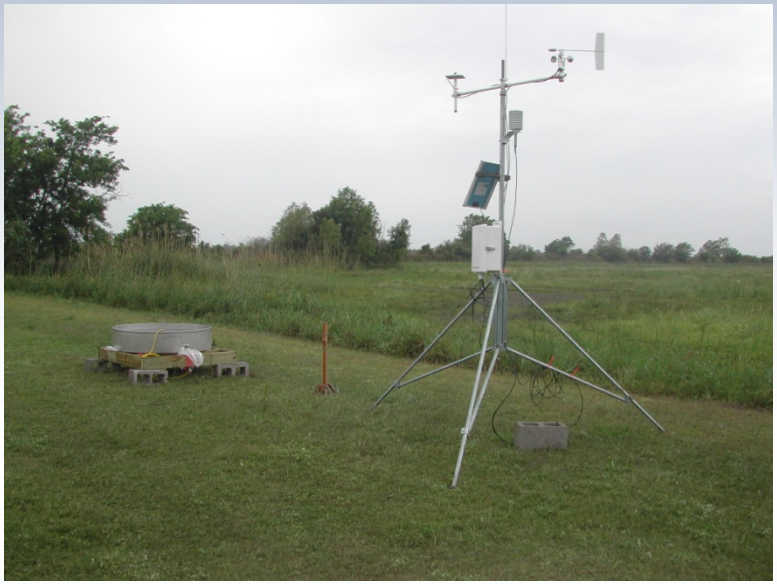

Turbidity
Salinity
TURBIDITY [NTU]
SALINITY [PPT]
500
450
400
350
300
250
200
150
100
50
0
35
30
25
20
15
10
5
0
10/01/06
10/03/06
10/05/06
10/07/06
10/09/06

Deployment of Meteorological Stations



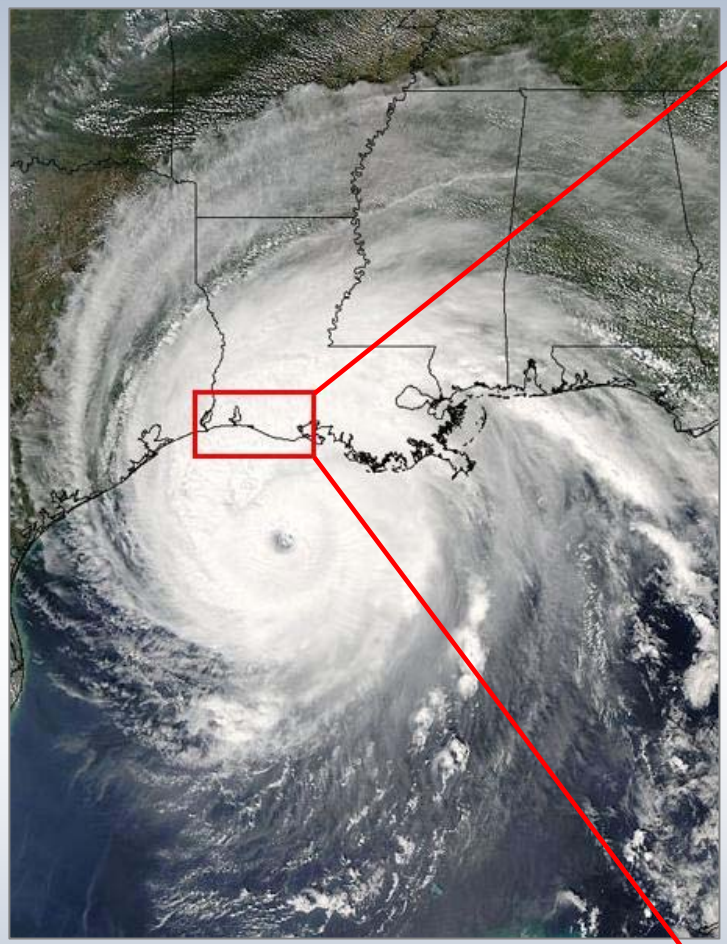
- Existing network for monitoring of weather parameters is poor.
- The University of Louisiana at Lafayette deployed two complete automatic weather stations, together with Class-A evaporation pans, on the marshes of the Chenier Plain.

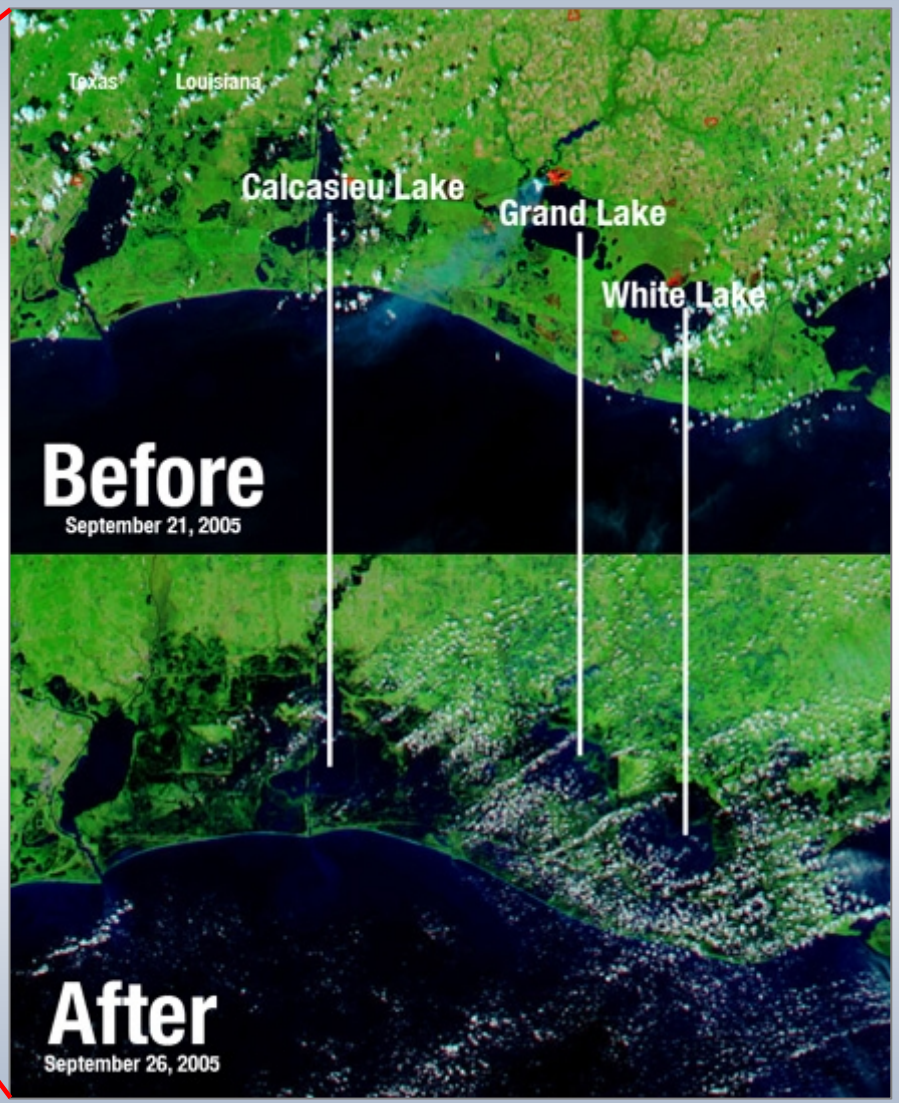
Cameron-Prairie Refuge Weather Station



Weather Station and
Evaporation Pan

Delays/setbacks: Hurricane season 2005

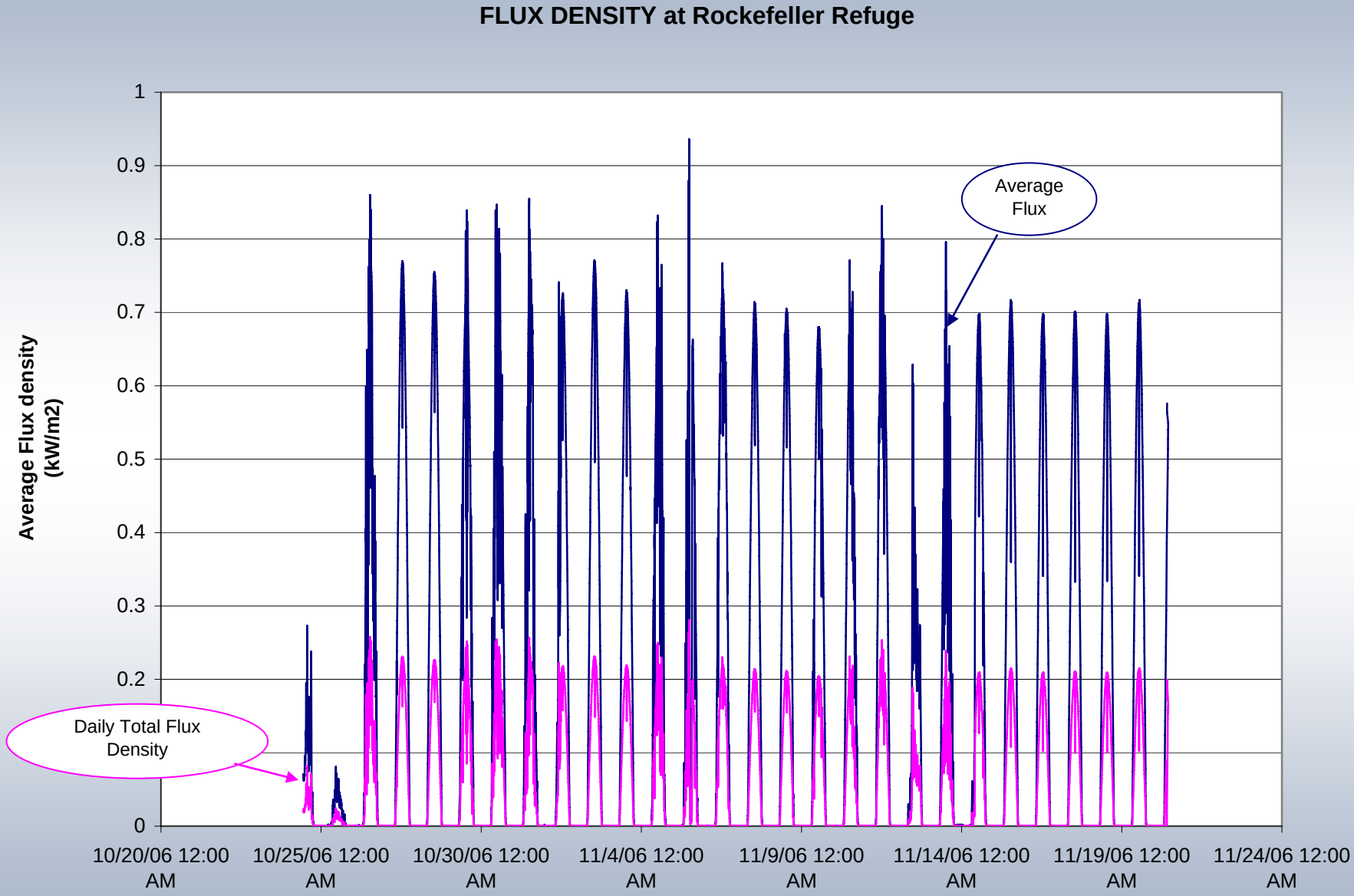




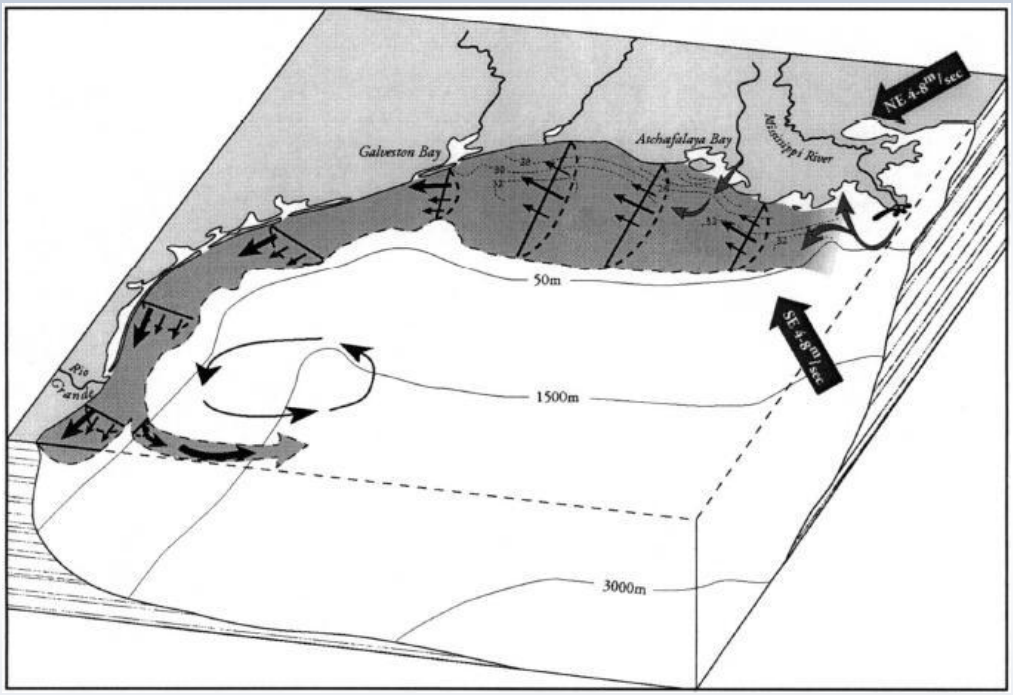
Two category-5 hurricanes:

- Katrina (landfall on Aug 29)
- Rita (landfall on Sep 24)

Hurricane Rita: Rockefeller Ref. Weather Station


FLUX DENSITY at Rockefeller Refuge
Average Flux density (kW/m2)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0
Average Flux
Daily Total Flux Density
10/20/06 12:00 AM
10/25/06 12:00 AM
10/30/06 12:00 AM
11/4/06 12:00 AM
11/9/06 12:00 AM
11/14/06 12:00 AM
11/19/06 12:00 AM
11/24/06 12:00 AM

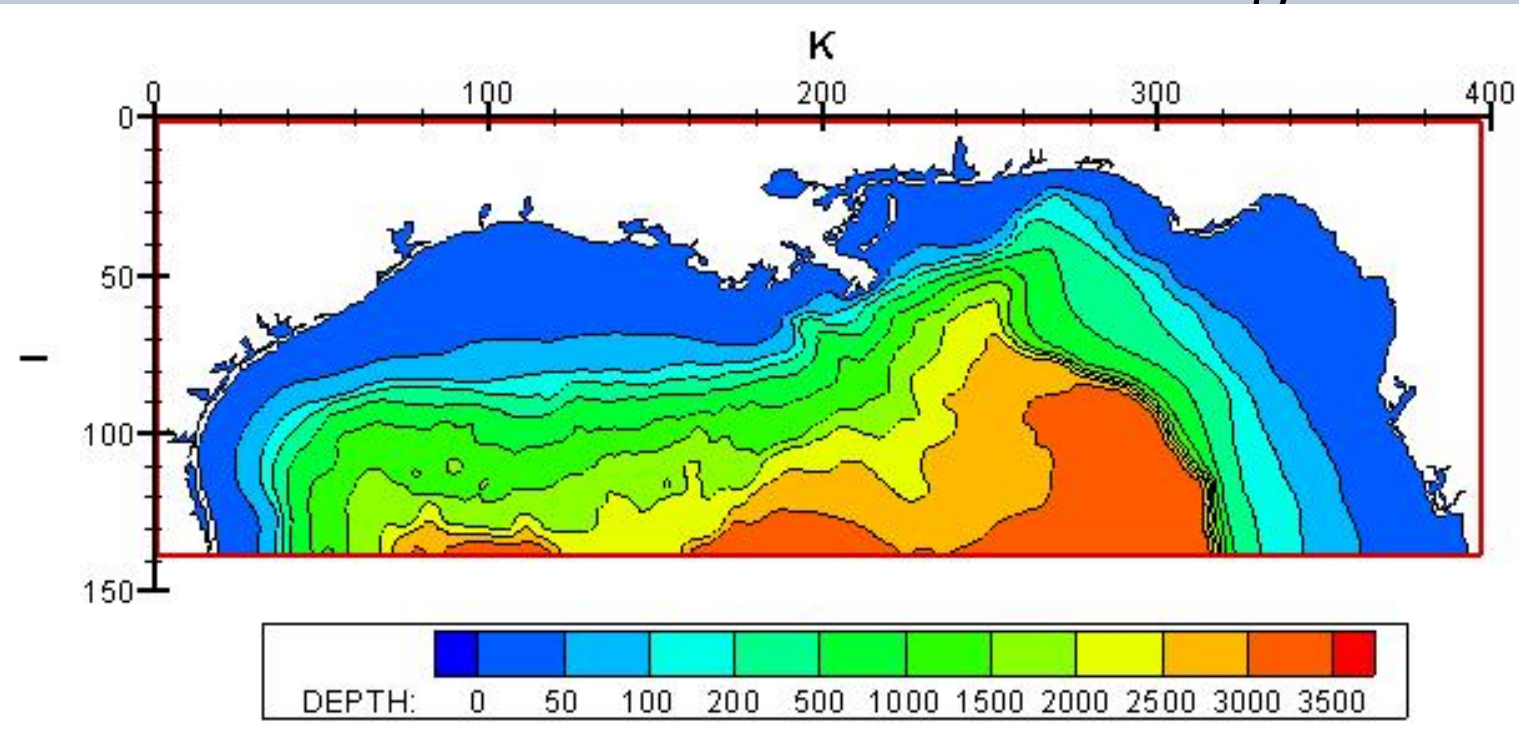
The SHELF model



Numerical model H3D (Stronach et al., 1993) used to:

- Track the Mississippi/Atchafalaya riverine plume
- Provide boundary conditions (sediments, salinity, water levels) to the Regional Chenier Plain Model

SHELF Model: H3D's horizontal grid



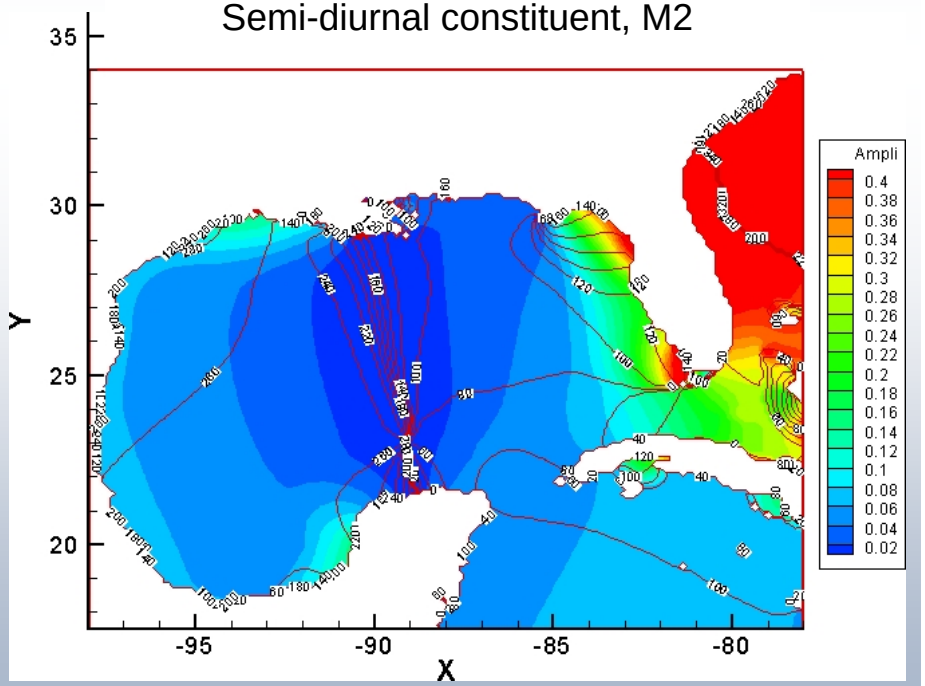
- Domain has 37,000+ "wet" cells, 4 x 4 km^2
- 47% of these cells have <200 m depth; shallow water processes and wind driven-circulation are important

SHELF Open Boundary: Forcing at the 26 °N line

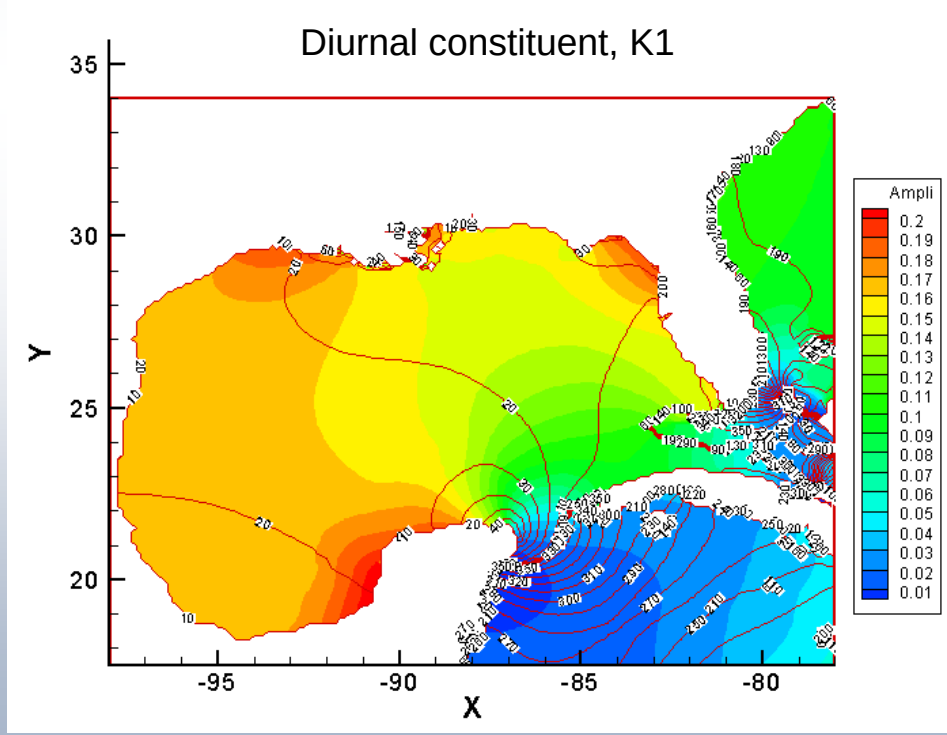
Tidal boundary conditions from Mukai et al. (2002):

ADCIRC 2-D tidal model for the USACE

Semi-diurnal constituent, M2

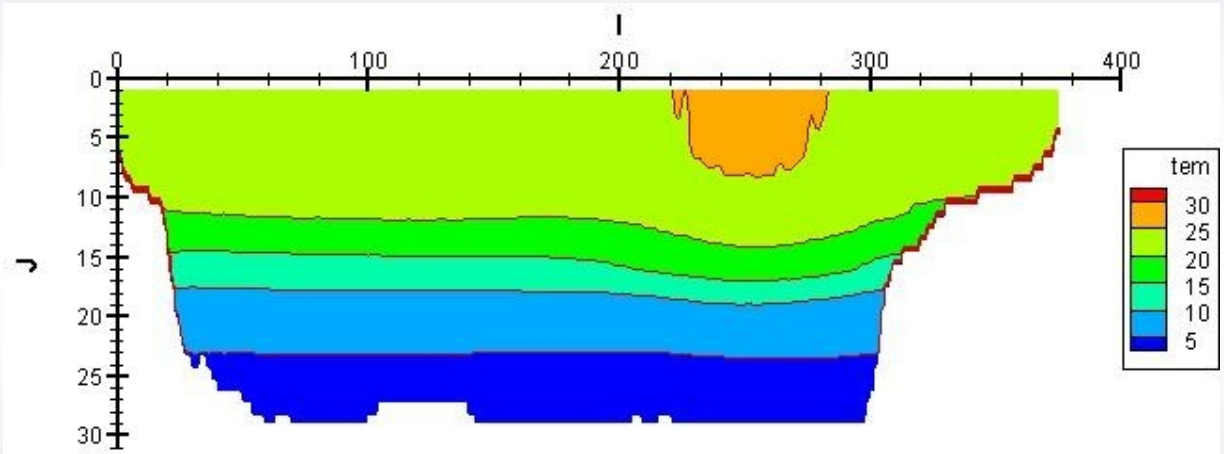


Diurnal constituent, K1



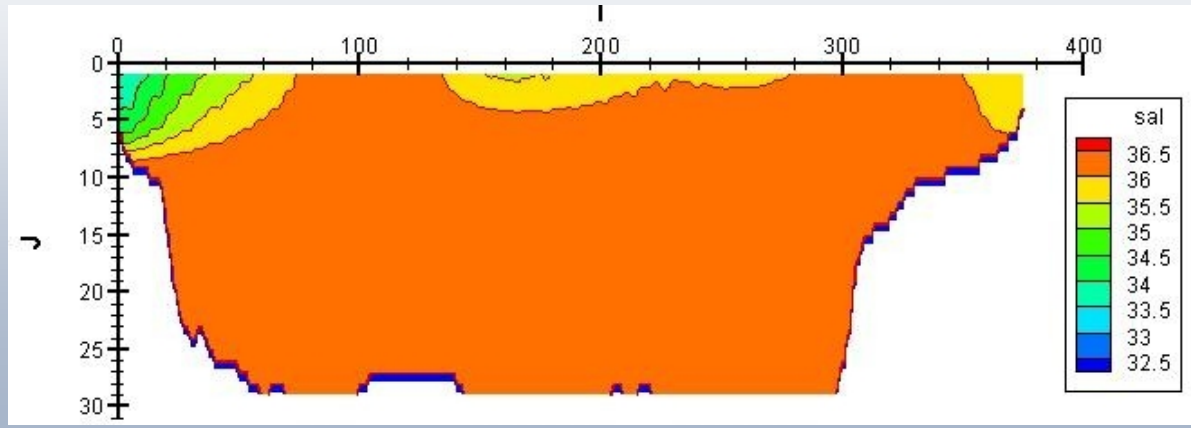
SHELF Open Boundary: Forcing at the 26 °N line

Temperature and salinity boundary conditions: monthly climatology by Boyer et al. (2005)

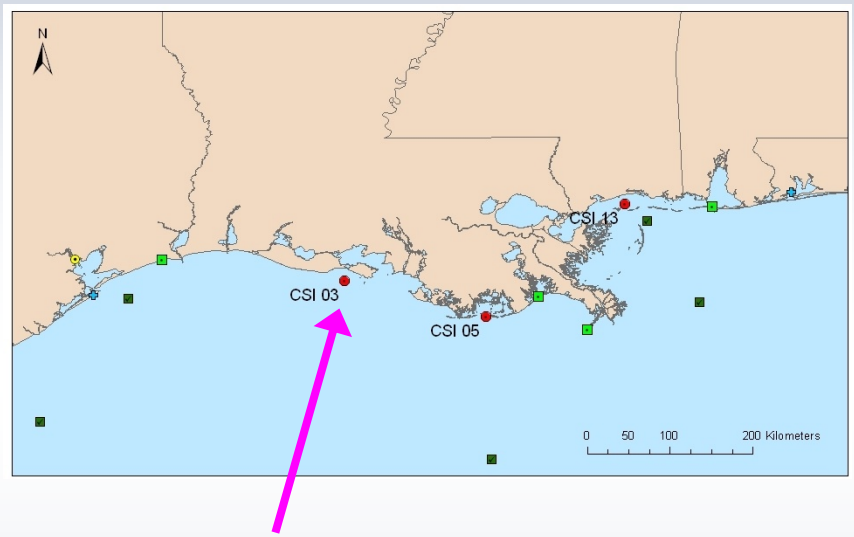


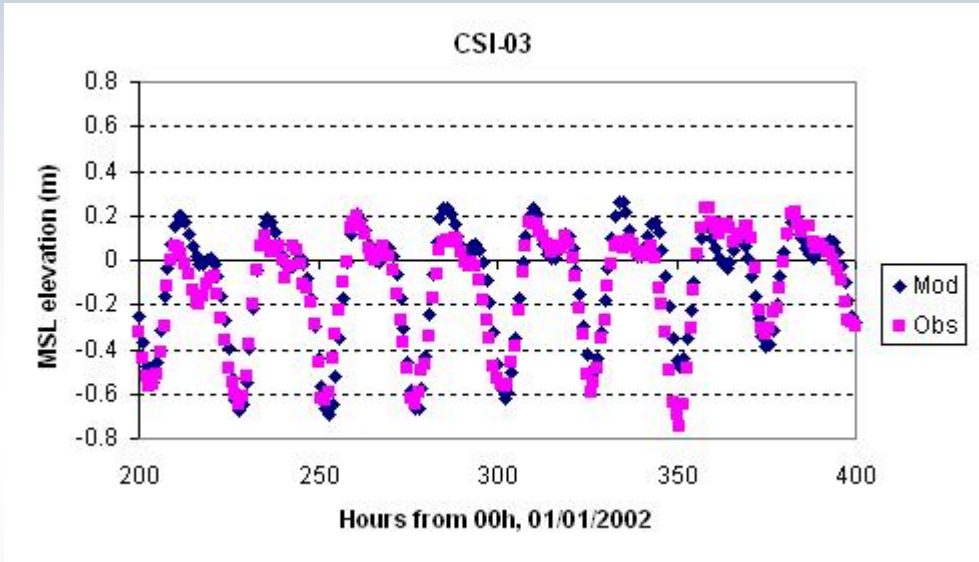
Temperature in April

Salinity in April



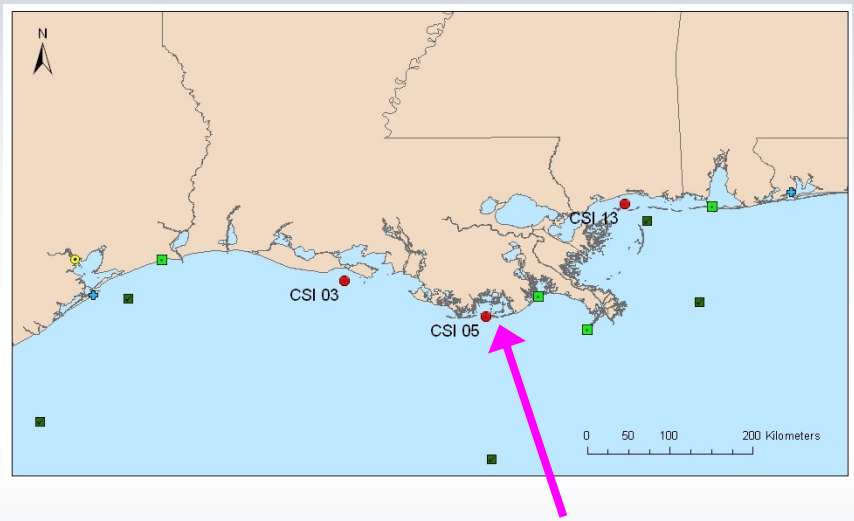
SHELF Calibration

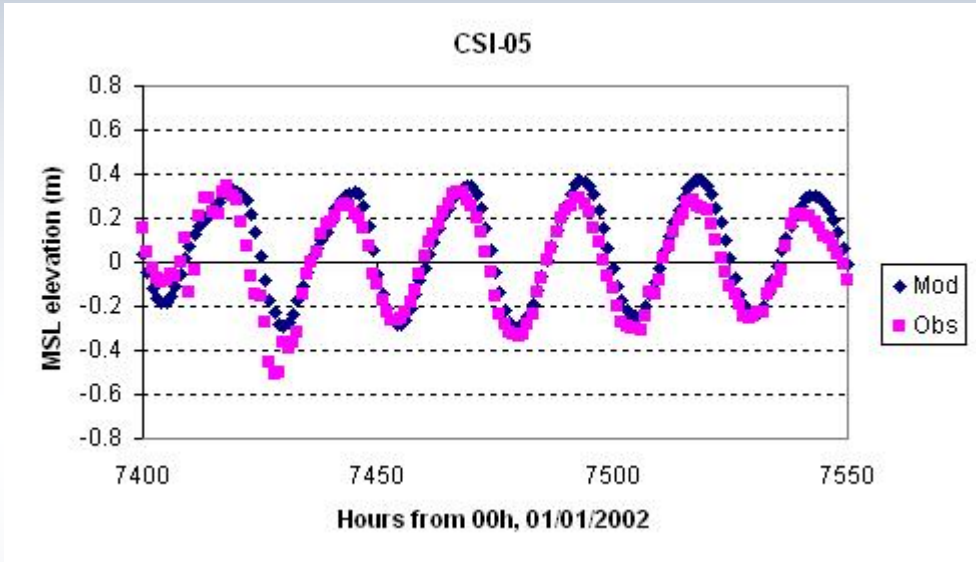




- Water-level comparison: WAVCIS station near Marsh Island

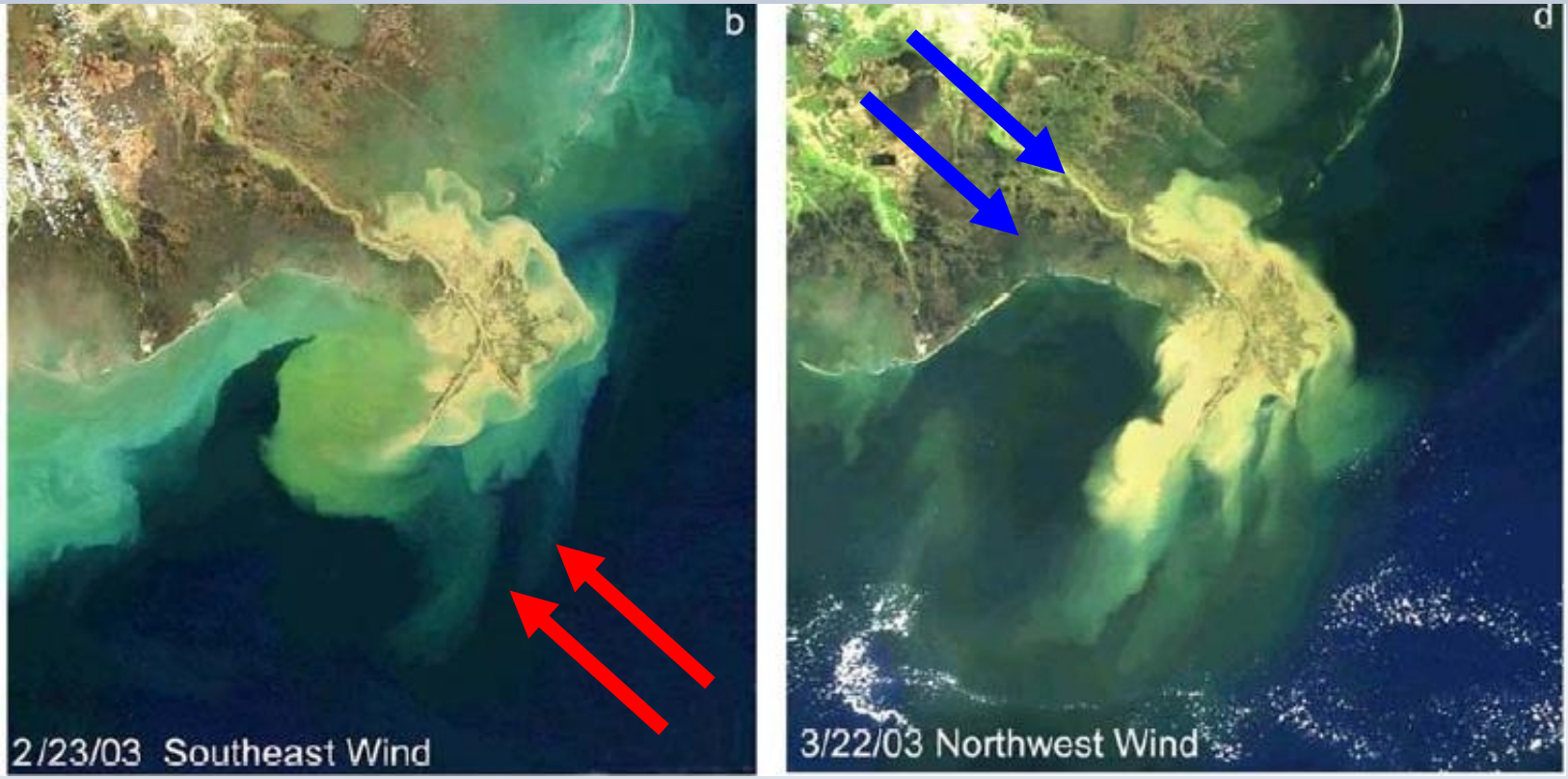
SHELF Calibration





- Water-level comparison: WAVCIS station in Terrebonne Bay

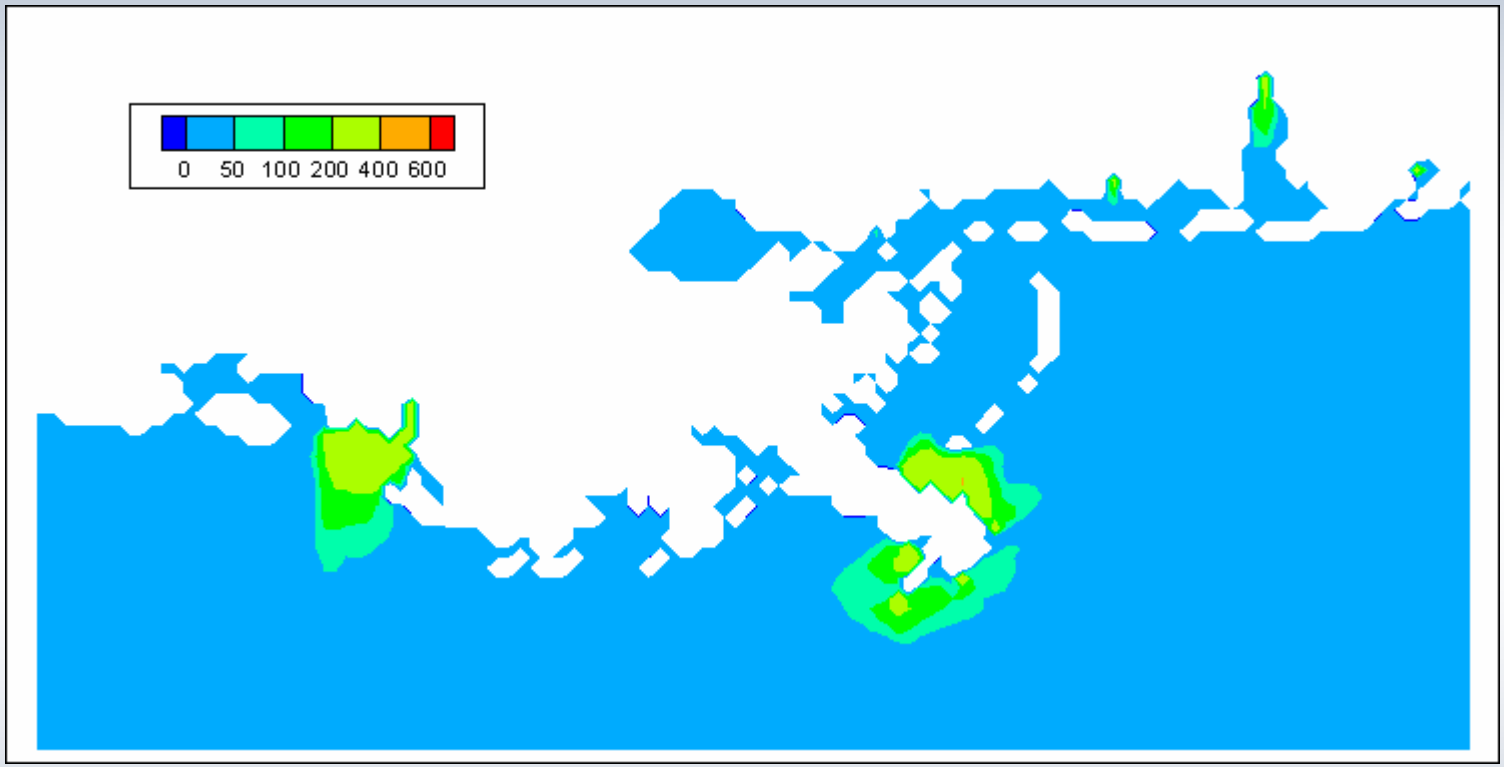
Mississippi River plume: satellite images



Typically, winds

- from the SE “attach” the plume to the Barataria Bay area
- from the NW advect the plume directly into deep GOM waters

SHELF results: Mississippi River plume



- Typically, only ~50% of fine sediments from the Mississippi River travel West (see also Etter et al., 2004)
- The Atchafalaya discharges into the wide and shallow (<2 m) Atchafalaya Bay, where it is subject to strong tidal and wind mixing

SHELF: Summary

- To understand the dynamics of the Atchafalaya/Mississippi river plume.
- To provide accurate representation of the hydrodynamics of the Northern Gulf.
- To provide boundary conditions (water levels, salinity, and sediment concentration) for the regional model.
- To study alternative river-management scenarios for the Mississippi River system, and their impact on the surrounding ecosystems.

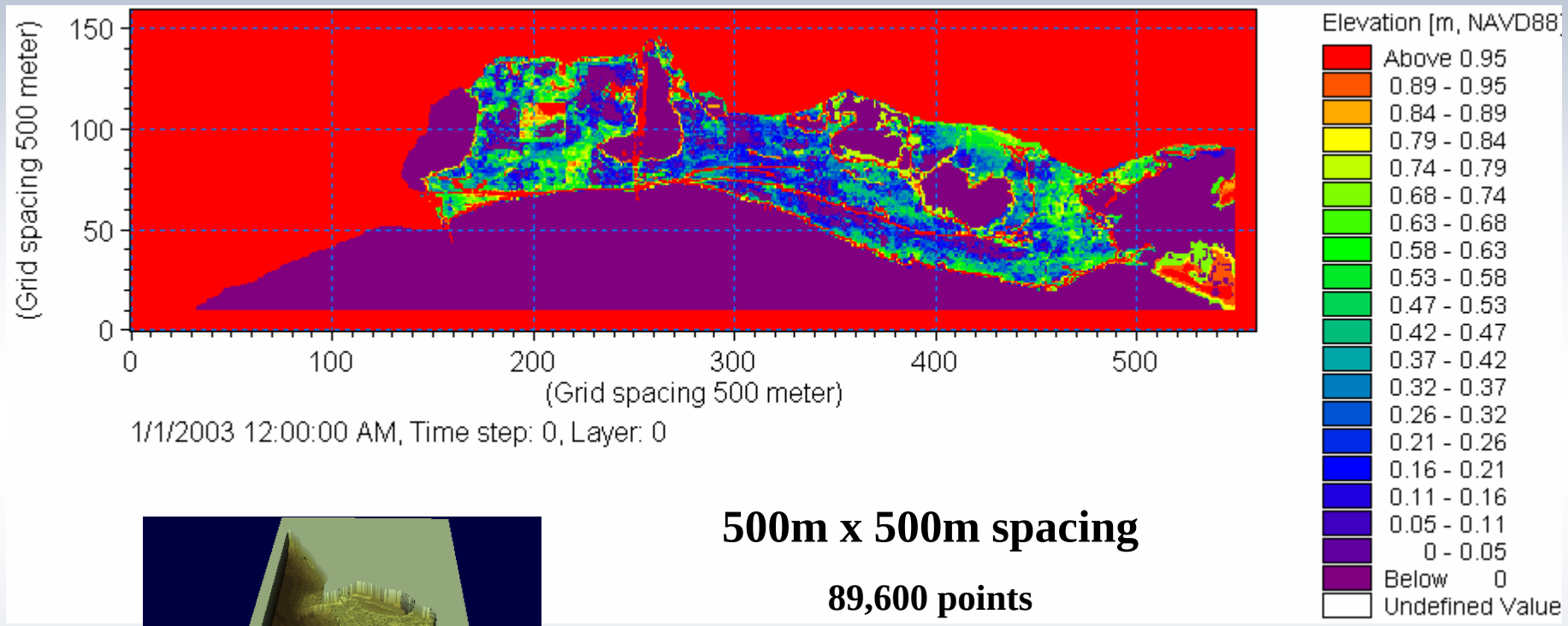
Regional Model

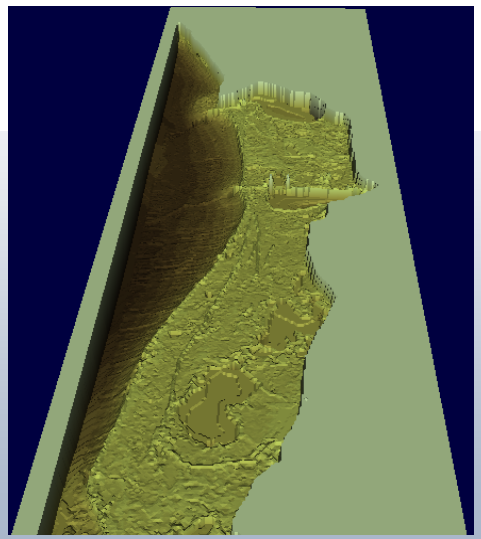
- Provides information about:
  - Circulation patterns
  - Temporal and spatial variability of salinity, sediment and other scalars
  - Frequency and duration of marsh inundation

Regional Model Setup

- DHI MIKE FLOOD
  - MIKE11, MIKE21 HD/AD unsteady modules
- Accepts time-varying boundaries
- Lateral flow exchange between marshes and canals
- Hydraulic structures include weirs, flap-gated culverts, control structures
- 2D Grid represents marsh, open water, and topographical features
- Wetting & Drying capabilities
- 1D channel network

MIKE21 Grid

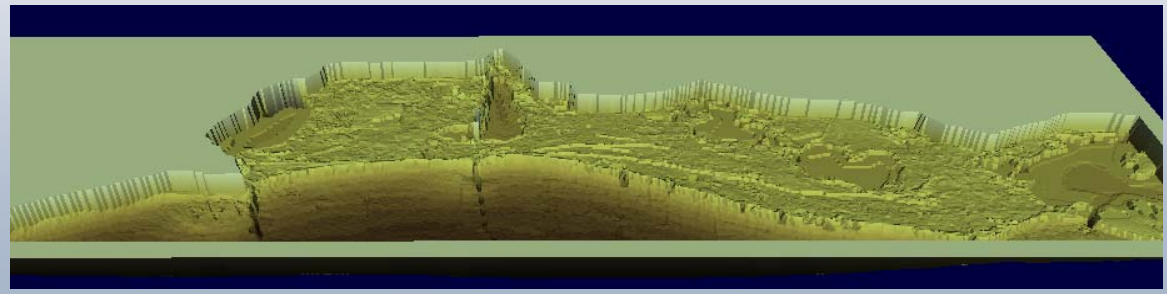




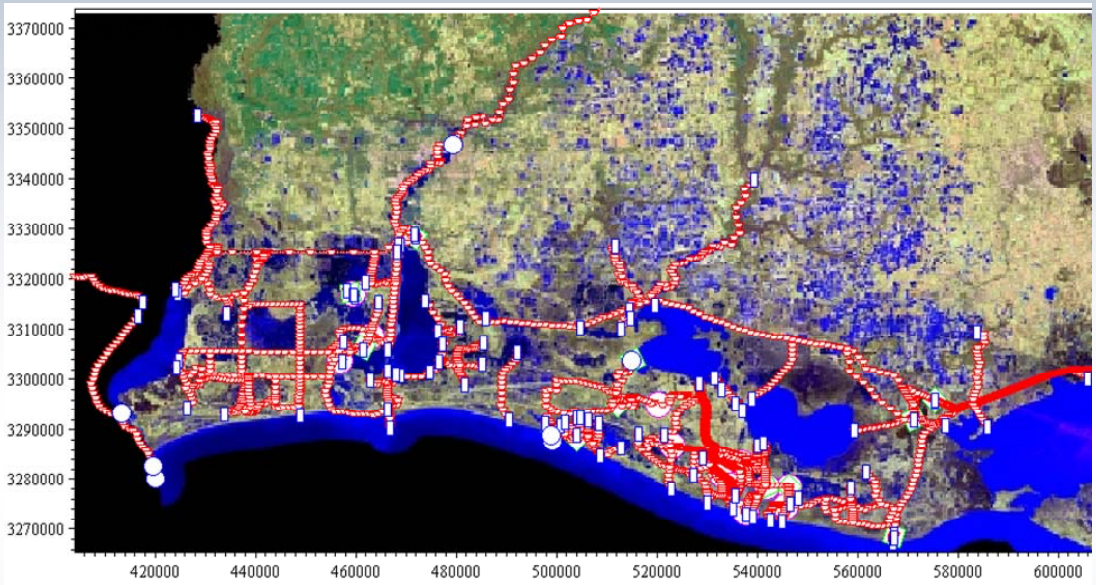
500m x 500m spacing

89,600 points

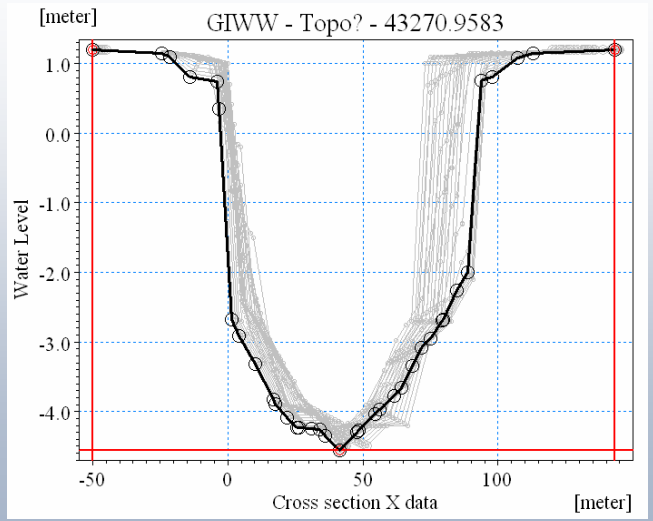
LIDAR/ NOS bathymetric soundings

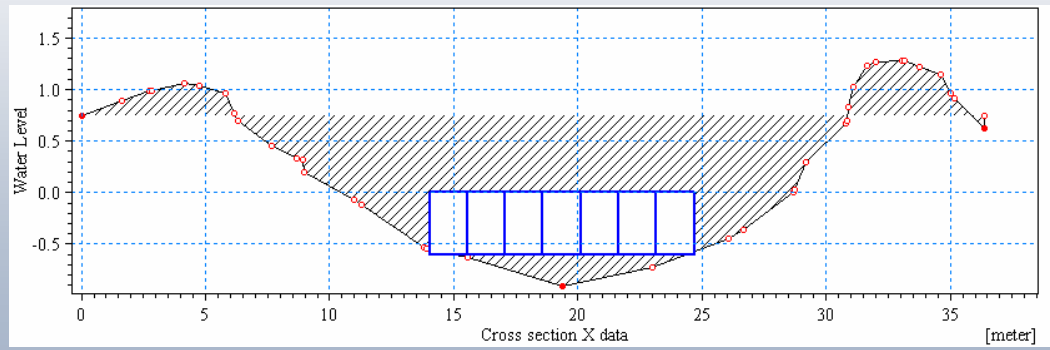


MIKE11 Channel Network



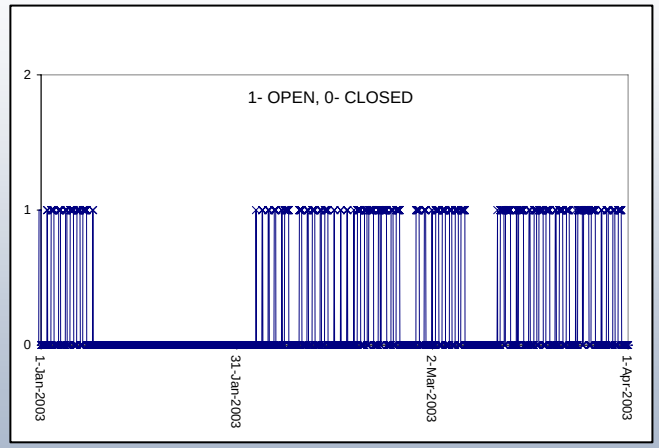
- **6,700 Computational points**
- **23 Hydraulic structures**
- **870 Miles of channels**
- **2,250 Cross-sections**





Structures Included

Real Time Structure Operations



Schooner Bayou Control Structure, 1,195/yr

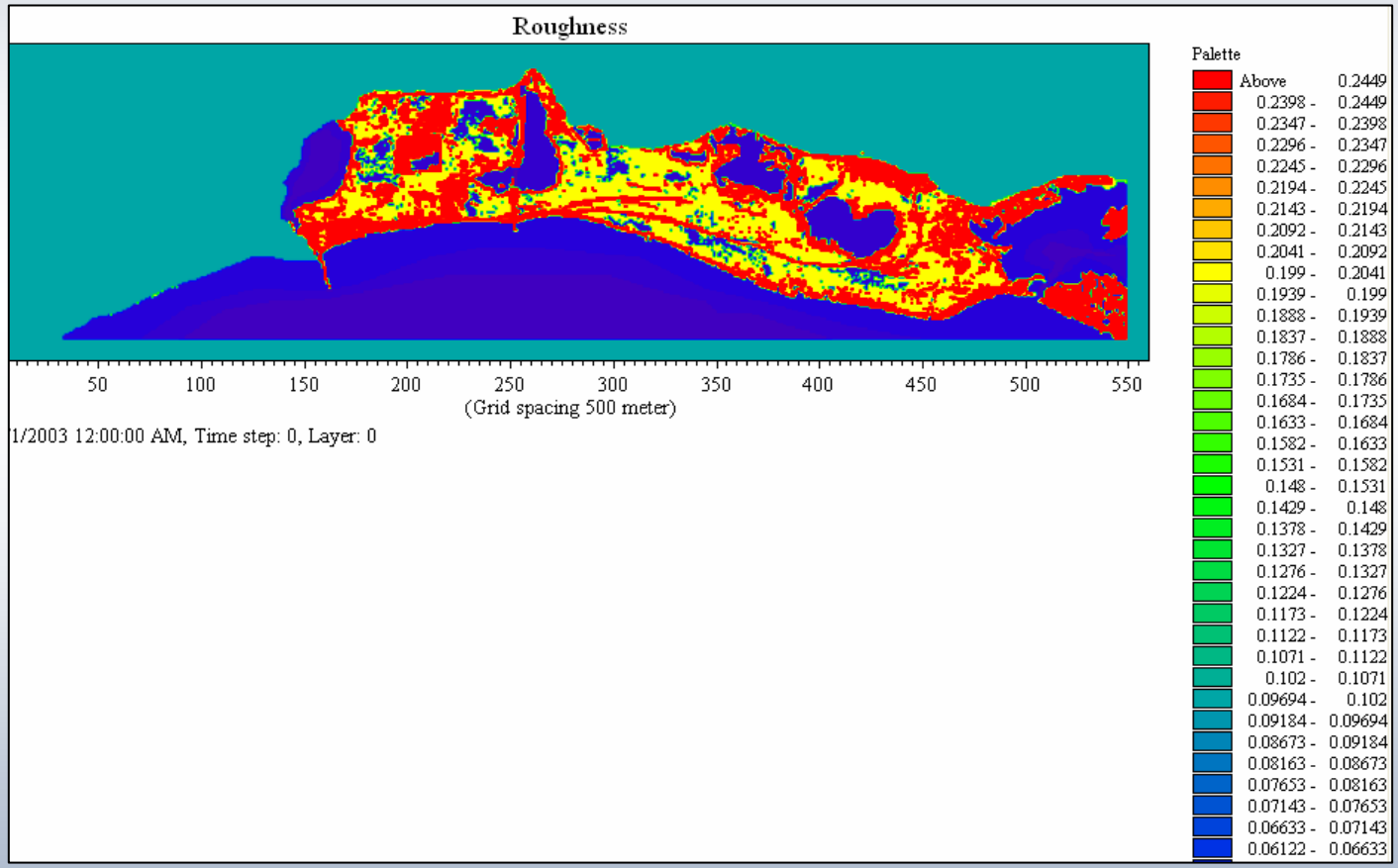
Model Calibration

- 2003 calendar year
- Calibrated for daily and monthly water levels and salinity
- Tropical storms affecting region in 2003: Bill, Claudette, Erika, and Grace
- 1-month HD/AD simulation = 5 hours CPU time
- Model sensitive to discharge, wind stress, and bathymetry and calibration parameters

Calibration Parameters

- Channel and lake bed Manning's numbers
- Open boundary mixing coefficients
- Dispersion coefficients
- Manning's numbers (roughness) influence the tidal signal
- Dispersion coefficients account for advective and diffusive and transport of particles, and scale resolution effects

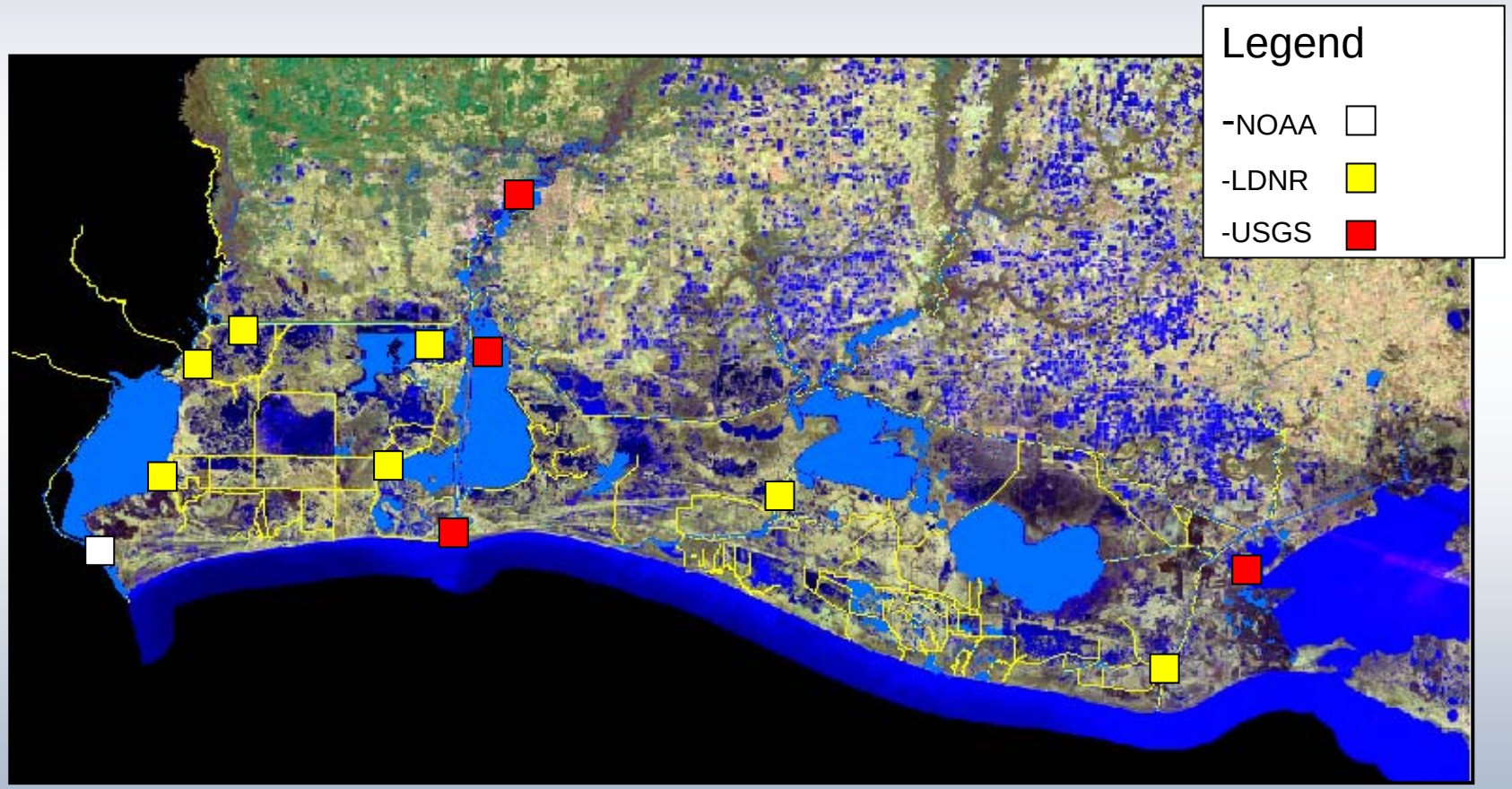
MIKE21 Roughness Map



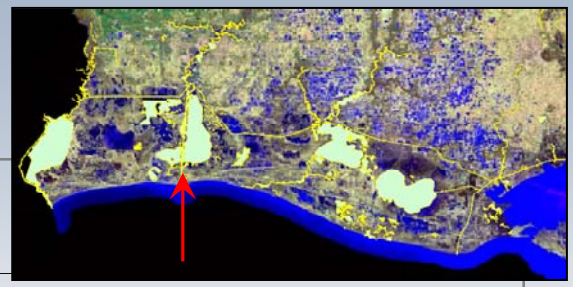
Calibration Values

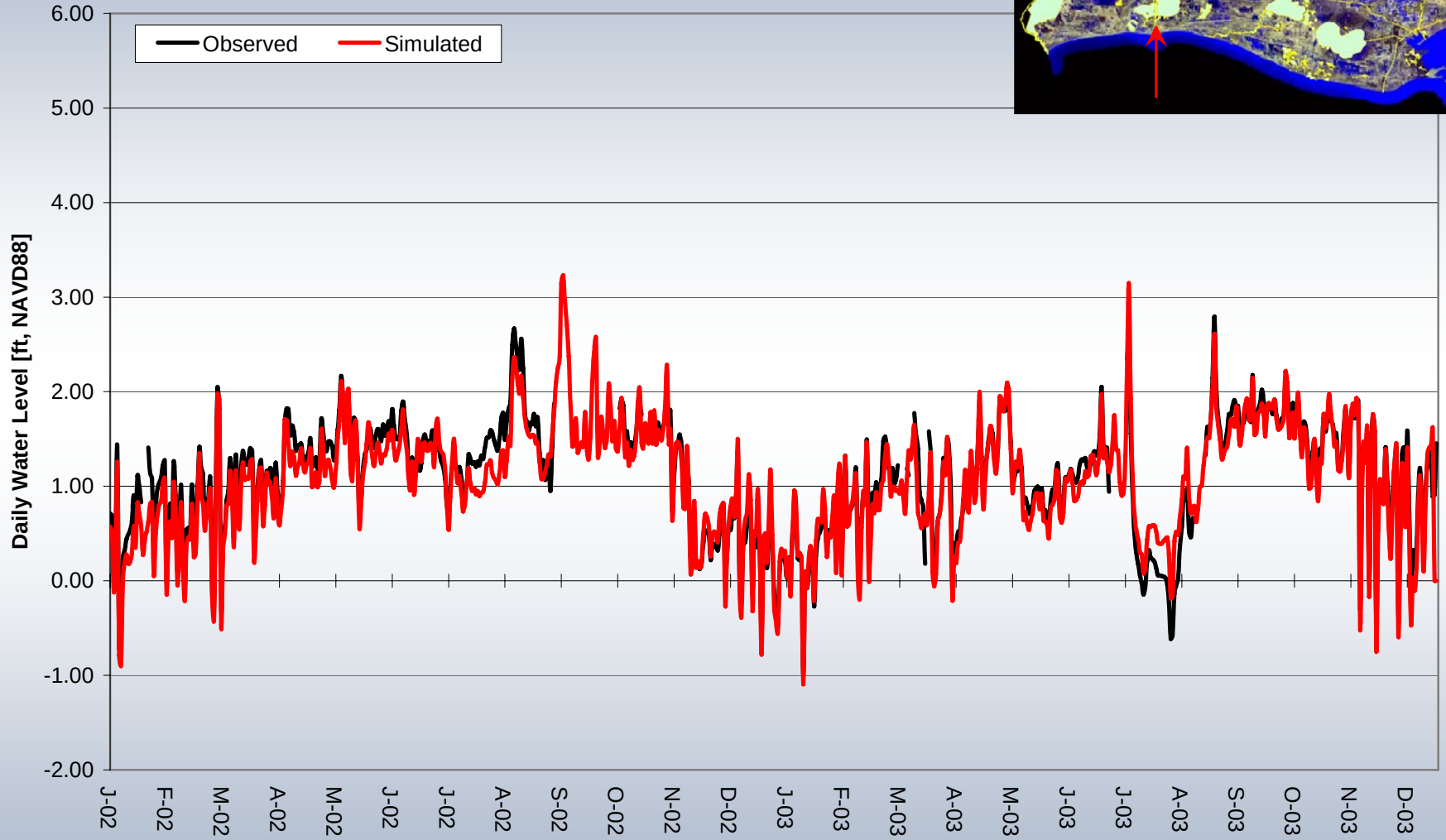
- MIKE11 manning's n = 0.020
- MIKE21 open water manning's n = 0.020 to 0.040
- MIKE11 dispersion coefficients: $D = aV^b$, where V is the cross-sectional velocity
- Values of a=10 to 500, b=0 to 1 give reasonable results
- MIKE11 mixing coefficients, K_{mix} between 0.5 and 1
- MIKE21 dispersion coefficient proportionality factors of 30 in both x and y directions

Calibration Points

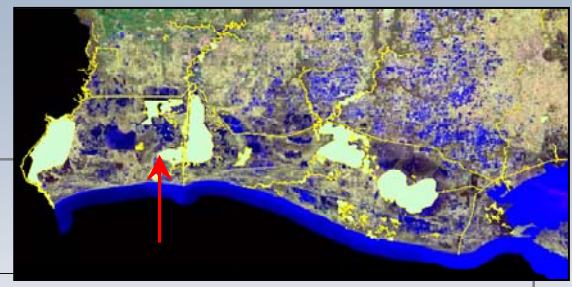


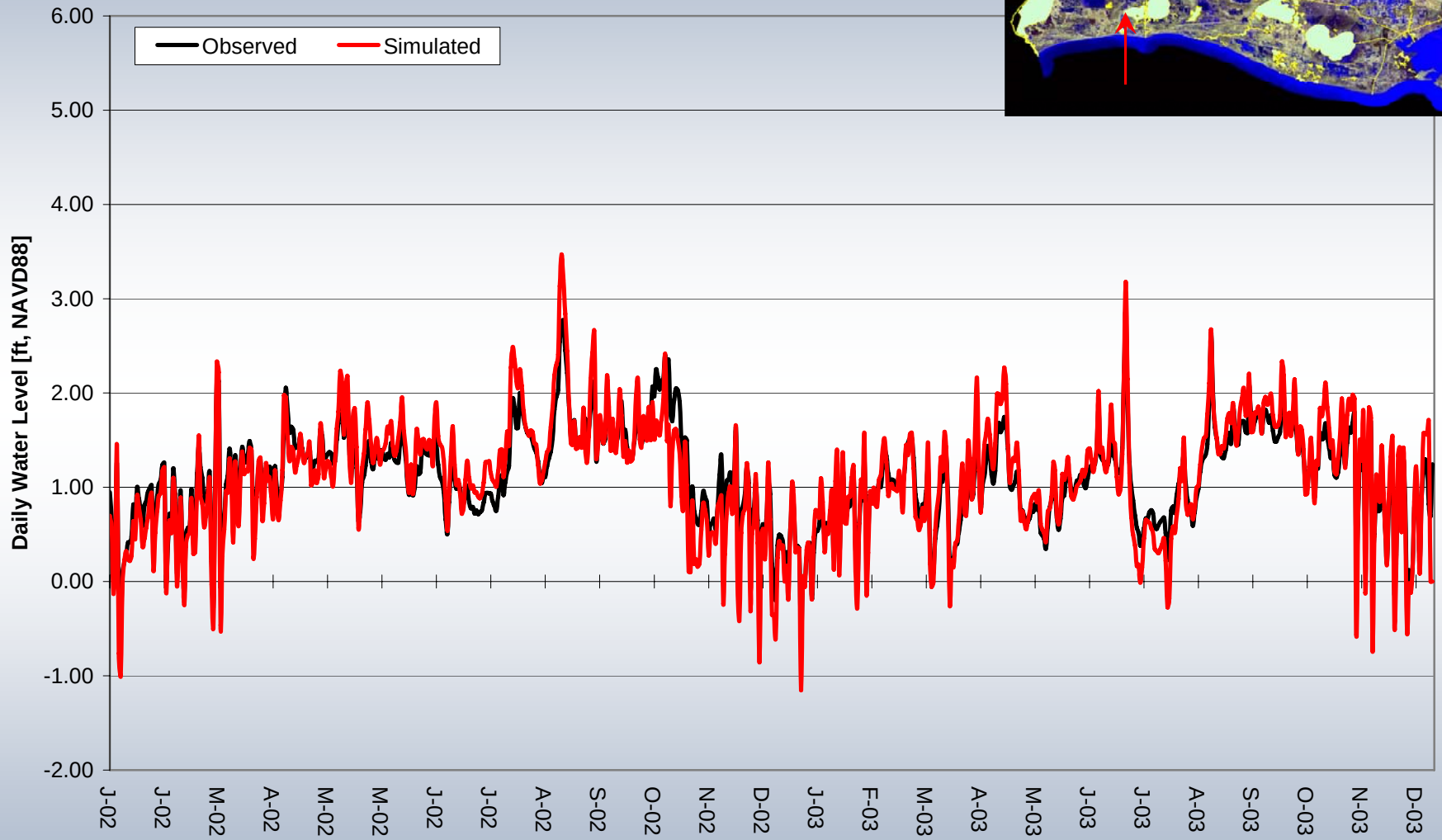
Model Results at USGS Cameron





Model Results at CS20-15R





Model Results at CS09-02R

Observed
Simulated
Calcasieu Lock Operations

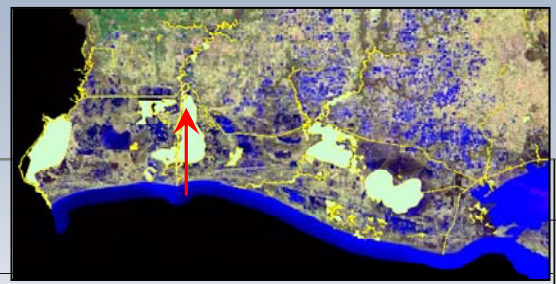
Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at Northlake



Observed
Simulated
Calcasieu Lock Operations

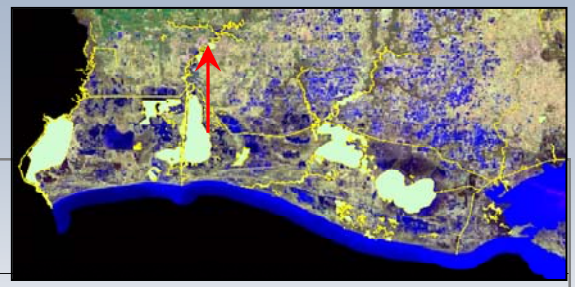
Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at I-10



Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at NOAA Sabine Pass

Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS32-03

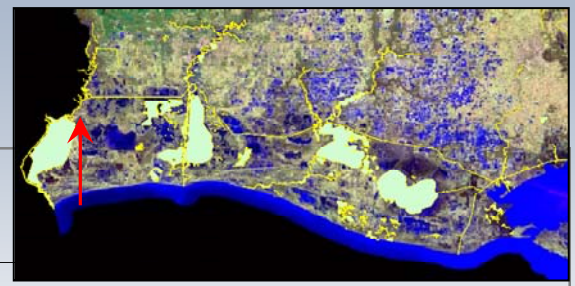
Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS32-04



Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS27-22

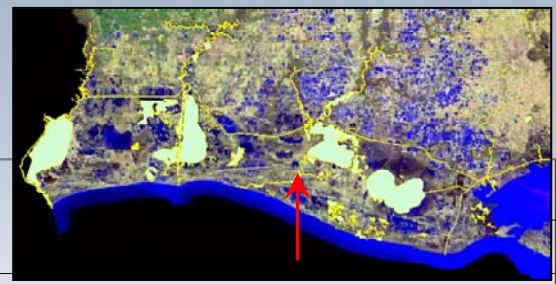
Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at ME11-01R



Observed
Simulated
Catfish Point Operations

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at ME04-36R

Observed
Simulated
Freshwater Lock Operations

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at Fearman Bay

Observed
Simulated

Daily Water Level [ft, NAVD88]

6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00

J-02 J-02 M-02 A-02 M-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Hydrodynamics Performance

Summary Statistics

	USGS Calcasieu Pass	
	Daily	Monthly
"N"	663.00	24.00
RMSDeviation, [ft]	0.19	0.15
Bias, [ft]	-0.07	-0.05
Observed Range, [ft]	3.81	1.54
Observed Average [ft]	1.08	1.10
RMS%	5%	10%
Efficiency []	0.96	0.93

	CS20-15R - West Cove	
	Daily	Monthly
"N"	728.00	24.00
RMSDeviation, ft	0.23	0.15
Bias, [ft]	0.00	0.00
Observed Range, [ft]	3.46	1.45
Observed Average [ft]	1.11	1.11
RMS%	7%	10%
Efficiency []	0.93	0.94

	USGS North Calcasieu Lake	
	Daily	Monthly
"N"	645.00	24.00
RMSDeviation, ft	0.21	0.12
Bias, [ft]	-0.07	-0.06
Observed Range, [ft]	4.02	1.37
Observed Average [ft]	1.15	1.18
RMS%	5%	9%
Efficiency []	0.95	0.95

	CS09-02R, Alkali Ditch	
	Daily	Monthly
"N"	641.00	24.00
RMSDeviation, ft	0.21	0.13
Bias, [ft]	-0.05	-0.05
Observed Range, [ft]	2.70	1.25
Observed Average [ft]	1.18	1.19
RMS%	8%	11%
Efficiency []	0.95	0.95

	USGS Calcasieu River I-10	
	Daily	Monthly
"N"	713.00	24.00
RMSDeviation, ft	0.31	0.18
Bias, [ft]	-0.15	-0.15
Observed Range, [ft]	4.15	1.43
Observed Average [ft]	1.35	1.34
RMS%	8%	13%
Efficiency []	0.92	0.91

	NOAA Sabine Pass	
	Daily	Monthly
"N"	705.00	24.00
RMSDeviation, ft	0.13	0.10
Bias, [ft]	0.08	0.07
Observed Range, [ft]	3.81	1.49
Observed Average [ft]	1.04	1.03
RMS%	3%	7%
Efficiency []	0.98	0.96

	CS32-03 Willow Bayou	
	Daily	Monthly
"N"	567.00	19.00
RMSDeviation, ft	0.18	0.10
Bias, [ft]	0.02	0.02
Observed Range, [ft]	2.21	1.16
Observed Average [ft]	1.17	1.17
RMS%	8%	8%
Efficiency []	0.96	0.97

	CS32-04 Black Bayou	
	Daily	Monthly
"N"	470.00	17.00
RMSDeviation, ft	0.21	0.15
Bias, [ft]	0.13	0.12
Observed Range, [ft]	3.30	1.23
Observed Average [ft]	1.12	1.12
RMS%	6%	12%
Efficiency []	0.93	0.92

	CS27-22 GIWW	
	Daily	Monthly
"N"	562.00	20.00
RMSDeviation, ft	0.24	0.23
Bias, [ft]	0.18	0.20
Observed Range, [ft]	3.59	1.07
Observed Average [ft]	1.08	1.09
RMS%	7%	22%
Efficiency []	0.91	0.82

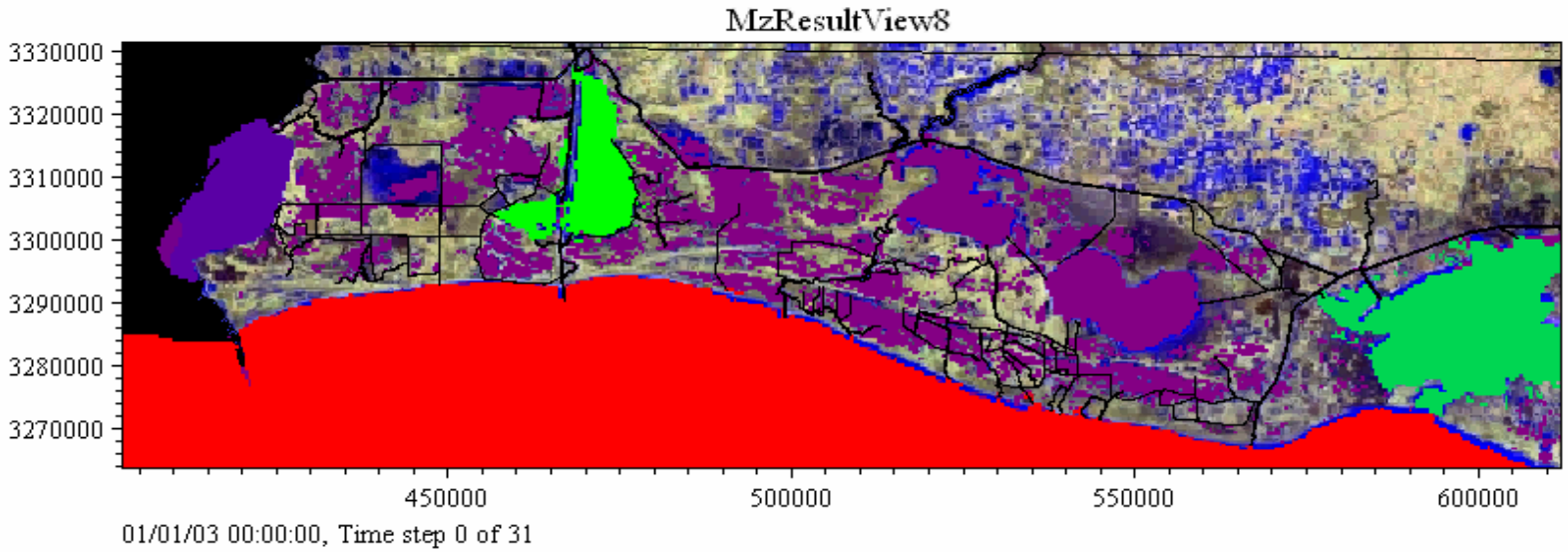
	ME11-01R Mermentau River	
	Daily	Monthly
"N"	695.00	24.00
RMSDeviation, ft	0.41	0.59
Bias, [ft]	-0.13	-0.06
Observed Range, [ft]	4.06	3.00
Observed Average [ft]	1.28	1.22
RMS%	10%	20%
Efficiency []	0.86	0.39

	ME04-36R Saw Tooth Channel	
	Daily	Monthly
"N"	549.00	21.00
RMSDeviation, ft	0.34	0.34
Bias, [ft]	0.01	0.06
Observed Range, [ft]	3.10	1.36
Observed Average [ft]	1.08	1.06
RMS%	11%	25%
Efficiency []	0.83	0.77

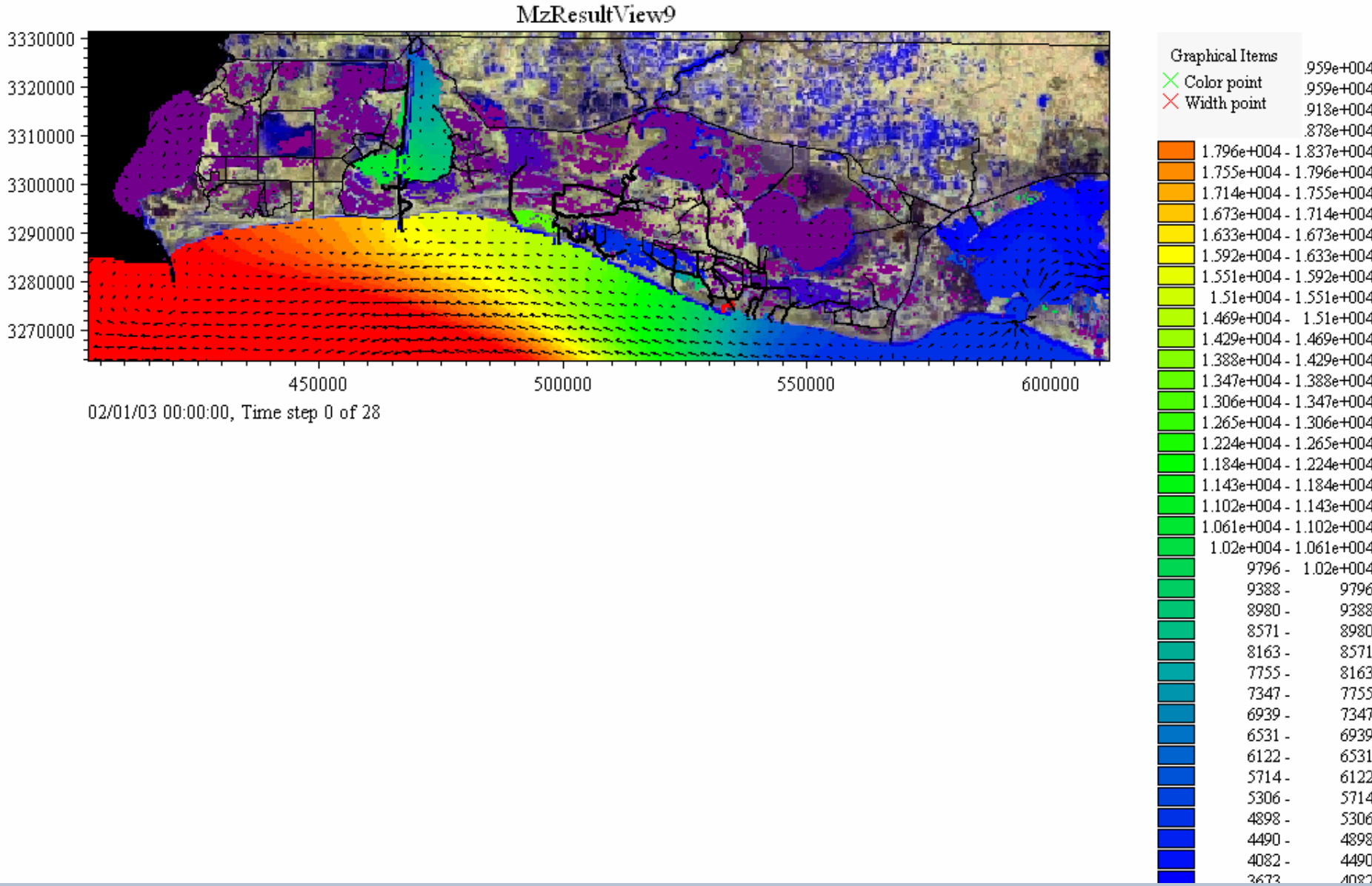
	USGS Fearman Bay	
	Daily	Monthly
"N"	722.00	24.00
RMSDeviation, ft	0.37	0.27
Bias, [ft]	0.05	0.05
Observed Range, [ft]	6.15	1.60
Observed Average [ft]	1.08	1.08
RMS%	6%	17%
Efficiency []	0.84	0.83

Model Performance

Regional Model Salinity

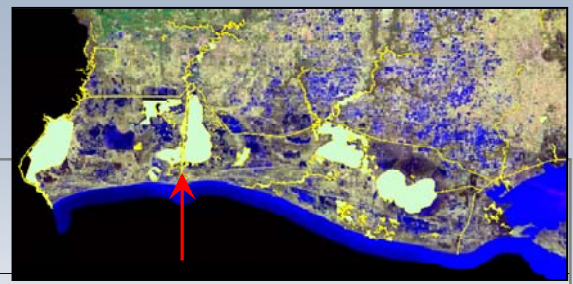


January 2003 Salinity



February 2003 Salinity

Model Results at USGS 080170118



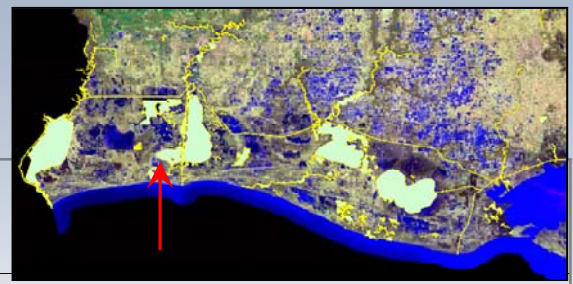
Observed
Simulated

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS20-15R



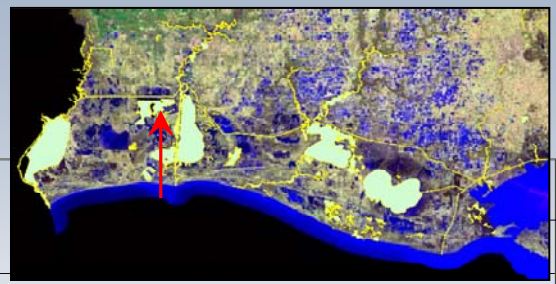
Observed
Simulated

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS09-02R



Observed
Simulated
Calcasieu Lock Operations

Daily Salinity [PPT]

40
35
30
25
20
15
10
5
0

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at North Calcasieu Lake

Observed
Simulated
Calcasieu Lock Operations

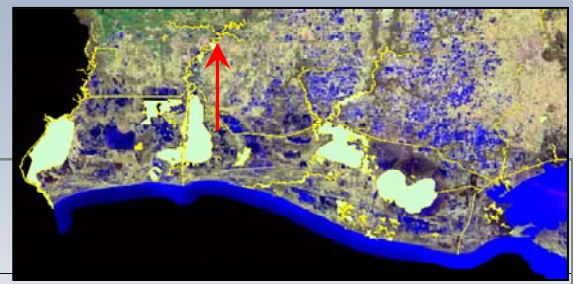
Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at USGS I-10



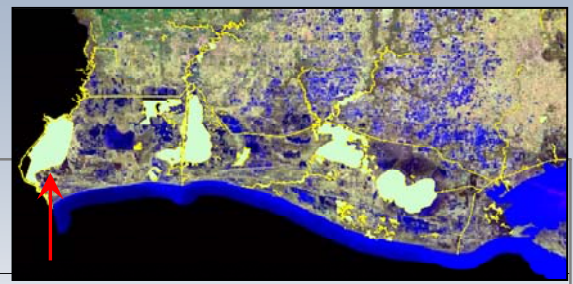
Observed
Simulated

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS32-03



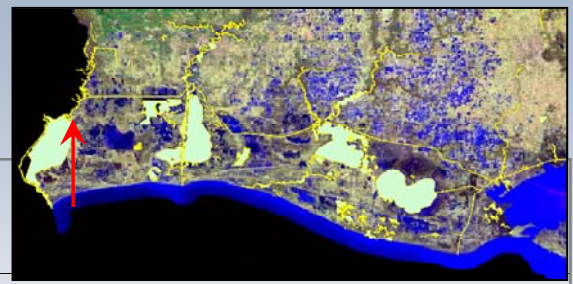
Observed
Simulated

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at CS32-04

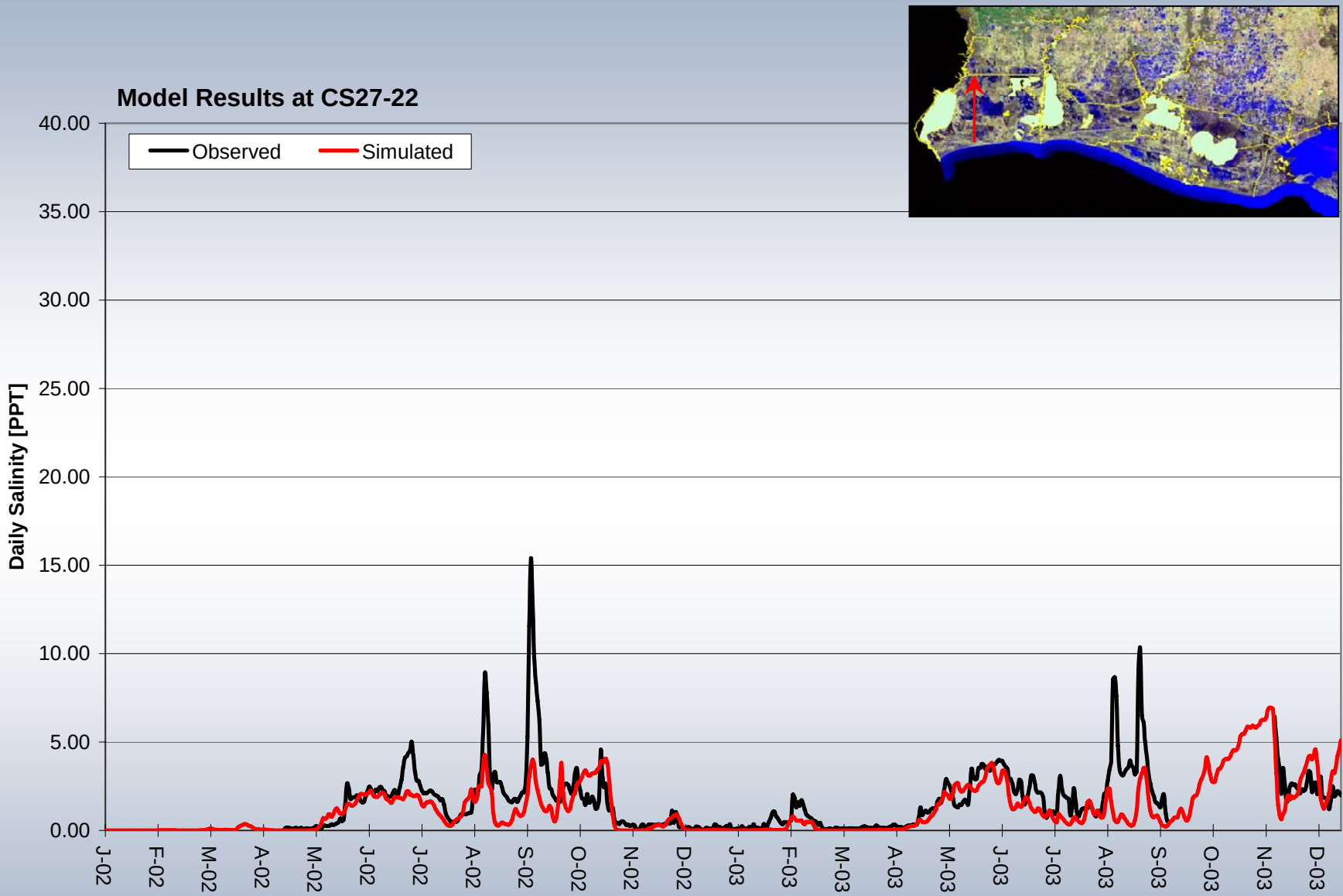


Observed
Simulated

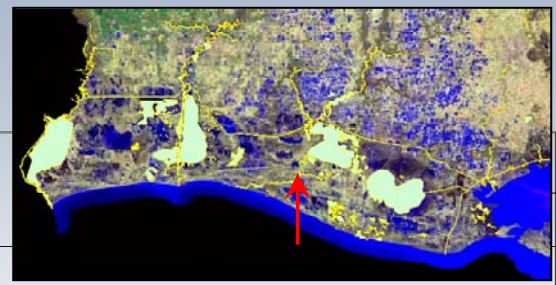
Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03


Model Results at CS27-22
Observed
Simulated
Daily Salinity [PPT]
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
J-02
F-02
M-02
A-02
M-02
J-02
J-02
A-02
S-02
O-02
N-02
D-02
J-03
F-03
M-03
A-03
M-03
J-03
J-03
A-03
S-03
O-03
N-03
D-03

Model Results at ME11-01R



Observed
Simulated
Catfish Point Operations

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at ME04-26R

Observed
Simulated
Freshwater Lock Operations

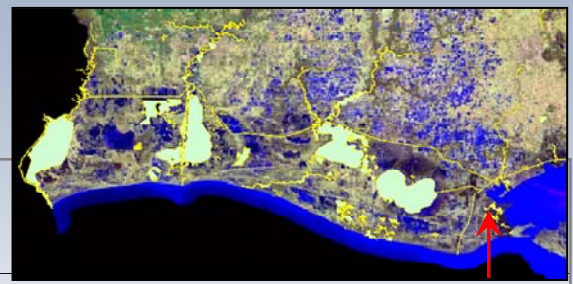
Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

Model Results at USGS Fearman Bay



Observed
Simulated

Daily Salinity [PPT]

40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00

J-02 F-02 M-02 A-02 M-02 J-02 J-02 A-02 S-02 O-02 N-02 D-02 J-03 F-03 M-03 A-03 M-03 J-03 J-03 A-03 S-03 O-03 N-03 D-03

	Calcasieu Pass near Cameron	
	Daily	Monthly
"N" (Comparisons)	651.00	24.00
RMSDeviation, [PPT]	4.71	3.73
Bias, [PPT]	-1.06	-2.78
Observed Range, [PPT]	28.13	17.41
Observed Average [PPT]	17.39	17.40
RMS% [%]	17%	21%
Efficiency	0.17	0.03
	CS20-15R near West Cove	
	Daily	Monthly
"N" (Comparisons)	728.00	24.00
RMSDeviation, [PPT]	5.50	4.83
Bias, [PPT]	3.31	3.30
Observed Range, [PPT]	19.33	14.27
Observed Average [PPT]	8.31	8.31
RMS% [%]	28%	34%
Efficiency	-0.30	-0.48
	CS09-02R Alkali Ditch	
	Daily	Monthly
"N" (Comparisons)	641.00	24.00
RMSDeviation, [PPT]	3.20	2.66
Bias, [PPT]	-1.22	-1.81
Observed Range, [PPT]	22.30	12.75
Observed Average [PPT]	7.25	7.12
RMS% [%]	14%	21%
Efficiency	0.48	0.44

	USGS North Calcasieu Lake	
	Daily	Monthly
"N" (Comparisons)	695.00	24.00
RMSDeviation, [PPT]	3.66	2.55
Bias, [PPT]	0.07	-0.50
Observed Range, [PPT]	22.78	15.55
Observed Average [PPT]	11.14	11.20
RMS% [%]	16%	16%
Efficiency	0.44	0.59

	USGS Calcasieu River at I-10	
	Daily	Monthly
"N" (Comparisons)	689.00	24.00
RMSDeviation, [PPT]	2.25	1.73
Bias, [PPT]	-0.41	-0.54
Observed Range, [PPT]	14.70	8.90
Observed Average [PPT]	3.83	3.76
RMS% [%]	15%	19%
Efficiency	0.57	0.59

	CS32-03 near Willow Bayou	
	Daily	Monthly
"N" (Comparisons)	567.00	19.00
RMSDeviation, [PPT]	3.05	2.72
Bias, [PPT]	2.74	2.59
Observed Range, [PPT]	12.06	7.79
Observed Average [PPT]	3.83	3.86
RMS% [%]	25%	35%
Efficiency	-0.35	-0.45

	CS32-04 Black Bayou	
	Daily	Monthly
"N" (Comparisons)	470.00	17.00
RMSDeviation, [PPT]	1.71	1.32
Bias, [PPT]	3.71	3.01
Observed Range, [PPT]	8.91	4.79
Observed Average [PPT]	2.38	2.53
RMS% [%]	19%	27%
Efficiency	0.31	0.34

	CS27-22 GIWW	
	Daily	Monthly
"N" (Comparisons)	562.00	20.00
RMSDeviation, [PPT]	1.52	1.06
Bias, [PPT]	-0.55	-0.47
Observed Range, [PPT]	15.35	4.29
Observed Average [PPT]	1.71	1.74
RMS% [%]	10%	25%
Efficiency	0.29	0.29

	ME11-01R Mermentau River	
	Daily	Monthly
"N" (Comparisons)	695.00	24.00
RMSDeviation, [PPT]	4.34	3.47
Bias, [PPT]	1.22	1.39
Observed Range, [PPT]	18.07	8.76
Observed Average [PPT]	2.64	2.55
RMS% [%]	24%	40%
Efficiency	-0.14	-0.33

	ME04-26R Freshwater Bayou	
	Daily	Monthly
"N" (Comparisons)	543.00	24.00
RMSDeviation, [PPT]	3.02	2.77
Bias, [PPT]	1.19	1.30
Observed Range, [PPT]	7.63	3.94
Observed Average [PPT]	1.96	1.86
RMS% [%]	40%	70%
Efficiency	-5.68	-8.26

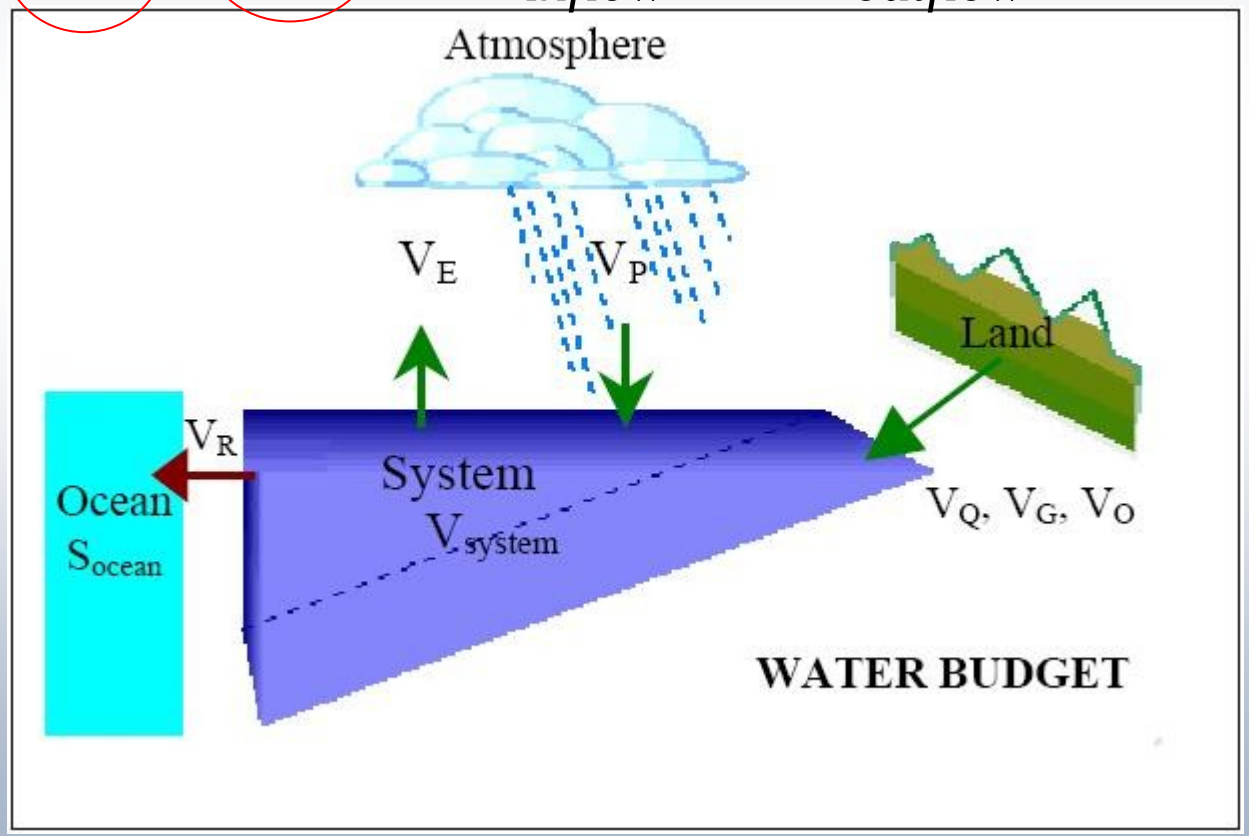
	USGS Fearman Bay	
	Daily	Monthly
"N" (Comparisons)	636.00	22.00
RMSDeviation, [PPT]	1.68	1.32
Bias, [PPT]	-0.53	-0.55
Observed Range, [PPT]	9.98	7.36
Observed Average [PPT]	3.61	3.58
RMS% [%]	17%	18%
Efficiency	0.47	0.59

Water Budget :

Data, Equipment, and Preliminary Analysis

Water Budget

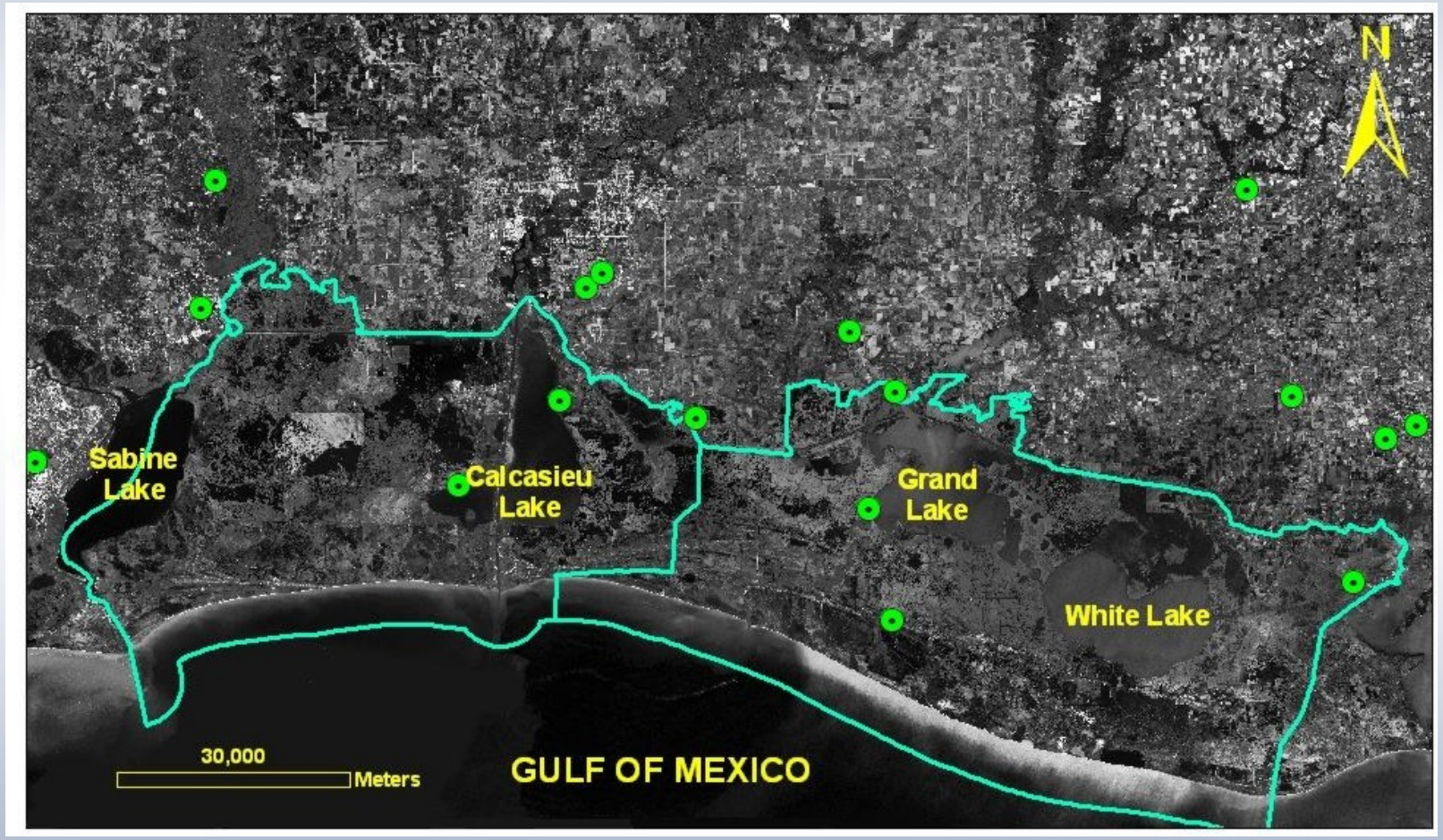
$$P - ET + Q_{inflow} - Q_{outflow} = \varepsilon$$



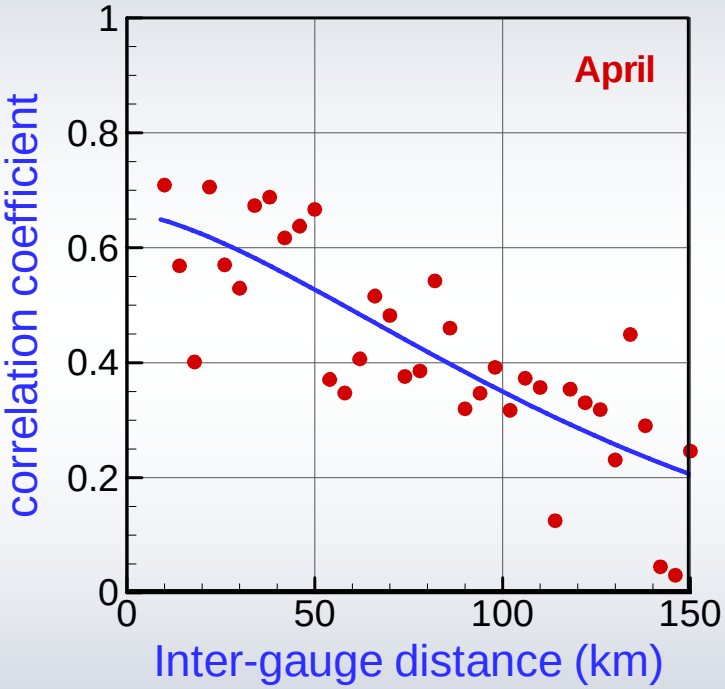
Precipitation

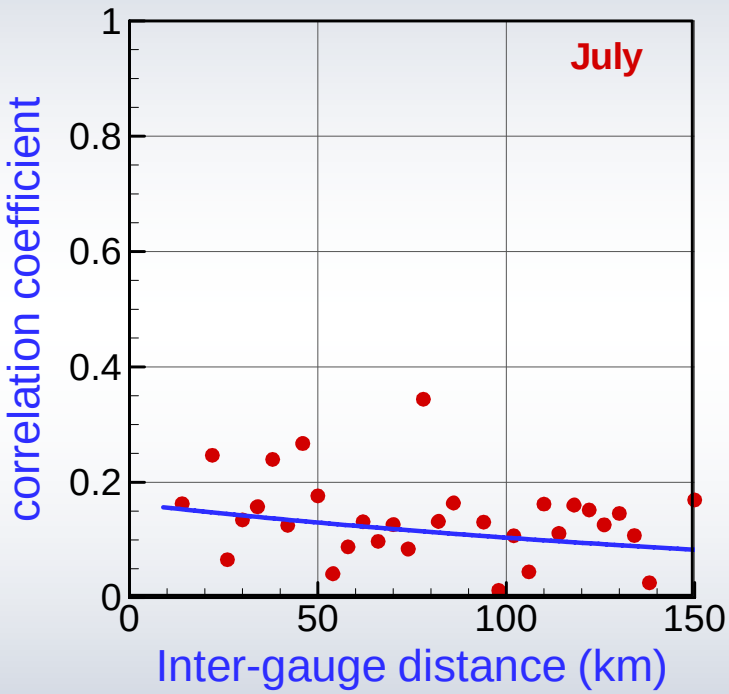
$$P - ET + Q_{inflow} - Q_{outflow} = \varepsilon$$

Rain gauges in the Chenier Plain

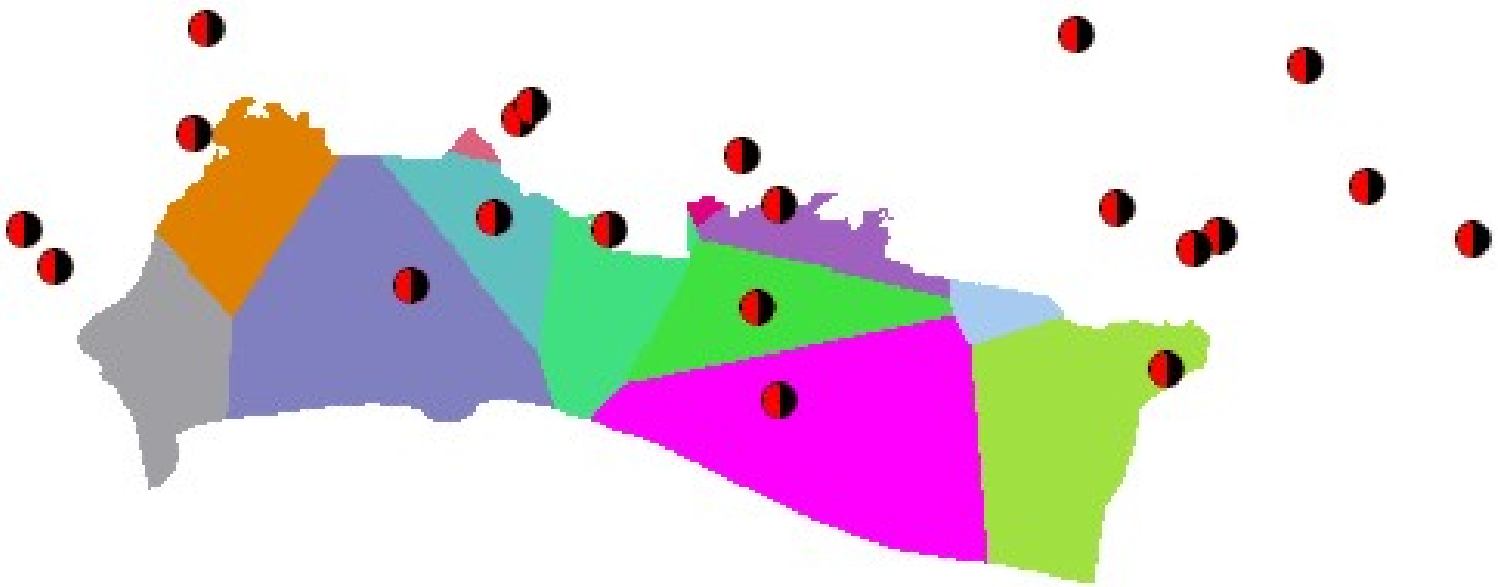


Spatial variability of rainfall





Thiessen polygons for Precipitation



Other methods to be considered:
Geo-statistical approach; e.g., Kriging optimal estimation method

$$P - ET + Q_{inflow} - Q_{outflow} = \varepsilon$$

Evapotranspiration

Actual ET =

Reference Potential ET_0 x K_c x K_s

Reference crop
Unlimited water supply

Vegetation-specific coefficient

Water-stress coefficient

List of equations and sources for ET calculations (1/7)

FAO 56 Penman-Monteith equation:

ET=f (Solar radiation, Temperature, wind speed, humidity)

$$ET_0 = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T_m + 273} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)}$$

Δ = slope of saturation vapor pressure [versus air temperature] curve (kPa/°C)
Rn = mean daily net radiation (MJ/m2.day)
G = soil heat flux (MJ/m2.day) [G ≈ 0 for day and ten-day periods]
γ = psychrometric constant (0.067 kPa/°C for 0-100 m elevation)
Tm = “mean” daily air temperature at 2 m height (°C)
U2 = mean daily wind speed at 2 m height (m/s)
es = “mean” saturation vapor pressure (kPa)
ea = actual vapor pressure (kPa)

Allen, R. G., Pereira, L. S., Raes, D., Smith, M. (1998). ‘‘Crop evapotranspiration: Guidelines for computing crop water requirements.’’ *Irrigation and Drainage Paper 56*, United Nations Food and Agriculture Organization, Rome.

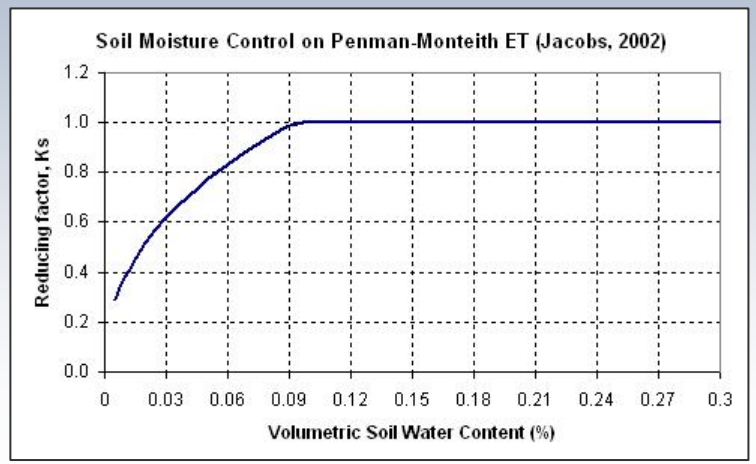
Challenges in Estimation of Basin-average ET

- Sparse stations
- Lack of necessary data
- Unknown quality of data
- Lack of information on vegetation-specific ET coefficients

Explanation for next slide

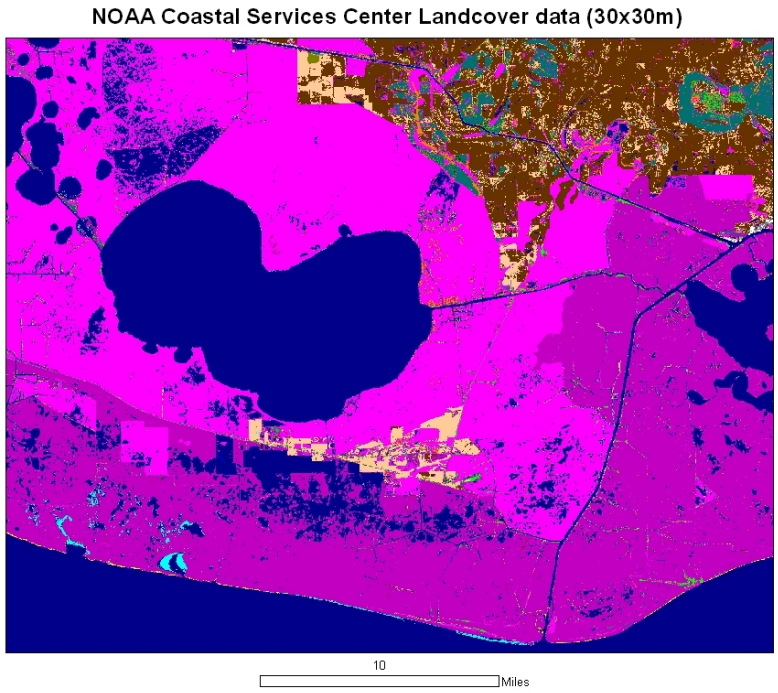
- Penman-Monteith equation to be used wherever possible
- Crop coefficient, K_c, to be used based on NOAA 30 x 30 m^2 landcover database
- Stress coefficient, K_s, will be set to one, based on relationship by Jacobs (2002) and on our soil moisture data (>>0.09%)

Atmospheric terms: Evapotranspiration



Local Evapotranspiration (ET) function of water supply (stress coefficient), Crop type, Reference ET:

$$ET = K_S \, K_C \, ET_0$$



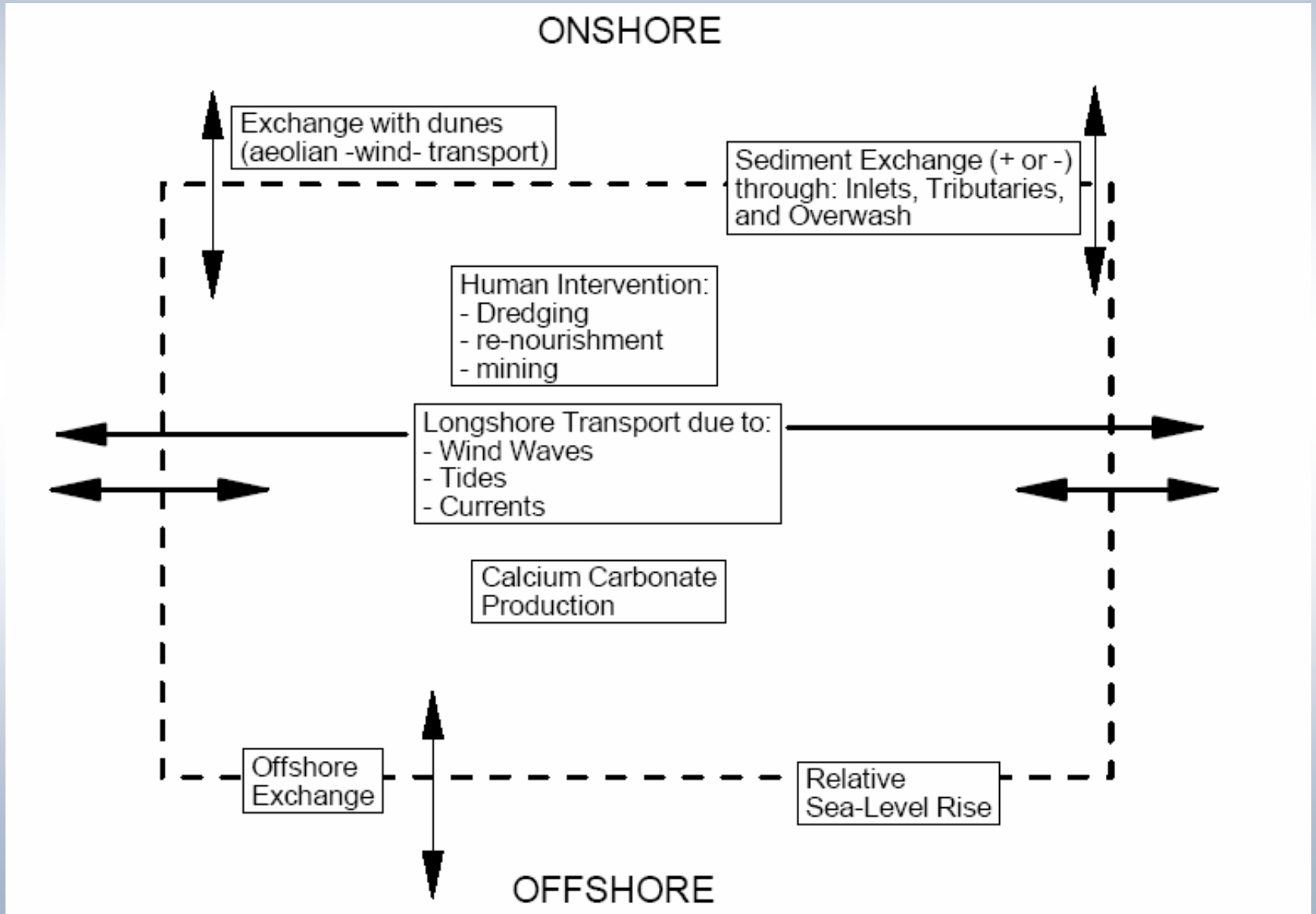
Penman-Monteith Reference ET equation, as recommended by the ASCE (Walter *et al.*, 2000):

$$ET_0 = \frac{0.408\,\Delta\left(R_n - G\right) + \gamma \dfrac{C_n}{T + 273} u_2 \left(e_s - e_a\right)}{\Delta + \gamma\left(1 + C_d u_2\right)}$$

Short reference crop, daily time step:

C_n = 900, C_d = 0.34

Sediment Budget



Methods


N
W
E
S
Image © 2006 TerraMetrics
© 2005 Google
Pointer 29°47'29.52" N 93°10'47.21" W elev 0 m
Streaming 100%
Eye alt 140.27 km

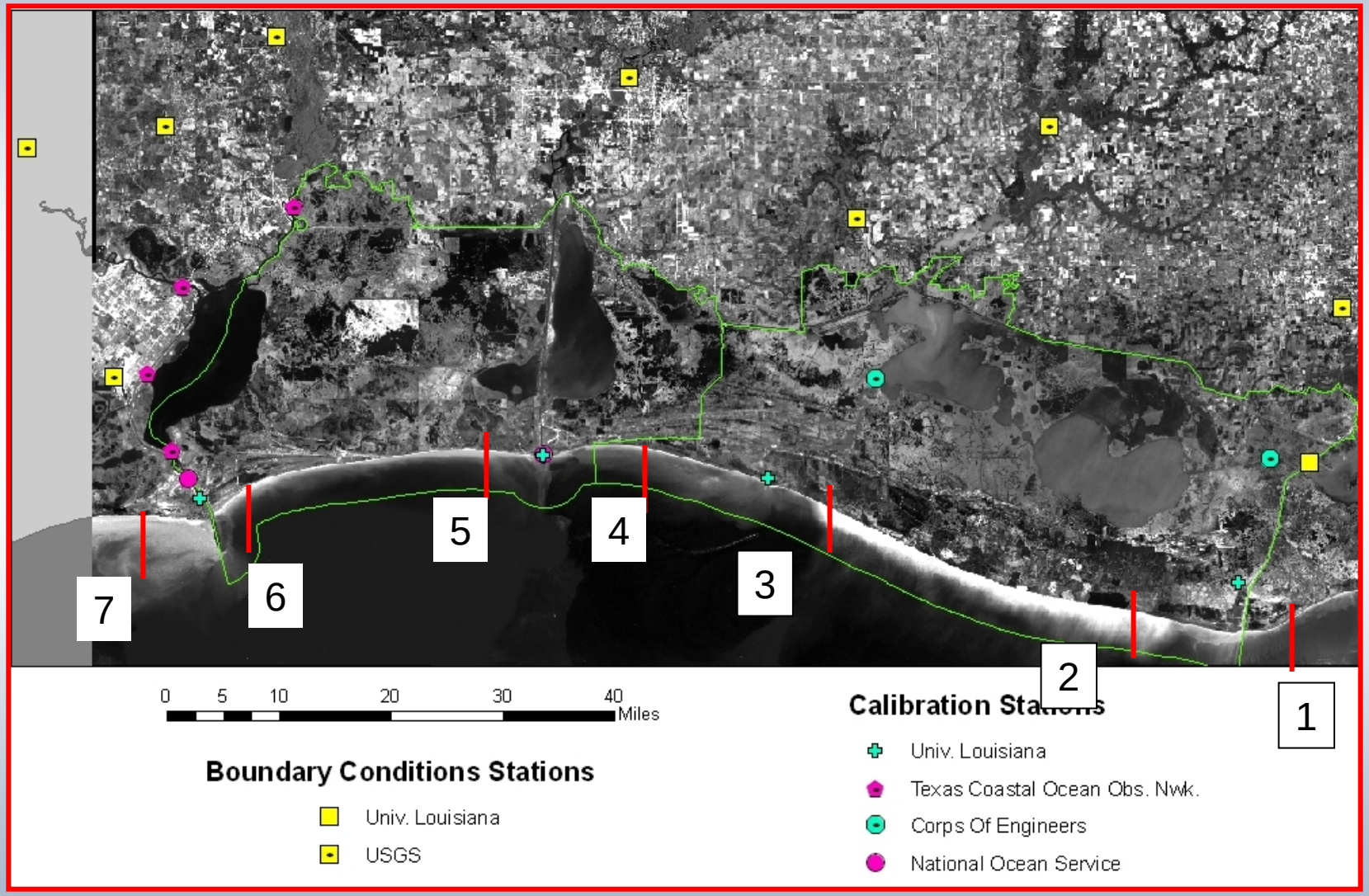
Method for Sediment Budget

- Offshore component:
  - Gulf Mexico (fine sediments from Mississippi and Atchafalaya Rivers)
  - A net component of fine sediment will be incorporated into the offshore component, as well as the near-shore component

Method for Sediment Budget

- Near shore exchange component:
  - Wave modeling (non-cohesive transport)
    - 1D models will be used to determine the non-cohesive longshore transport component
  - Supplement findings with dredging records, and using general trends from Bathymetric surveys, grain size analysis
    - These records and field data will be used to determine storage and accumulation quantities in the system.

Beach cross sections

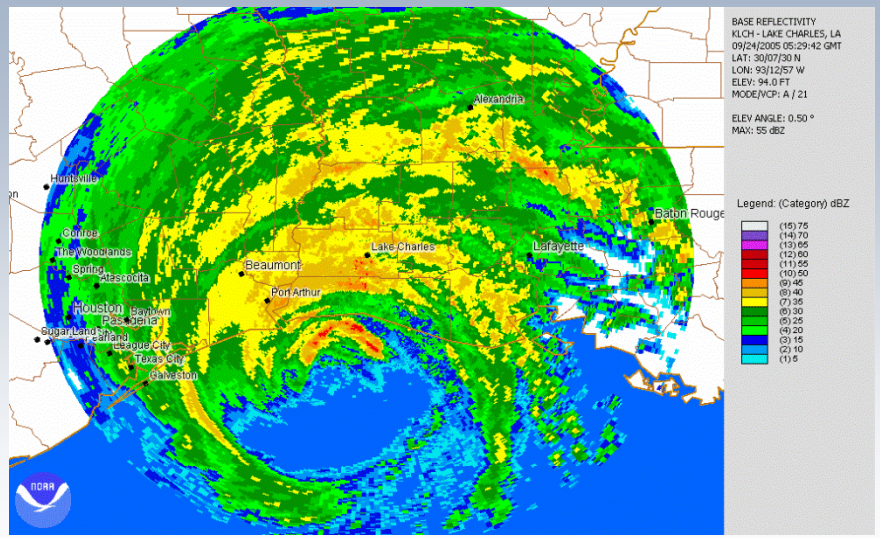


Method for Sediment Budget

- Onshore component:
  - Exchange with tidal passes using fluxes computed from regional modeling
    - Fluxes computed from the model will be used to determine net exchange between the interior wetlands and water bodies and the beach

Method for Sediment Budget

- River/upland input:
  - Turbidity input from gauges placed in rivers and suspended sediment grab samples
    - River input will be computed using continuous turbidity measurements as well as suspended sediment grab samples collected at the same locations



Louisiana Coastal Protection and Restoration: Chenier Plain Project

Scope

- Hydrologic Modeling of the Mermentau-Calcasieu Basins
- Hydrodynamic Modeling of the Chenier Plain Region
- Analysis/Assessment of the Hurricane Category 5 Levee protection Alternatives
  - 100 yr storm conditions
  - Hurricane cat 5 + 5/10 yr rainfall storm
- Participate with COE design of drainage structures (e.g. pump stations, reservoirs, detention ponds, etc.)

Hurricane Barrier Plan Alignments

Area = 6500 Sq. Miles

Legend

Watershed Boundary

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Watershed Boundary

Model Setup – 07/06/07

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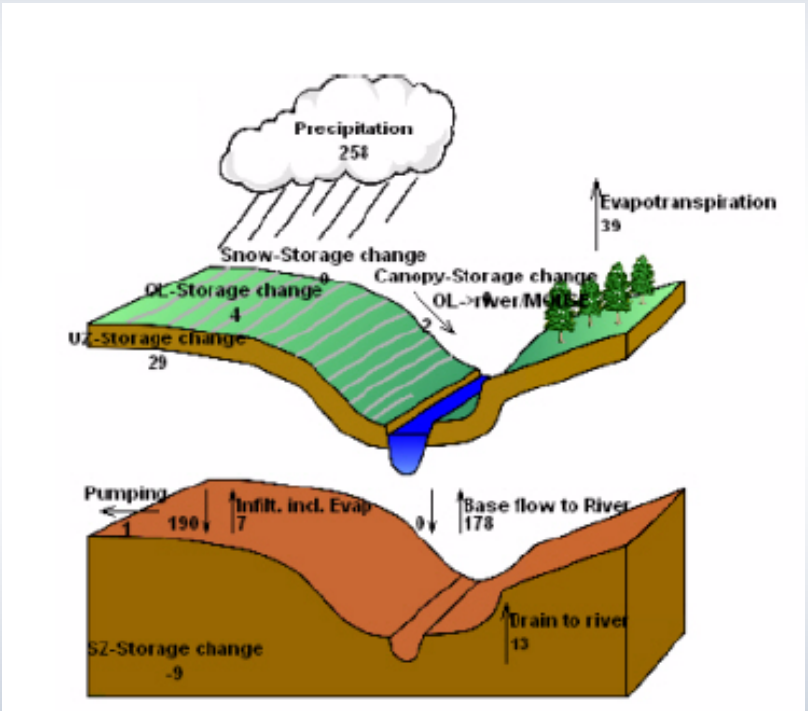
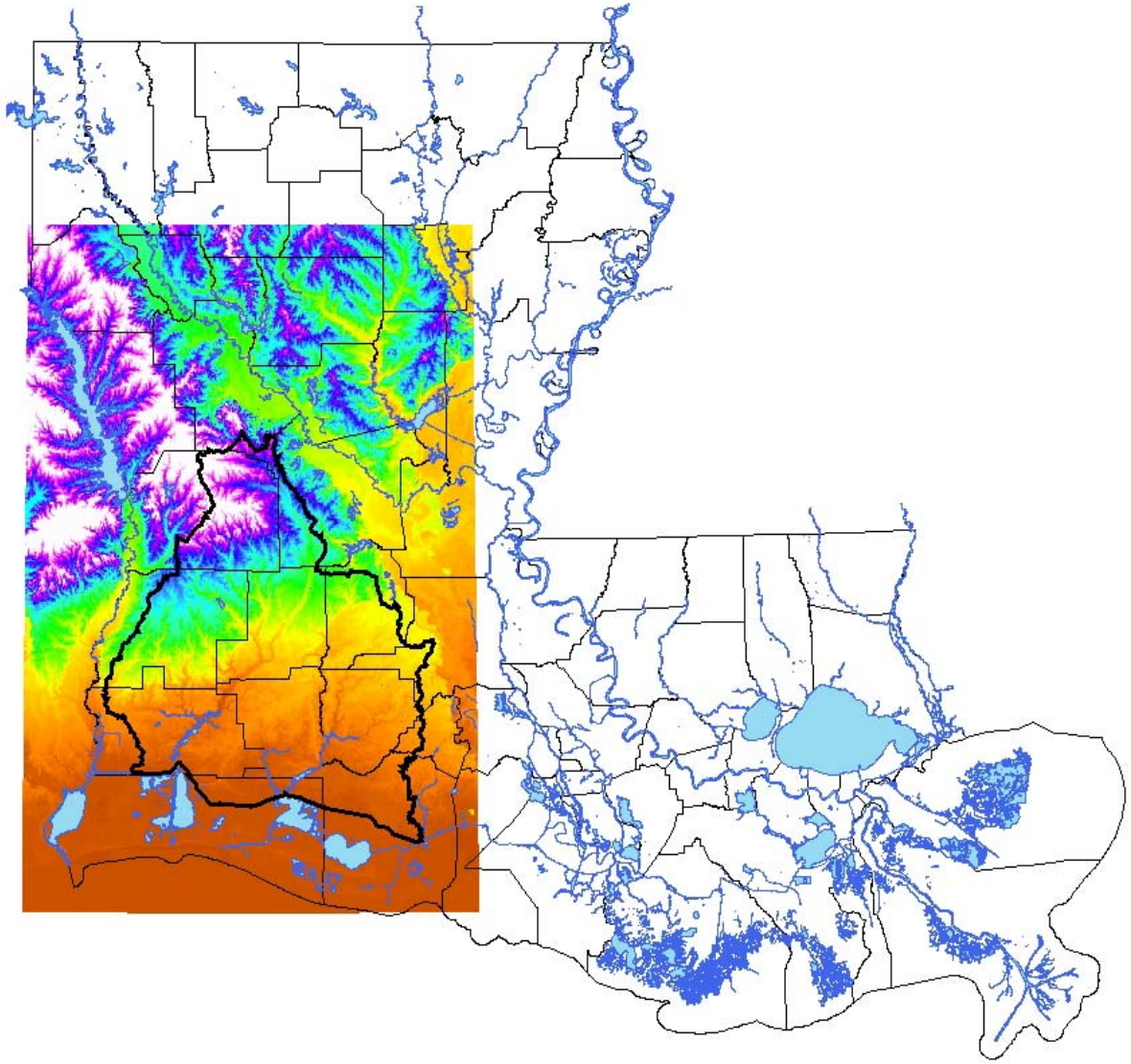
MIKE SHE

- MIKE SHE is a physically-based distributed hydrologic model.





Topography Data:

- USGS Seamless Data Distribution System

- 30 m resolution

3D Visualization of topography

Elevation Legend

185 ft NAVD 88

0 ft NAVD 88

Digital Elevation Model

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University of Louisiana Lafayette

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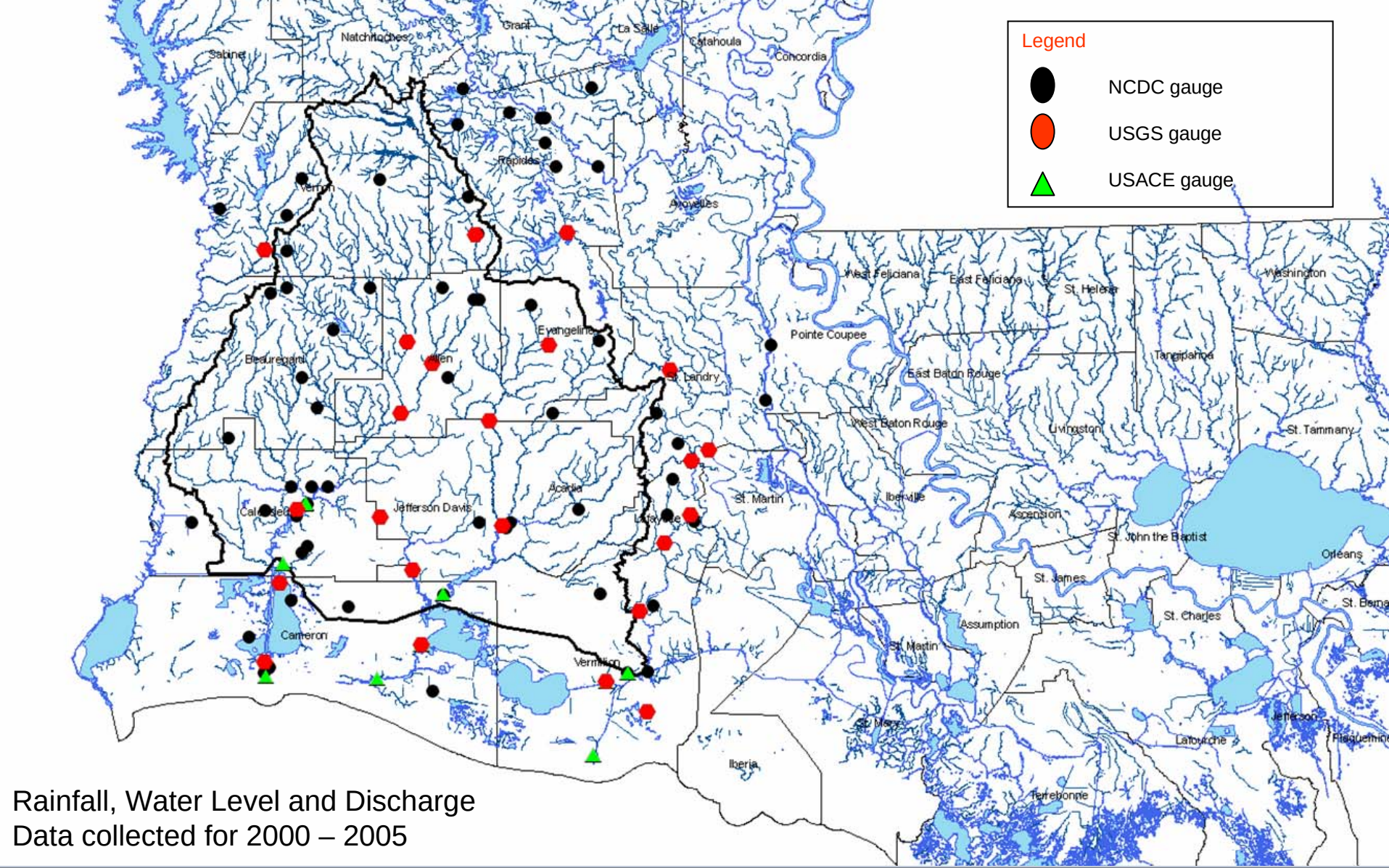

Rainfall, Water Level and Discharge
Data collected for 2000 – 2005

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All Available Gauges

Model Setup – 07/06/07

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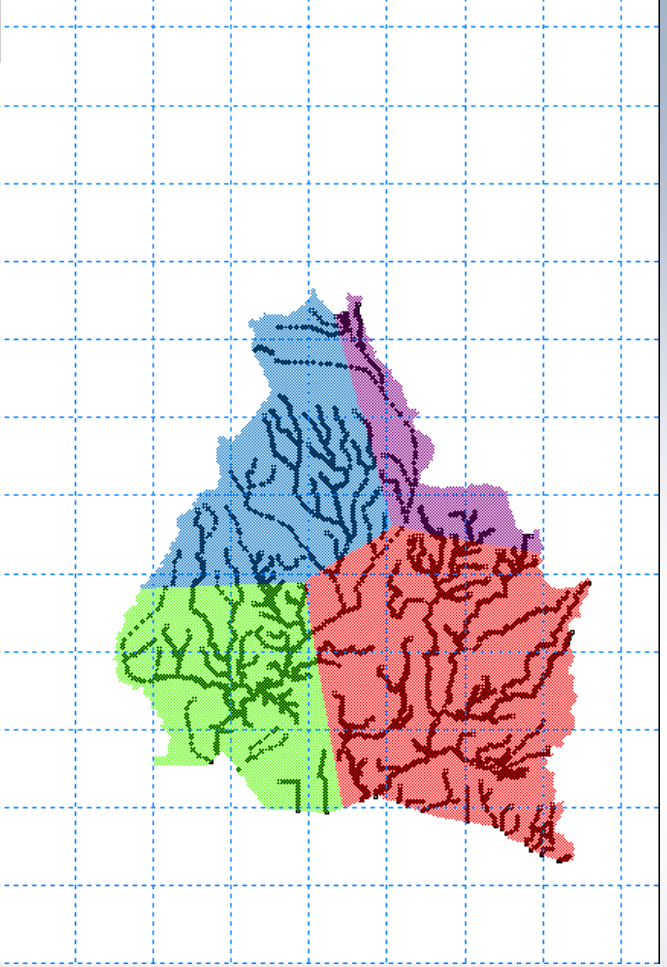

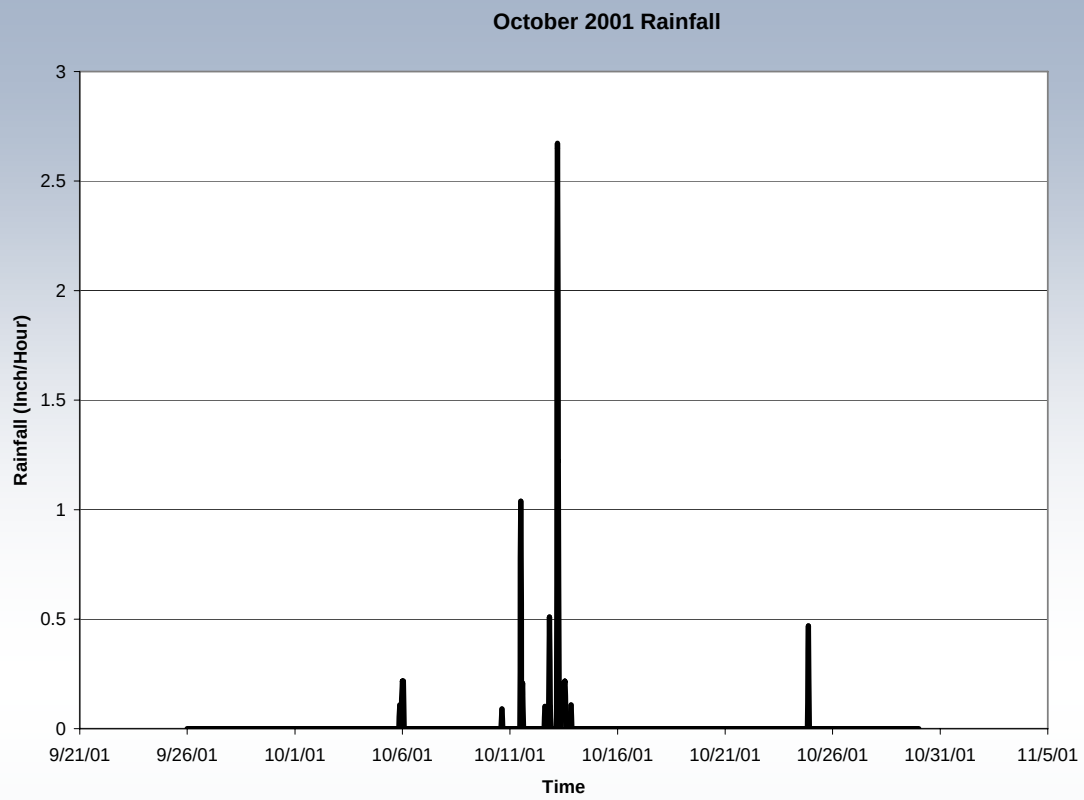

4 Hourly rain Gauges

Total Rainfall = 8.49 inches

10/13/01 → rainfall = 5.00 inches

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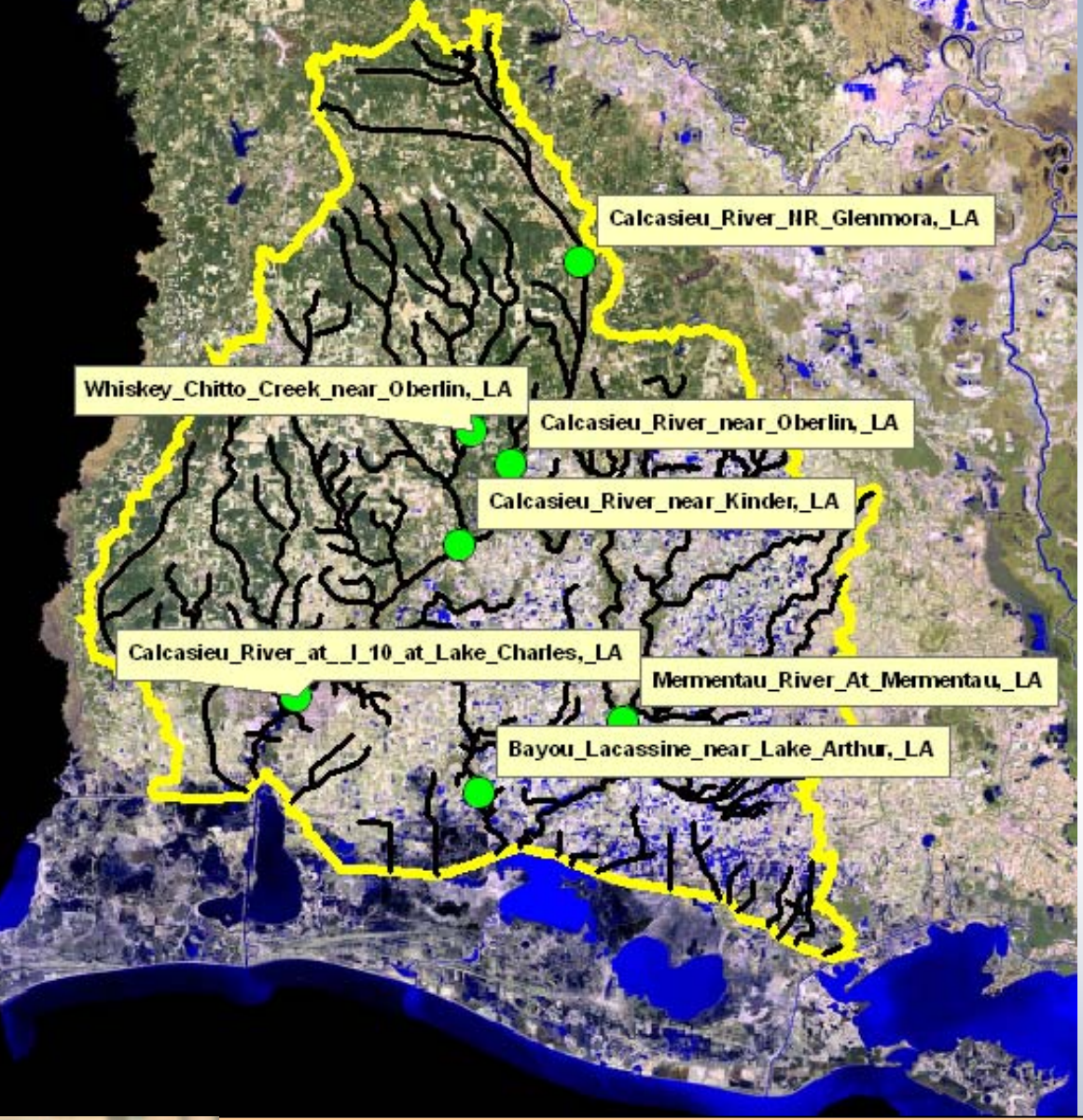

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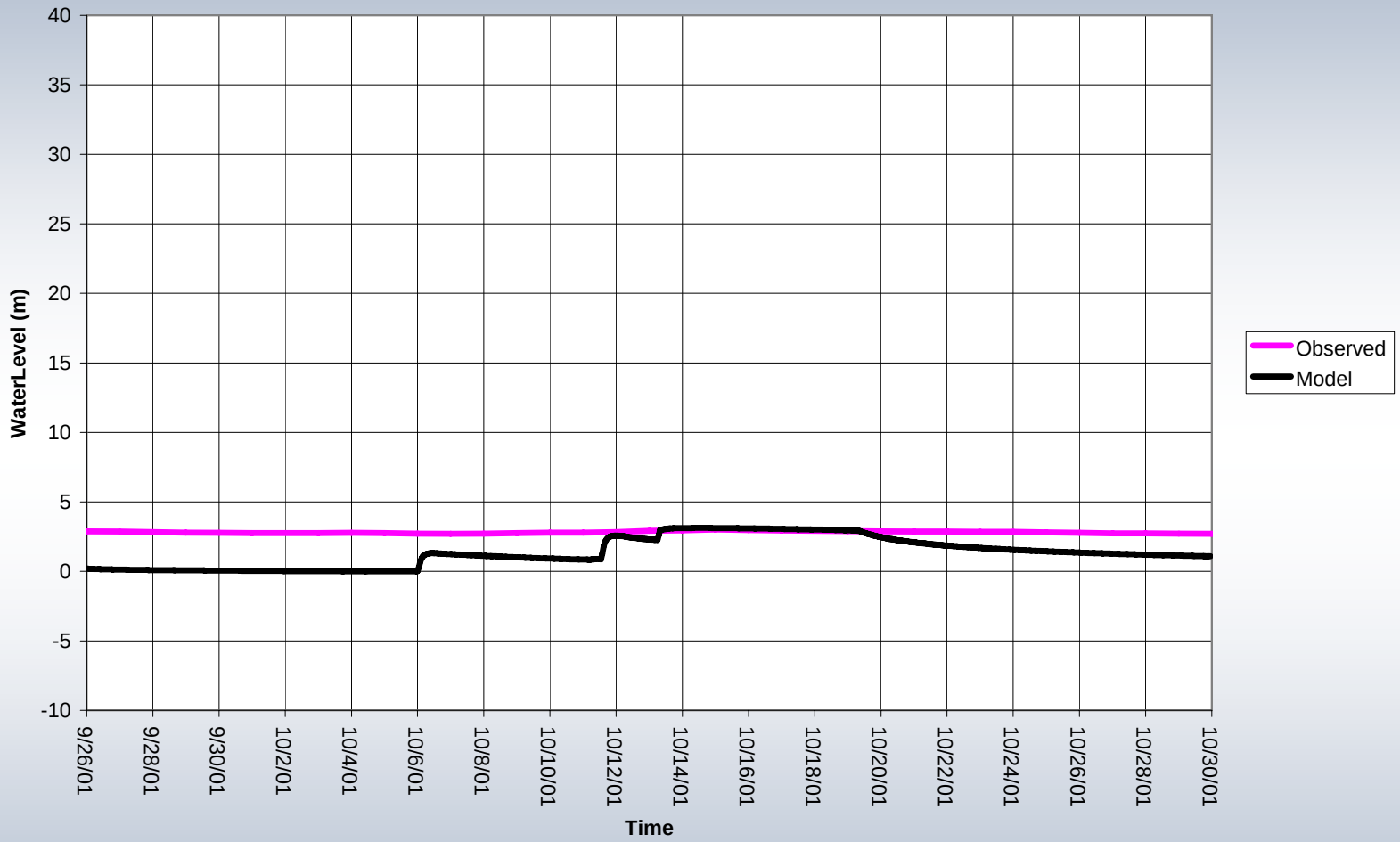
Water Level at Lacassine



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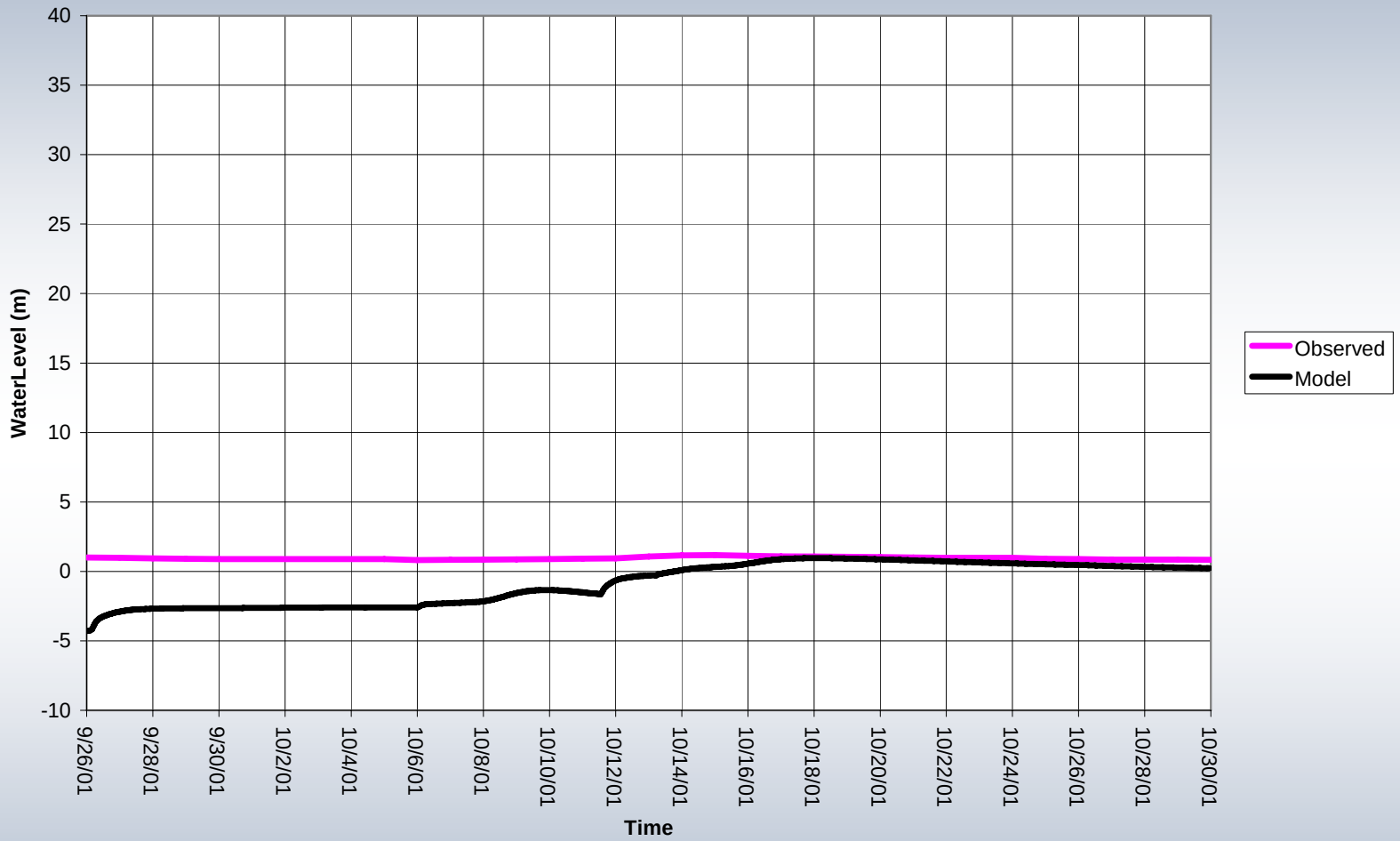
Water Level at Mermentau River



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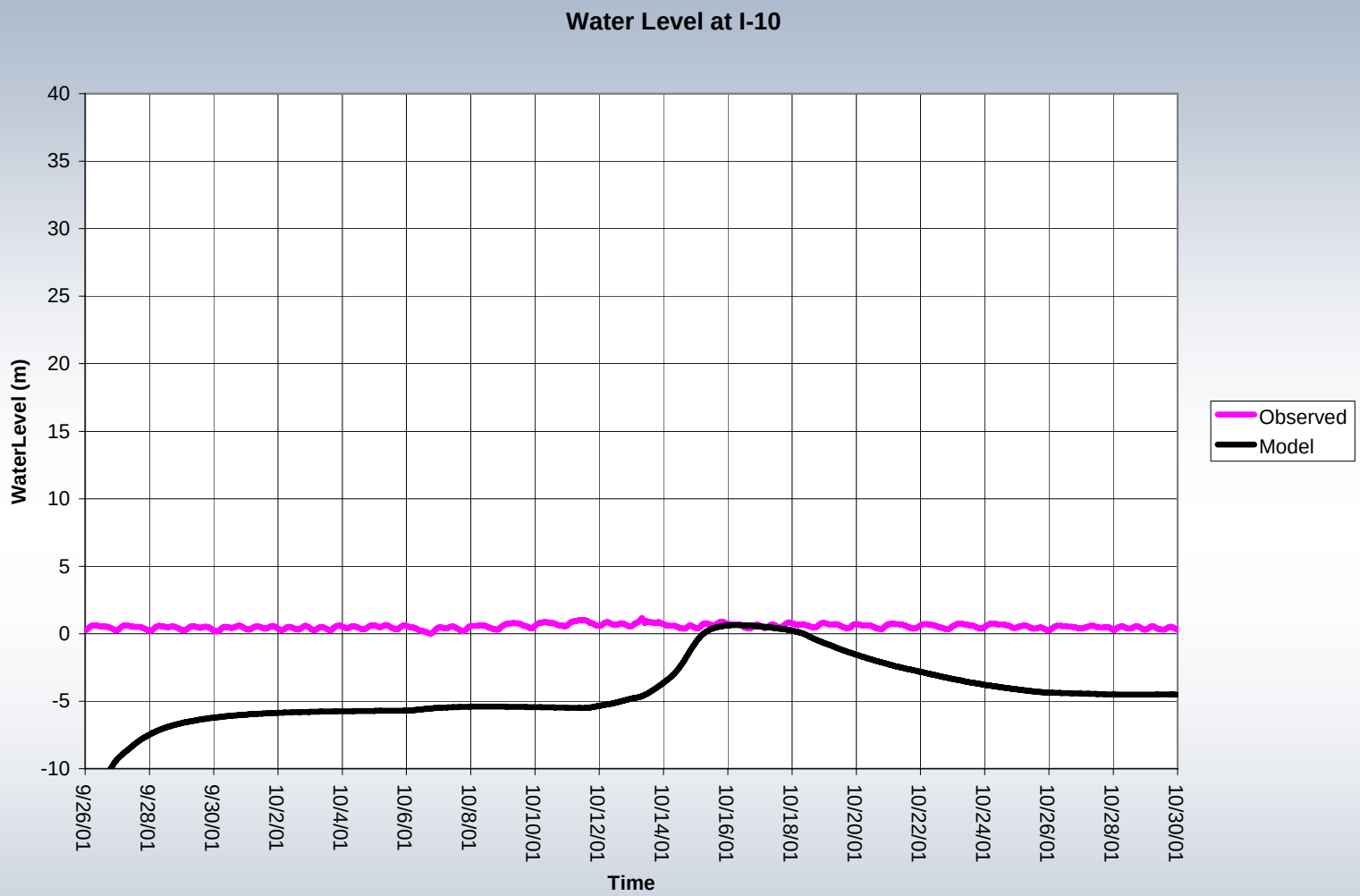

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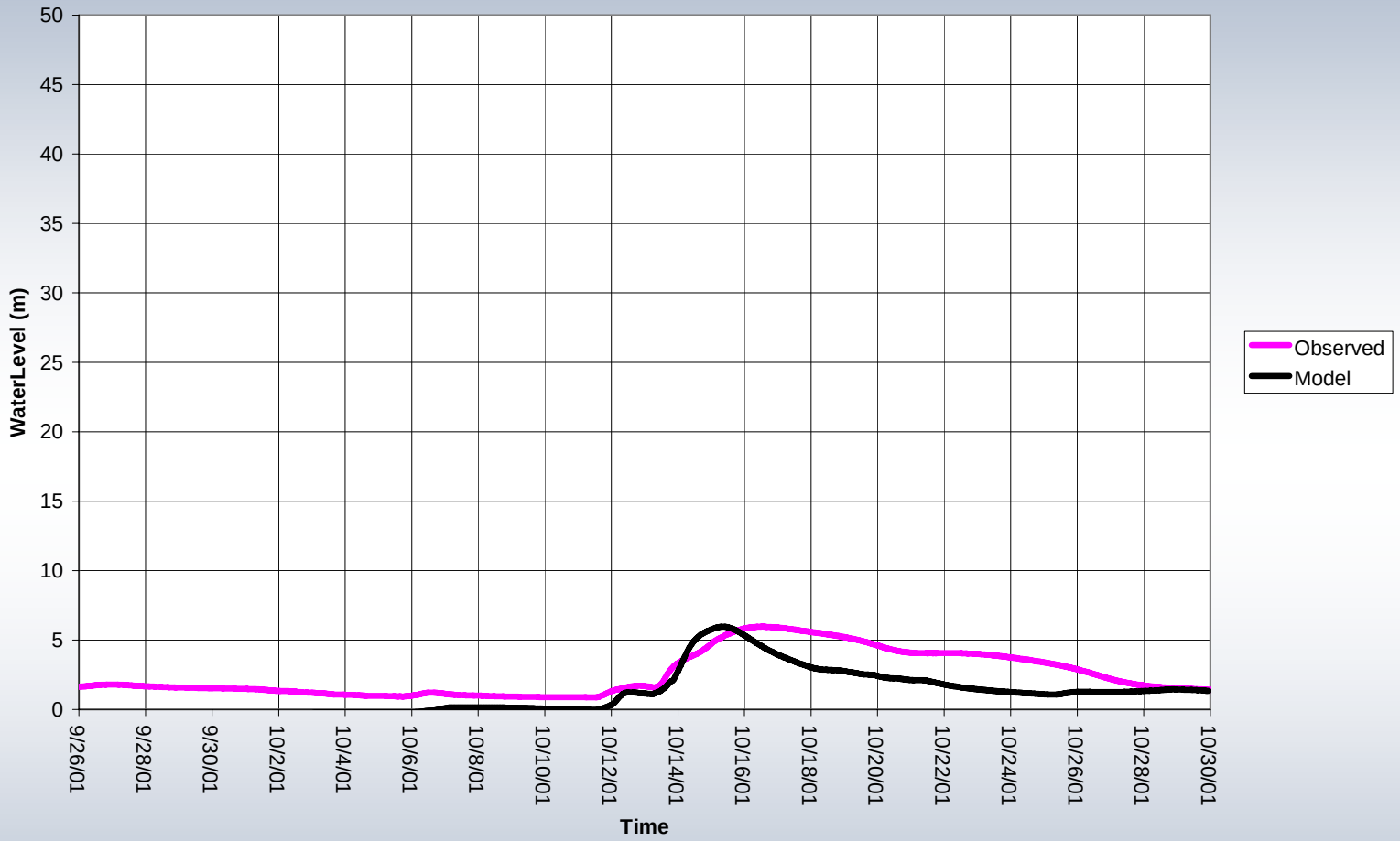
Water Level at Kinder



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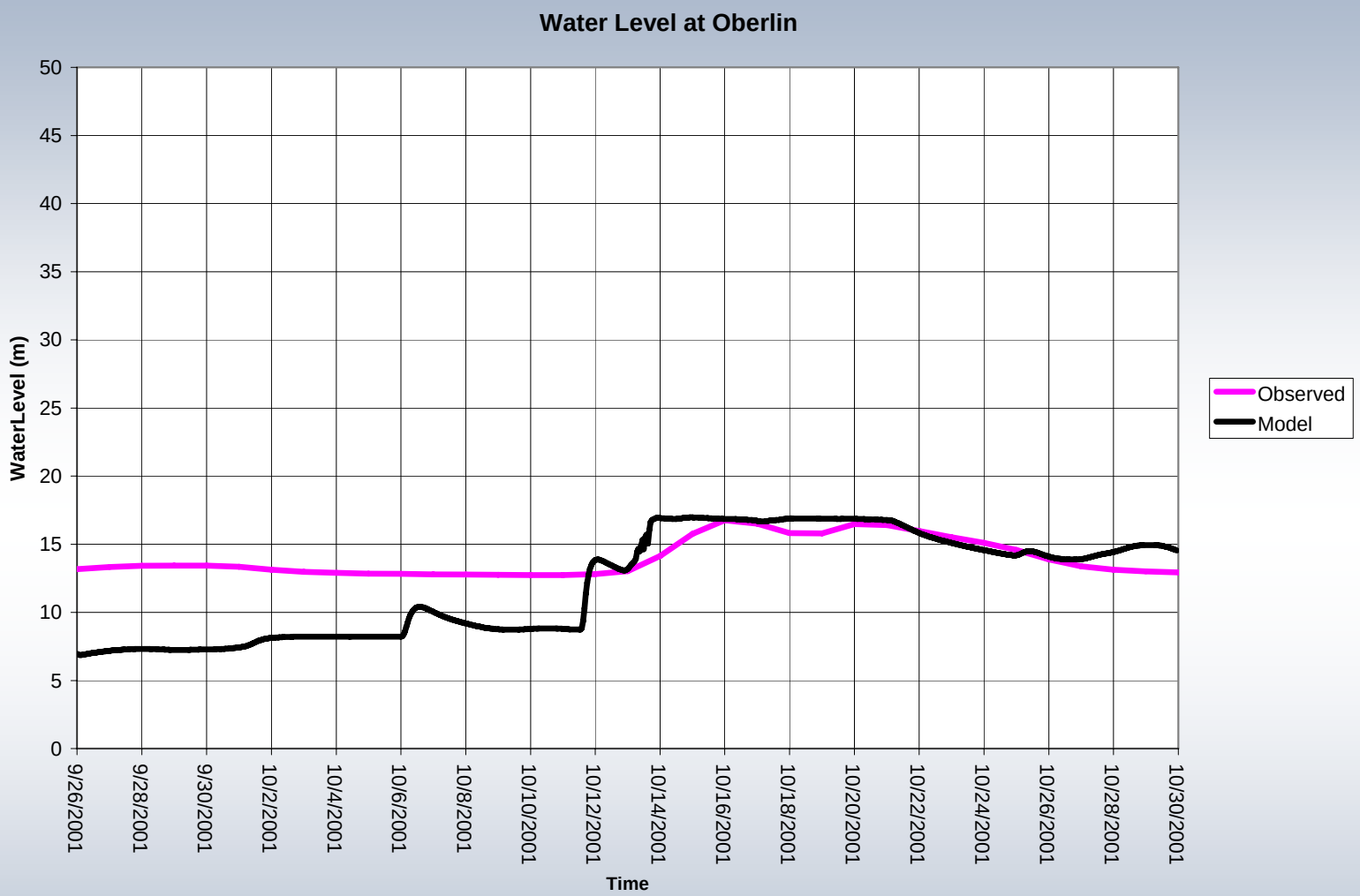

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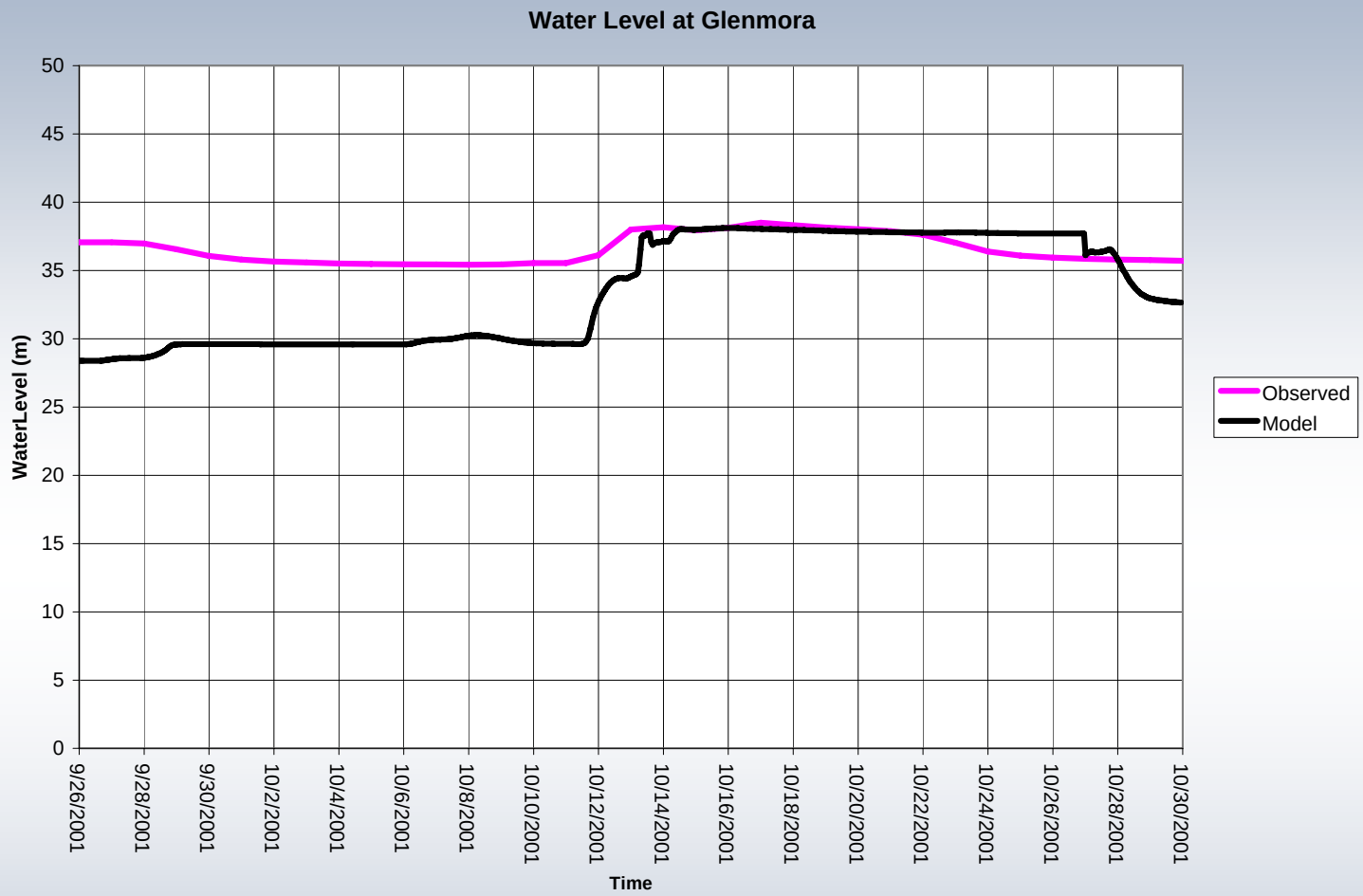

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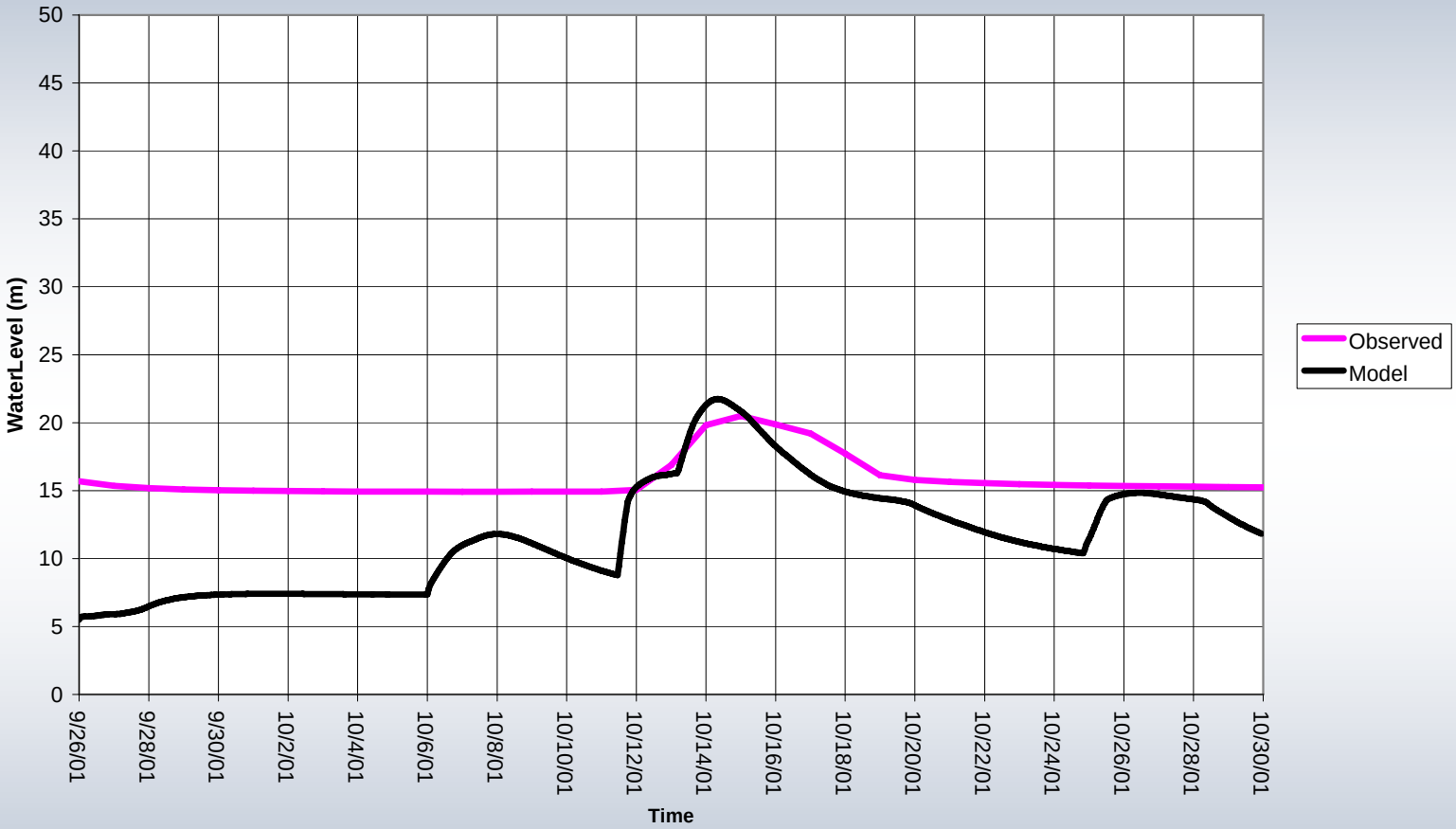
Water Level at Wiskey Chitto



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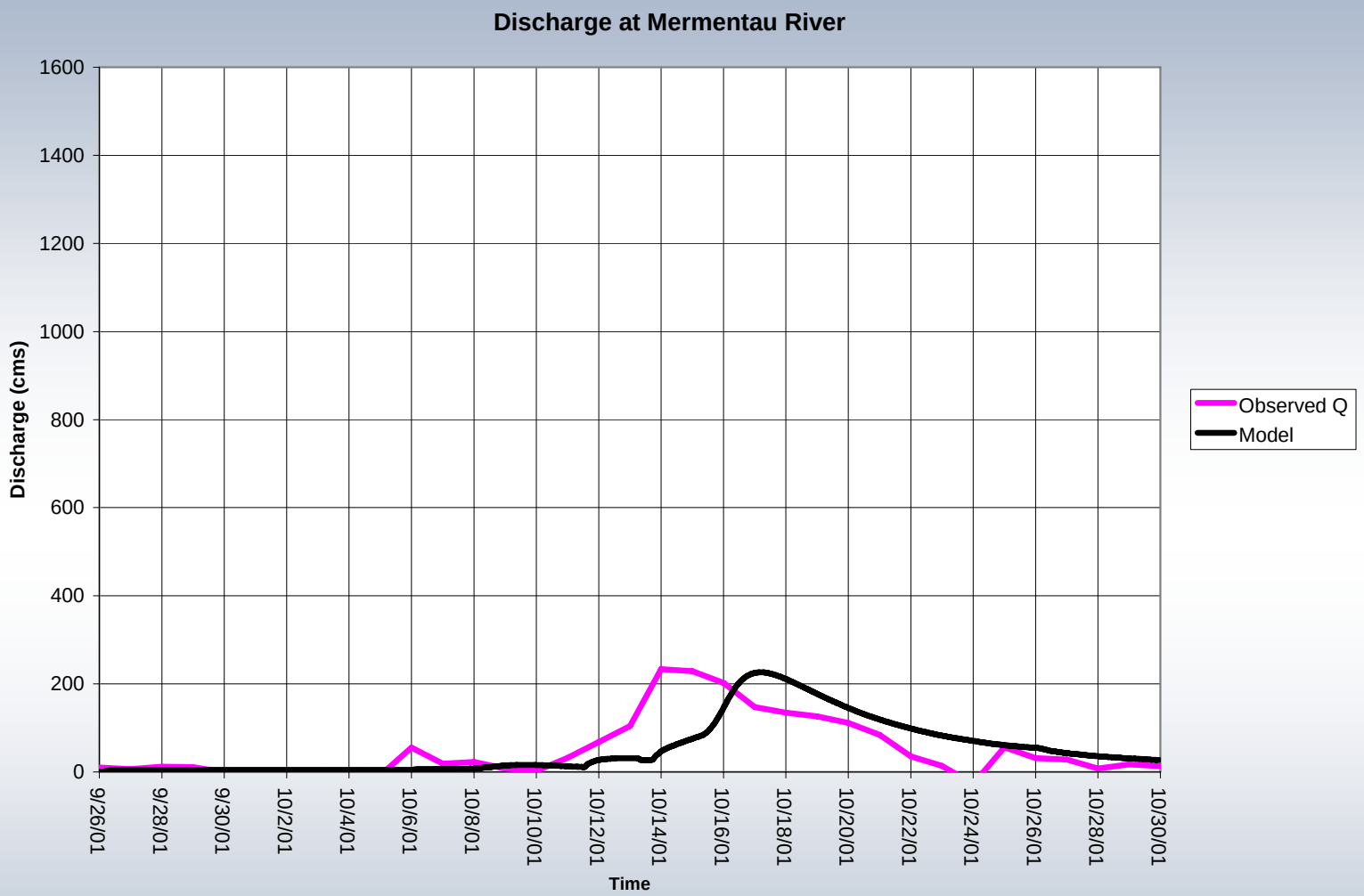

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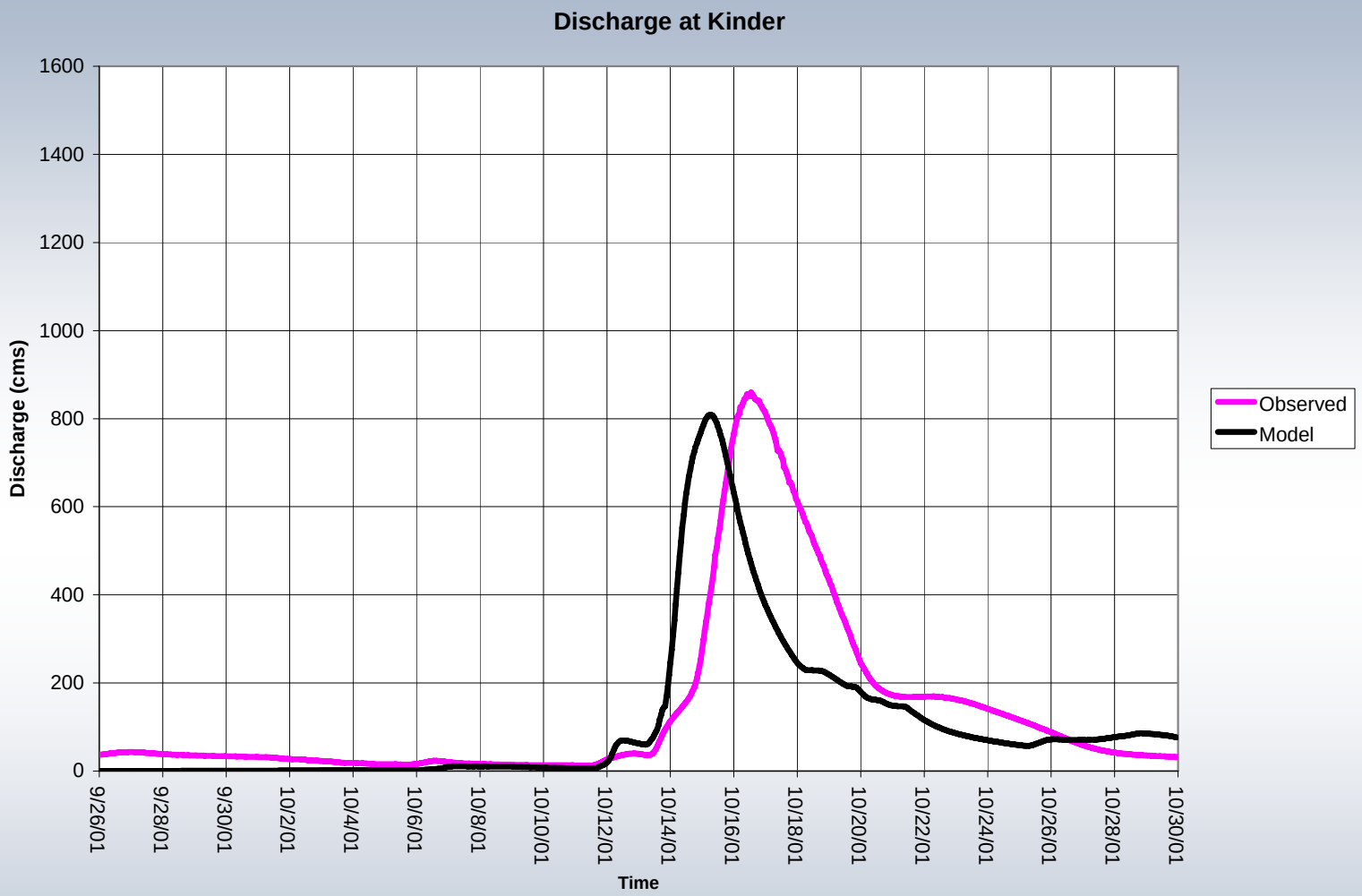

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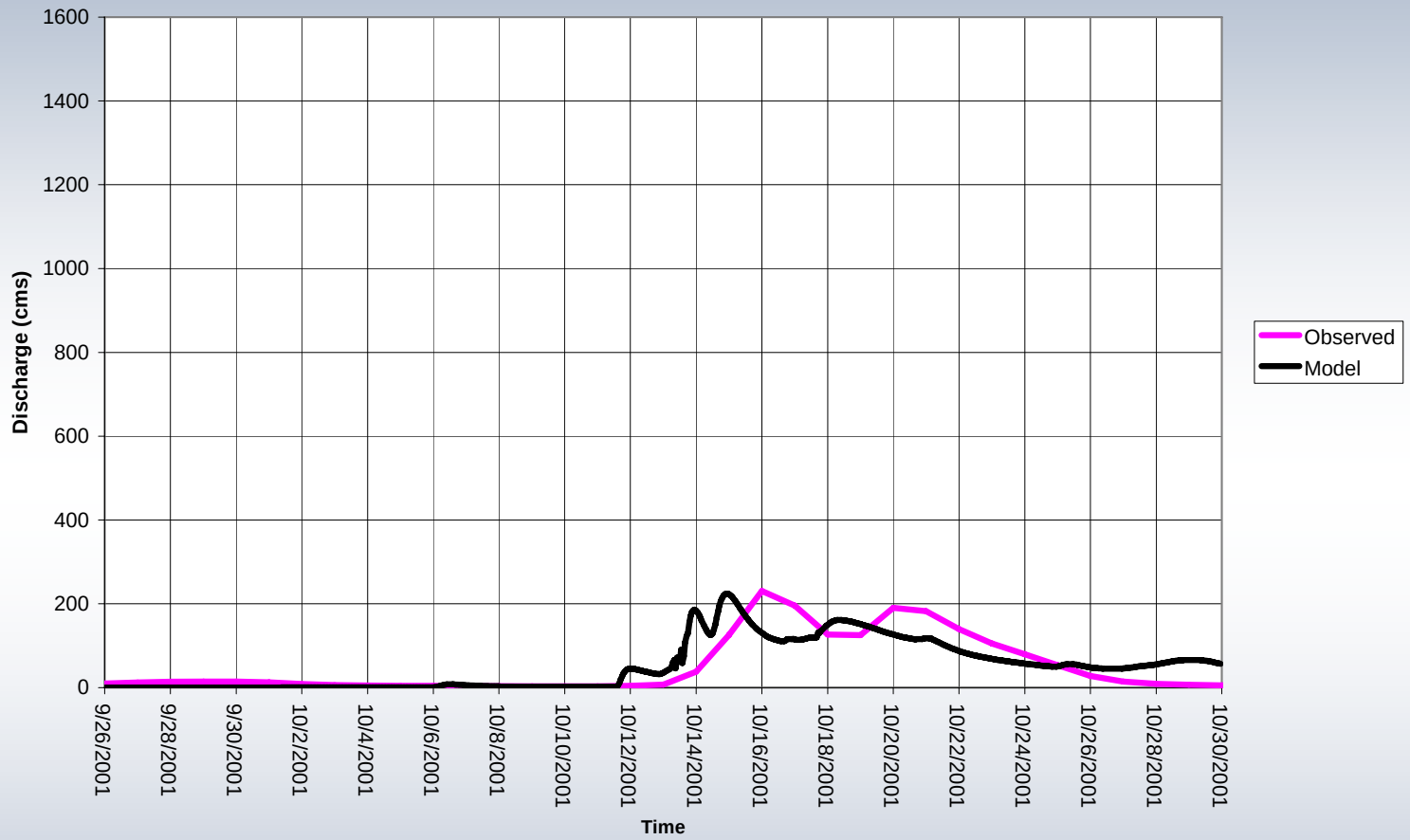
Discharge at Oberlin



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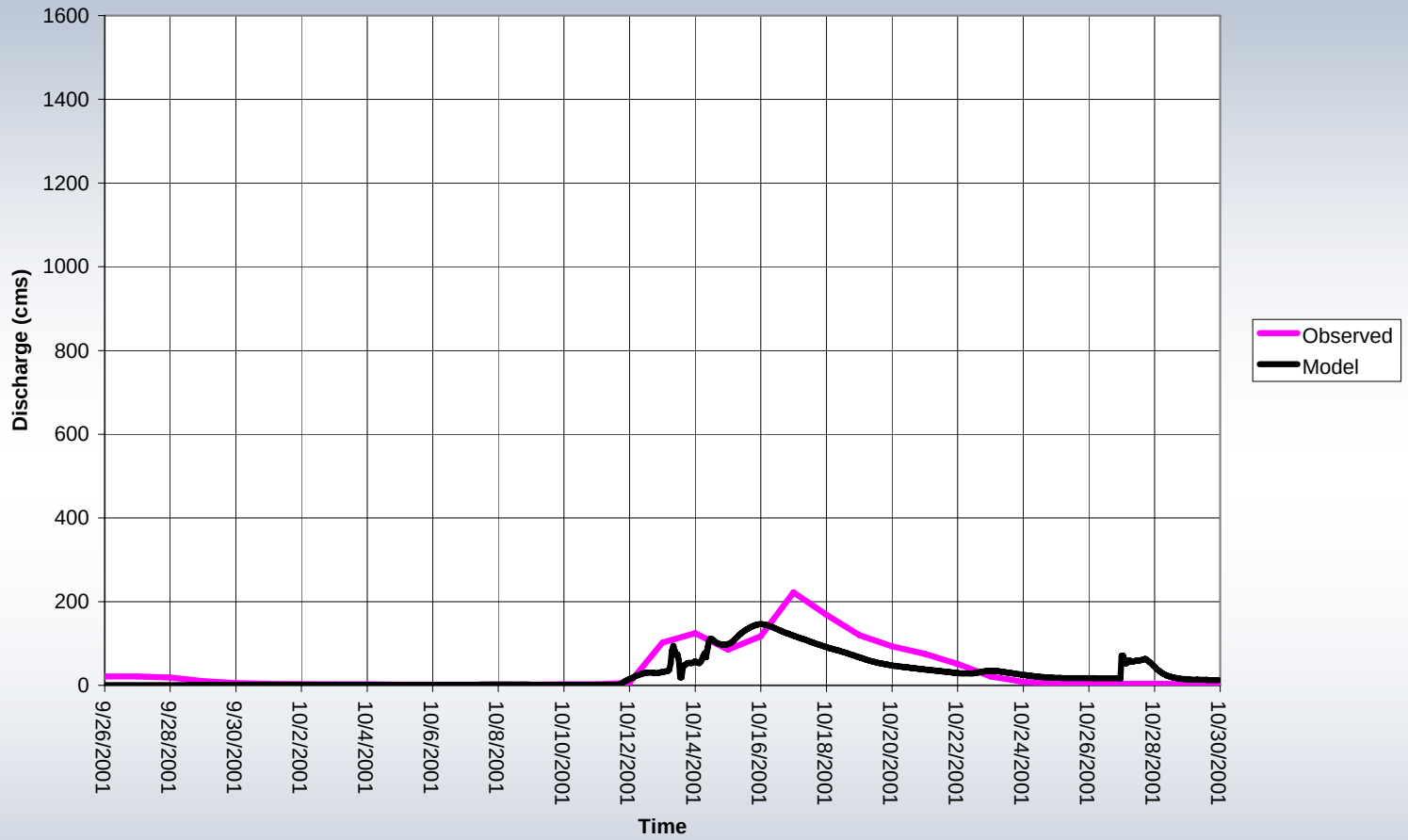
Discharge at Glenmora



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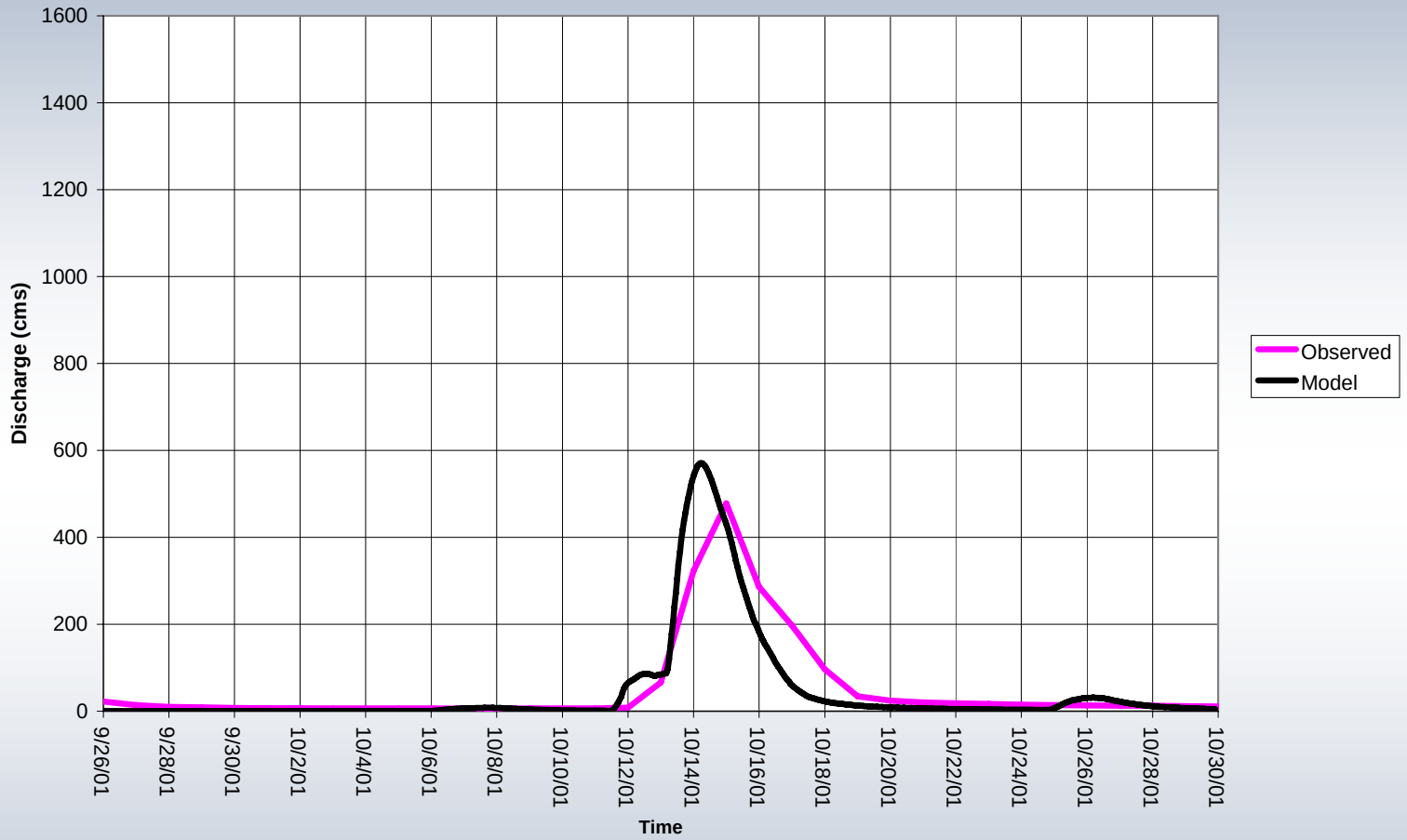
Discharge at Wiskey Chitto



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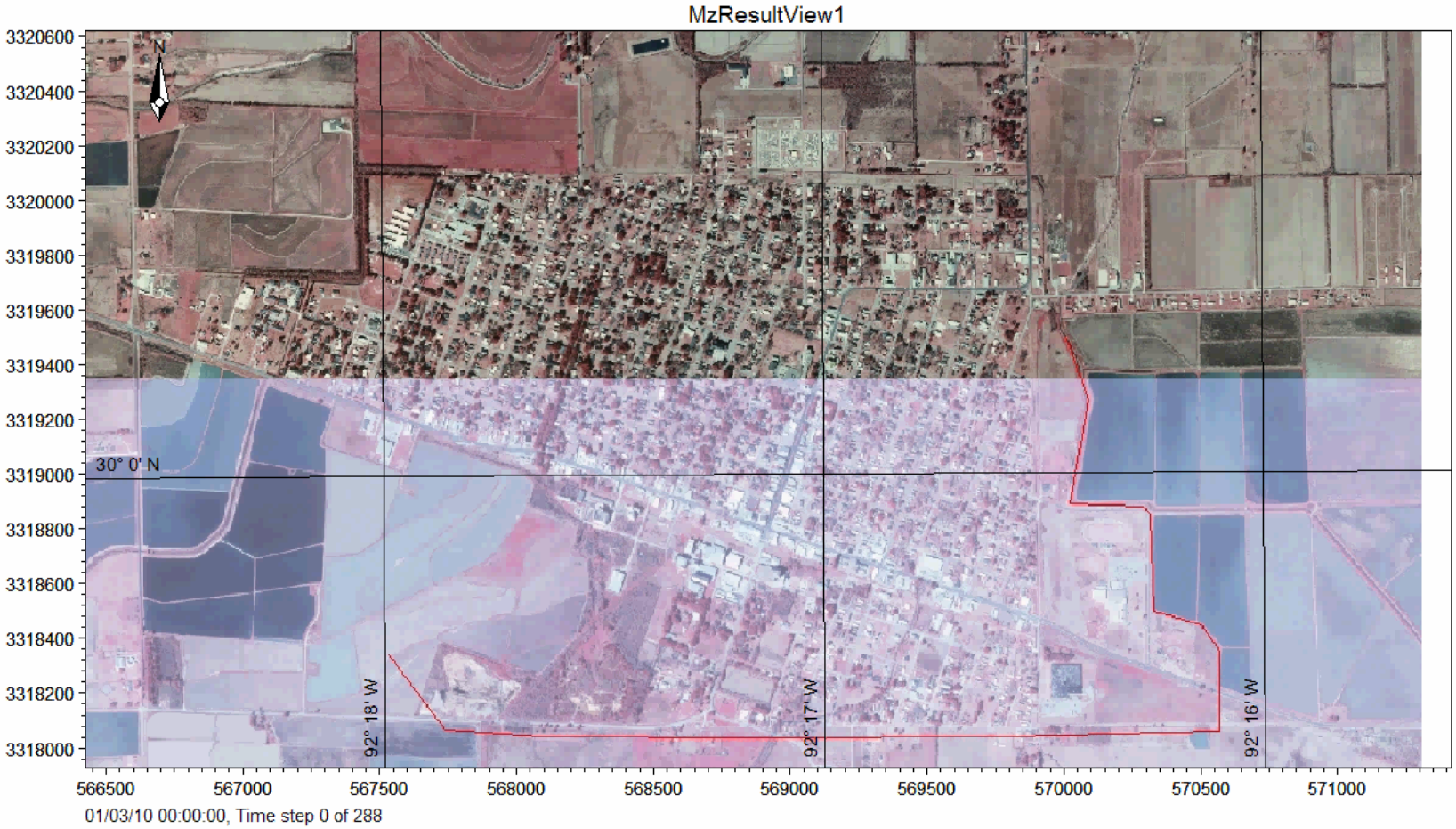
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3.5 - 3.553
Below 3.5
Undefined Value

Questions???

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