Integrating Precipitation Dynamics into FUNWAVE, Unveiling the Physical Interaction of Waves and Precipitation.

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Date: *10/1/2023*

Presenting to: International Wave Workshop

Importance of Precipitation in Compound Flooding

- Flooding is one of the deadliest and costliest natural disasters, particularly in coastal areas with a higher population
- A compound flooding (CF) is flooding caused by the interaction of the open ocean, atmosphere, and watersheds
- Nonlinear wave model can fully capture the interaction between Precipitation and wave.
- Neglecting interaction results in an inaccurate estimate of water level, leading to underestimation of velocity and vorticity components, especially at shorelines

Jacksonville, hurricane Irma

Motivation

Consequences

Higher inundation levels, Frequent road closures,
excess water in stormwater systems, deterioration of roads, infrastructure
exposure to saltwater, beach erosion, severe property damage

Motivation

Absence of CF modeling in small scale model containing 3 drivers and above
Neglecting Rainfall Impact Leads to Underestimated Results

Importance

Accurately predicting compound flooding is important
because of recent instances of Wet Storms and difference between
predicted and estimated inundation extent

Downstream Models

Two categories of numerical nearshore model

- **Phase averaging (spectral models)**

A superposition of waves at different frequencies and directions described by their energy

- **Phase resolved**

Describe individual wave motions, including direct, dynamical simulation of non-linear transformations and wave-driven flows, including transient effects

FUNWAVE: It is a high-order, fully nonlinear Boussinesq Wave Model.

Advantages: Ability to model with Tide, Wave, and River discharge interaction.

Feature	Phase-averaged model	Phase-resolved model
Infragravity waves, transient zone process	NO	Yes
Unstructured mesh	Yes	No
Computational expense	Low	High

Phase-averaged model	Phase-resolved model
ADCIRC+SWAN	FUNWAVE
SCHISM-WWIII	SWASH
XBeach-SB	NHWAVE

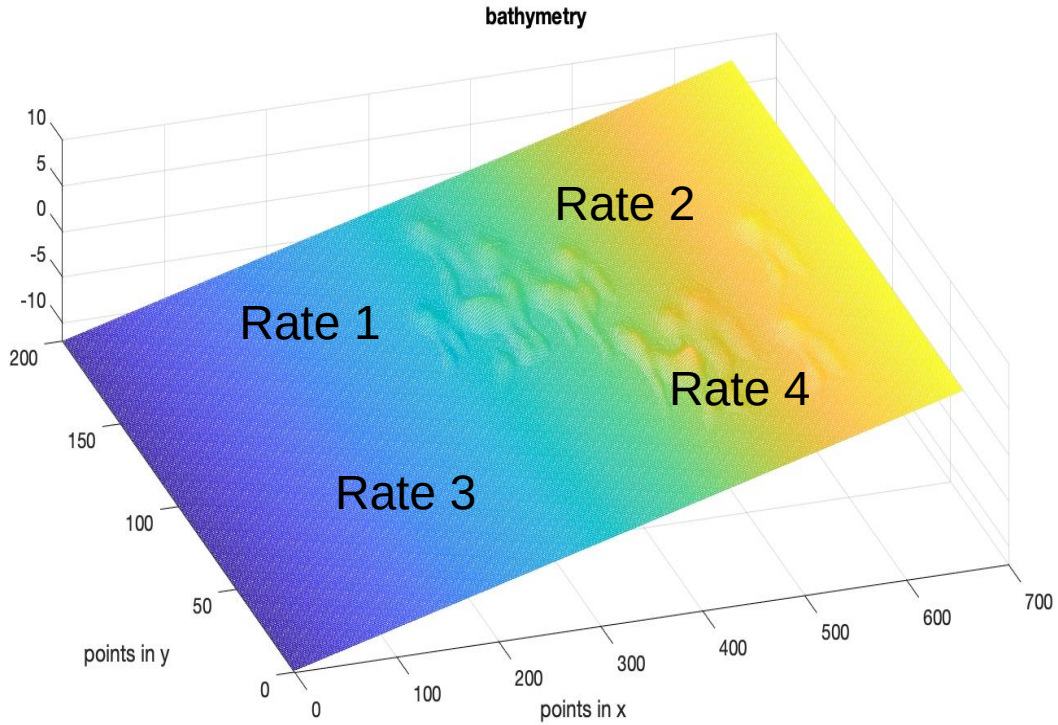
Stephanie Contardo 2020

Wave and Precipitation Interaction

FUNWAVE

Gap:
Absence of Rainfall Data in Water level modeling

Precipitation File:
New version contains a module with precipitation effects.
Possibility of adding multiple Rainfall rate to the domain.



Wave and Precipitation Interaction

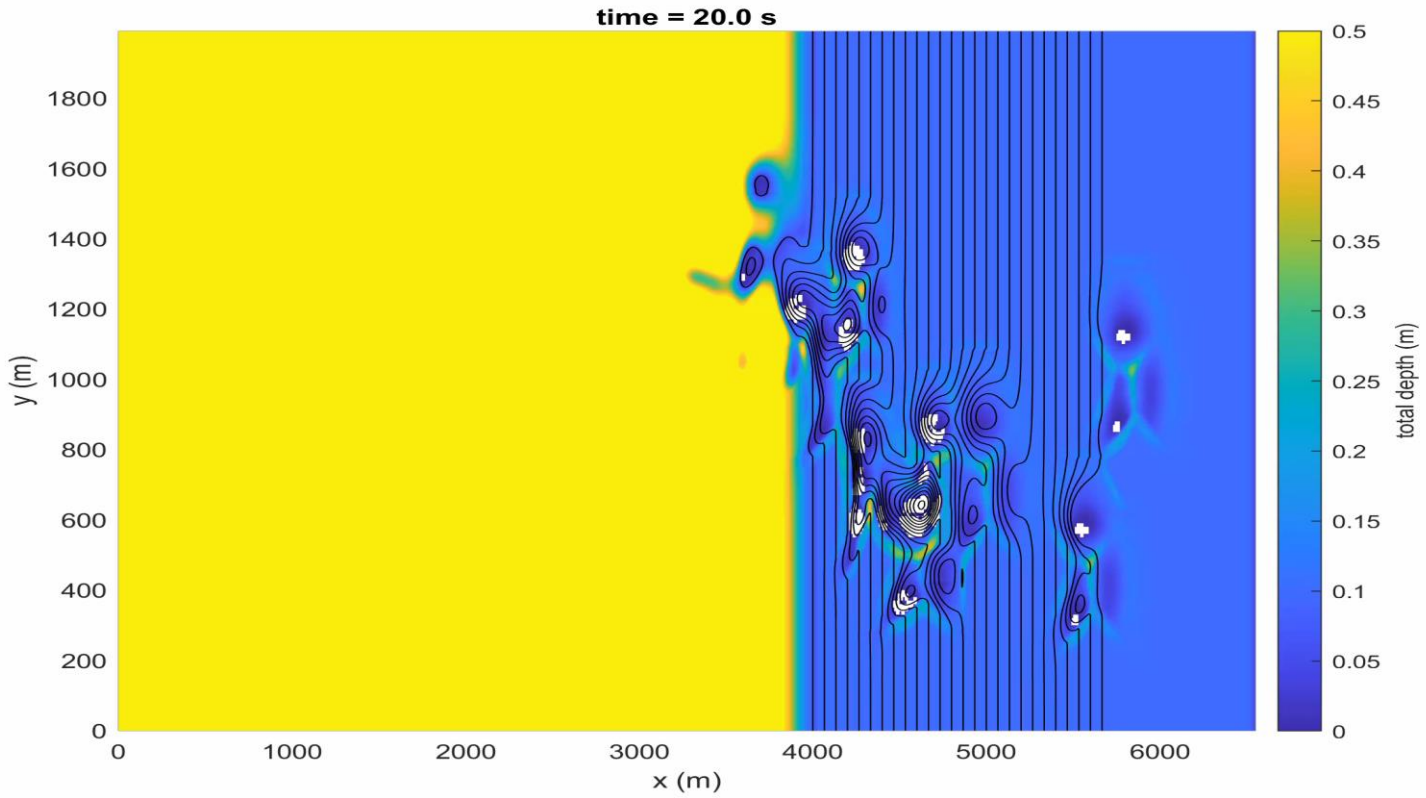
❖ Precipitation File

File contains:

- Dimensions of rain rate files (rate 1, 2, …)
- Starting time of rain rate file
- Rain rate file (containing rate numbers in mm/hour)
- Time of next rain rate:
- Rain rate file

The bathymetry consists of a Slope bottom with hills on east side.

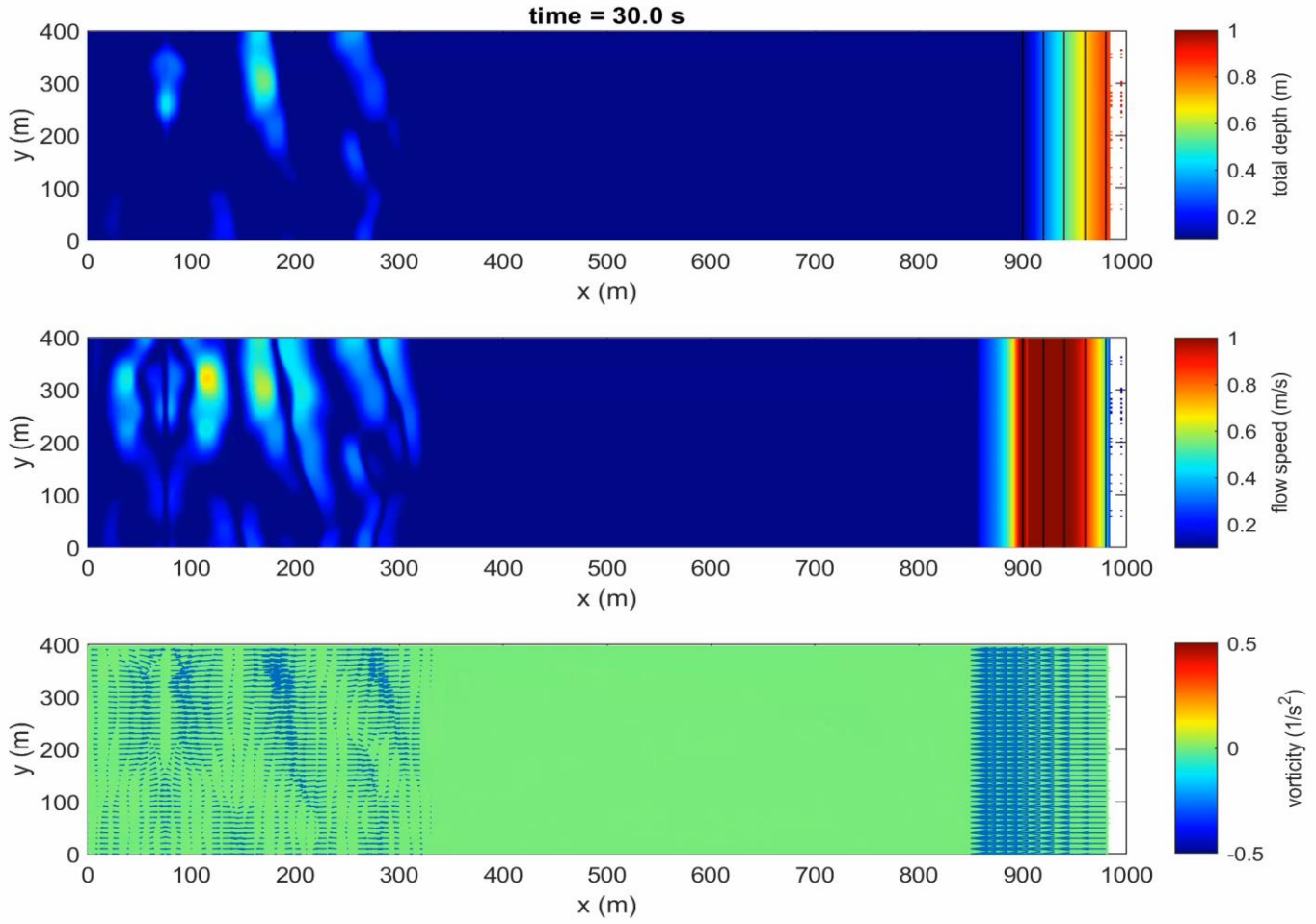
❖ Precipitation effects on Hills



Wave and Precipitation Interaction

The figure shows the interaction between Extreme rainfall and waves at the shoreline

- Interaction can specify the wet/dry area in the shoreline
- Incorporating precipitation will result in a more accurate estimation of radiation stress and mass volume



Summary

- Incorporating multiple flood drivers and accounting for their interactions simultaneously
- Incorporating precipitation into each time step of the model enhances the accuracy of estimating the downstream boundary condition's water level in the compound flooding model
- Specifying wet/dry areas accurately can result in improved estimation of storm surge and inundation extent