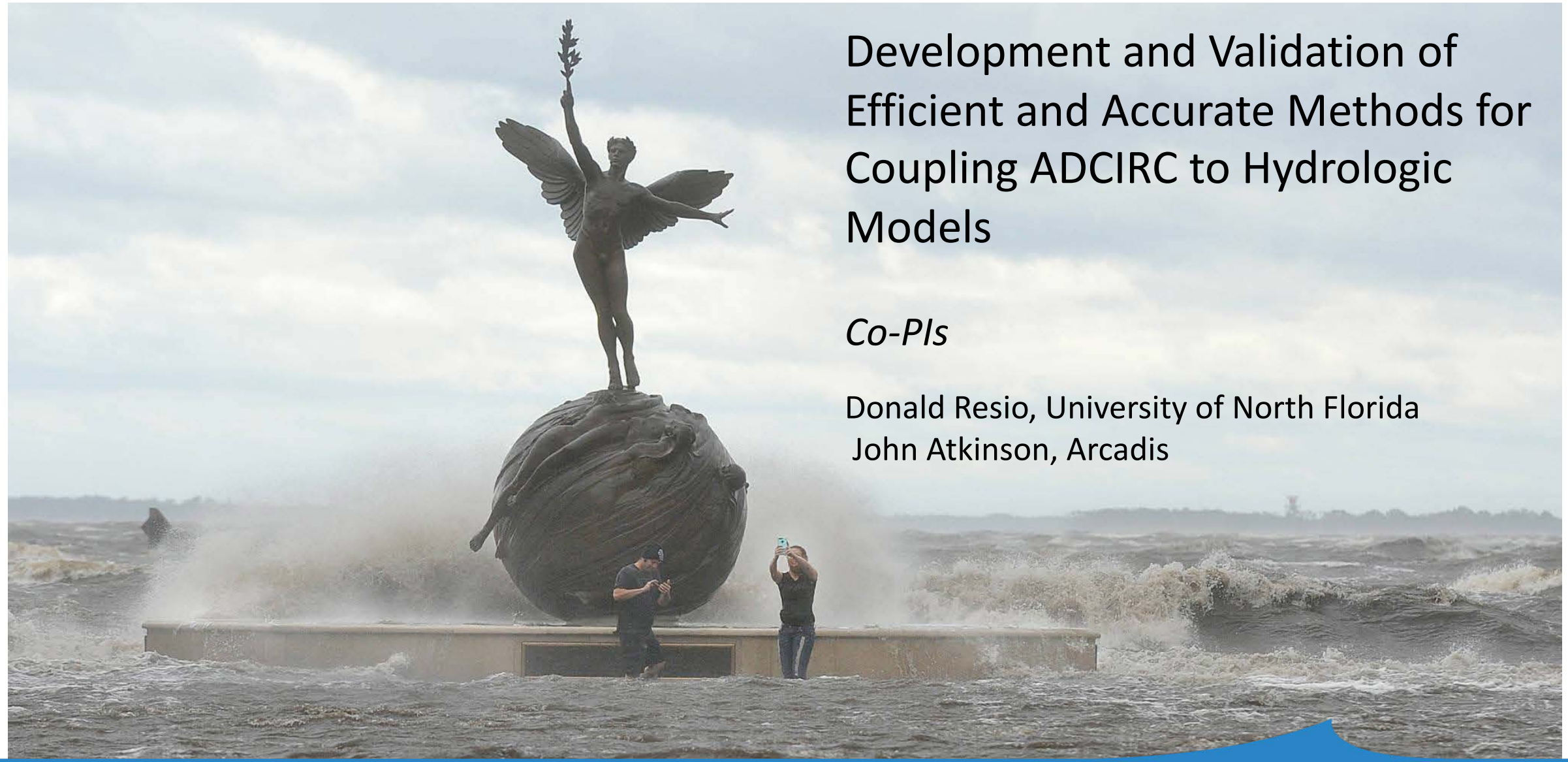

Development and Validation of Efficient and Accurate Methods for Coupling ADCIRC to Hydrologic Models

Co-PIs

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MAJOR PROBLEMS Being Addressed:

FEMA/USACE are already encountering large computational burdens when computing storms in the Joint Probability Method.

This method is required for accurate estimates of hazards, since it is **not what has happened** but **what can happen** **that is an important lesson we learned from Hurricane Katrina!**

AS will be shown later in this presentation, the effect of multiplicity of storm simulations makes both the numerical and statistical considerations much more complex.

The number of simulations and different processes included in this type of study is much larger than the previous FEMA flood studies.

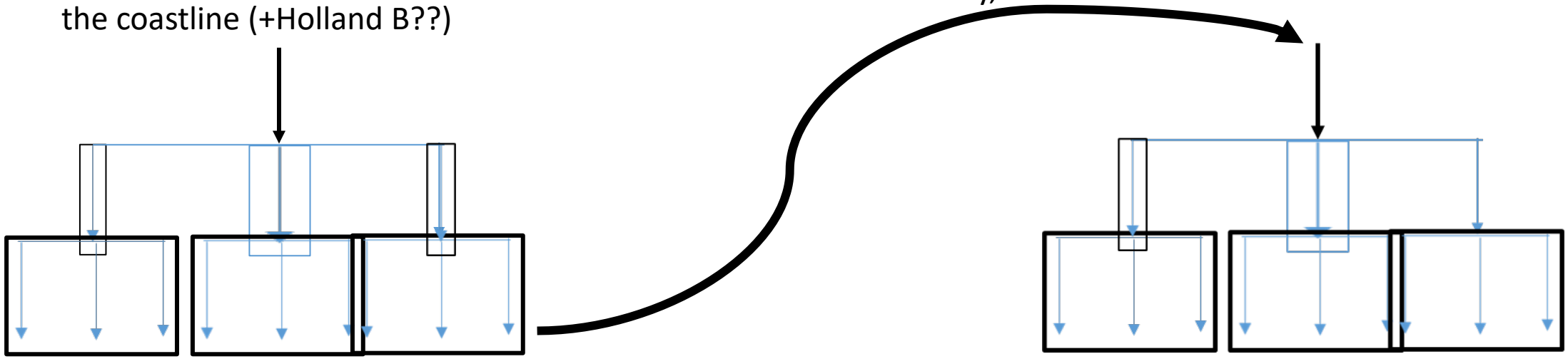
Coupling Hydrology with ADCIRC

- **How can we use an inexpensive hydrology and hydraulic model to enhance ADCIRC modeling combined-flood results, while maintaining good accuracy and reasonable run-time?**
- **Use full ADCIRC in fully-coupled mode for additional small (10-50?) set of runs:**
  - **Surge only (already run)**
  - **Surge with medium rainfall and two antecedent conditions/2 upriver discharge**
  - **Surge with heavy rainfall and two antecedent conditions/2 upriver discharges**
- **ADCIRC will "bracket" the potential inundation along rivers and inland areas.**
- **Most Expedient coupling - handoff surge is at river mouth as BC to inexpensive river model.**
- **Use river model to evaluate sensitivity to "many" rainfall and river conditions.**
- **Develop a spatially variable uncertainty term for hydrologic applications via comparisons to and calibration with the ADCIRC results.**

The Statistical Coupling of These Processes Must Consider Correlations Among These Parameters

Storm Parameters: Landfall, size, central pressure forward speed and heading relative to the coastline (+Holland B??)

Hydrologic Parameters: rainfall patterns, antecedent conditions, discharge at up-river boundary, etc.

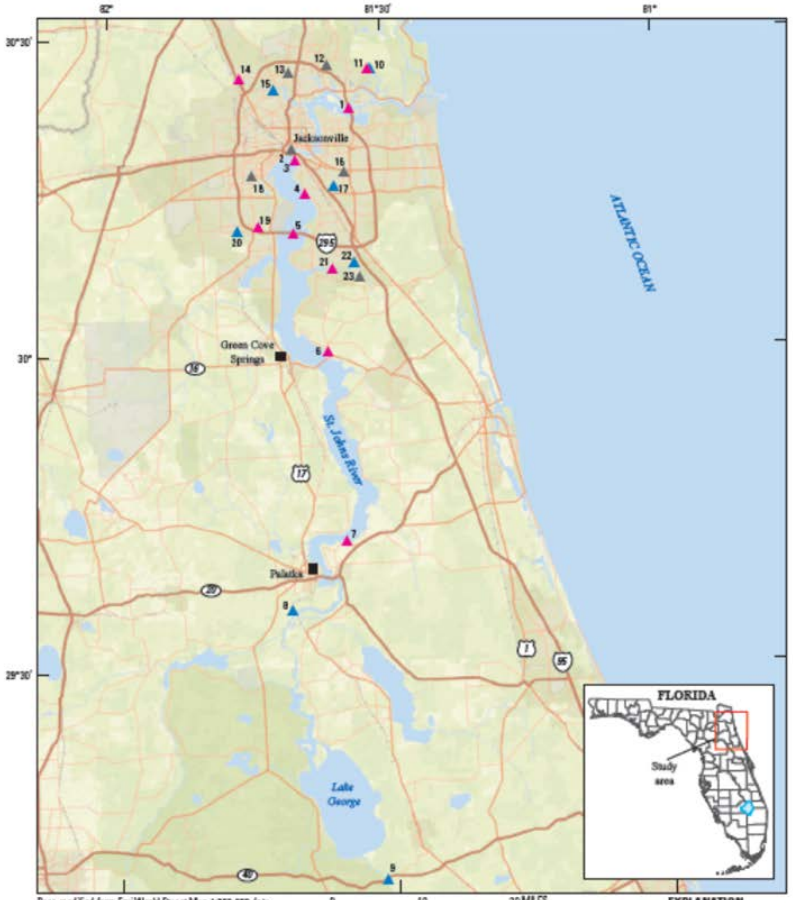


Each storm has to vary 5 parameters for each simulation. **Only three shown here.** Typically means that total storm parameters typically in the range of 400 – 800 storm simulations.

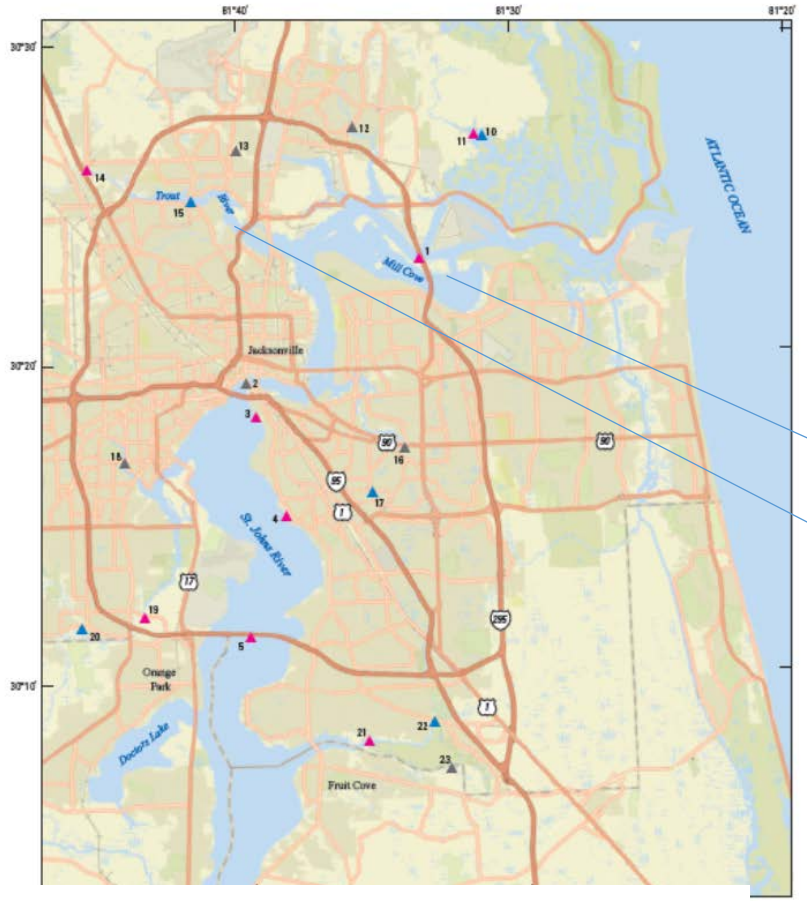
New Surface Response Function method with objective error metrics being tested for application of an ongoing FEMA re-study

= NEED FOR EFFICIENCY

Each hydrologic coupling uses at least 5 parameters for each hydrologic simulation. **Only three shown here.** Typically means that total storm parameters typically in the range of 400 – 800 simulations might be needed for complete JPM estimate.



Large-scale view of area and gages (red triangles denote gages)



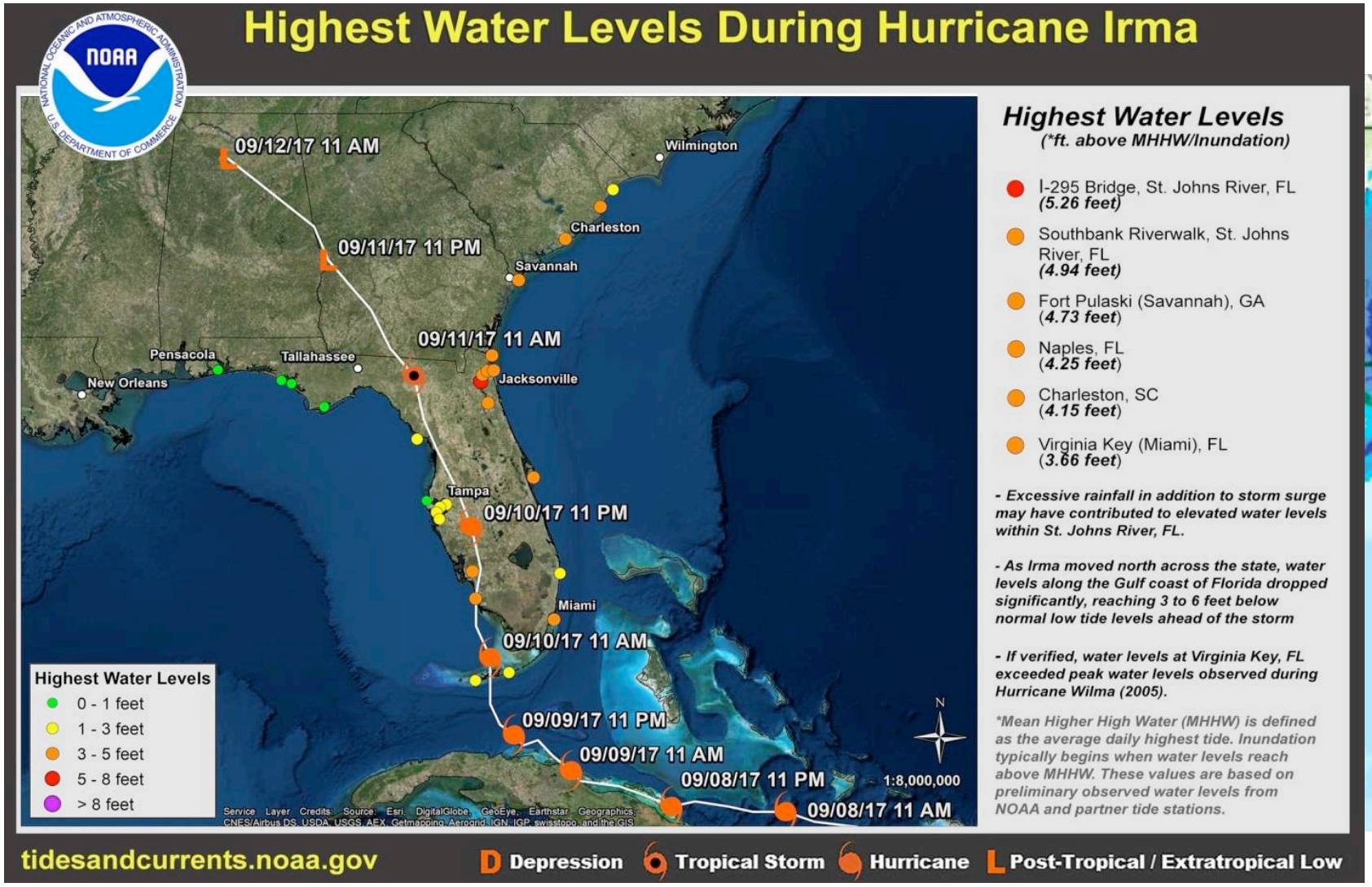
Focused view of area and gages For Jacksonville area(red triangles denote gages)

Present Test Case is difficult – Hurricane Irma (2017)

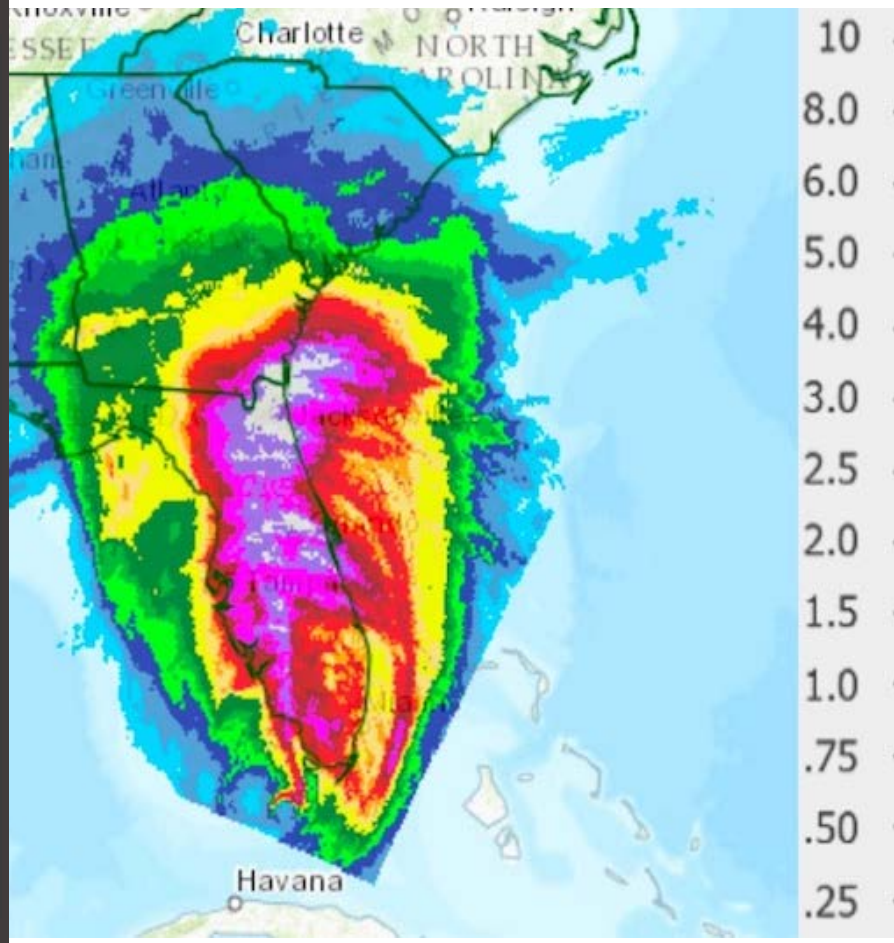
Ortega River

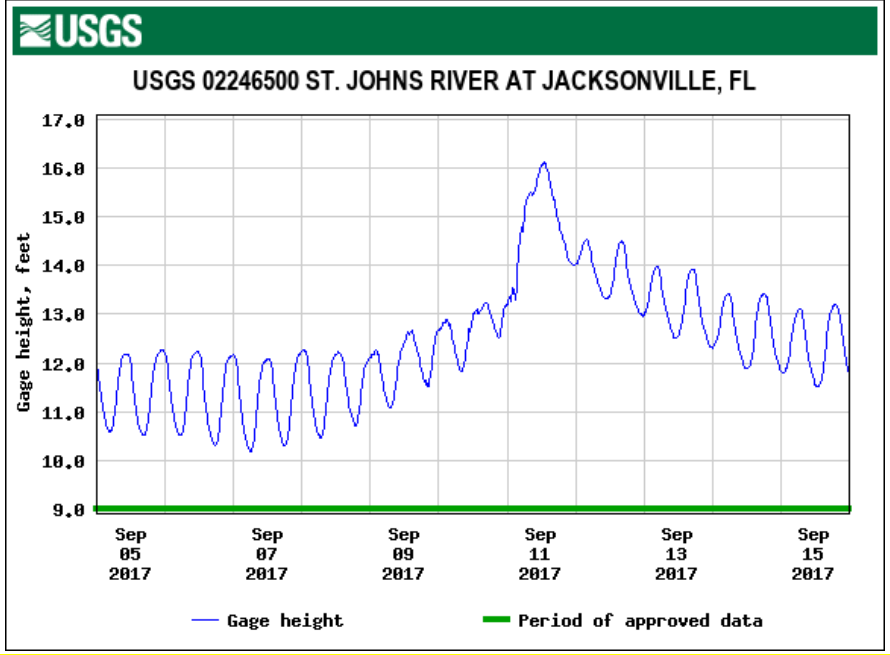
Main Street USGS gage

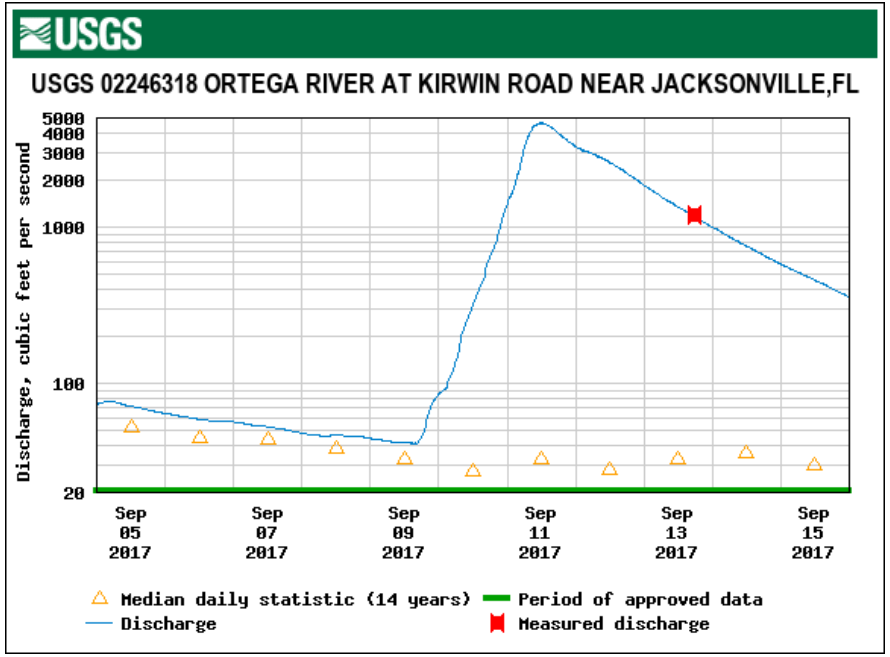
Important Point: This is not a storm that would be run in a typical JPM study!!



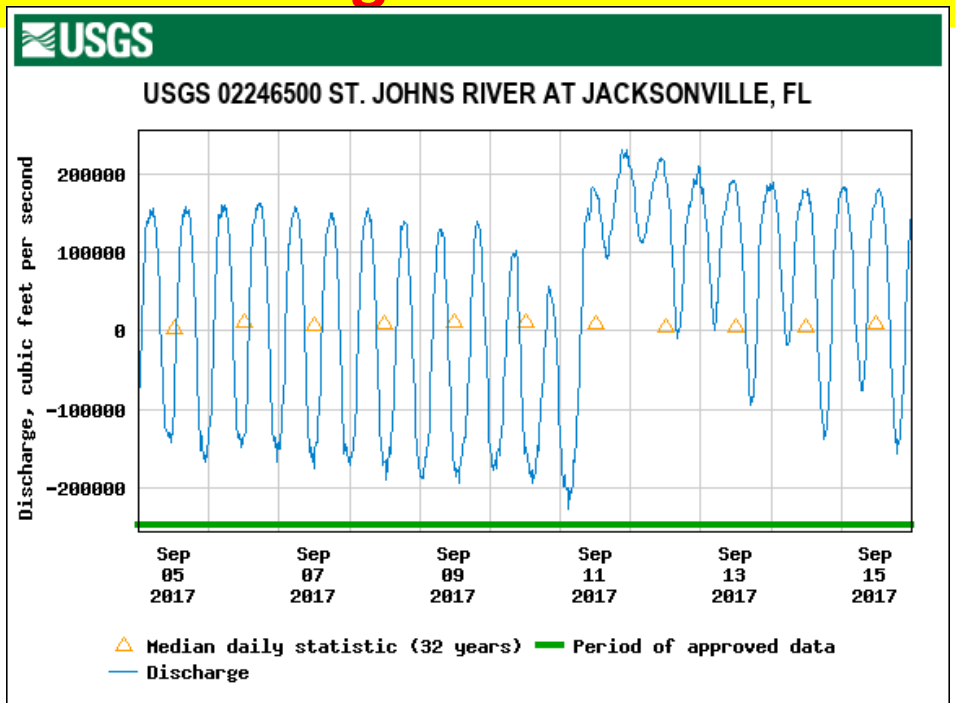
Rainfall during Hurricane Irma (inches)







The main flooding occurred with fresh water



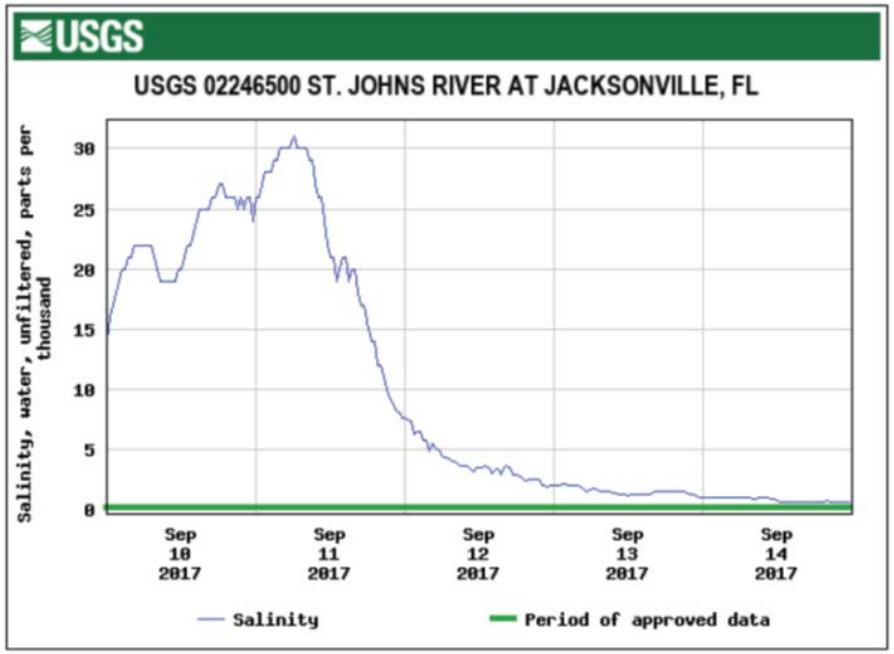


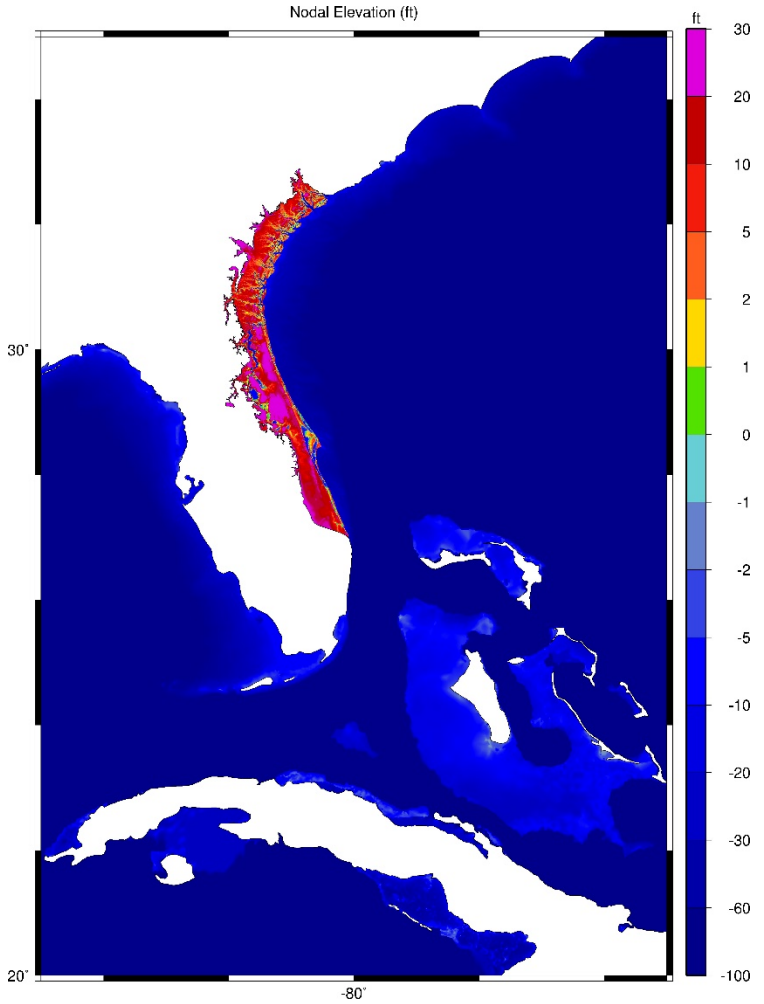
Figure 48. Instantaneous salinity during Hurricane Irma at St. Johns River at Jacksonville, Florida.

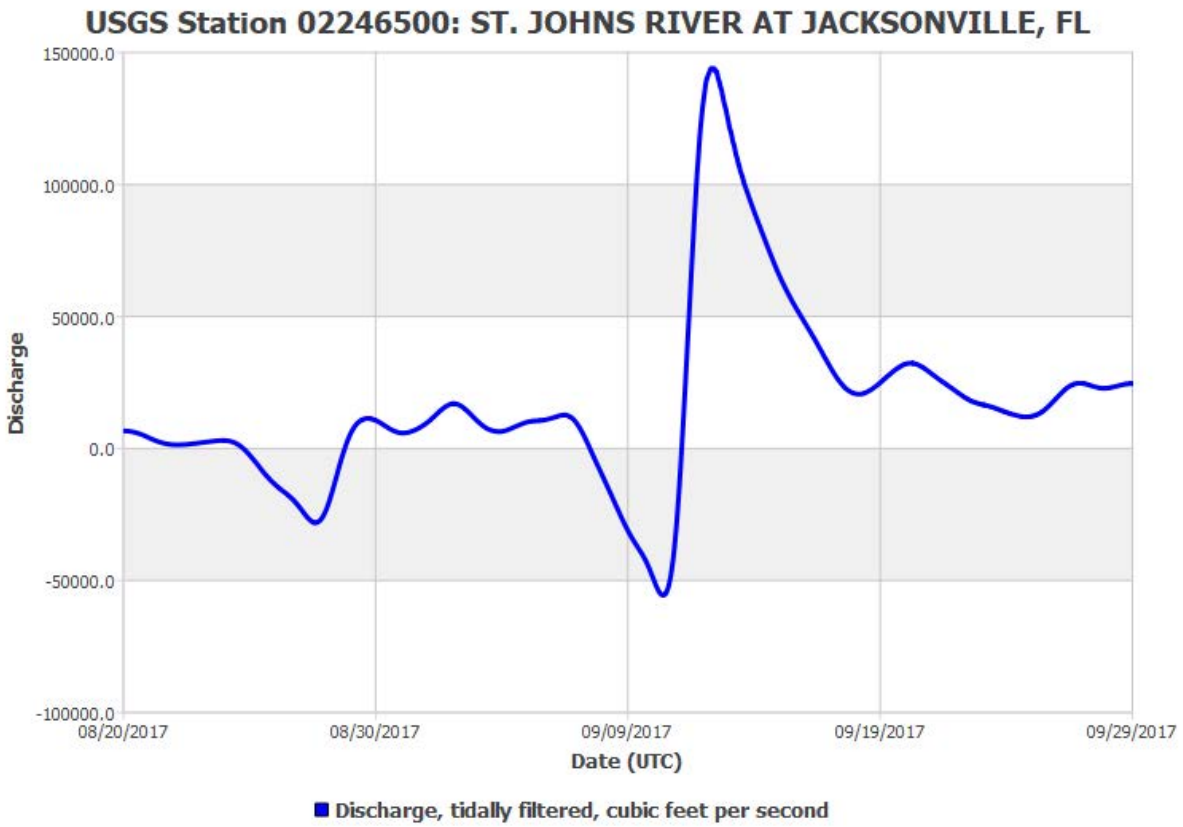
Some Conclusions to This Point

- Irma is a complex event and a “great” challenge for any model
- We are testing a suite of 1-D model of the flow – all posed in a curvilinear grid that follows the river.
- Major tributaries are of two types:
  - Parallel bypassing conduits
  - Side streams
- We are testing 4 different explicit models within the 1-D paradigm
  - Diffusive + volume conservation
  - Leapfrog + volume conservation
  - Diffusive + volume conservation and momentum conserving
  - Leapfrog + volume conservation and momentum conserving

ADCIRC Testing Ongoing with Hurricane Irma

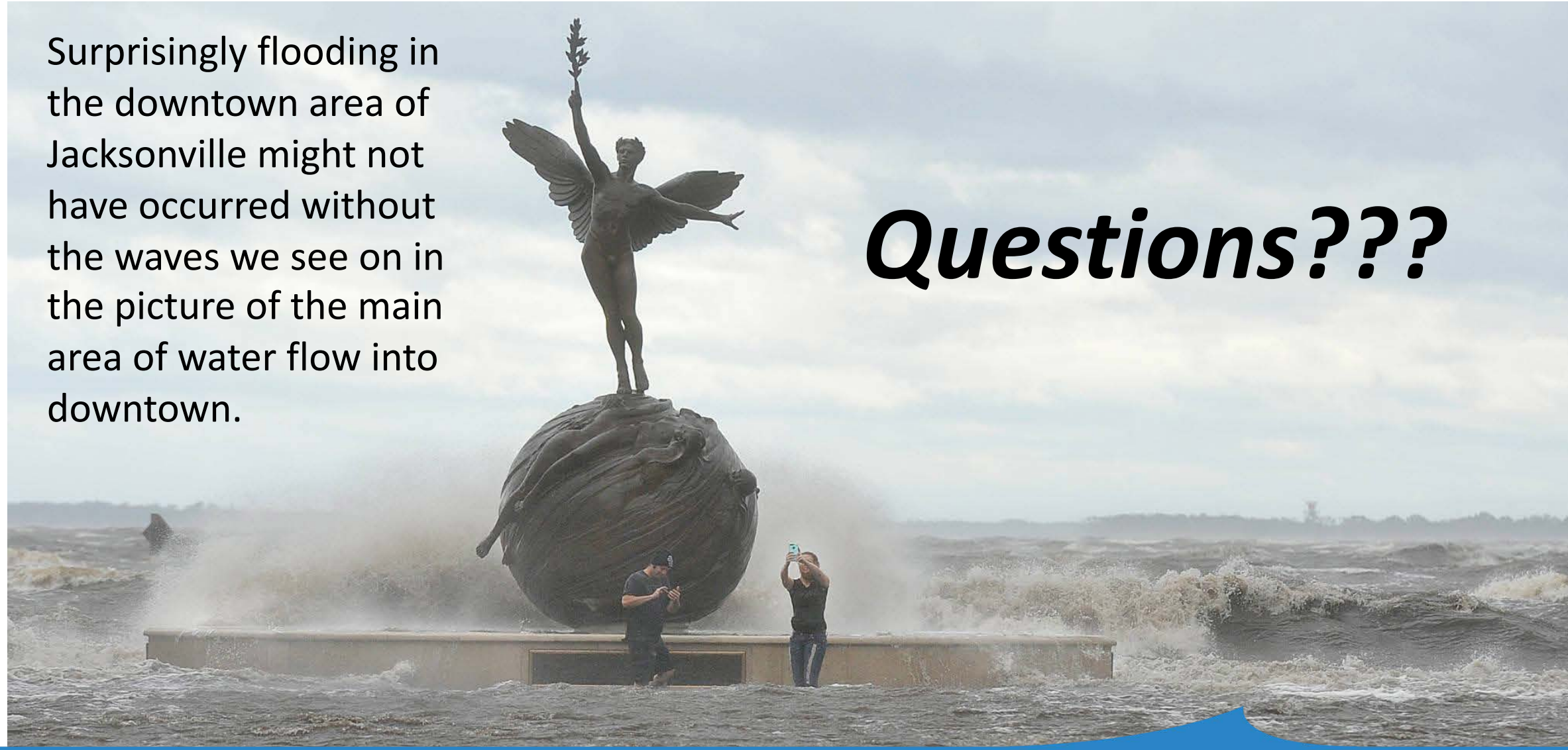
1. Can ADCRIC with rainfall generate these flows?
2. Or do we need an inflow BC?





- Upper limit of model requires a stage-discharge boundary condition and initial conditions for state of the river
- 2-D models of discharge have difficulty resolving the topography for the river and its tributaries
- It may be possible to use Gradually Varied Flow approximation (quasi-steady-state) in the tributaries in the 1D model to provide reasonable estimates of flooding in those sub-basins efficiently
- New version of JPM-OS will be needed for an efficient JPM-OS – with clear objective metrics for statistical accuracy
- e
- We welcome any and all new ideas on this topic.

Surprisingly flooding in the downtown area of Jacksonville might not have occurred without the waves we see on in the picture of the main area of water flow into downtown.



Questions???