Multi-tiered ADCIRC-based storm surge and wave prediction system

- Brian Blanton, RENCI/UNC-Chapel Hill
- Jason Fleming, Seahorse Coastal Consulting
- Jess Smith, RENCI/UNC-Chapel Hill
- Rick Luettich, IMS/UNCCH, DHS-CRC
Research/Applications Work and Accomplishments

• ASGS Real-time Tropical Cyclone Predictions
  • Implemented NOAA HSOFS grid as baseline prediction grid
  • Consistent resolution for US east coast and Gulf of Mexico

• Probabilistic Hurricane Track Method
  • UNC MS Student Jess Smith

• Homeland Security Enterprise
• Mission 5
• Strengthen National Preparedness and Resilience
• Advancing the ADCIRC model and it’s software ecosystem
ADCIRC Surge Guidance System (ASGS)  
http://NC-CERA.RENCI.ORG

Very high spatial resolution, NOAA HSOFS/ESTOFS ADCIRC grid

Collaboration between RENCI, Seahorse Coastal, UNC IMS, the DHS CRC @ UNC, and LSU

Predictions based on Nat’l Hurricane Center’s official (OFCL) storm track and intensity forecast

Primary public dissemination: http://nc-cera.renci.org

Used by:
- FEMA/DHS
- US Coast Guard
- Insurance Companies (e.g., Travelers)
- US Army Corps of Engineers
- Researchers
- Emergency Managers
- System Operators
ADCIRC Surge Guidance System (ASGS)
http://NC-CERA.RENCI.ORG

Unique Hits

356
3,327
85,377

ADCIRC Surge Guidance System (ASGS)
http://NC-CERA.RENCI.ORG

750K ????

Hurricane XYZ (2018)
ADCIRC Surge Guidance System (ASGS)
http://NC-CERA.RENCI.ORG

Are We Prepared

Hurricane XYZ (2018)

750K ????
ADCIRC Surge Guidance System (ASGS)
http://NC-CERA.RENCI.ORG

Preventing for 2018 Atlantic Hurricane Season

RENCI Investment in CERA infrastructure

Web/Database Server
Dual Intel Xeon Gold
192 GB DDR4-2666 RAM
Intel 1TB NVMe SSD for tile storage and caching
two in a RAID 1 mirror for redundancy
Two 120 GB SSD in a RAID 1 mirror for OS install

Tile/Data Servers
Dual Intel Xeon Gold
192 GB DDR4-2666 RAM
Intel 4TB NVMe SSD for tile storage and caching
two in a RAID 1 mirror for redundancy
Two 120 GB SSD in a RAID 1 mirror for OS install
Probabilistic Hurricane Track Generation for Storm Surge Prediction

- Jess Smith, RENCI/UNC
- Masters Thesis work
- Funded by DHS/CRC
- Defended Dec 2017
- Hired at RENCI to continue work
- Reported on at AMS 2017 and 2018
- Manuscript in preparation
Probabilistic Hurricane Track Generation for Storm Surge Prediction

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• Develop a model for rapid cyclone forecast track ensembles
• Extends work of Davis et al, 2010
  • Cross-track error only
• Incorporates Along Track error and intensity error (Max Wind Speed)
Probabilistic Hurricane Track Generation for Storm Surge Prediction
Probabilistic Hurricane Track Generation for Storm Surge Prediction

[Graphs and diagrams showing probabilistic forecast error for cross-track and along-track predictions over different time intervals.]
Probabilistic Hurricane Track Generation for Storm Surge Prediction

Cross-track Forecast Error, years 2000:

Along-track Forecast Error, years 2000:

CTE + ATE - 27×27 Tracks
Probabilistic Hurricane Track Generation for Storm Surge Prediction
Probabilistic Hurricane Track Generation for Storm Surge Prediction

• Currently developing skill assessment using Brier Skill approach
• Develop a hierarchy of optimal grid resolutions and number of simulations needed to achieve a specified level of accuracy
  • “Closer to landfall, fewer storms, higher grid resolution”
• Manuscript in preparation; distillation of J. Smith’s MS Thesis
Probabilistic Track Generation for Hurricane Storm Surge Estimates
Probabilistic Track Generation for Hurricane Storm Surge Estimates
Probabilistic Track Generation for Hurricane Storm Surge Estimates
End User Engagement

• NOAA
  • Nat’l Ocean Survey, Coast Survey Development Laboratory

• Provided NOAA HSOFS grid
• Uses ADCIRC/ASGS in NOAA operational environments for storm surge guidance
End User Engagement

• USACE, MVN District
  • Operates a version of ASGS for operational decision making for New Orleans area.
  • Provides valuable critiques of product usefulness, accessibility, and confidence
  • Provides feedback on ADCIRC and the ASGS system itself
End User Engagement

• FEMA/DHS
  • Federal Insurance and Mitigation Administration
  • Federal Insurance and Mitigation Administration
  • Using ASGS output in real-time
  • Particularly during Hurricane Irma (2017)
    • Post-storm hindcasts for damage assessments
End User Engagement

- NCC Watch / DHS
  - National Coordinating Center for Communications – COMM-ISAC
  - National Cybersecurity & Communications Integration Center
- RPS Group
  - On behalf of USCG
- Travelers Insurance
  - Disaster relief planning
- Eric M. Nelson | Senior Vice President | CAT Strategy & Analysis
  - “I would like to also thank you for the service you do for the public. We appreciate the ability to evaluate your tool to help us with disaster relief planning.”
End User Engagement

• US Coast Guard
  • Uses ADCIRC/ASGS output for Search and Rescue operations
    • For the Pamlico/Albemarle Sounds area (no other real-time guidance available)
  • In 2017:
    • 50 SAR cases in NC area that used ADCIRC/ASGS
      • 11 operational SAR cases
      • 39 training or law enforcement
  • Communicates with USCG decision makers on ASGS output in nc-cera.renci.org
Transition

• ASGS/CERA: Product delivery during storm events

• Presentations at Amer. Met. Soc. 2018, Austin TX
  • The ADCIRC Surge Guidance System for Coastal Zone Decision Support ([Recorded Presentation](#))
    • Jason Fleming, R. Luettich, M. Agnew, C. Kaiser, N. Dill, and Z. Cobell
  • Probabilistic Track Generation for Hurricane Storm Surge Estimates
    • Jessica Smith, B. Blanton and R. Luettich
  • Assimilation of Observed Water Levels into Storm Surge Model Predictions ([Recorded Presentation](#))
    • Taylor Asher, R. Luettich, J. Fleming, and B. Blanton
Transition

- ADCIRCWeek and User BootCamp
- http://adcirc2018.eventbrite.com

- DATES
  - Sun, Apr 8, 2018 - Fri, Apr 13, 2018

- LOCATION
  - NOAA Center for Weather / Climate Prediction
  - College Park, MD
Anticipated Project Impact

• **ASGS/CERA Operations** continue to have large impact on end-users and stakeholders.
  - Preparedness
  - Real-time decision-making
  - Post-storm assessments

• **Probabilistic track generator** will impact the ASGS Operations with statistically based track variations and optimal distribution sampling, given resource constraints and ADCIRC grid sizes.
Proposed Follow-on Work

• Continue Real-time ASGS/CERA system
  • Upcoming hardware refresh for website infrastructure

• Unify ADCIRC-related work under one umbrella project

• Artificial Intelligence/Machine Learning approaches to cyclone track predictions
  • Current exploratory work with Anton Bezuglov, Buena Vista Univ (Iowa)
  • DHS Summer Research Fellow at DHS/CRC/RENCI, summer 2016
  • “Can a sequence of neural networks out-perform the NHC official forecast track (OFCL)?“
Proposed Follow-on Work

- Preliminary work:
- ANN simulation of historical data