## ICCE 2018 (July 30 – August 3) Baltimore, Maryland

### Modeling of the effect of land-building projects on storm surge and hurricane waves in coastal Louisiana

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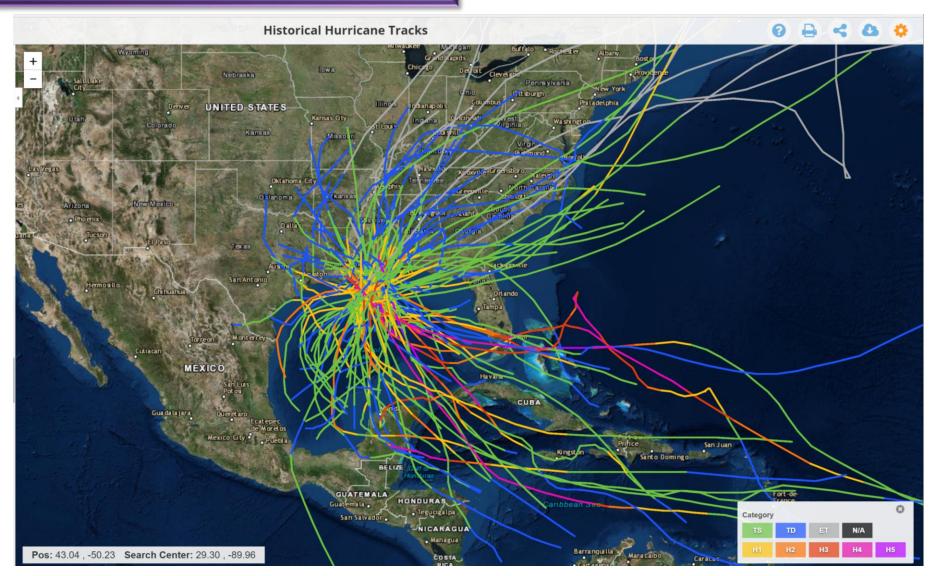


#### Outline

- Introduction
- Model setup
- Model validation (Hurricane Isaac, 2012)
- Numerical experiments
- Conclusions

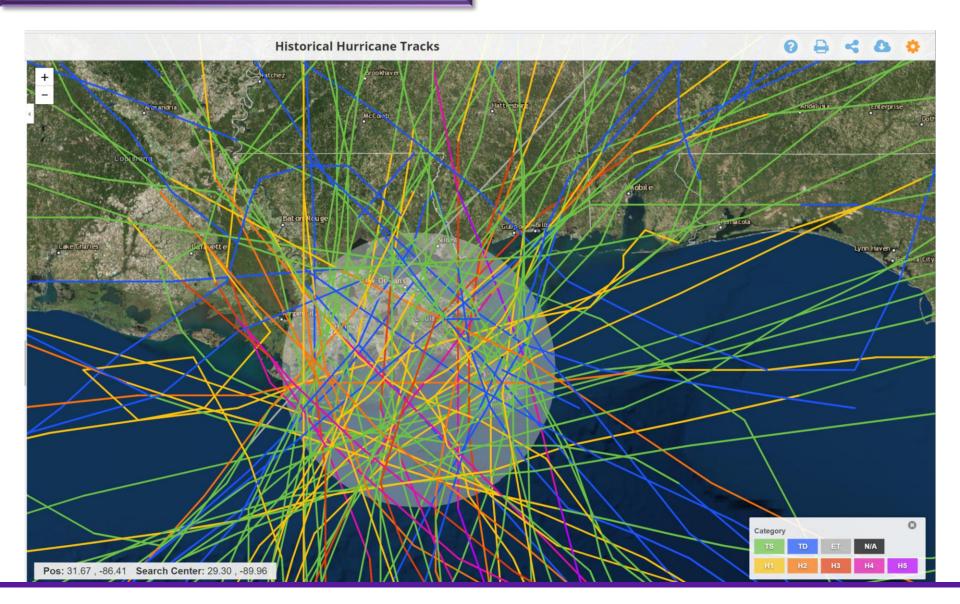
# Storm events in coastal Louisiana

NOAA Historical Hurricane Tracks <a href="https://coast.noaa.gov/hurricanes/">https://coast.noaa.gov/hurricanes/</a>

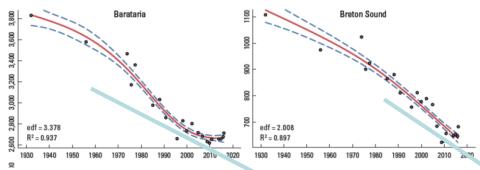


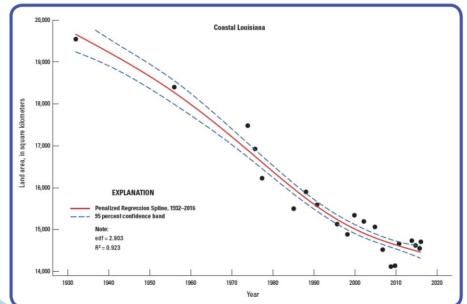
# Storm events in coastal Louisiana

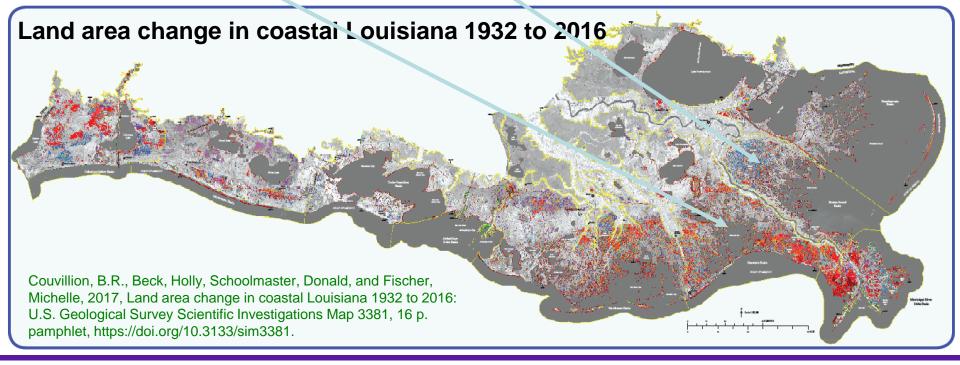
NOAA Historical Hurricane Tracks <a href="https://coast.noaa.gov/hurricanes/">https://coast.noaa.gov/hurricanes/</a>



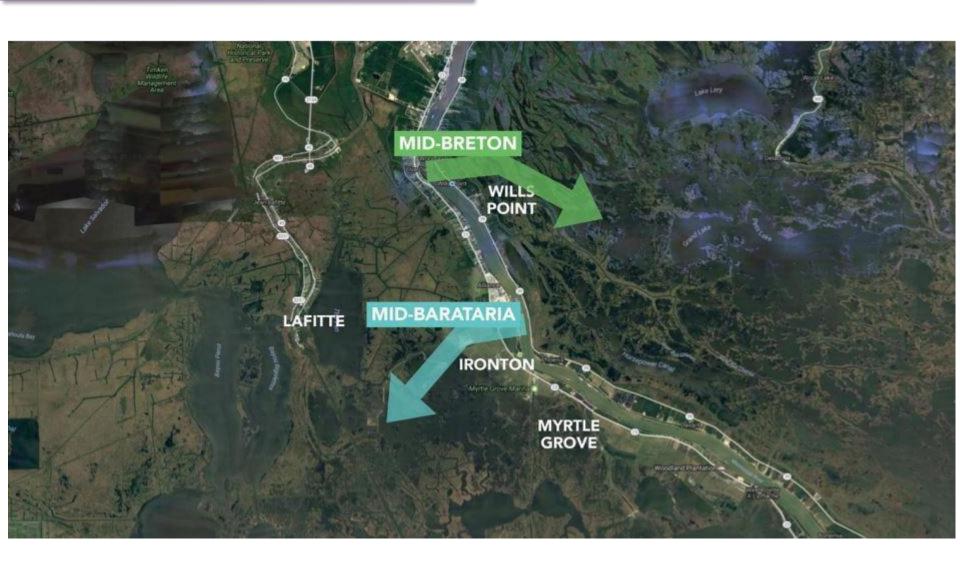
# Land loss in coastal Louisiana





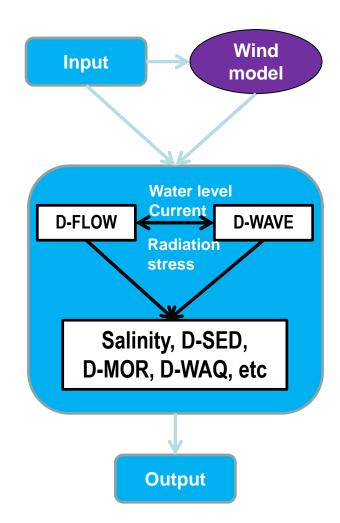


### Sediment diversion Projects by CPRA



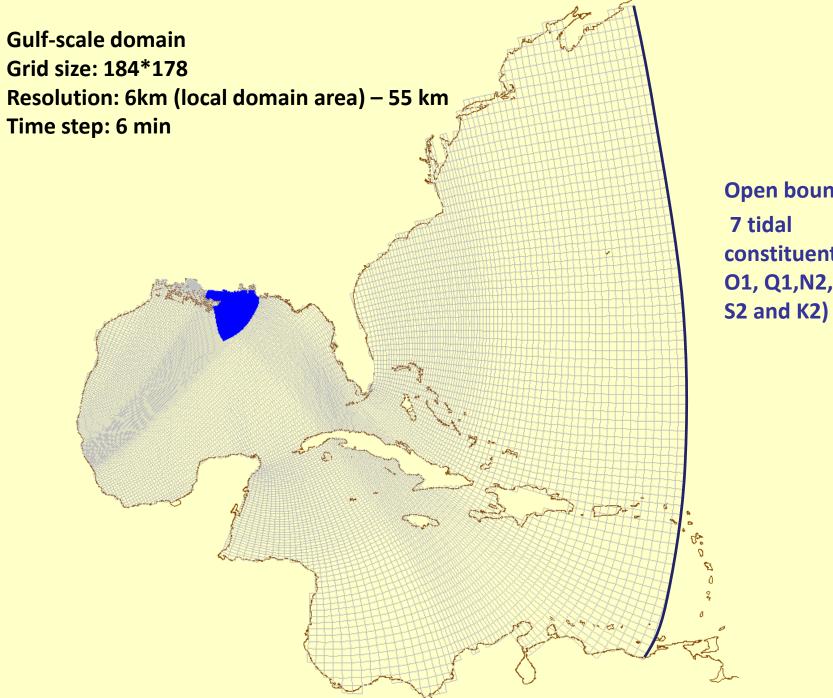
#### Delft3D

- The Delft3D suite, developed by Deltares, can carry out simulations of flows, sediment transports, waves, water quality, morphological developments and ecology.
- Delft3D-FLOW is a multi-dimensional (2D or 3D) hydrodynamic (and transport) simulation program which calculates non-steady flow and transport phenomena that result from tidal and meteorological forcing on a rectilinear or a curvilinear, boundary fitted grid.
- Delft3D-FLOW+Delft3D-WAVE

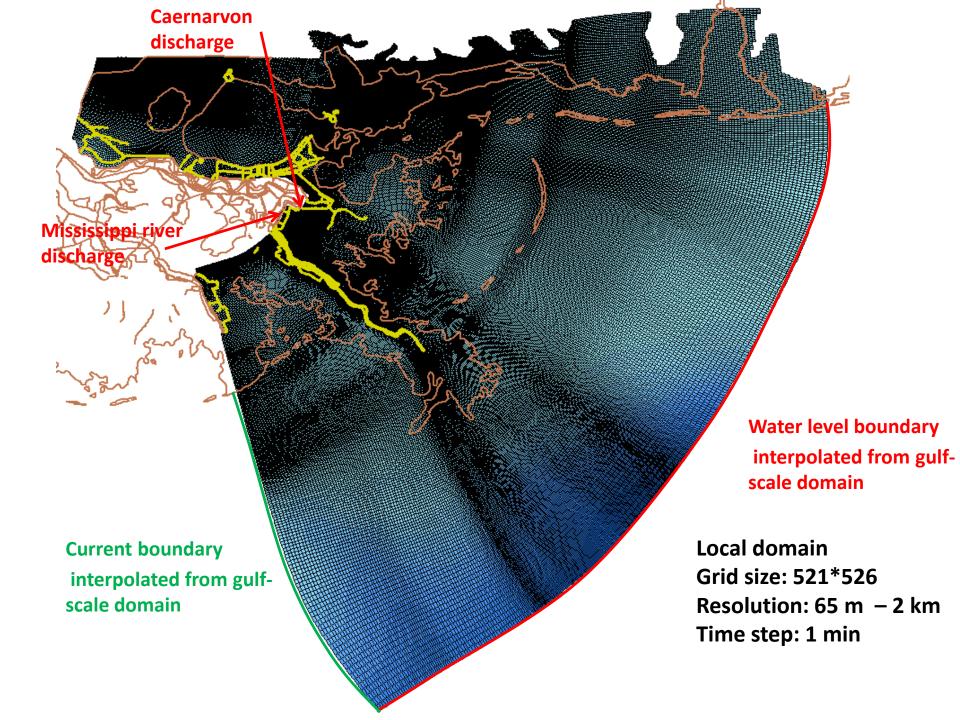


#### Features

- Online coupling of FLOW and WAVE
- Nesting computation
- Levees
- Vegetation



**Open boundary** constituents (K1, O1, Q1,N2, M2,



#### Vegetation











During the summer of 2013, the U.S. Geological Survey, Louisiana State University, University of Louisiana at Lafayette, and the Louisiana Department of Wildlife and Fisheries Coastal and Nongame Resources Division jointly completed an aerial survey to collect data on 2013 vegetation types in coastal Louisiana. Plant species were listed and their abundance classified. On the basis of species composition and abundance, each marsh sampling station was assigned a marsh type: fresh, intermediate, brackish, or saline (saltwater) marsh. The current map presents the data collected in this effort.

#### Methodology

There are numerous datasets available to conduct analyses of marsh change in coastal Louisiana. Most prior studies have used either National Wetlands Inventory data or vegetation type maps produced by O'Neil (1949), Chabreck and others (1968), Chabreck and Linscombe

(1978, 1988, 1997), Linscombe and Chabreck (n.d. [2001]), and Sasser and others (2008). During the summer of 2013, the U.S. Geological Survey, Louisiana State University, University of Louisiana at Lafavette, and the Louisiana Department of Wildlife and Fisheries Coastal and Nongame Resources Division jointly completed an aerial survey to collect data on 2013 vegetation types in coastal Louisiana (table 1). The current map presents the data collected in this effort.

The 2013 aerial survey was conducted from a 206 Bell Jet Ranger helicopter by using techniques developed over the last 30 years while conducting similar vegetation surveys. Transects flown were oriented in a north-south direction and spaced 1.87 miles (mi) (3 kilometers [km]) apart. Sampling sites were located at a spacing of 0.5 mi (0.8 km) along these transects. Transects covered coastal marshes from the Texas State line to the Mississippi State line and from the northern extent of fresh marshes to the southern end of saline (saltwater) marshes on the beaches of the Gulf of Mexico or of coastal bays. Navigation along these transects and to each sampling

site was accomplished by using Global Positioning System (GPS) technology and geographic information system (GIS) software operating on a ruggedized laptop, a procedure that was established during the 1997 vegetation survey by Chabreck and Linscombe (1997).

As the surveyors reached each sampling station, plant species were listed and their abundance classified. On the basis of species composition and abundance, each marsh sampling station was assigned a marsh type: fresh, intermediate, brackish, or saline (saltwater) marsh (Visser and others, 1998, 2000, 2002). The data generated from the survey were later delineated by using the same base map as that used to map the data collected during the 1997 (Chabreck and Linscombe, 1997), 2001 (Linscombe and Chabreck, n.d.), and 2007 (Sasser and others, 2008) surveys. Delineations of marsh boundarie usually followed natural levees, bayous, or other feature that impede or restrict water flow.

The biophysical characteristics of various vegetation types.

Vegetation type	Average stem height (m)	Average stem diameter (mm) <sup>e</sup>	Average stem density (m <sup>-2</sup> ) <sup>e</sup>
Fresh marsh	0.76 <sup>a</sup>	5.59	578
Intermediate marsh	0.50 <sup>b</sup>	2.03	2095
Brackish marsh	$0.50^{c}$	1.50	740
Saline marsh	0.40 <sup>d</sup>	3.67	341

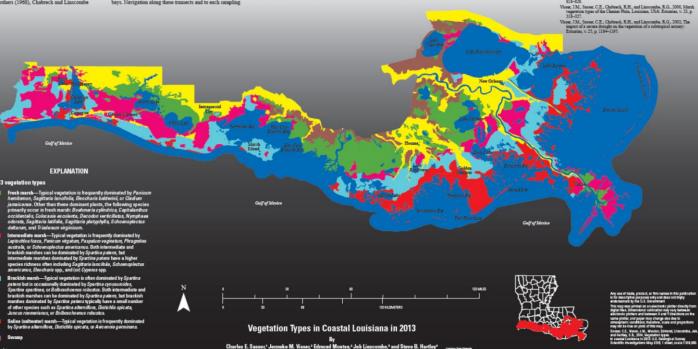
<sup>a</sup> United States Department of Agriculture (USDA) natural Resources Conservation Services (NRCS) herbaceous plant online database (http://plants.usda.gov/java/factSheet).

n marsh 2001 assessment—Salt marsh dieback in Louisiana: Brow

- No data for Intermediate marsh, assumed the same as Brackish marsh.
- Randall and Foote (2005).
- McKee et al. (2006).
- e Visser (2007).

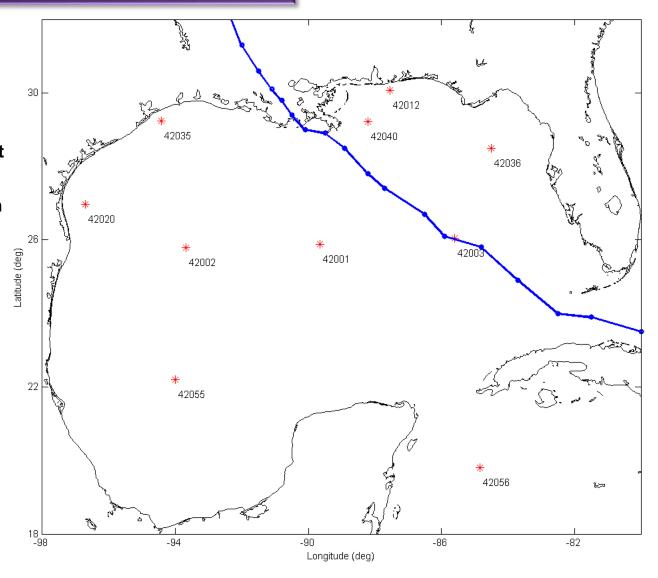
Saline (saltwater) marsh

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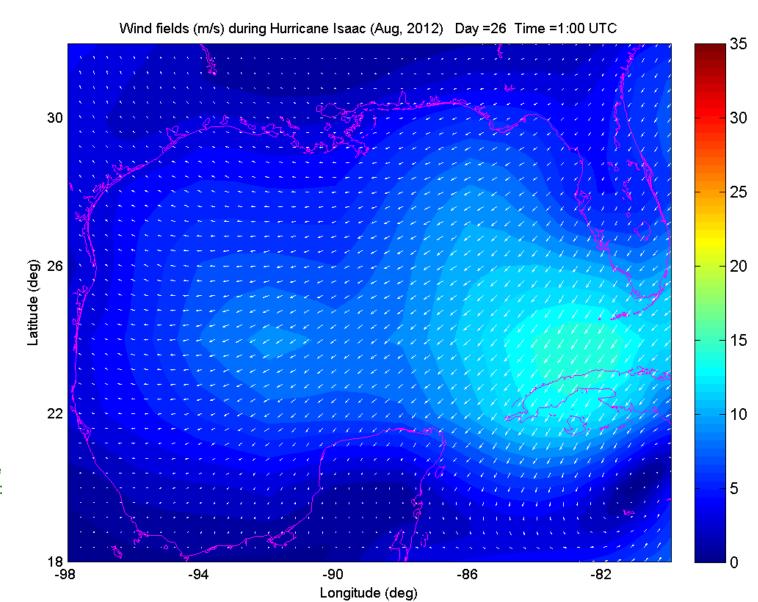


#### Hurricane Isaac (2012)

As a Category I hurricane near the Louisiana Coast on August 28, 2012, with winds of 80 mph (130 km/h) and lowest pressure of 965 mb.

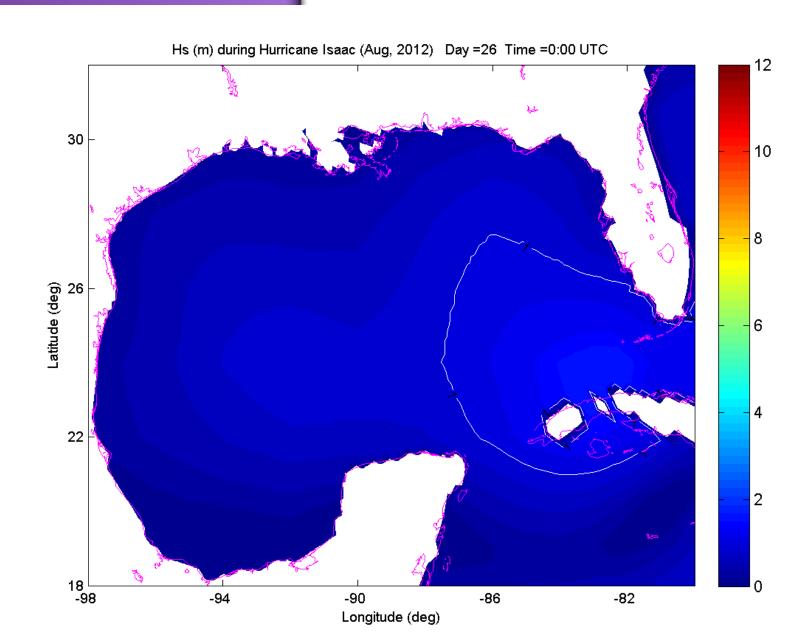


#### Isaac winds

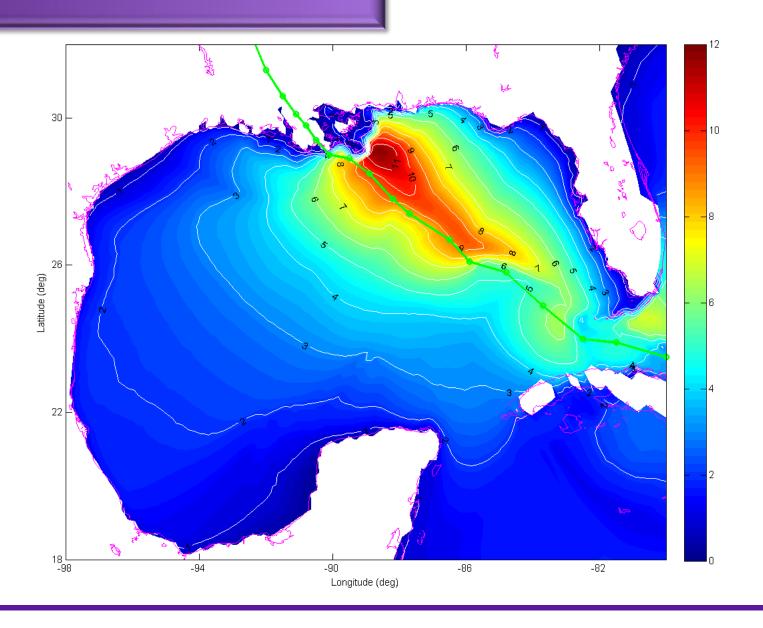


- Hu, K., Chen, Q., and Kimball, K.S., 2012. Consistency in hurricane surface wind forecasting: An improved parametric model, *Natural Hazards*, 61:1029–1050.

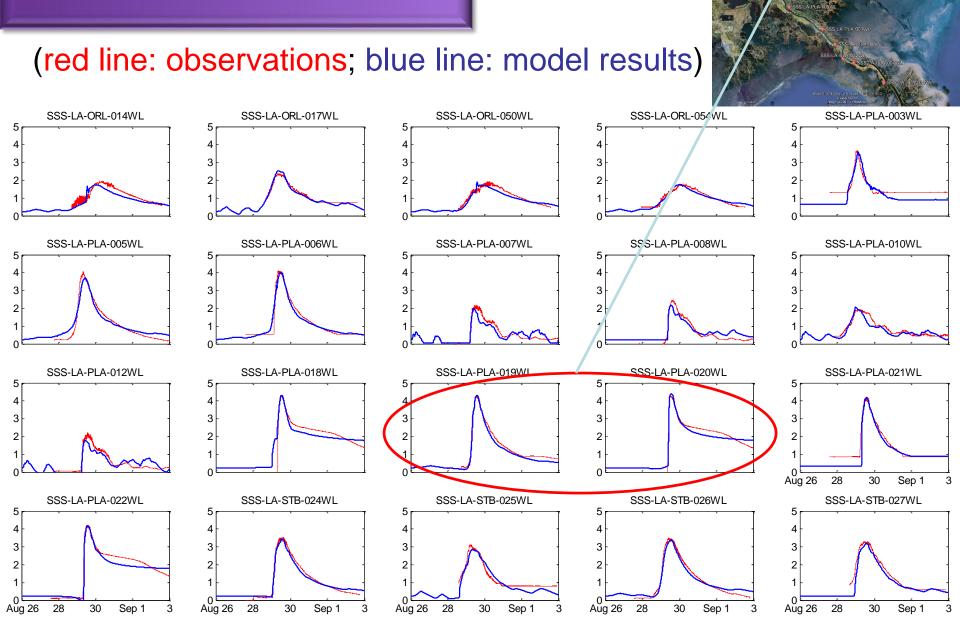
#### Hs (m) by Isaac



#### Maximum Hs (m)

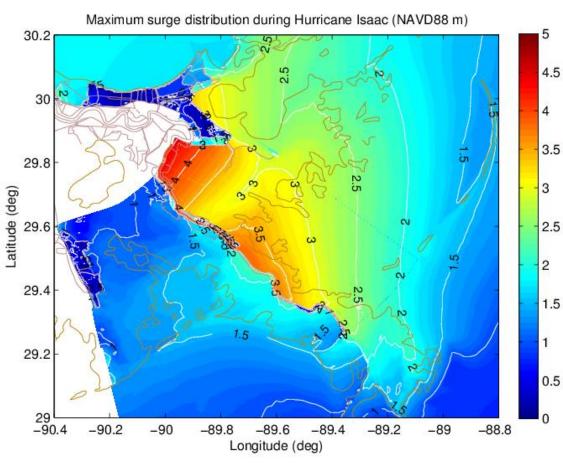


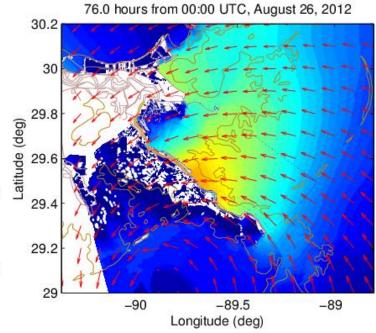
#### Water level comparison

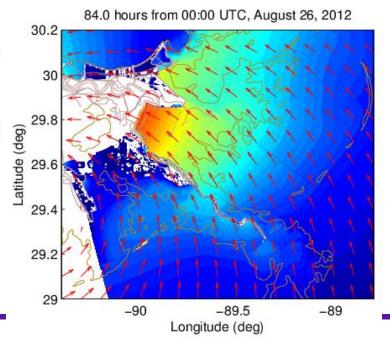


1.0 hours from 00:00 UTC, August 26, 2012 30.2 5 30 29.8 3 Latitude (deg) 29.6 2 29.4 29.2 0 29 L -90.4 -90.2 -89.2 -90 -89.8 -89.6 -89.4 -89 -88.8 Longitude (deg)

#### Maximum surge (m)

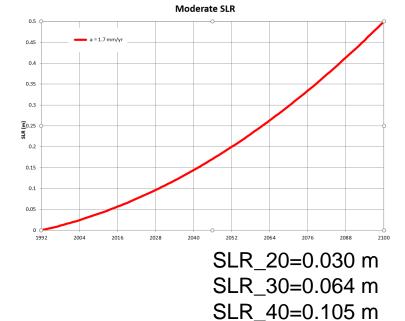






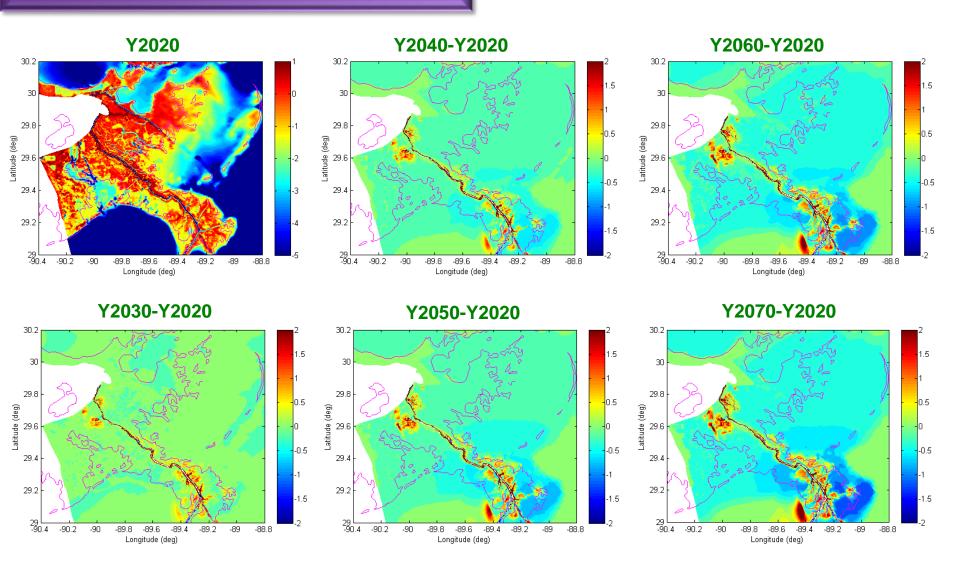
#### Numerical experiments

- Six years (2020, 2030, 2040, 2050, 2060 and 2070)
- For each year, input predicted bathymetry and vegetation map (with projects or w/o projects)
- Moderate sea level rise (SLR)
- Major factors
  - Diversion project
  - Vegetation
  - Waves
  - SLR

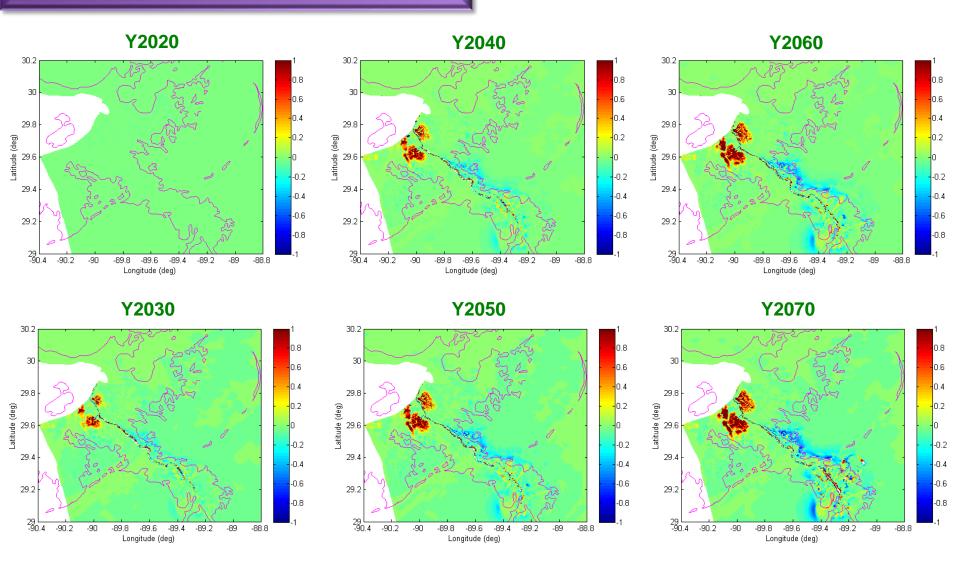


SLR\_50=0.150 m SLR\_60=0.202 m SLR 70=0.258 m

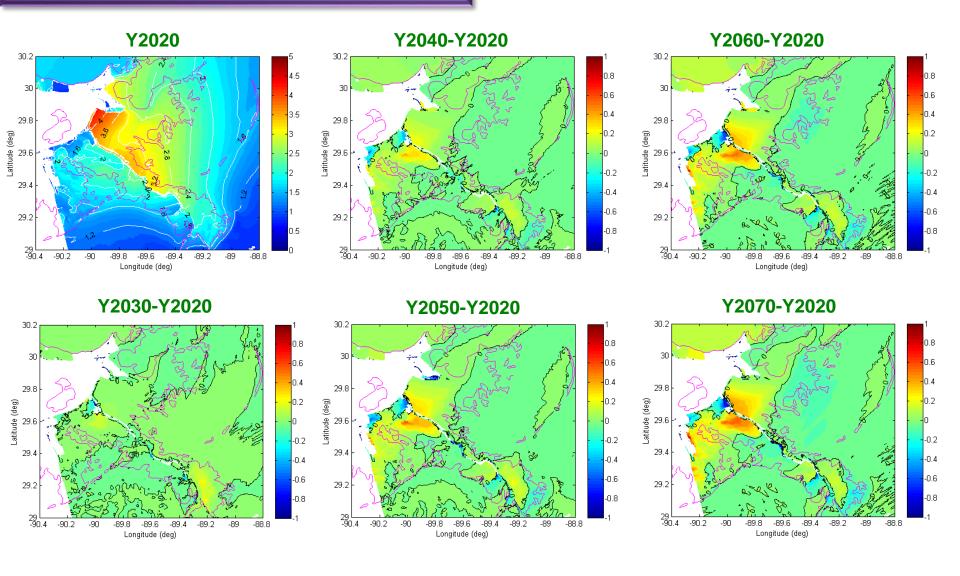
# Bathymetry and elevation changes (m) (with project)



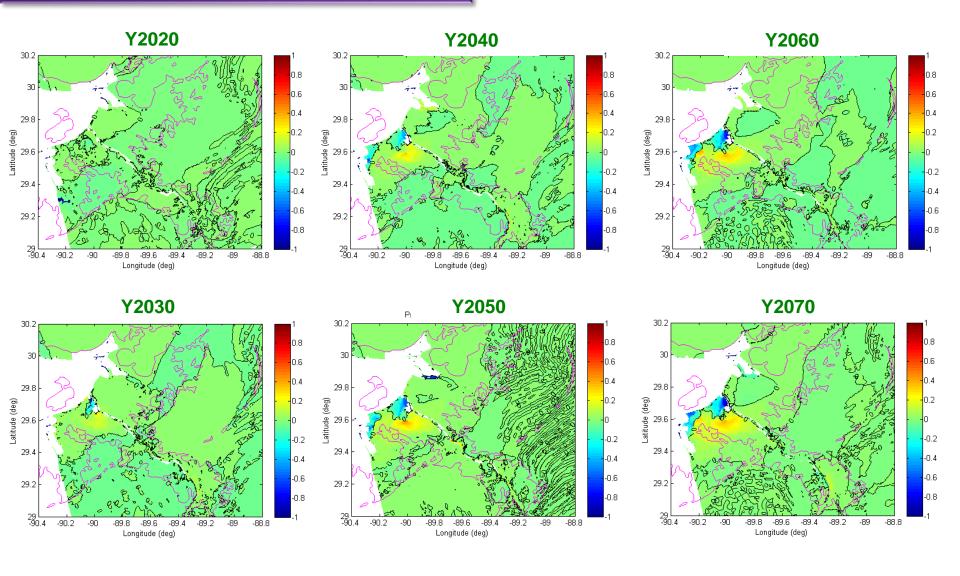
# Elevation changes (m) (with project – w/o project)



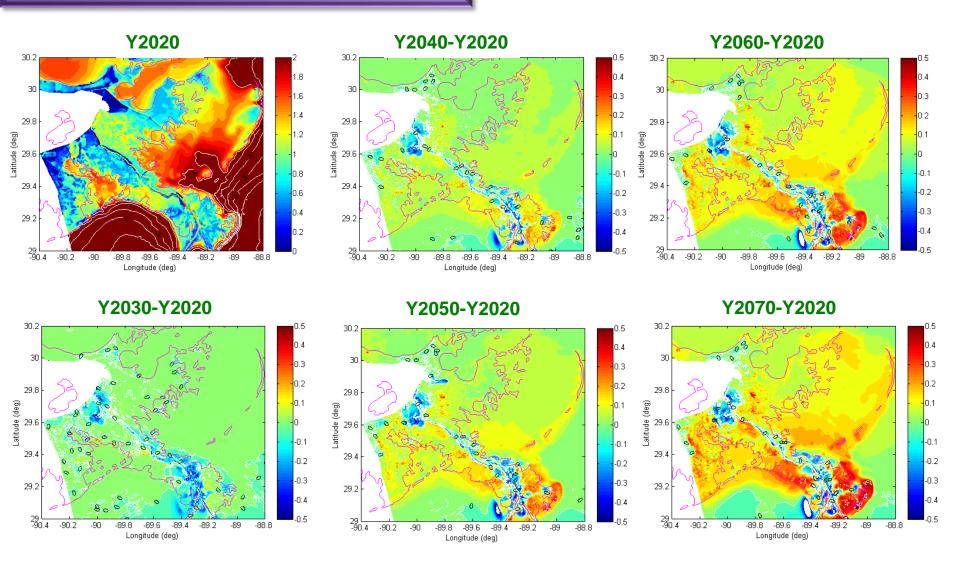
Maximum surge and changes (in m, MSL) during Hurricane Isaac (with projects, vegetation, waves and SLR)



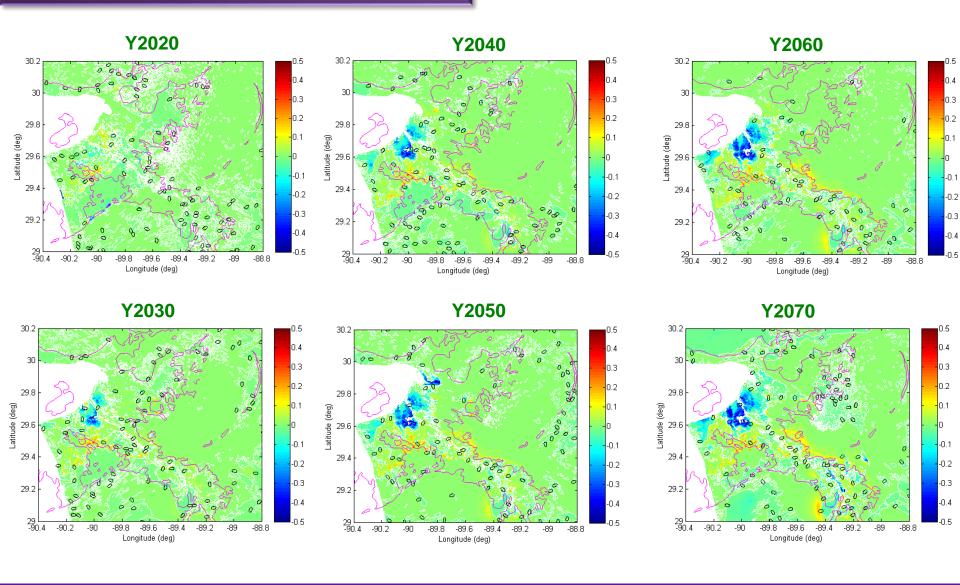
## Project effect on maximum surge (in m) (with projects – w/o projects)



#### Maximum Hs and changes (in m) during Hurricane Isaac (with projects, vegetation and SLR)



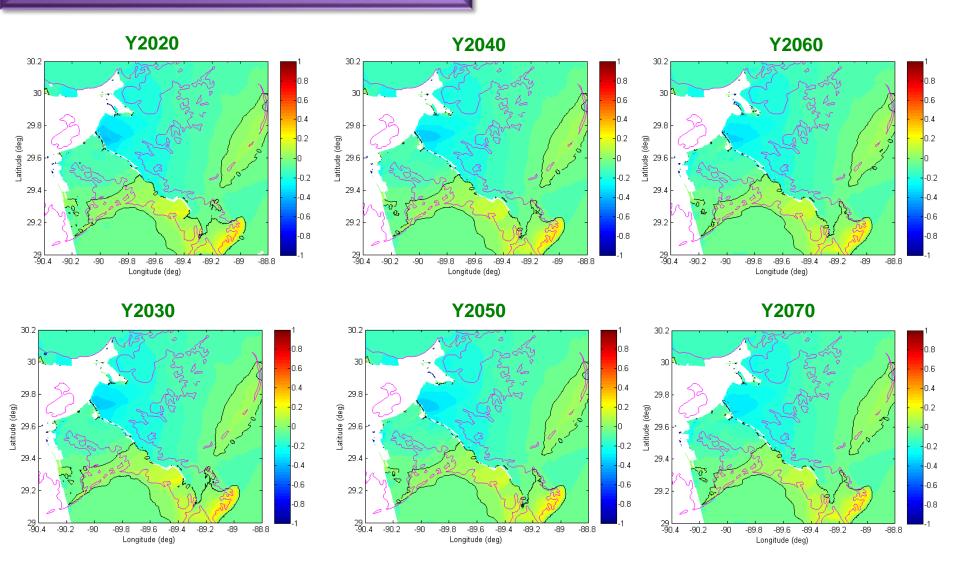
# Project effect on maximum Hs (in m) (with projects – w/o projects)



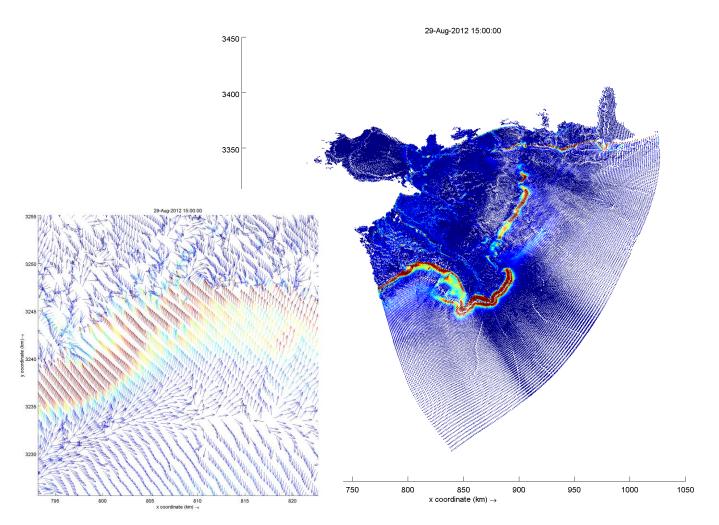
#### Conclusions

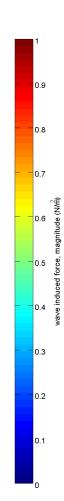
- The coupled Delft3D model was successfully applied to coastal Louisiana for storm surge and hurricane wave simulations;
- The mid-Barataria diversion project would reduce both surge and waves in construction areas, while to the south of the project, surge and waves would increase;
- The mid-Breton diversion project would reduce waves nearby, but it would have little effect on surge under Hurricane Isaac conditions because of the unique geometry of Breton Sound.

## Wave effect on maximum surge (in m) (with waves – w/o waves)

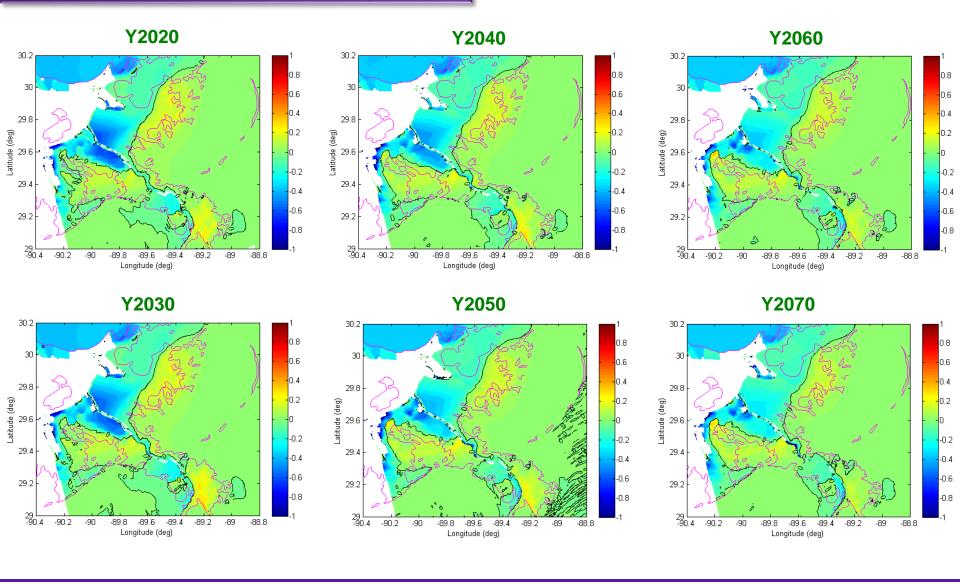


### Wave-induced force

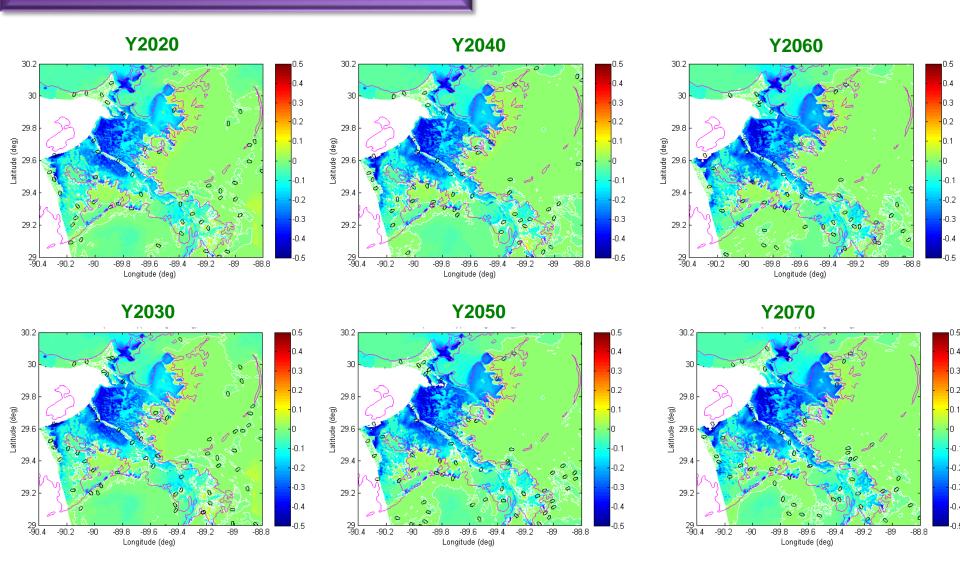




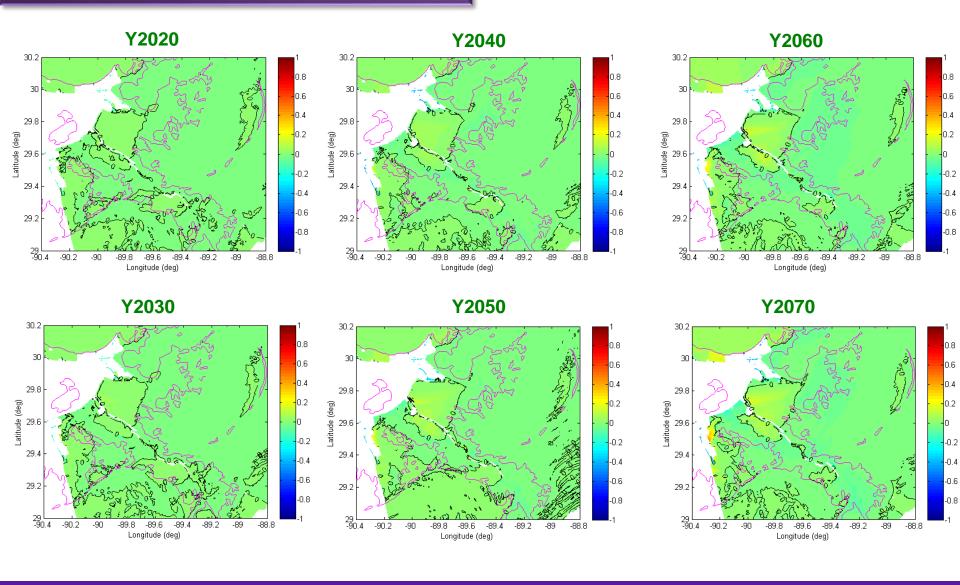
### Vegetation effect on maximum surge (in m) (with vegetation – w/o vegetation)



# Vegetation effect on maximum Hs (in m) (with vegetation – w/o vegetation)



# SLR effect on maximum surge (MSL, in m) (with SLR – w/o SLR)



# SLR effect on maximum Hs (in m) (with SLR – w/o SLR)

