FLEMING, SEAHORSE CONSULTING
DHS COASTAL RESILIENCE CENTER
ADCIRC PROJECT
YEAR 5 PROGRESS REPORT
July 1, 2019 – June 30, 2020 (Updated 12/21/2020)

I. INTRODUCTION

Project Title: The ADCIRC Surge Guidance System as a Conduit for Innovation

Principal Investigator Name/Institution: Jason G. Fleming, Seahorse Coastal Consulting

Additional Research Participants/Partners: Brett Estrade, Coastal Computing Services, LLC; Sarah Lipuma, Duke University

Short Project Description ("elevator speech"):

We are positioning our ADCIRC Surge Guidance System software (ASGS) as a real time 24/7 delivery vehicle for the innovations developed at the CRC that have the best value proposition for our key stakeholders. We are also researching asset database driven products beyond storm surge that are more directly relevant to the needs of our transition targets. Finally, we are setting up outreach and training activities that will benefit new users as well as generate sales leads for sustainable funding going forward.

II. PROJECT NARRATIVE

1. Project overview: Over the years, CRC researchers have developed significant innovations to enhance coastal resilience and coastal hazard decision support. However, when it comes to transition, there is often no clear path for reliably delivering these new technologies into the hands of the people that need them.

It is difficult for Universities and their staff to deploy and support a technology with the round-the-clock reliability that is key for emergency operations. Furthermore, if the innovations developed at the CRC are transitioned to end user agencies piecemeal, each one may be not significant enough on its own to justify the ongoing expense of transition. And even if they do transition successfully in isolation from each other, the benefit of synergy between them is lost.

To address these challenges, we are positioning our technology, the ADCIRC Surge Guidance System (ASGS), as a conduit that runs 24/7/365 to deliver the innovations developed at the CRC to end user agencies. We also provide training and outreach to end users, and we collect O&M funding from end user agencies to sustain the innovation pipeline. As an added benefit, this approach breaks down the silos separating the CRC PIs by aggregating and integrating their research products into a common delivery vehicle, thus taking advantage of the synergies between them.

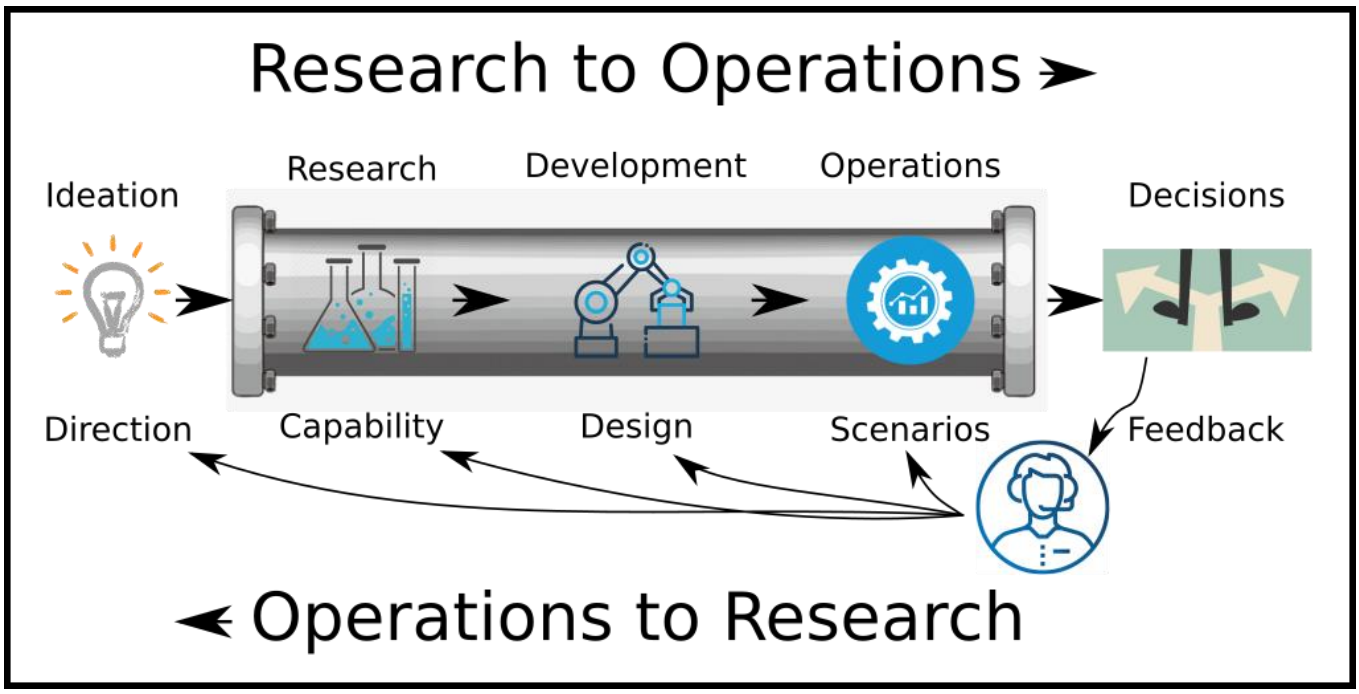

Figure 1 The Research-to-Operations pipeline is critical for advancing the state of the practice, while the Operations-to-Research feedback system continuously renews the vitality and relevance of the research enterprise. The construction and maintenance of this pipeline is a project in itself; it acts as a force multiplier for research spending.

Finally, this project also acknowledges the crucial importance of communication and raising the profile of the advancements funded by DHS OUP with significant emphasis on travel to stakeholder sites, presentations at meetings with National relevance, and on business development for sustainable funding streams.

2. Results: Our 24/7 hurricane decision support operations provided key support for life and property decisions for the US Coast Guard, FEMA, and other Federal agencies (including the US Army Corps of Engineers) as well as State agencies including the Louisiana Coastal Protection and Restoration Authority (LA CPRA) and the North Carolina Department of Transportation, among others.

During this Year 5, we were able to complete several of our objectives, despite the issues associated with COVID-19. We hosted our first ever virtual ADCIRC Boot Camp from April 1st through April 3rd. Through this we recognized that we are able to reach a much greater, worldwide audience than the in-situ format we had been working with prior to COVID-19. We have continued to provide ongoing operation of ADCIRC Surge Guidance System and it is well within the realm of working 24/7 to produce guidance for current and historical events for the US Coast Guard, State and Regional stakeholders, and the private sector. For this, we have enlisted the aid of Brett Estrade of Coastal Computing Services, LLC. Jason and Brett continue to work together to formalize the developer/operator tasks.

3. End users: We have had several end users with the year 5 research projects. *Gordon Wells*, Research Associate at the Center for Space Research at the University of Texas and Texas State Operations Center in Austin. We have been delivering results for Gordon to use since 2010 during the Deepwater Horizon spill, and our most recent interactions were during Cindy and Harvey in the 2017 hurricane season. Gordon and the Texas State Operations Center (SOC) used our ADCIRC wind and water level guidance to make decisions about moving high profile vehicles, pre-positioning rescue and recovery assets, and operating the TxDOT Ferry system, among other things. We already have a CRC project in place to develop an inland wind product to fulfill a request he made, and we are planning multiple site visits to Texas to develop a sustainable funding agreement.

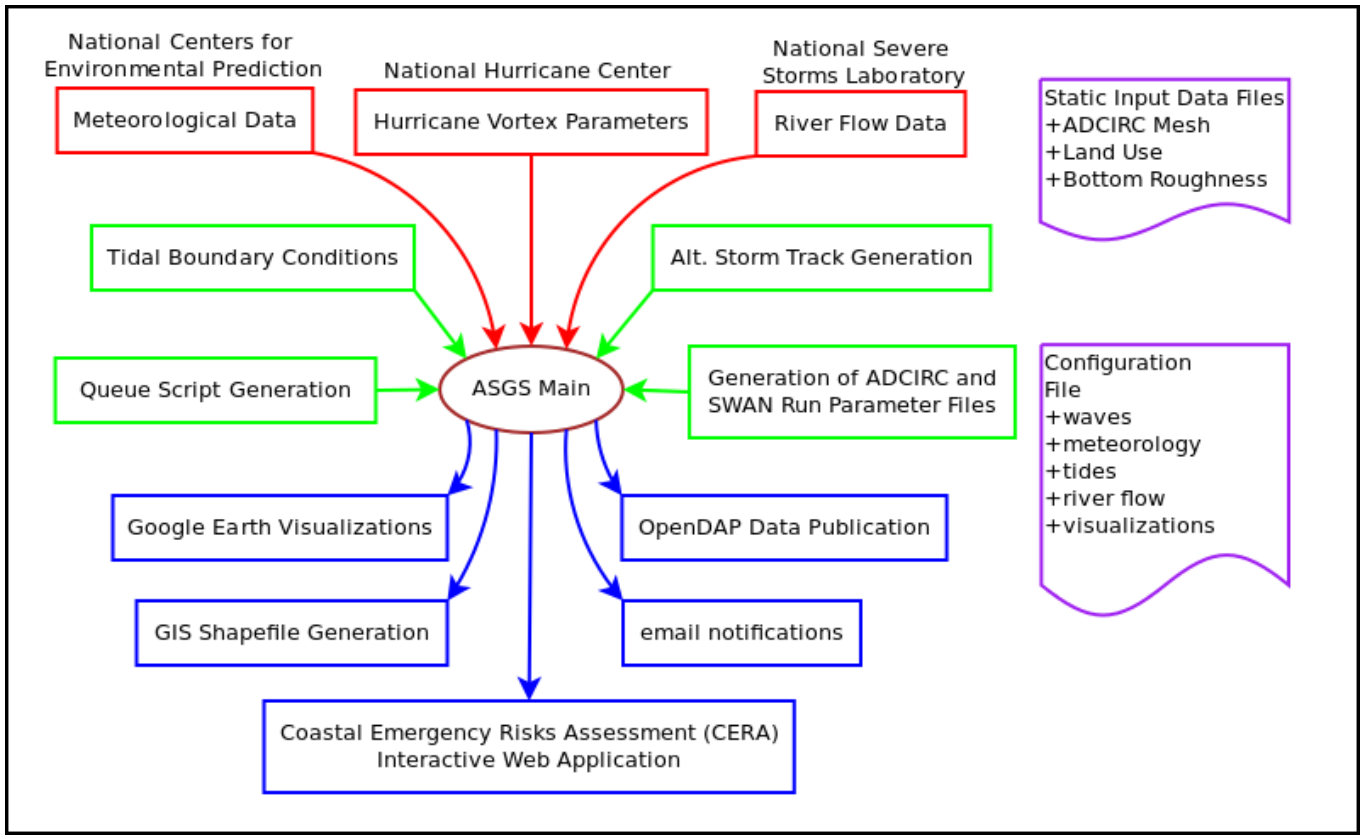

Figure 2 Research innovations require a clear technical structure for integration, delivery, and feedback collection. The ADCIRC Surge Guidance System (ASGS) provides this structure.

Lead Hydrologist for the West Gulf River Forecast Center of the National Weather Service during the Year 5 performance period. This person has specifically expressed an interest in developing model guidance for total water level, including both coastal storm surge and river discharge. Our research deliverables include improvements for modelling river discharge, and we are planning site visits to the WGRFC for outreach, training, and product feedback.

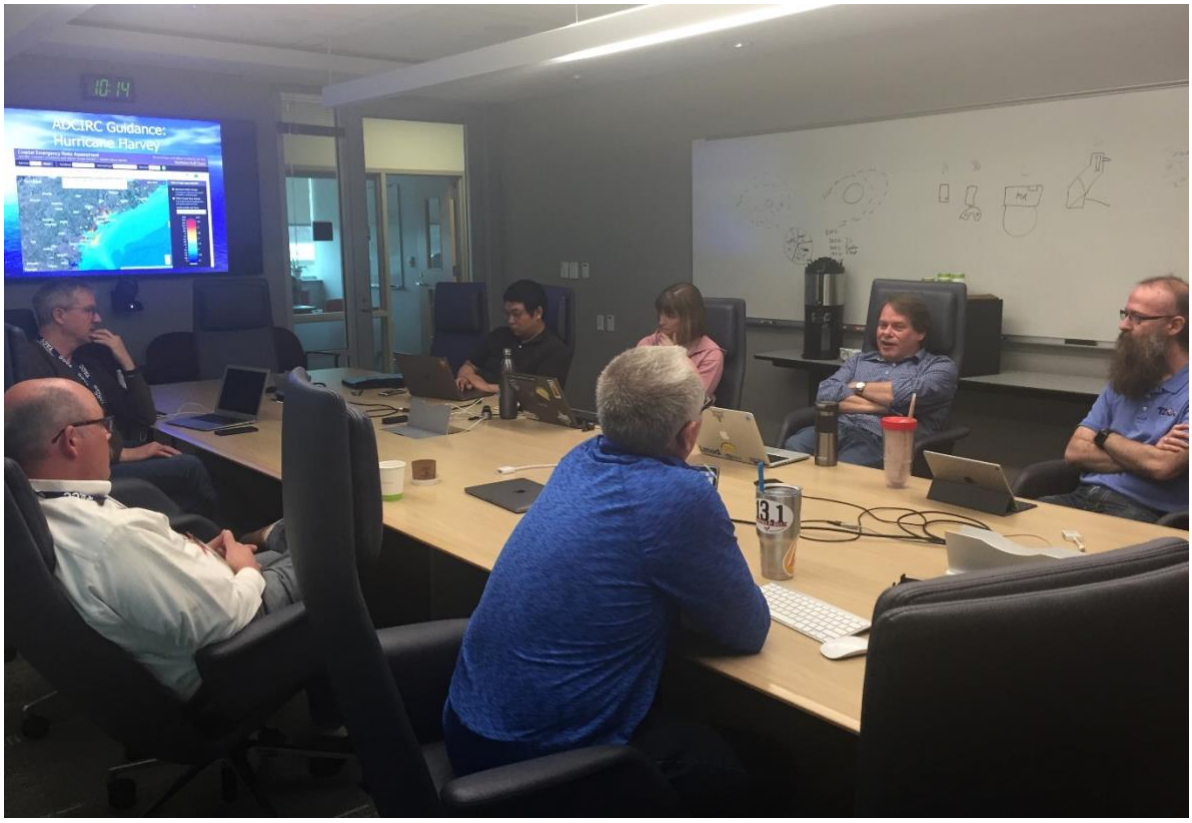

Figure 3 Success: Our new Summit meetings with our HPC partners brought key players together: science (Clint Dawson), end users (Gordon Wells), HPC (Bill Barth et al, from TACC), and Operations (Jason Fleming, Brett Estrade, and Carola Kaiser). The focus was on building relationships to facilitate the practical logistics of real time model guidance production.

Ignacio Harrouch, Director of Operations for Louisiana Coastal Protection and Restoration Authority (CPRA). The CPRA has responsibility to operate the flood protection structures (gates) and pumps throughout the hurricane protection system as well as the rest of the State of Louisiana. We have a sustainable funding contract already in place with CPRA (via LSU) to produce water level information products via ASGS. Ignacio and his team will be using our model guidance for water level (especially with timing information) to make operational decisions. He is providing detailed feedback on the effectiveness and appropriateness of our products and services; this feedback will be incorporated in future products for CPRA. We have multiple visits planned for Baton Rouge to provide outreach and training as well as receive feedback to strengthen this relationship and maintain its financial stability and growth.

Search and Rescue (SAR) Environmental Data Coordinator for the US Coast Guard during the Year 5 performance period. This person coordinates the acquisition and use of model guidance data for winds and currents for Search and Rescue Operations for the US Coast Guard. USCG SAROPS has been using our ADCIRC guidance from ASGS for water currents in the Albemarle-Pamlico Sound of North Carolina operationally since 2016. They have also recently expressed an interest in additional model products as well as expansion of

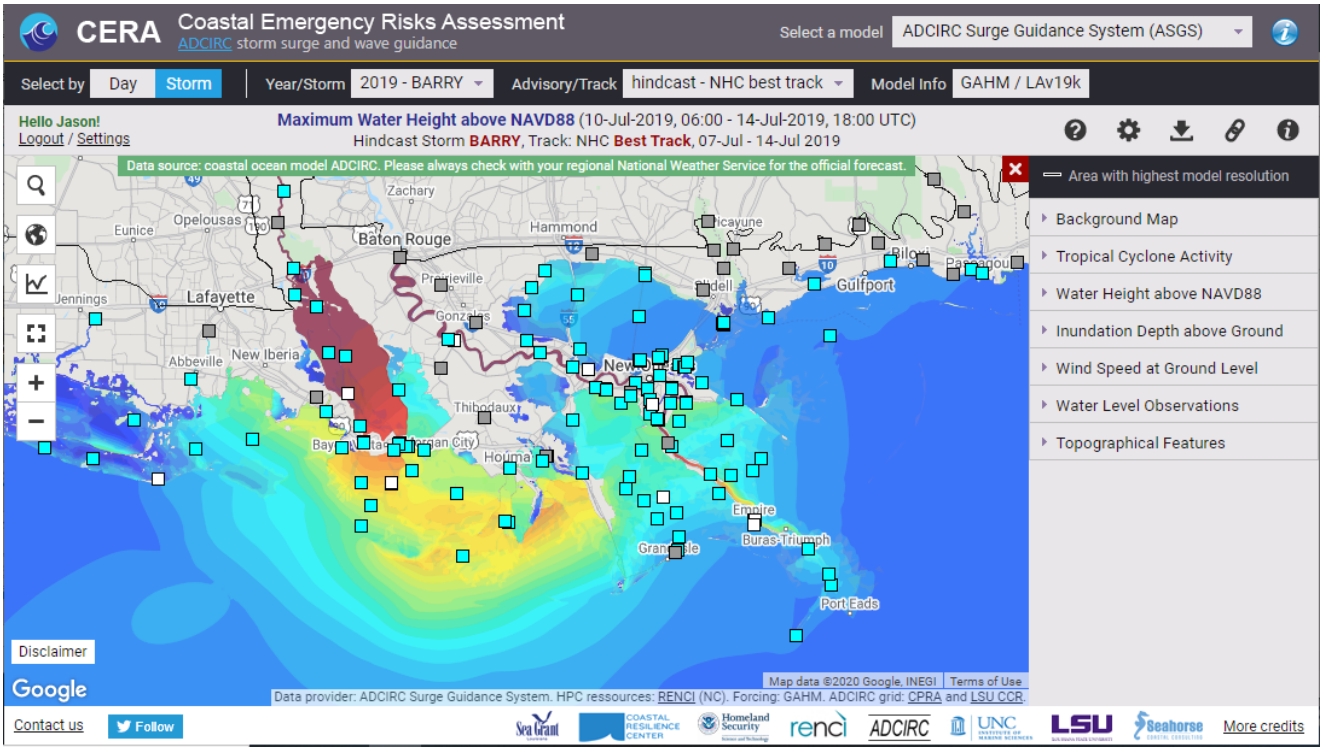

Figure 4 Hurricane Barry of 2019 successfully showcased the strength and uniqueness of our services and data products to high level stakeholders, particularly Ignacio Harrouch, Director of Operations at the Louisiana Coastal Protection and Restoration Authority (LA CPRA).

the use of our model guidance in other regions, starting with Lake Pontchartrain in Louisiana. We have begun developing plans for sustainable SAR funding going forward with Eoin Howlett at RPS ASA (their prime contractor for environmental data services) with new products in new geographical areas, both in the US and internationally.

Tom Langan, Engineering Supervisor, North Carolina Floodplain Mapping Program (NCFMP). Tom has expressed an interest in the resolution enhancement work that CRC PI Casey Dietrich has developed with leveraged research funding. The workflow that Casey has developed is fully functional and is used to enhance the resolution of storm surge results from the level of the ADCIRC mesh up to the spatial scale of the DEM, which is typically much finer. We have been working with Casey, in particular at our successful RENCI Hurricane Model Guidance Summit in January 2020, to operationalize his existing workflow and coordinate with Tom regarding the suitability and effectiveness of the resolution enhanced water level results for decision support in North Carolina.

4. Transition: During this Year 5, we were able to complete several of our objectives, despite the issues associated with COVID-19. We hosted our first virtual ADCIRC Boot Camp from April 1st through April 3rd. Through this we recognized that can reach a much greater, worldwide audience than the in-situ format we had been working with prior to COVID-19. We have continued to provide ongoing operation of ADCIRC Surge Guidance System and it is well within the realm of working 24/7/365 to produce guidance for current and historical events for the US

Coast Guard, State and Regional stakeholder, and the private sector. For this, we have enlisted Brett Estrade of Coastal Computing Services, LLC. Jason and Brett continue to work

together to formalize the developer/operator tasks. Finally, we had over 30 participants in our virtual Boot Camp from all over the United States and the world.

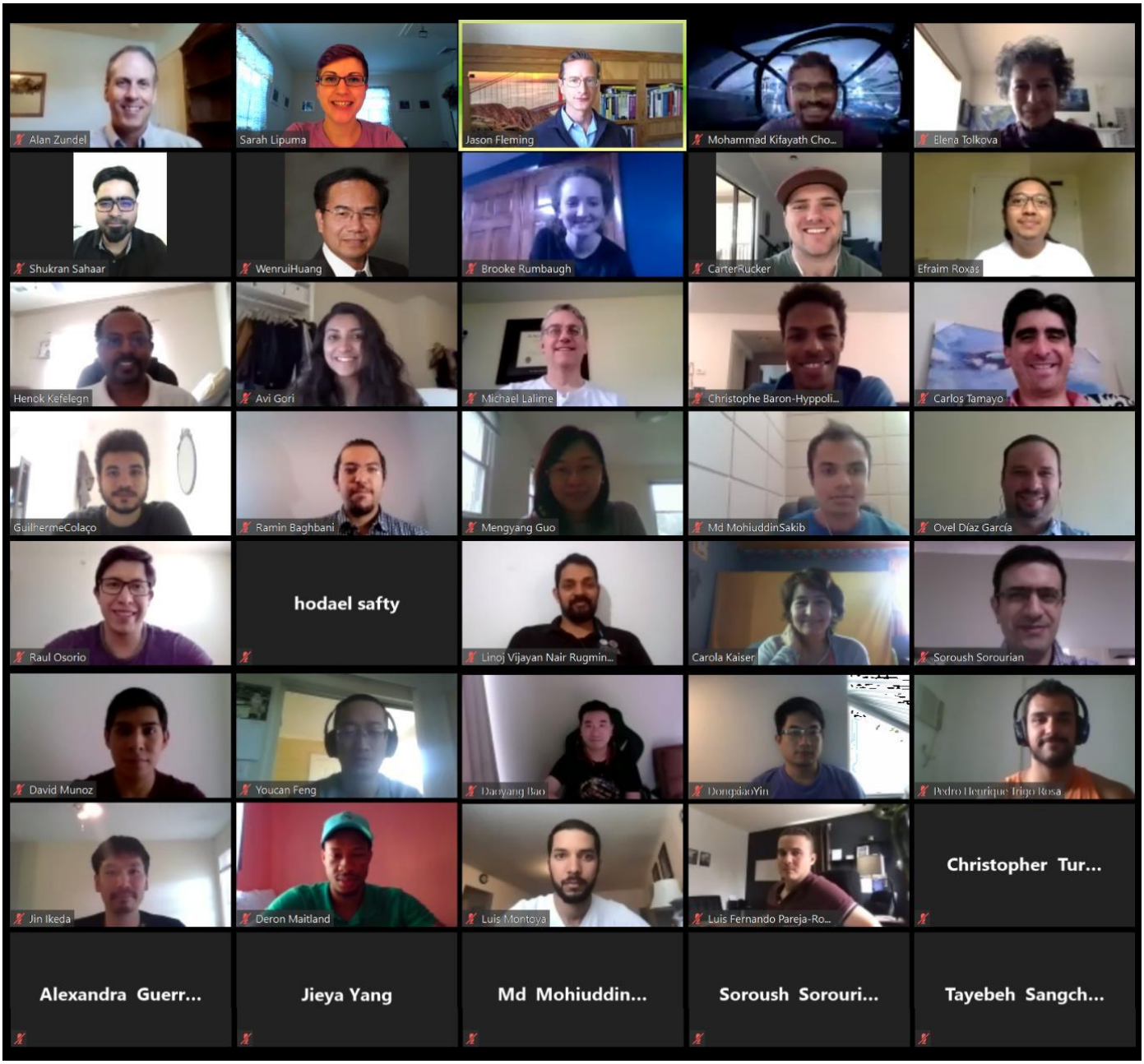

Figure 5 Our first ever **Virtual ADCIRC Boot Camp** in 2020 was a great success, with many new participants registering to participate after the change to a fully virtual format was announced. This increased the reach of the event considerably, as well as reducing the cost for all involved. We are taking this as a very positive lesson learned for all future training events.

5. Project Impact: Describe the real-world impact of your project that you accomplished or worked toward during Year 5. Include information about how your project's outcomes advanced current technologies or capabilities, especially with regard to DHS component agencies (e.g., saves lives, saves money and/or property, increases operational efficiency)

We made significant advances in coordination of real time model guidance, including training (Virtual ADCIRC Boot Camp in Spring 2020), team coordination for operational efficiency (leading virtual weekly meetings throughout calendar 2020 and leading daily virtual meetings during an active tropical cyclone event), actual storm impacts during this record breaking hurricane season (Tropical Storm Cristobal being the most significant event in the performance period ending 30 June 2020), and commercial transition for value proposition design including business model generation and testing based on stakeholder feedback gathered in Years 1-4. End user impact of this real time model guidance included the public sector at all levels as well as the private sector, academic researchers, and NGOs.

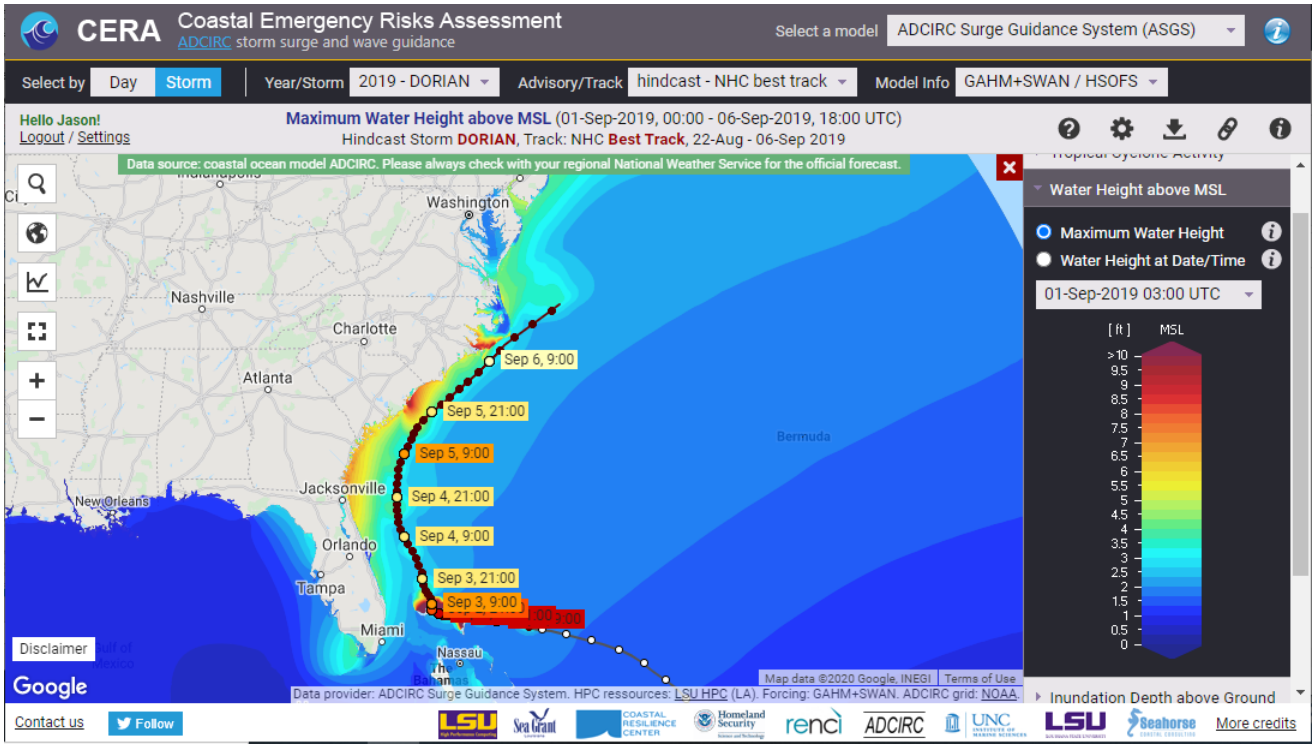

Figure 6 Hurricane Dorian of 2019 decimated the Bahamas and was forecast to do the same to Miami. We successfully deployed three FEMA meshes to provide guidance, leveraging the existing investments made by DHS for the HSE for Flood Insurance Studies (FIS) to also protect life and property in real time.

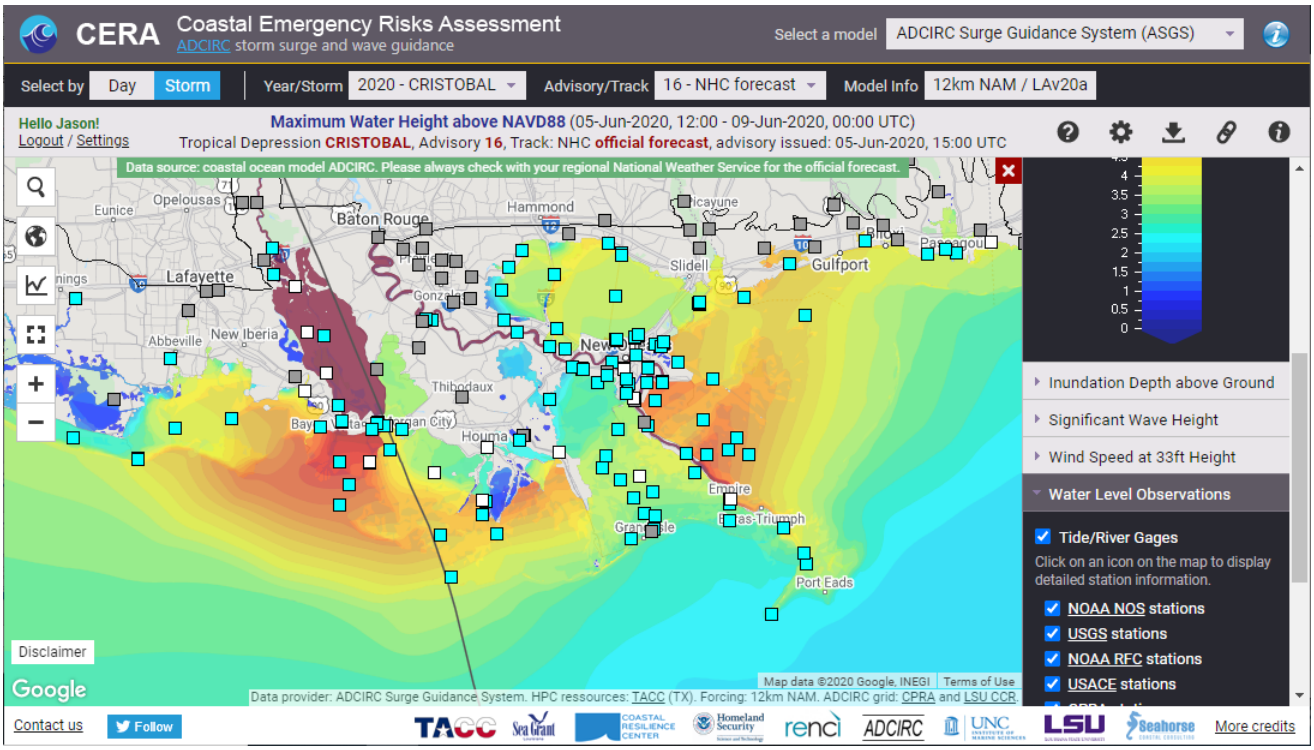

Figure 7 Tropical Storm Cristobal was our third named storm of the already active 2020 hurricane season. Our data products are now so important to LA CPRA that they timed the initiation of their battle rhythm to coincide with the first arrival of our model guidance products. Our model guidance team also held daily briefing calls with them each morning to discuss our latest results.

6. Unanticipated Problems: COVID-19 has impacted several of our outreach opportunities. In addition, a side-effect was that several of the super-computer locations were under-staffed during the pandemic. This led to unexpected computer outages that weren't solved within a timely manner due to diminished staffing.

Figure 8 This is a screenshot of one of our real time model guidance coordination calls meant to illustrate our process for achieving operational efficiency for the HSE through coordination and execution during active tropical cyclone events.

7. Student Involvement and Awards:

a) We have been working with Sarah Lipuma, a graduate student studying coastal policy and land use planning at Duke University that is interested in storm surge impacts on communities. She also co-organized the first all-virtual ADCIRC Users Group and ASGS Boot Camp meetings this year.

b) Sarah Lipuma is a graduate student. Beyond this, several participants in the Boot Camp were graduate students and post-doctoral researchers from different Universities.

a) List any degrees attained by CRC-supported students during Year 5. Include student name and degree (BS, MS, Ph.D.) and major or field of study.

N/A

b) List any awards/recognition students achieved during Year 5.

N/A

8. Interactions with CRC education projects: None

III. RESEARCH ACTIVITIES AND TRANSITION MILESTONES

1. Year 5 Research Activities and Milestone Achievements:

Year 5 Research Activities and Milestones: Status as of 6/30/2020			
Research Activity	Proposed Completion Date	% Complete	Explanation of why activity/milestone was not completed
Experimenting with boundary conditions in ADCIRC from National Water Model	12/31/2021	40%	Insufficient calendar time : no cost extension needed
Complete testing of the resolution enhancement algorithm	06/30/2021	40%	Insufficient calendar time : no cost extension needed
Complete evaluation of results from multiresolution modeling	06/30/2021	40%	Insufficient calendar time : no cost extension needed
Research Milestone			
Integration of National Water Model boundary conditions in ASGS	12/31/2021	40%	Insufficient calendar time : no cost extension needed
Merge resolution enhancements workflow into ASGS post processing	06/30/2021	40%	Insufficient calendar time : no cost extension needed
Add workflow option to ASGS to implement multiresolution modeling	12/31/2021	40%	Insufficient calendar time : no cost extension needed

2. **Year 5 Transition Activities and Milestone Achievements**:

Year 5 Transition Activities and Milestones: Status as of 6/30/2020			
Transition Activity	Proposed Completion Date	% Complete	Explanation of why activity/milestone was not completed
Coordination a meeting between the developer, stakeholder, and institution for all transition activities	6/30/2020	100%	
Ongoing handling and managing support requests related to decision support services.	6/30/2020	100%	
Travel to client sites to gather technical requirements and feedback and establish business relationships.	6/30/2020	100%	
Planning and Organizing 2020 ADCIRC Boot Camp for graduate students, postdocs, faculty members, and practicing professionals to learn the details of running the ADCIRC model.	4/30/2020	100%	
Provide operational support for existing ADCIRC Surge Guidance System for all clients and stakeholders.	6/30/2020	100%	
Complete onboarding for the new backup ASGS Developer/Operator.	6/30/2020	100%	
Complete monthly readiness exercises to evaluate and demonstrate readiness.	6/30/2020	100%	
Prototype e-commerce portal implementation	6/30/2021	40%	Covid – 19 and prep for a unique hurricane season has delayed this
Travel to technical, business, and scientific meetings as described in the planned travel schedule below.	12/31/2021	50%	Covid -19 (travel replaced with virtual meetings)
Transition Milestone			
Successful delivery of Year 5 deliverables assigned to transition project participants	6/30/2021	50%	
Complete a report detailing support ticketing system and related metrics for use in improving client and stakeholder experiences as well as sales conversion.	6/30/2021	50%	Survey sent out to CERA users, Surveys sent out to Boot Camp participants
Highly available ASGS results produced and delivered redundantly and robustly 24/7/365.	6/30/2020	100%	

Delivering 2020 ADCIRC Boot Camp for graduate students, postdocs, faculty members, and practicing professionals to learn the details of running the ADCIRC model.	4/30/2020	100%	Completed virtually due to covid-19
Ongoing operation of existing ADCIRC Surge Guidance System for all clients and stakeholders.	6/30/2020	100%	We continue to produce quality guidance
Complete onboarding for the new backup ASGS Developer/Operator.	6/30/2020	100%	Brett Estrade
Complete monthly readiness exercises to evaluate and demonstrate readiness	6/30/2020	100%	With Covid-19, we were a little delay, but 3 named storms within 2 weeks has remedied this.
Prototype e-commerce portal implementation ready for business in 2020 hurricane season	6/30/2021	50%	Covid-19

3. **Research Project Product Delivery.**

Table: Research Project Product Delivery

Product Name and Function	**Brief Product Description, including type** (e.g., software, algorithm, guidance document, knowledge product)	**Date Delivered** (or projected date of delivery)	**Recipient or End User(s)**

IV. PUBLICATIONS AND METRICS

1. Publications:

- "Dynamic Water Level Correction in Storm Surge Models Using Data Assimilation." Authors: Taylor G. Asher, Richard A. Luettich Jr. and Jason G. Fleming. Submitted to Ocean Modelling. In revision.
- "Influence of storm timing and forward speed on tides and storm surge during Hurricane Matthew." Authors: Ajimon Thomas, JC Dietrich, TG Asher, M Bell, BO Blanton, JH Copeland, AT Cox, CN Dawson, JG Fleming, RA Luettich. Ocean Modelling. Published. https://doi.org/10.1016/j.ocemod.2019.03.004
- "Forecasting Model, Forecast Advisories and Best Track in a Wind Model, and Observed Data – Case Study Hurricane Rita." Authors: Abram Musinguzi, Muhammad Akbar, Jason

G. Fleming, Samuel K. Hargrove. Journal of Marine Science and Engineering. Published. J. Mar. Sci. Eng. 2019, 7(3), 77; https://doi.org/10.3390/jmse7030077

- Media coverage of the 2019 Texas ADCIRC Week training event that PI Jason Fleming organized: "DesignSafe ADCIRC Provides Storm Surge Simulators for Natural Hazards Community" (picked up and republished by HPCWire): https://www.hpcwire.com/off-the-wire/designsafe-adcirc-provide-storm-surge-simulators-for-natural-hazards-community/
- CRC Coverage of 2019 ADCIRC Users Group Meeting event that PI Jason Fleming organized: https://www.flickr.com/photos/133219410@N05/albums/72157709249042136

2. Performance Metrics

N/A