

Improving predictions of coastal flooding via sub-mesh corrections

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1. Motivation

- The ADvanced CIRCulation model (ADCIRC) is used to predict coastal flooding during extreme storm events.
- High resolution is computationally costly
 - Hinders the speed of ADCIRC runs
 - Delays the forecast predictions
- This study aims to increase the accuracy and efficiency of ADCIRC by:
 - Adding sub-mesh correction factors to the governing equations
 - Running on coarsened meshes



- ADCIRC meshes are created by interpolating to elevations specified by a DEM.
- Through the interpolation process, bathymetric details contained within the mesh can be left out.



ADCIRC mesh creation for Caernarvon Marsh, LA

T Sub-mesh features: Hydraulic features that influence flow

10 m

- Exist below the resolution of the mesh.
- Include: small scale channels and ponds, marsh grasses, roadways

2. Wetting and Drying



3. Sub-mesh calculations

 Sub-mesh calculations are performed using a high resolution digital elevation



Tidal Channel

Marsh Grass

- In traditional ADCIRC, elements are either treated as fully wet or fully dry.
- At the wetting and drying front, this methodology leaves a vertical wall of water between a wet and dry element.
- In reality the ground surface is either fully wet or dry.
- In a model, the wet/dry interface can be represented more realistically by using a partially wet element.

- model (DEM) underlying a ADCIRC mesh of coarser resolution.
- Sub-mesh correction factors such as ϕ and $\langle H \rangle_G$ are found by integrating the space surrounding each vertex
- Sub-mesh quantities are precomputed and read into ADCIRC.

4. Governing Equations

• Governing equation for mass in 1D with averaged variables.

$$\phi \frac{\partial^2 \langle \zeta \rangle_W}{\partial t^2} + \phi \tau_0 \frac{\partial \langle \zeta \rangle_W}{\partial t} + \frac{\partial \phi \langle \tilde{J}_x \rangle_W}{\partial x} + \frac{\partial \phi \langle \tilde{J}_y \rangle_W}{\partial y}$$





6. Summary/future work

- Testing of the new wetting and drying algorithm and sub-mesh averaging is on-going.
- Testing on more realistic domains is soon to come.
- The end goal of this section of the project will be to:
 - Cut the run time of ADCIRC at least by half
 - Maintain the accuracy a high resolution mesh
- Incorporation of additional correction factors will be involved in future work.