Landfalling Tropical Cyclones and Their Coastal Impacts

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ICoM research objectives of this project:
- Better understand hurricane Impacts over the coastal regions and its potential changes in a changing climate
- Develop a landfalling tropical cyclone rainfall climatology for model evaluation and inter-comparisons

Data:
- NCEP Stage IV QPE (4 km, hourly radar+gauge precipitation over CONUS), 2002-2019
- Tide gauges, NDBC buoys, satellite observations

Model:
- Unified Wave Interface-Coupled Model (UWIN-CM) is a coupled atmosphere-wave-ocean model (WRF-UMWM-HYCOM)

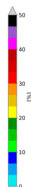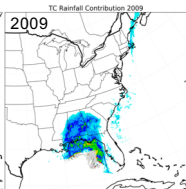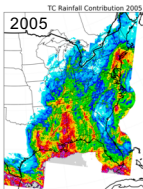U.S. DEPARTMENT OF **ENERGY**
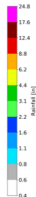Office of Science
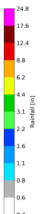
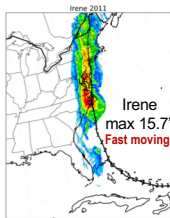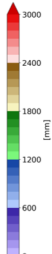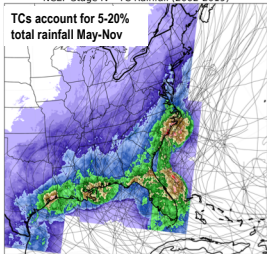**Pacific Northwest** NATIONAL LABORATORY

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Hurricanes and Coupled Modeling Group

Landfalling TC Rainfall Climatology:

NCEP Stage IV - TC Rainfall (2002-2019)

TCs account for 5-20% total rainfall May-Nov
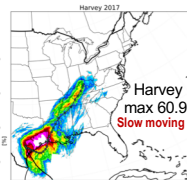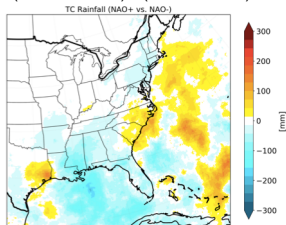

Irene 2011

Irene max 15.7"
Fast moving

Harvey 2017

Harvey max 60.9"
Slow moving

2005

2009

TC Rainfall Contribution 2005

TC Rainfall Contribution 2009

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Decadal Variability of TC Rainfall
(2012-19 NAO+) – (2002-11 NAO-)

TC Rainfall (NAO+ vs. NAO-)

UWIN-CM Impacts Forecast of Hurricane Irene (2011) and Superstorm Sandy (2012)

Irene

UWIN-CM Rainfall
24 to 29 Aug. 2011

Max Height Above Pre-Storm High Tide
26 - 30 August 2011 (Hurricane Irene)
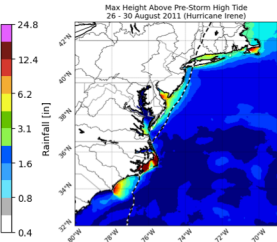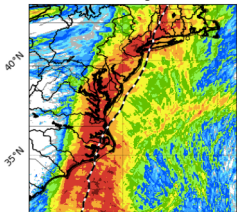
UWIN-CM – coupled atmosphere-wave-ocean model

- Weather Research and Forecasting (WRF):

  12/4/1.3 km horizontal resolution 45 vertical levels, Initial and boundary conditions from ERA5 or NCEP GFS
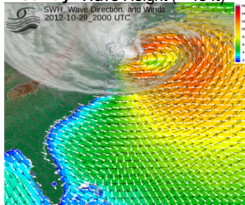
- University of Miami Wave Model (UMWM):

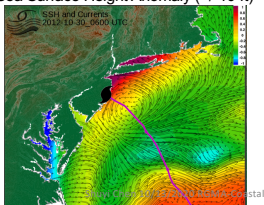 4 km horizontal resolution, 36 directional bins and 37 frequency bins from 0.0313 – 2.0 Hz

- HYbrid Coordinate Ocean Model (HYCOM):

  1/25 deg (~4 km) horizontal resolution, 41 vertical levels, initial and boundary conditions from global 1/12 deg. HYCOM
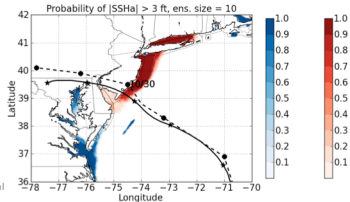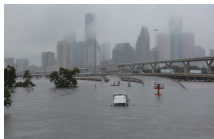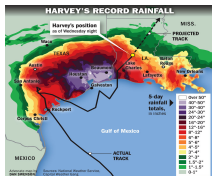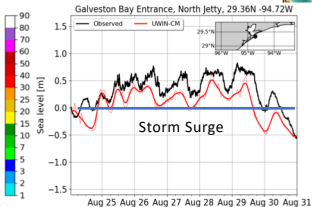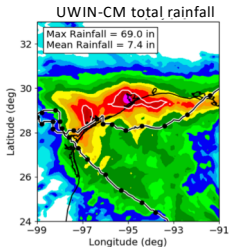
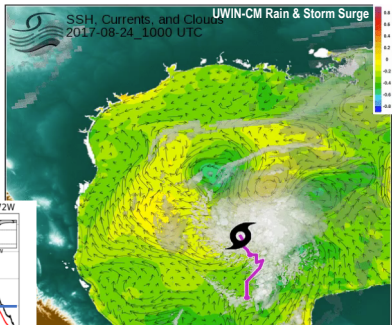**Sandy** Wave Height (> 45 ft)

Sea Surface Height Anomaly (+/-10 ft)

Ensemble Forecasts: Sea Surface Height Anomaly

Hurricane Harvey (2017) – **Flooding**: <u>Rain</u>, <u>Surge</u>, <u>Built Environment</u>

HARVEY'S RECORD RAINFALL

Built environment without good natural drainage

UWIN-CM Rain & Storm Surge

SSH, Currents, and Clouds
2017-08-24_1000 UTC

UWIN-CM total rainfall

Max Rainfall = 69.0 in
Mean Rainfall = 7.4 in

Galveston Bay Entrance, North Jetty, 29.36N -94.72W

Observed — UWIN-CM

Storm Surge

Grand Challenges - <u>Observing</u> and <u>Modeling</u>
- TC wind, rain, waves, current, surge, flooding in a changing climate and rising seas
- Coastal/inland watershed/rivers, urban built environments, risk decision making

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