Forecasting Hurricane Storm Surge on the Mississippi River

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Today's Talk

Hurricane Betsy – September 11, 1965 (Mississippi River - Louisiana)

- The Problem – Surges from Hurricanes
- Sea, Lake, and Overland Surge Heights (SLOSH Model)
- Dynamic Wave Operational Model (DWOPER)
- Merging These Together to Forecast River Surges

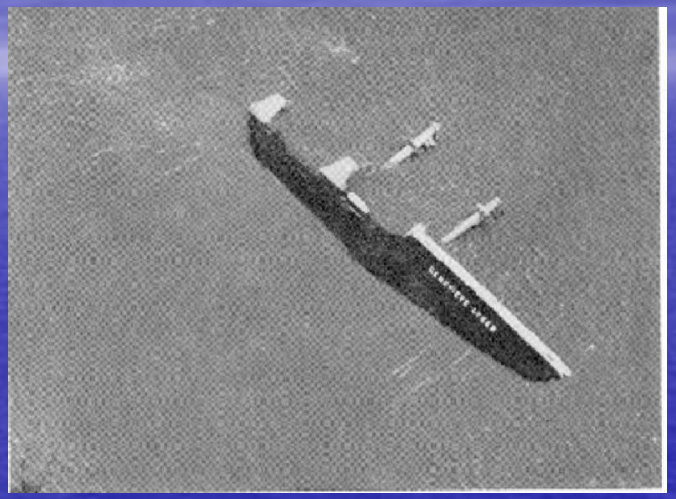
Hurricane Storm Surge
The Problem

Hurricane Betsy – September 11, 1965
(Mississippi River – Louisiana)

- Hurricanes can cause the Mississippi River to rise rapidly due to Storm Surge
- Ships can be grounded or swamped due to these rapid rises

Hurricane Storm Surge – The Problem

- Flood gates and loading docks must be closed which takes time to complete

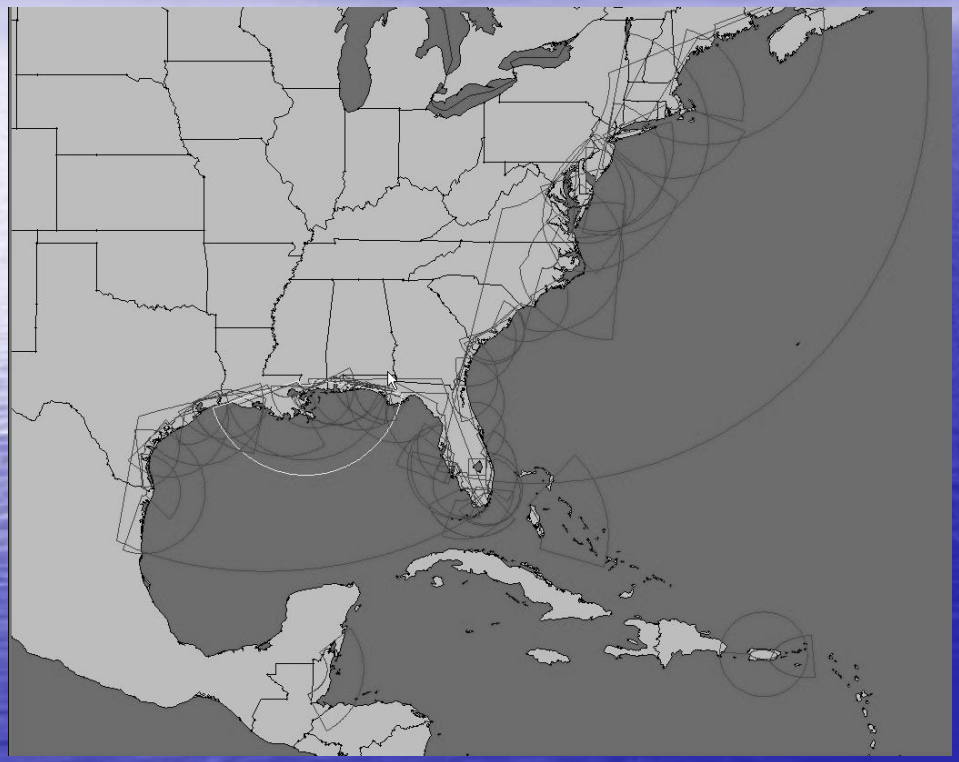


Hurricane Betsy – September 11, 1965

SLOSH Model

- Sea, Lake, and Overland Surge Heights (SLOSH Model)
- Forecasted storm surge from hurricanes based on
  - Forward Speed
  - Intensity
  - Track
  - Size

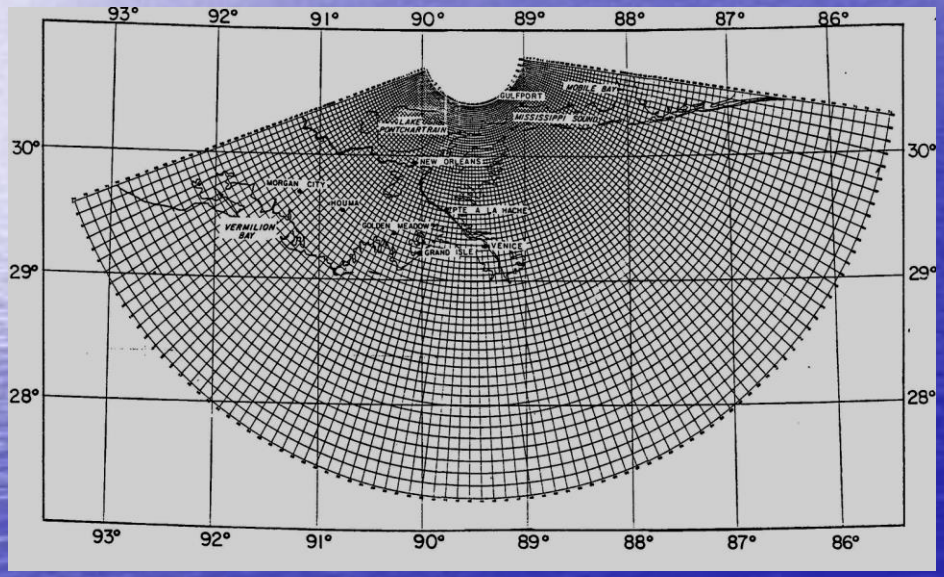
SLOSH Model – Cont'd



Lake Ponchartrain Basin
(outlined in white)

- **SLOSH can be run for 35 grids/basins along the Gulf or Atlantic Coasts**
- **Each basin grid is a continuously changing polar grid**
- **Lake Pontchartrain basin used in our analysis**

SLOSH Model – Cont'd



- Higher resolution inland
- Contains topography and levees which is periodically updated

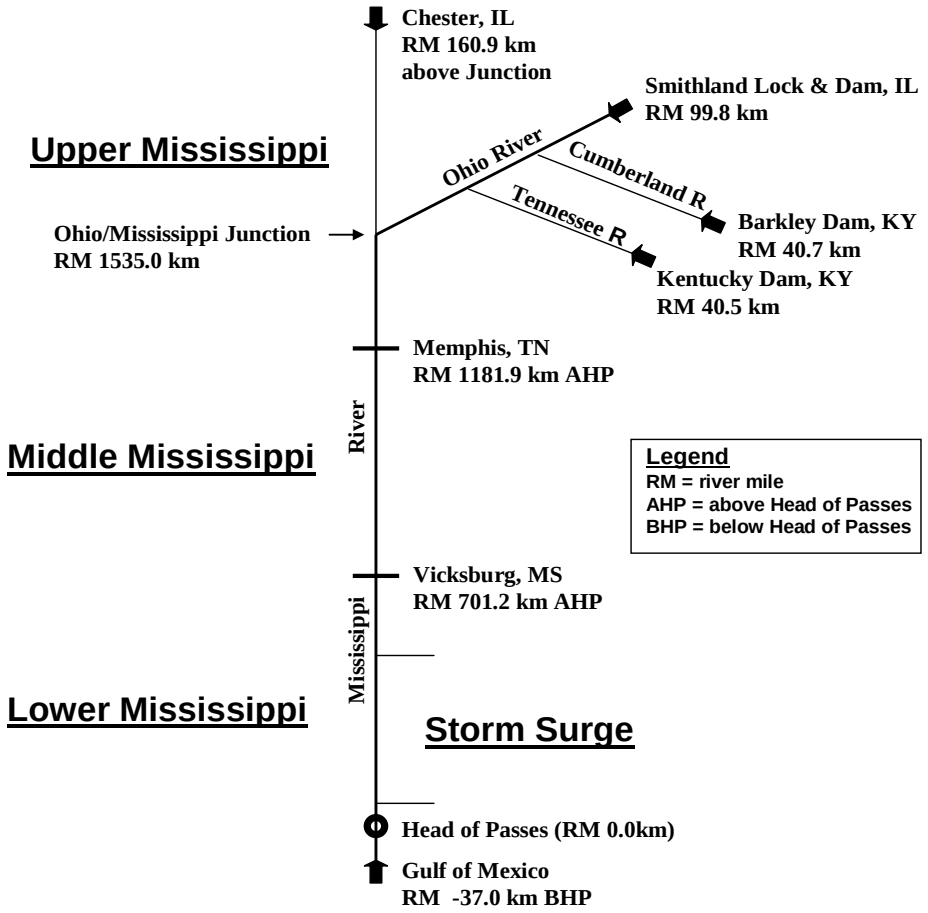
SLOSH Model

- Model is run about 24 hours prior to landfall based on TPC forecast
- Output provided to NWS offices in a binary file
- SLOSH Display program allows for animation of output from SLOSH
- Local software determines hydrograph at West Pointe a la Hache where continuous levees begin along the Mississippi River

DWOPER

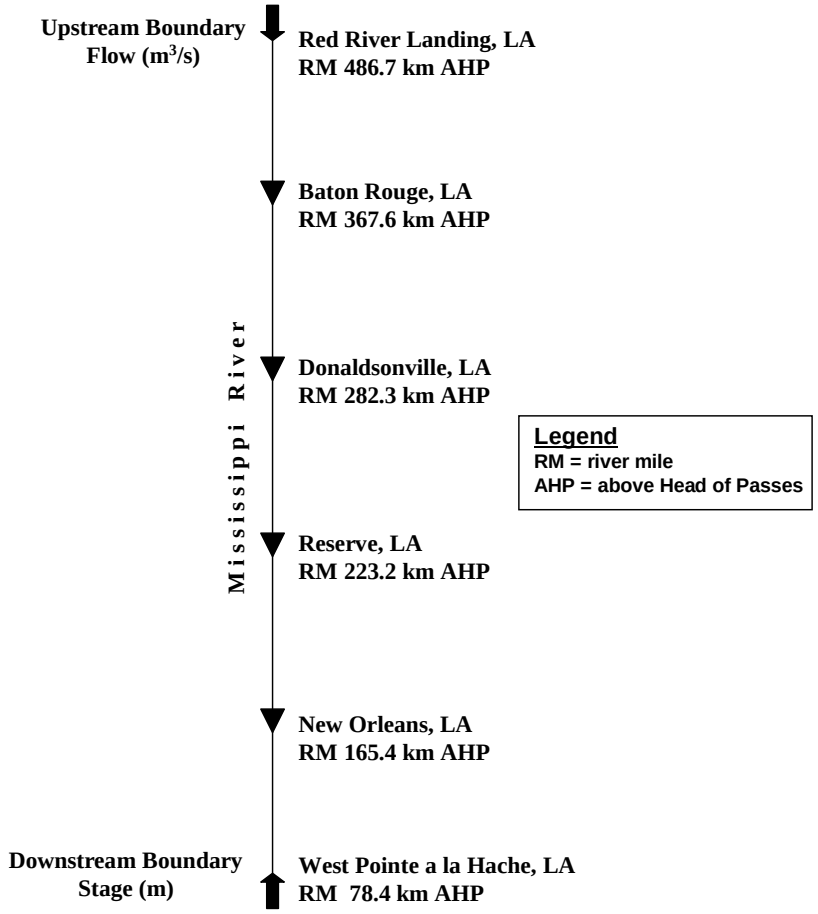
- NWS Dynamic Wave Operational Model (DWOPER)
- One-dimensional unsteady state flow model
- LMRFC has DWOPER setup to run on the Lower Ohio/Mississippi Rivers to the Gulf of Mexico

LMRFC
DWOPER Schematic
Lower Ohio/Mississippi



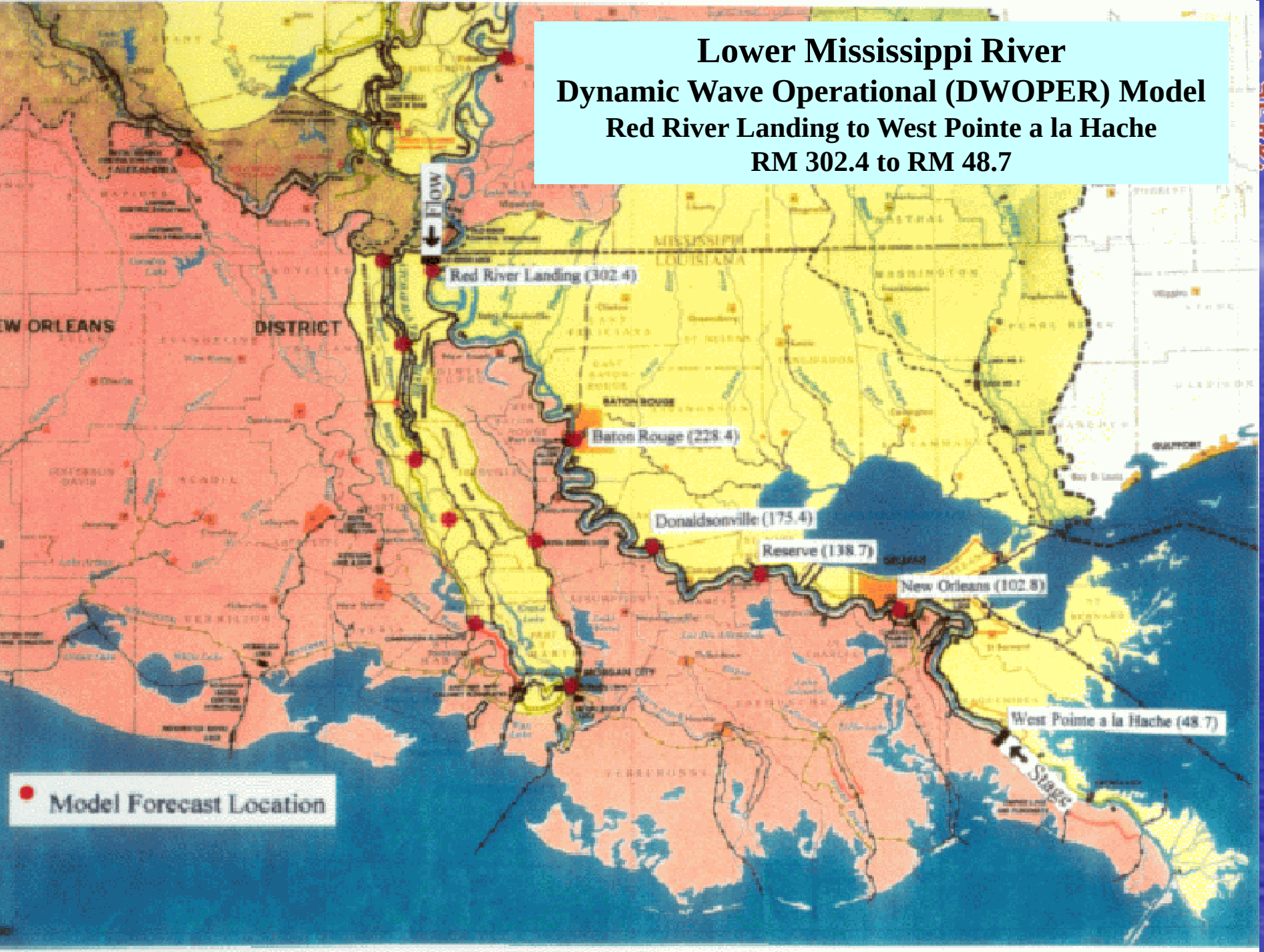
DWOPER SCHEMATIC

Storm Surge Segment



DWOPER – Cont'd

- For storm surge, run model from Red River Landing, LA, to West Pointe a la Hache, LA
- West Pointe a la Hache – start of continuous levees along both sides of the Mississippi River
- Upstream boundary Stream flow at Red River Landing
- Downstream boundary Forecasted storm surge hydrograph (stage) at West Pointe a la Hache


Lower Mississippi River
Dynamic Wave Operational (DWOPER) Model
Red River Landing to West Pointe a la Hache
RM 302.4 to RM 48.7
Flow
Red River Landing (302.4)
Baton Rouge (228.4)
Donaldsonville (175.4)
Reserve (138.7)
New Orleans (102.8)
West Pointe a la Hache (48.7)
Stages
Model Forecast Location
DISTRICT

Merging SLOSH Output with DWOPER

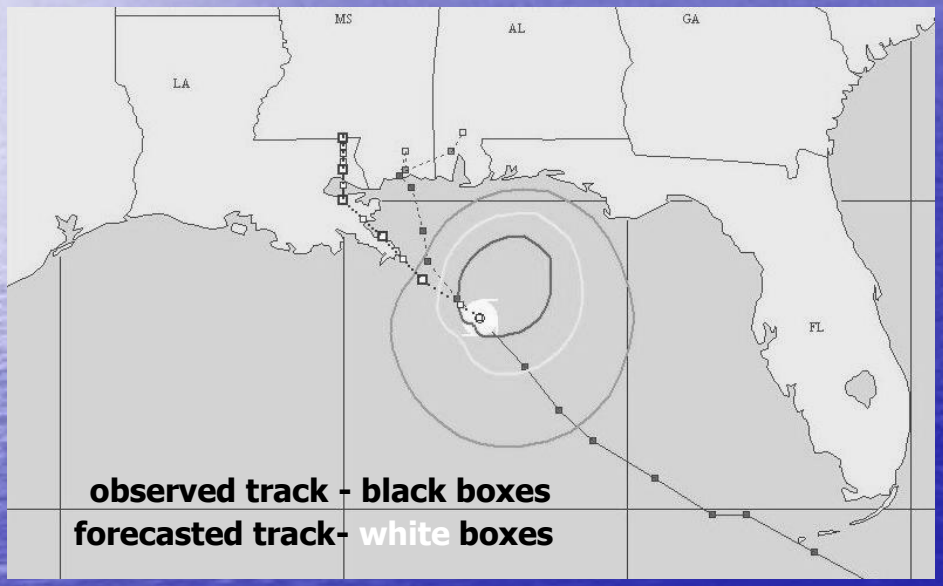
- Within 24 hours of landfall, SLOSH model runs produce a forecasted surge hydrograph (stage) at West Pointe a la Hache
- LMRFC uses the SLOSH forecasted surge at West Pointe a la Hache as the DWOPER downstream boundary condition
- DWOPER models the surge wave as it propagates upstream
- Flood wave fully contained within levee system with no lateral inflows or outflows

Merging SLOSH Output with DWOPER

- LMRFC issues stage forecasts with crests on the Mississippi River at and below Red River Landing
- NWS field offices may issue river warnings or include other river information in Hurricane Local Statements

Hurricane Georges 1998

Location 24 hours prior to landfall

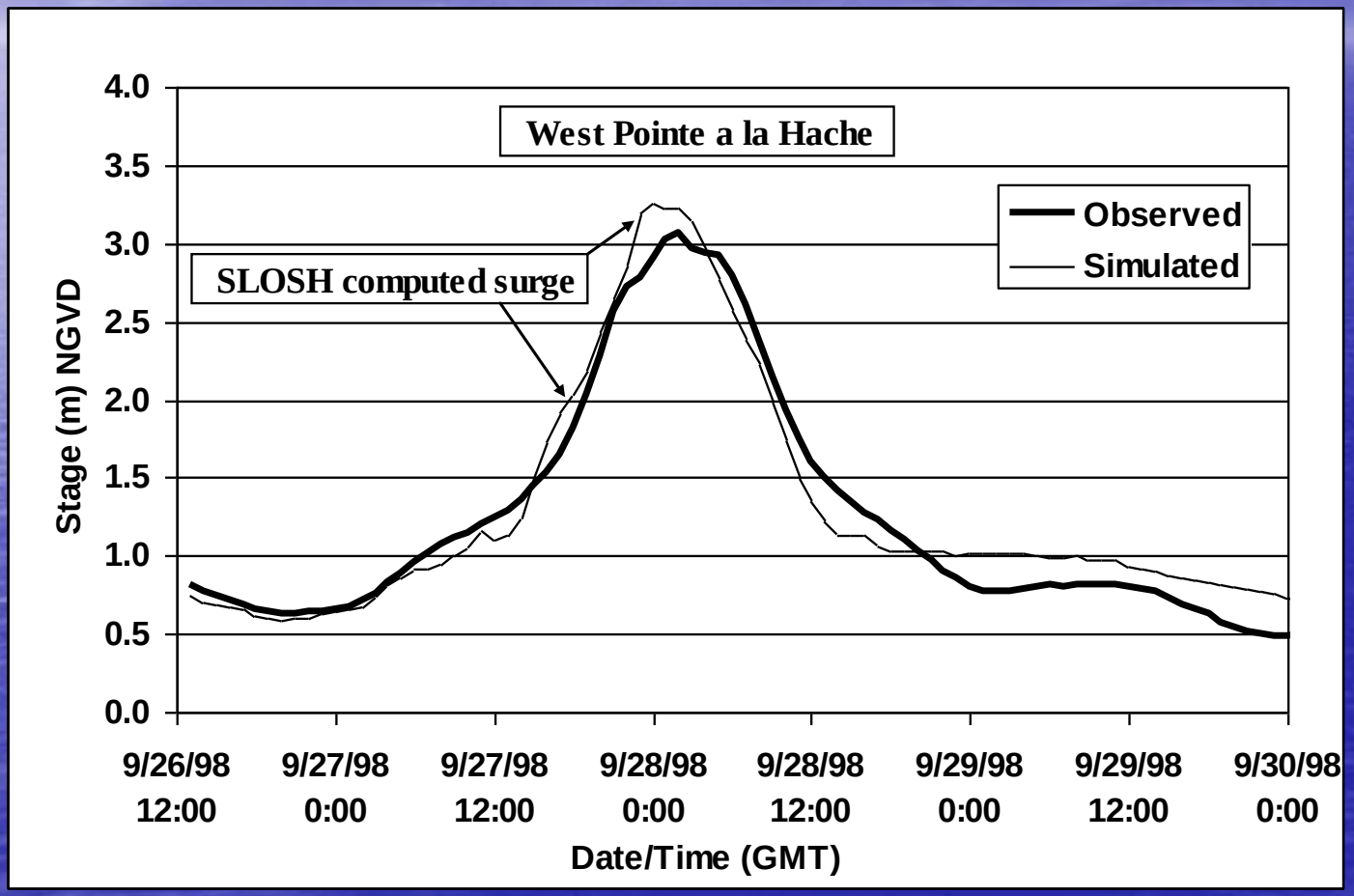


- forecast 24 hours prior to landfall
- SLOSH runs provide forecasted stage heights at West Pointe ala Hache

Hurricane Georges Surge

September 1998

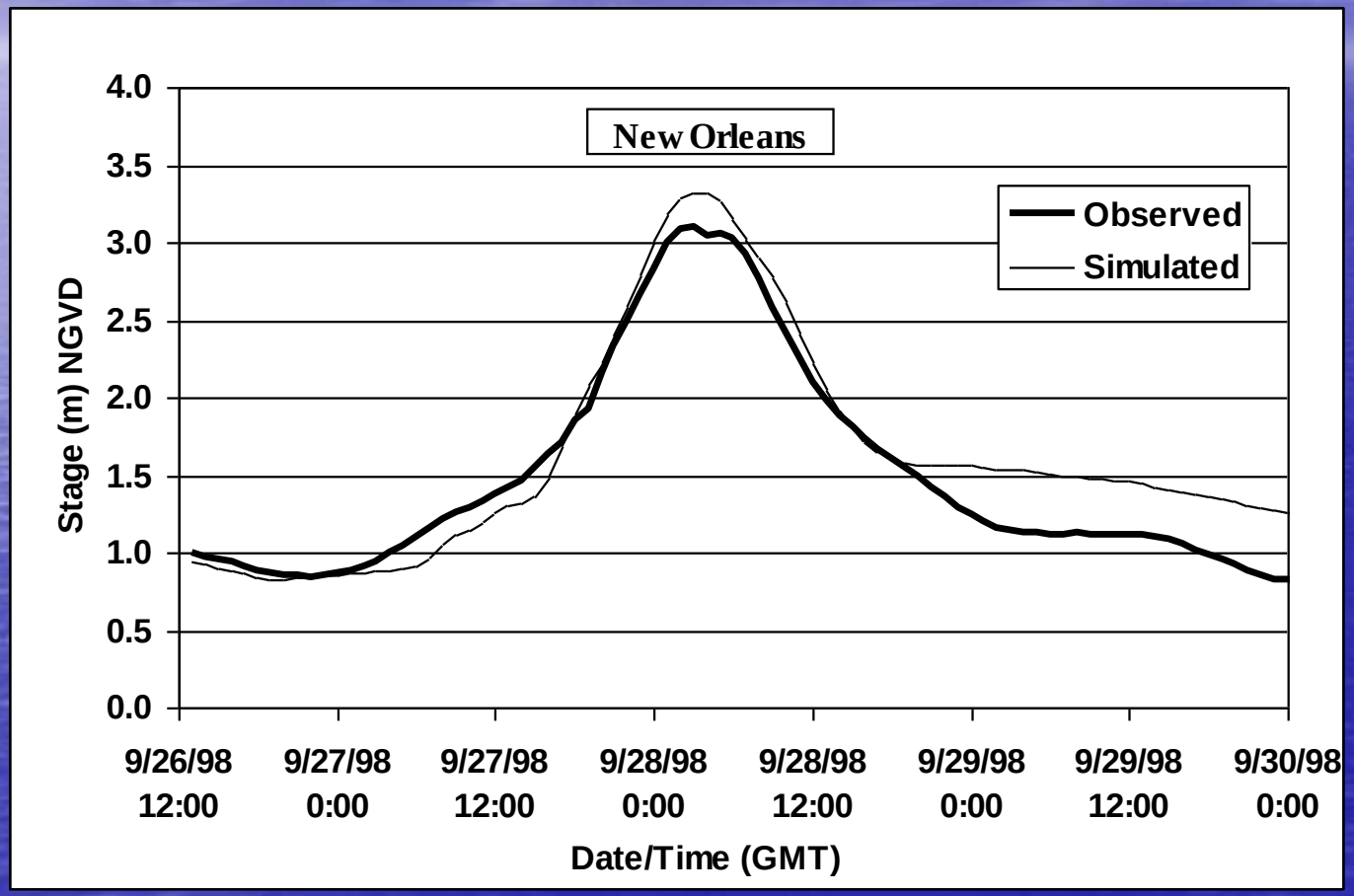
Mississippi River at West Pointe a la Hache, LA



Hurricane Georges Surge

September 1998

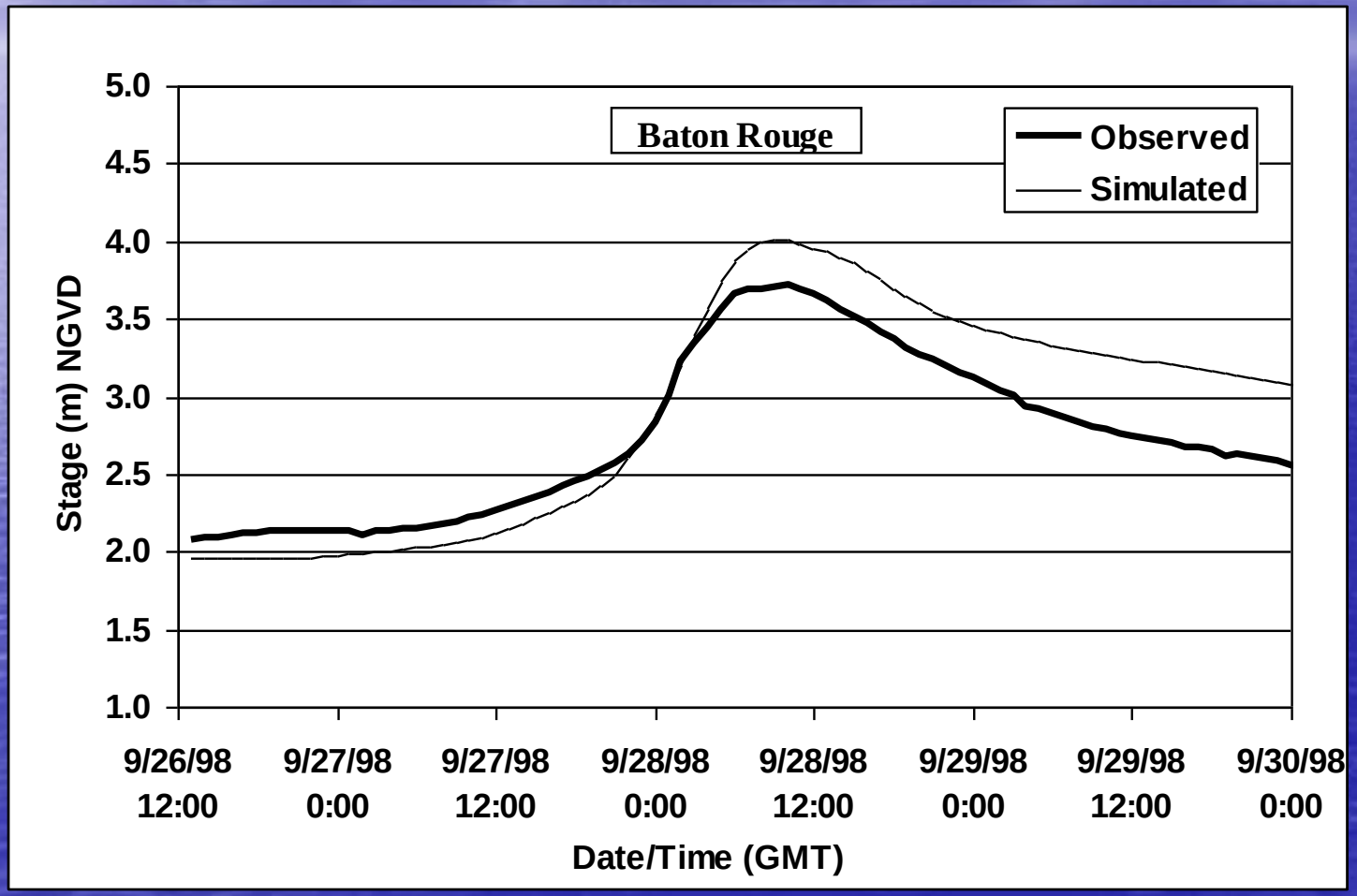
Mississippi River at New Orleans, LA



Hurricane Georges Surge

September 1998

Mississippi River at Baton Rouge, LA



Real-time River Forecasts

Hurricane Georges' Surge

RIVER FORECAST...LOWER OHIO/MISSISSIPPI RIVER
LOWER MISSISSIPPI RIVER FORECAST CENTER
NATIONAL WEATHER SERVICE SLIDELL LA
1020AM CDT SUN SEP 27 1998

STATION	FS	7AM STG	24HR CHG	.....F O R E C A S T..... 0928	0929	0930	1001	1002	CREST/DATE/TIME	...OBSERVED...
MISSISSIPPI RIVER										
RED RIVER LANDING	48	20.4	+1.1	21.9	21.4	20.9	20.9	20.7	22.5 9/28 7 PM CDT	21.80 9/28 2PM CDT
BATON ROUGE	35	7.5	MSG	12.3	9.4	8.9	8.5	8.4	13.0 9/28 9AM CDT	12.19 9/28 5AM CDT
DONALDSONVILLE	27	5.5	+0.9	12.0	7.1	6.8	6.4	6.4	12.0 9/28 7AM CDT	MSG
RESERVE	22	4.8	+0.9	11.0	6.0	5.8	5.7	5.7	11.2 9/28 6AM CDT	10.35 9/28 1AM CDT
NEW ORLEANS	17	4.5	+1.1	10.2	5.8	5.6	5.5	5.5	10.8 9/28 4AM CDT	10.16 9/27 10PM CDT

FS = FLOOD STAGE IN FEET NGVD
STG = STAGE IN FEET NGVD
MSG = MISSING

NOTE: All NWS river forecasts are issued to the public in English units

Summary - Conclusions

- Ability to merge the SLOSH model output with land-based dynamic river models
- Produces excellent river surge forecasts when SLOSH predicted surge hydrographs are reasonable
- Hurricane induced river surges propagate rapidly upstream
- Provides valuable river surge information for shipping/barge industry and for flood gate management
- Concept should be applied to smaller coastal rivers and streams