A flexible infrastructure for coastal ocean and inland hydrology models coupling (P 1/2)

Saeed Moghimi[1,2], Edward Myers[1], Jaime Calzada[1,2], Sergey Vinogradov[1], Yuji Funakoshi[1], Lei Shi[1]

[1] NOAA National Ocean Service, Office of Coast Survey

[2] University Corporation for Atmospheric Research

Beheen Trimble[3], Ali Abdolali[3], Roham Bakhtyar[3], Andre Van der Westhuysen[3], Kazungu Maitaria[3], Panagiotis Velissariou[3]

[3] NOAA National Weather Service

Unified Forecast System (UFS)

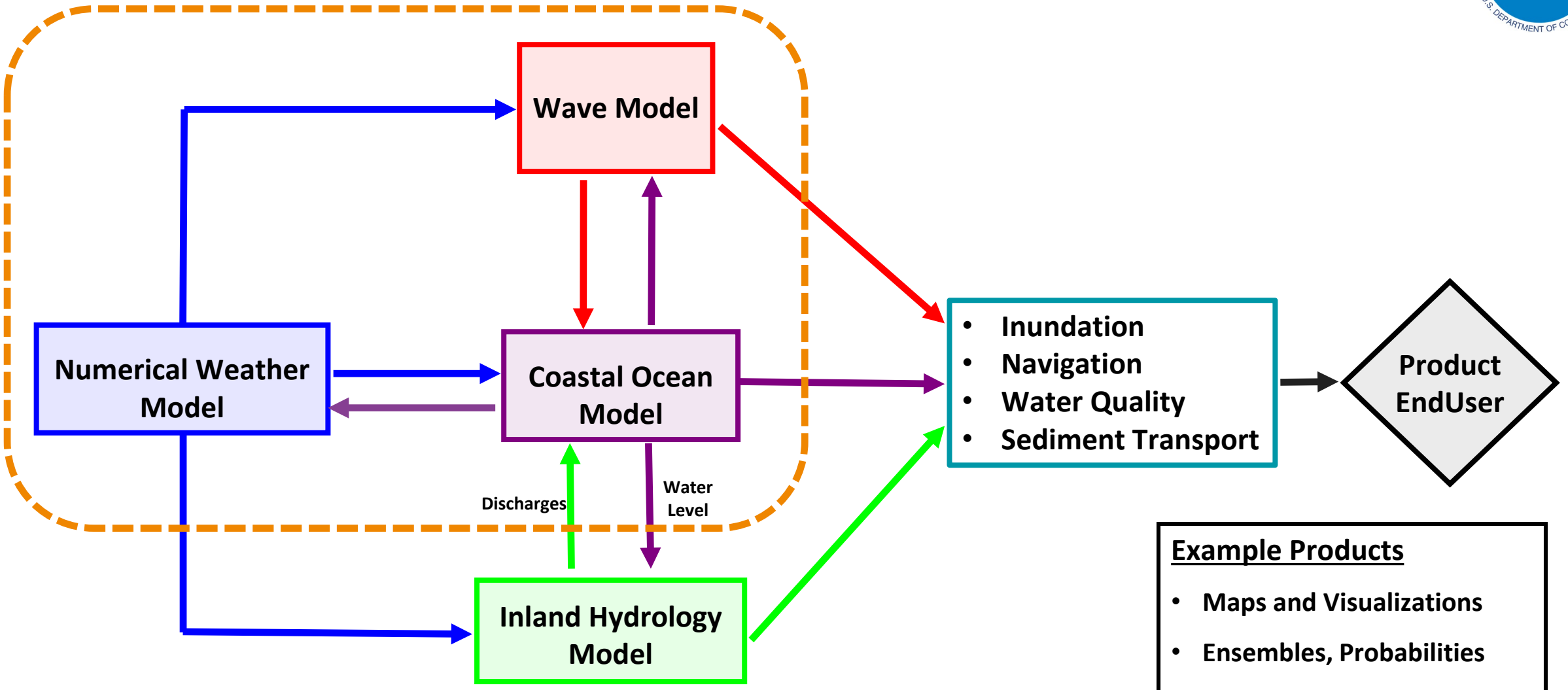
National Unified Operational Prediction Capability (NUOPC) Layer

ESMF/NUOPC enabled models (Selected)

CST	**Coastal ocean**	**ADCRIC, ROMS, FVCOM, SELFE/SCHISM**
ATM	atmosphere	FV3 (Finite-Volume Cubed-Sphere Dynamical Core),
OCN	ocean	MOM5 and MOM6 (Modular Ocean Model)
WAV	wave	WWIII (WAVEWATCH III)
ICE	sea ice	CICE (Los Alamos Sea Ice Model)
HYD	hydrology	WRF-Hydro (Weather Research and Forecast Model Hydrology), NWM
LND	land	LIS (Land Information System)

Validating | In development | Plan to develop

Coastal ocean modeling framework

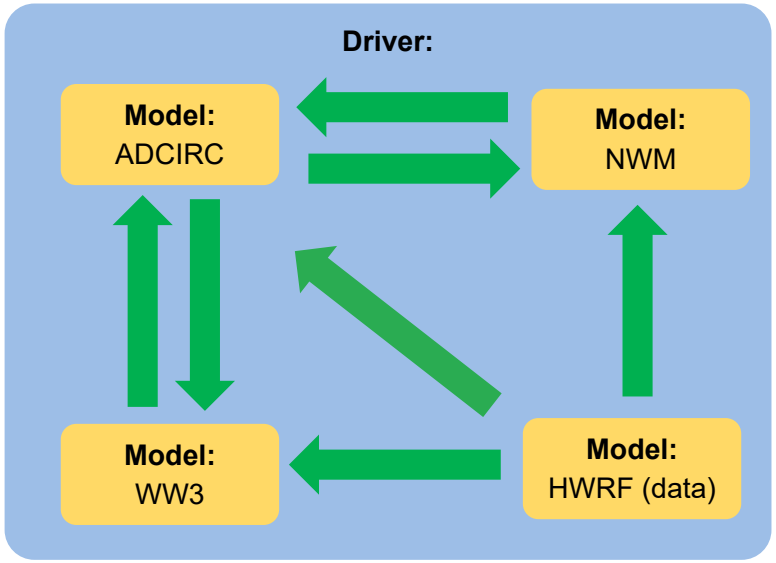


Example Products

- Maps and Visualizations
- Ensembles, Probabilities
- Product Uncertainties
- Wave Conditions

COASTAL Act application

NOAA's Environmental Modeling System (NEMS)



NUOPC components

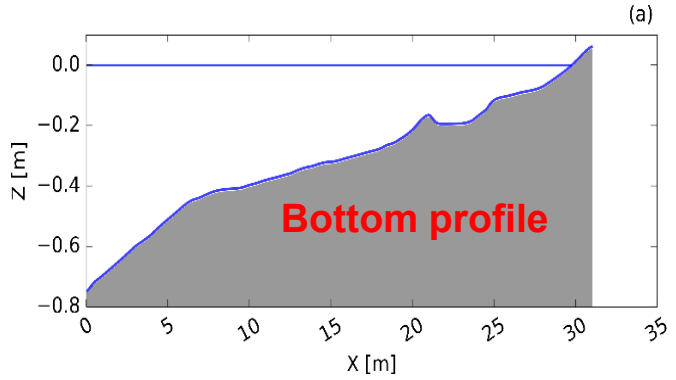
NOAA Technical Memorandum NOS CS 41

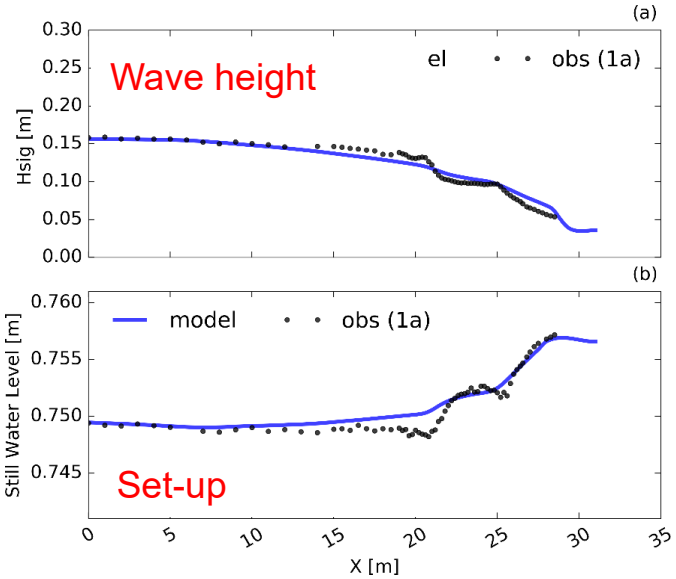
DEVELOPMENT OF A FLEXIBLE COUPLING INTERFACE FOR ADCIRC MODEL FOR COASTAL INUNDATION STUDIES

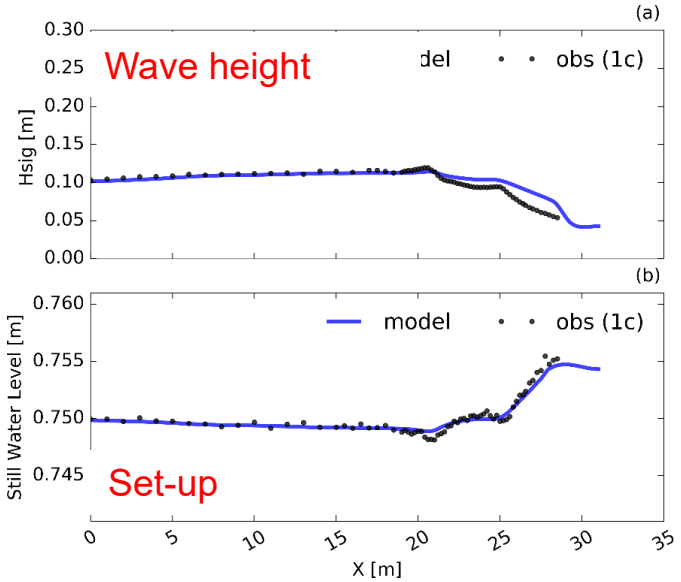
Moghimi et al, 2019;

WaveWatch III and ADCIRC sub-system validation

Boer, 1996 wave flume test case



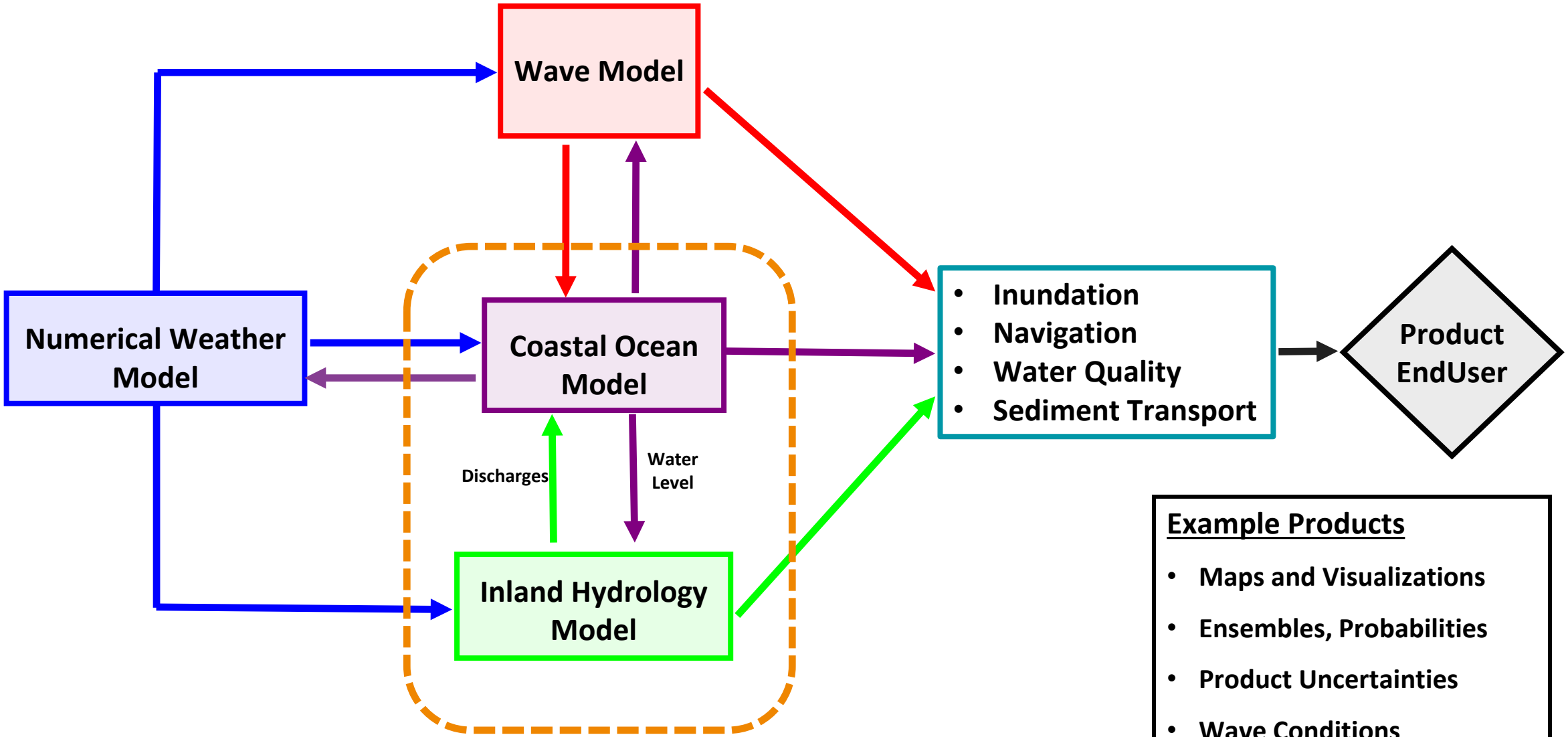




Moghimi et al, in review

All model configurations and results are pre-decisional and for official use only.

Coastal ocean modeling framework



Example Products

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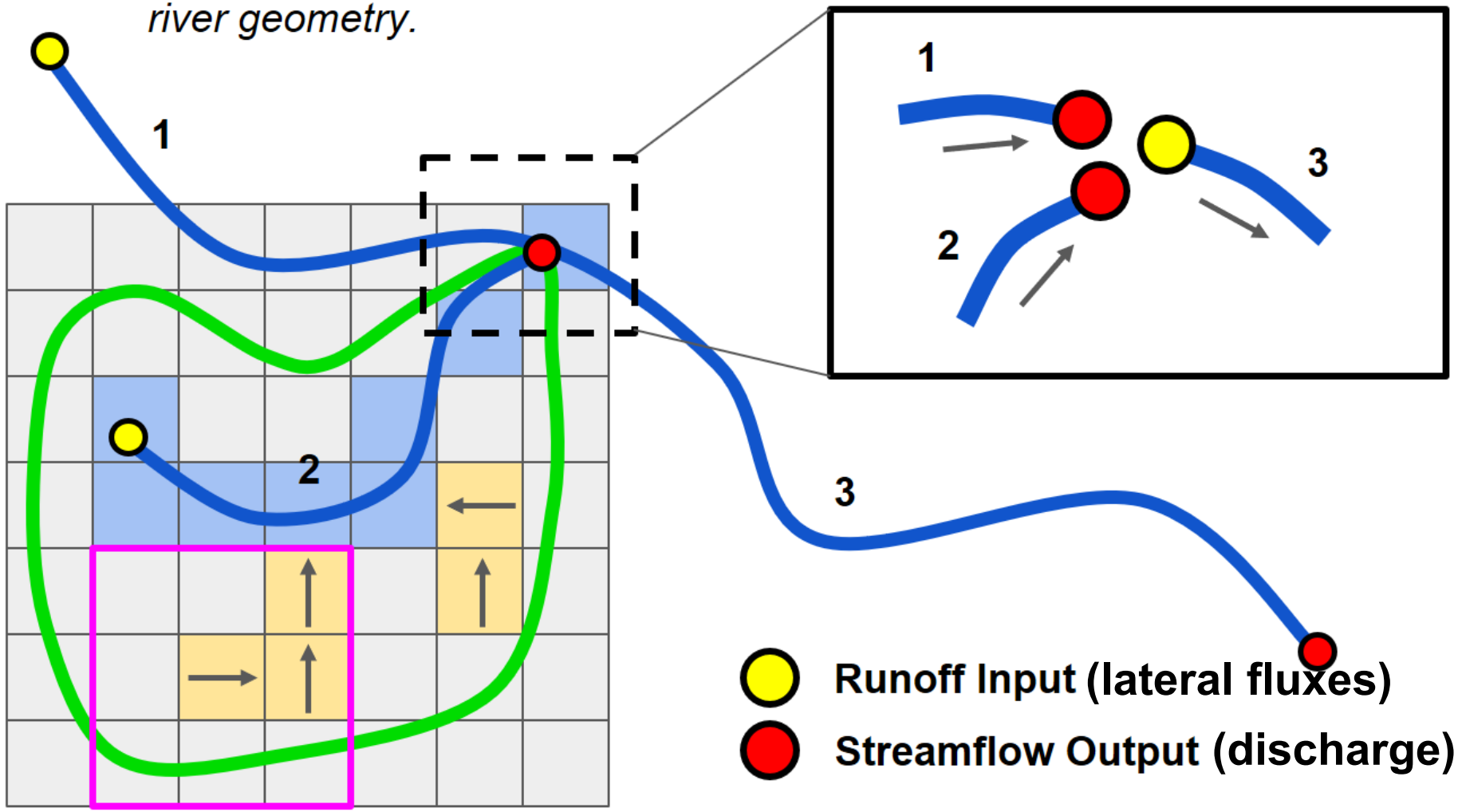
- Wave Conditions

NWM/hydrology channel structure

NWM streamflow output indexed by feature_id. Does not contain river geometry.



Cosgrove et al, 2018

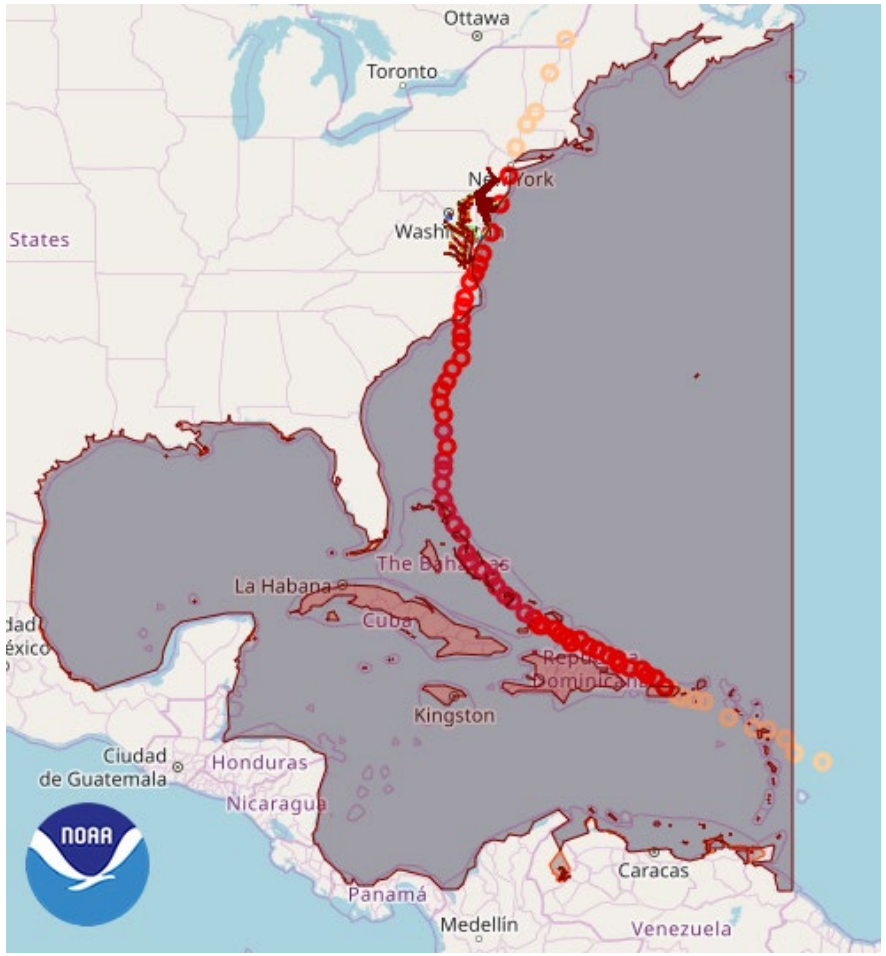
Compound inland-coastal flooding: a 3D creek-to-ocean approach (P 2/2)

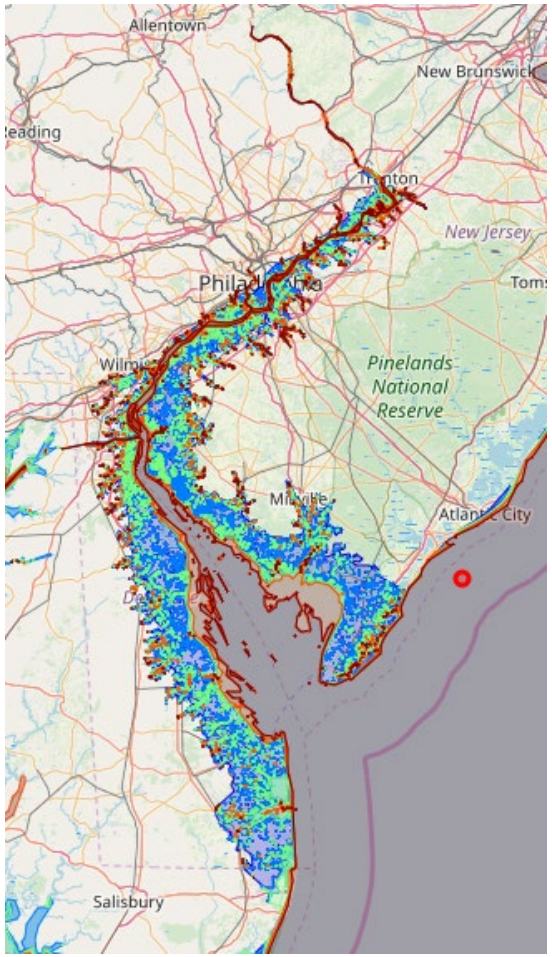
Saeed Moghimi[1,2], Edward Myers[1], Zizang Yang[1], Jaime Calzada[1,2]
[1] NOAA National Ocean Service
[2] University Corporation for Atmospheric Research

Joseph Zhang[3], Wei Huang[3], *Fei Ye[3]*
[3] Virginia Institute of Marine Science

Open source @ https://github.com/schism-dev/

SCHISM model domain





Irene, 2011 case:

2011-7-27 ~ 2011-9-10 (50 days)

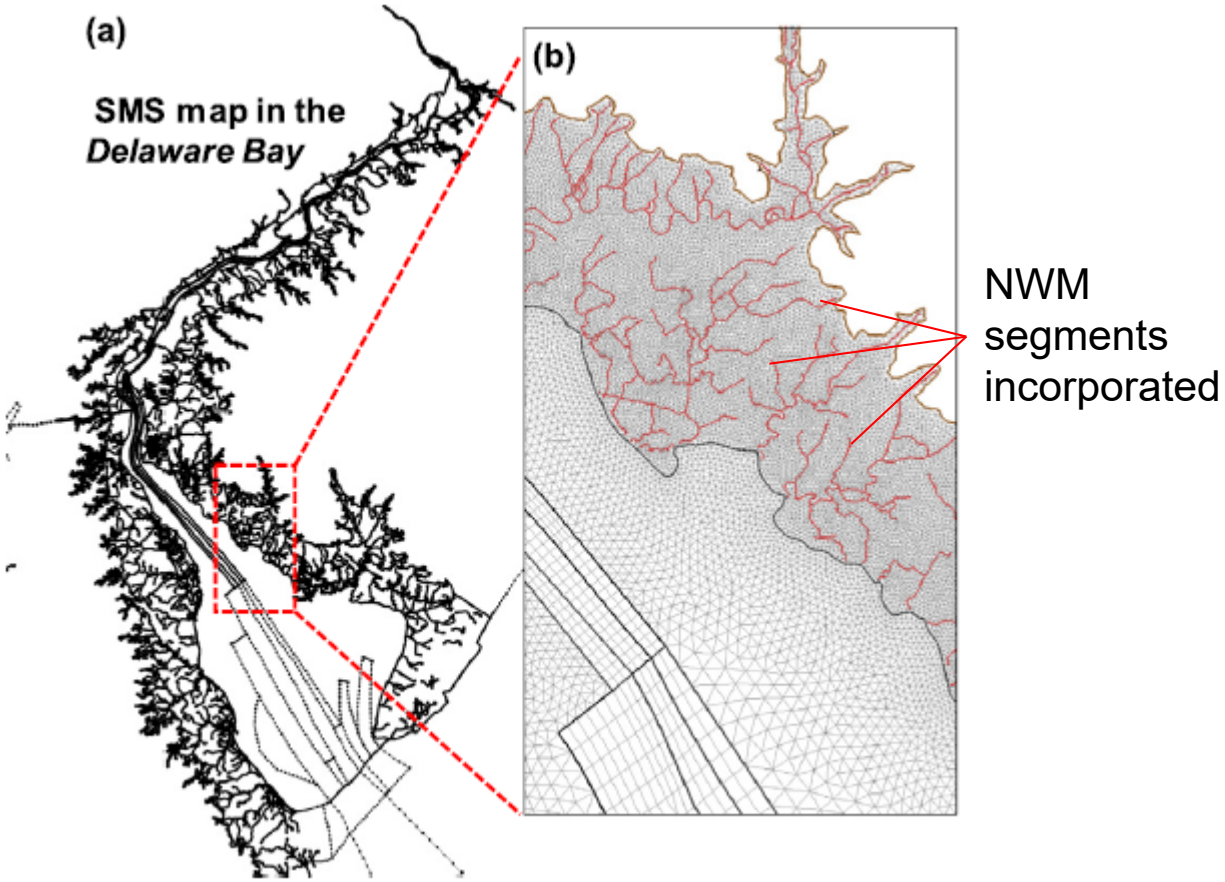
- *Time step: 150 seconds*
- *20 m to 7 km*
- *Baseline (3D baroclinic): 80x Real Time on 1440 cores of Pleiades (NASA)*
- *The 2D model runs approximately 57 times faster than the baseline and can be efficiently conducted using as few as 40 cores.*

- ❑ Use a large domain for storm surge
- ❑ Resolve Gulf Stream to get baroclinic response right during storms
- ❑ Coupled with National Water Model (NWM) at 10 m above MSL
- ❑ Seamless creek-to-ocean capability

Computational domain development

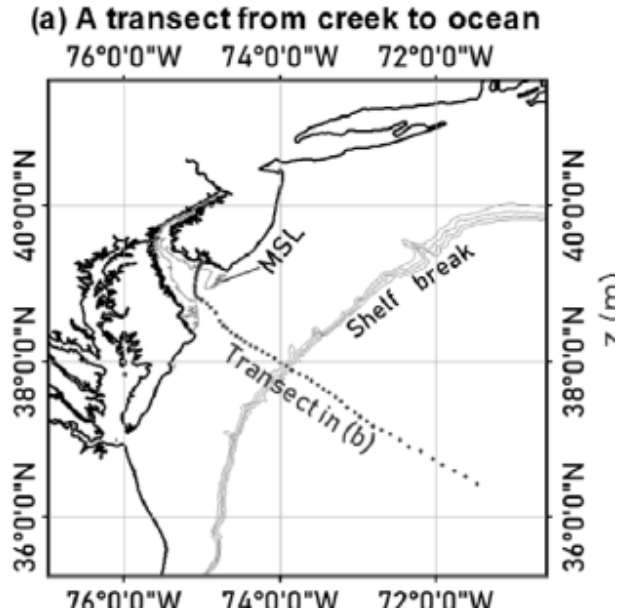
- Combine NWM shapefiles and the grid boundary
- Add main shipping channel
- Use a large domain for storm surge
- Resolve Gulf Stream to get baroclinic response right during storms

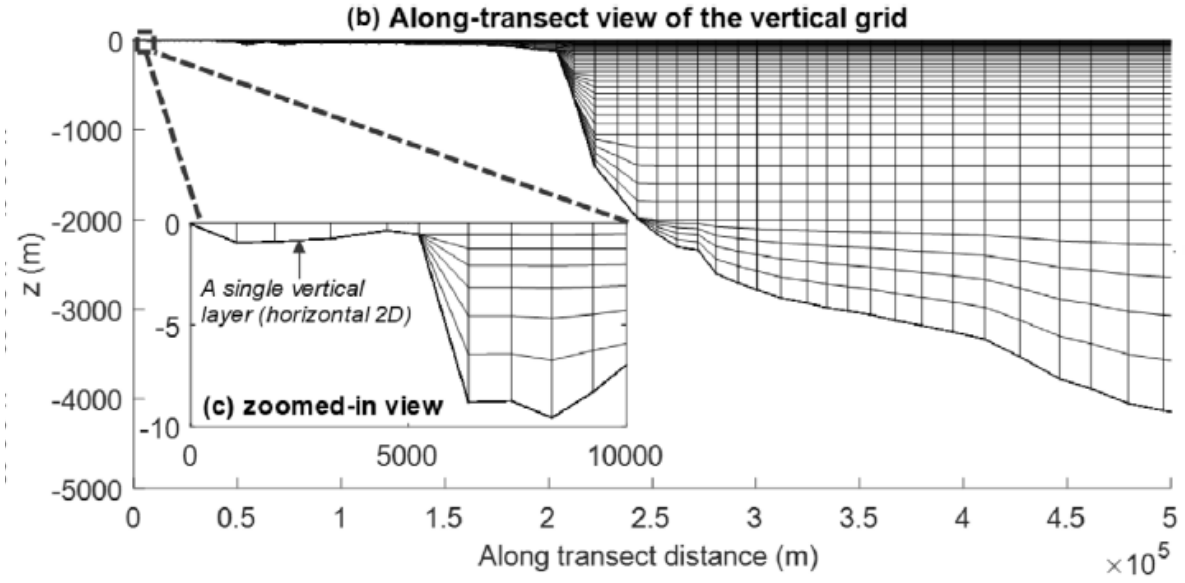
Horizontal mesh



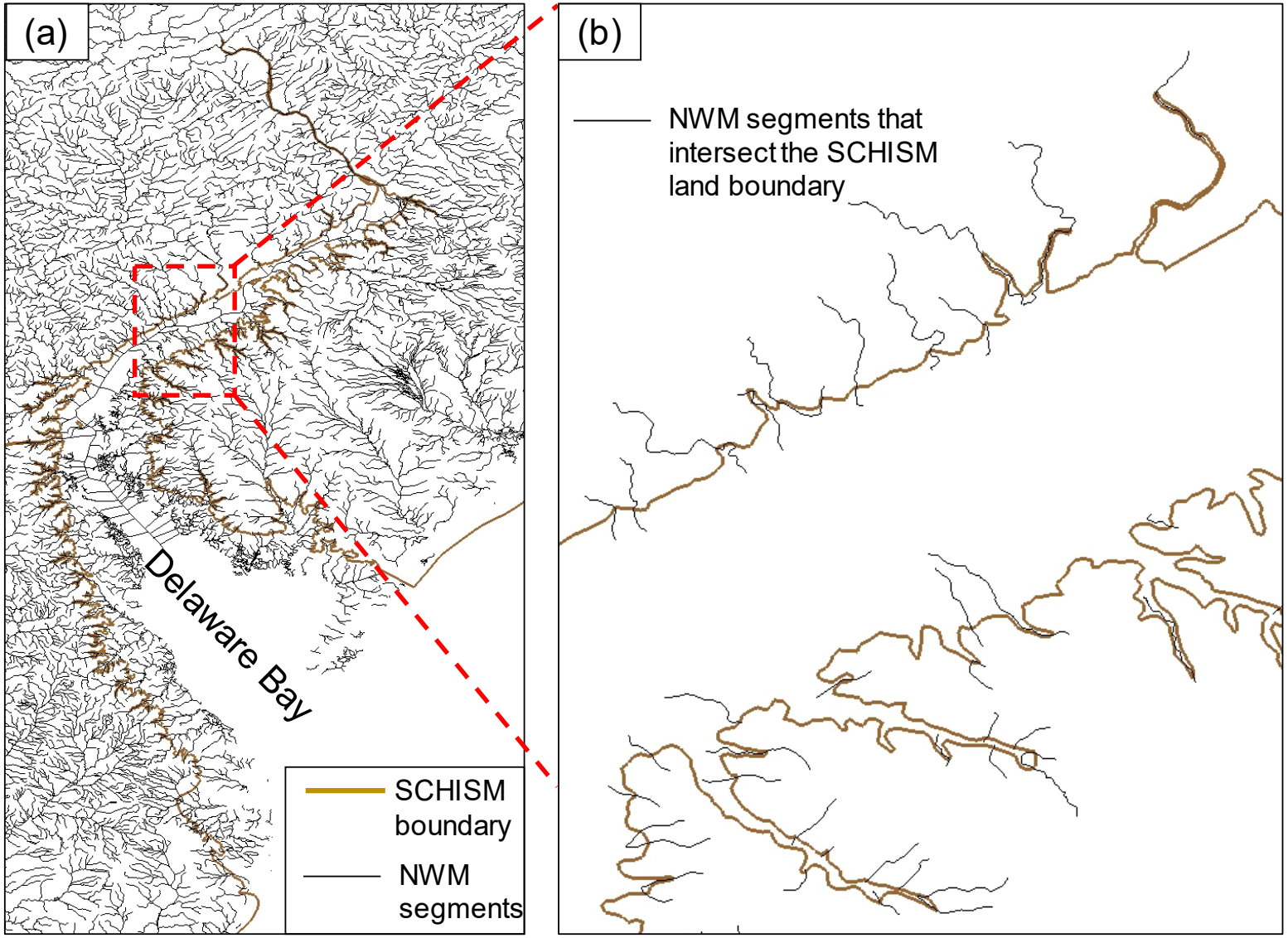
NWM segments incorporated

Vertical grid





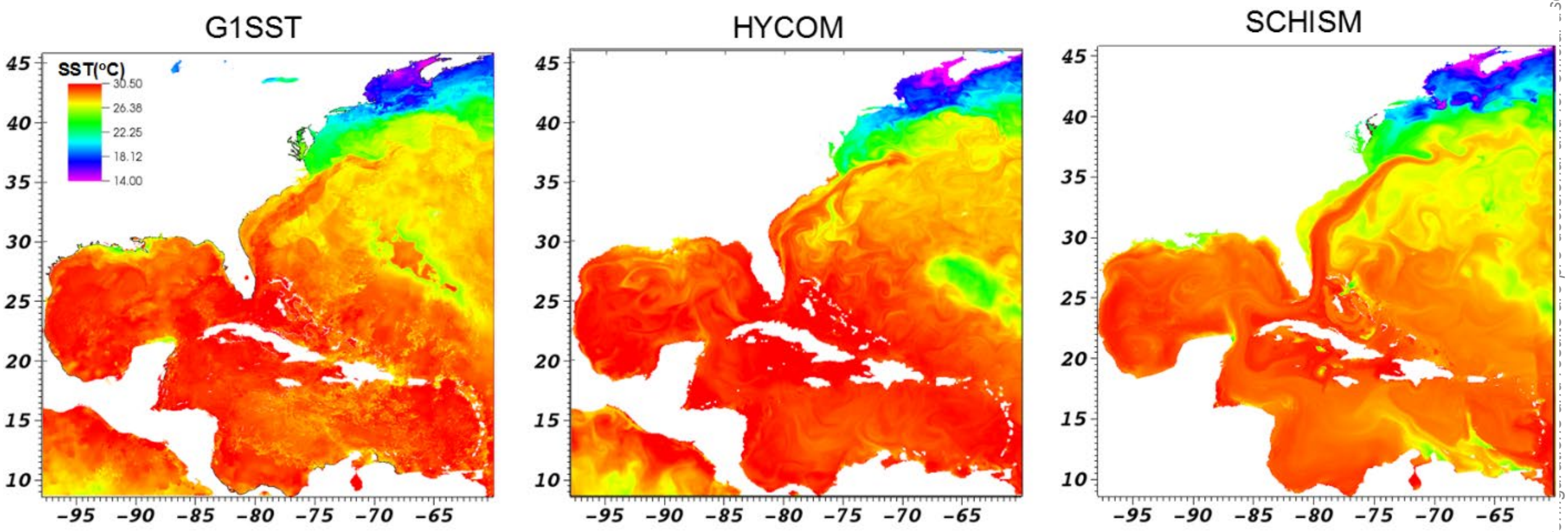
Exploring Creek-to-Ocean 3D modeling: SCHISM and NWM coupling



- The intersection points between NWM Segments and the SCHISM land boundary are determined.
- NWM flows are directly imposed based on the streamflow of the intersecting segments
- One-way coupling at the moment, from NWM to SCHISM

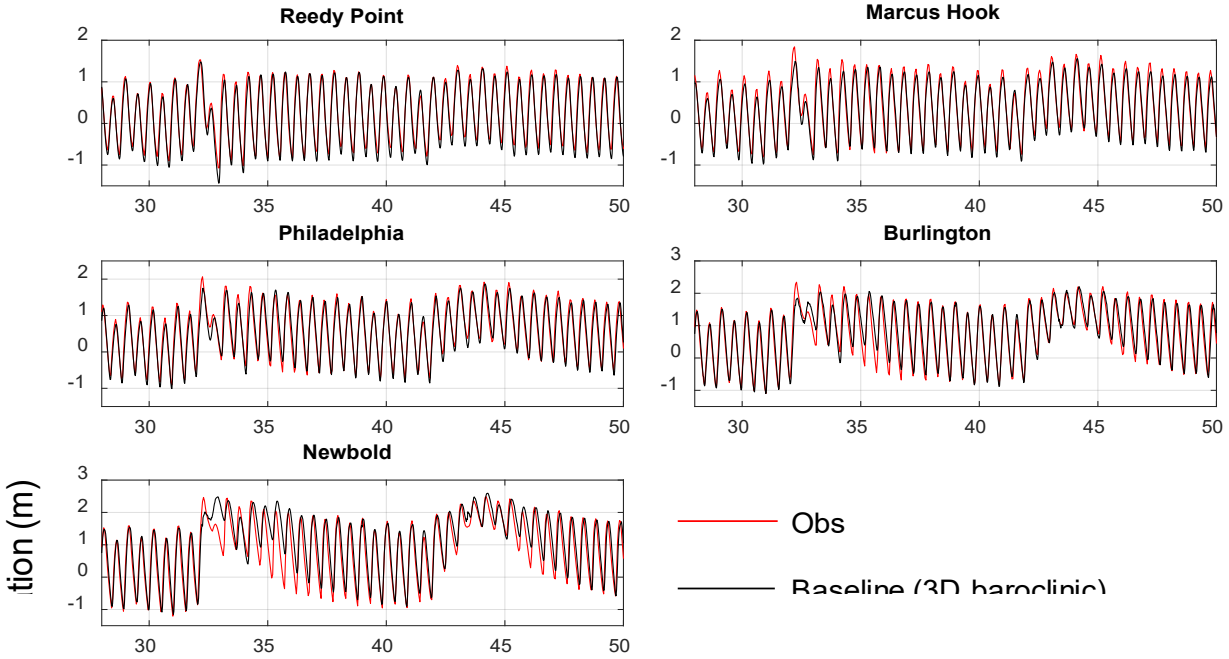
1) Ye et al, 2020; Ocean Modelling; 2) Zhang et al, 2020; Ocean Dynamics

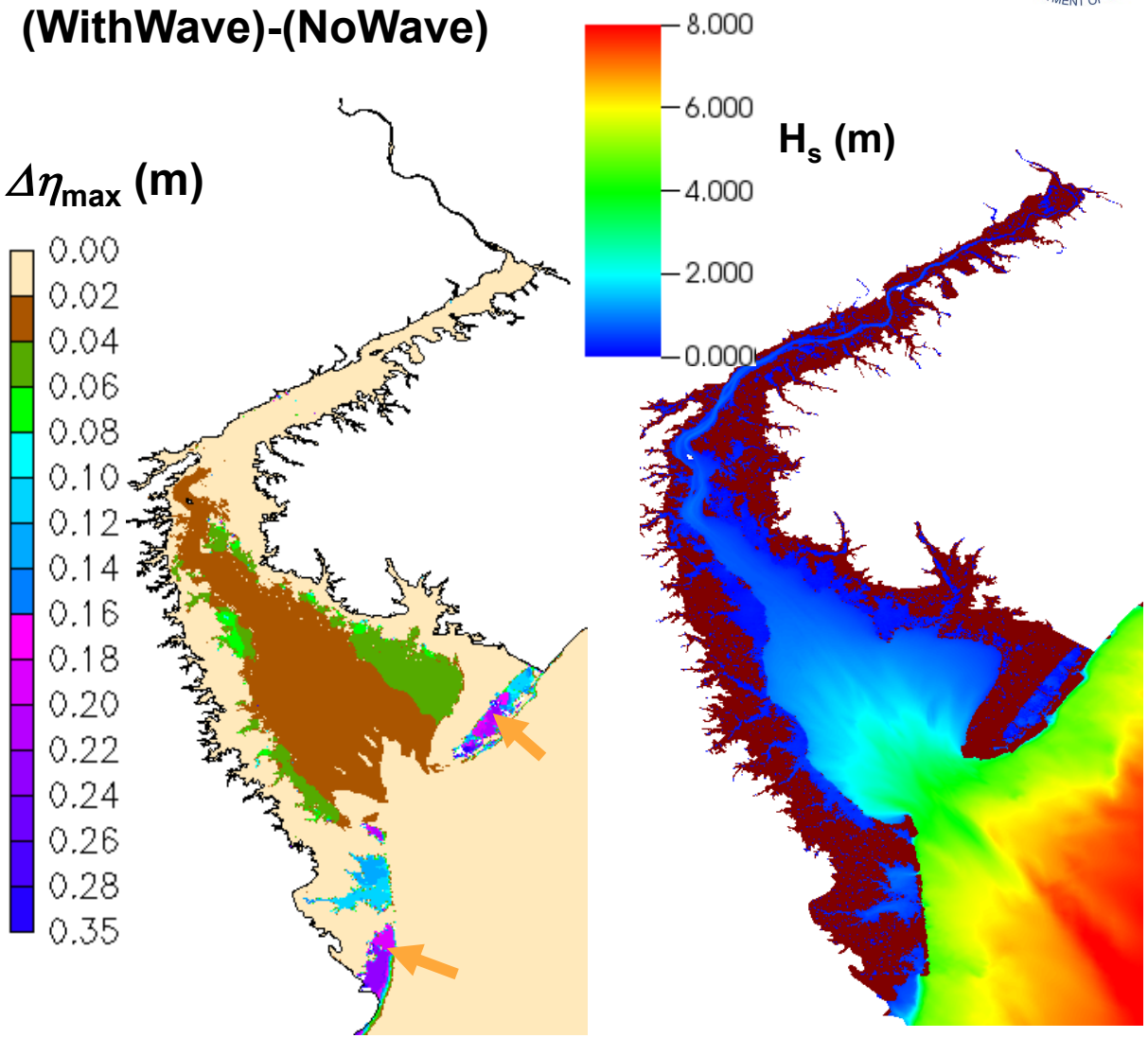
Comparison of SST ten days after Irene (2011-09-07)



*Simulating storm surge and compound flooding events with a creek-to-ocean model: **Importance of baroclinic effects**;* F Ye, YJ Zhang, H Yu, W Sun, S Moghimi, E Myers, K Nunez, R Zhang, ..., 2020, ***Ocean Modelling*** 145, 101526; DOI: https://doi.org/10.1016/j.ocemod.2019.101526

Total Water Level : Wave contribution





- Elevations are generally well simulated
- Larger errors upstream possibly due to uncertainties in DEM and datum

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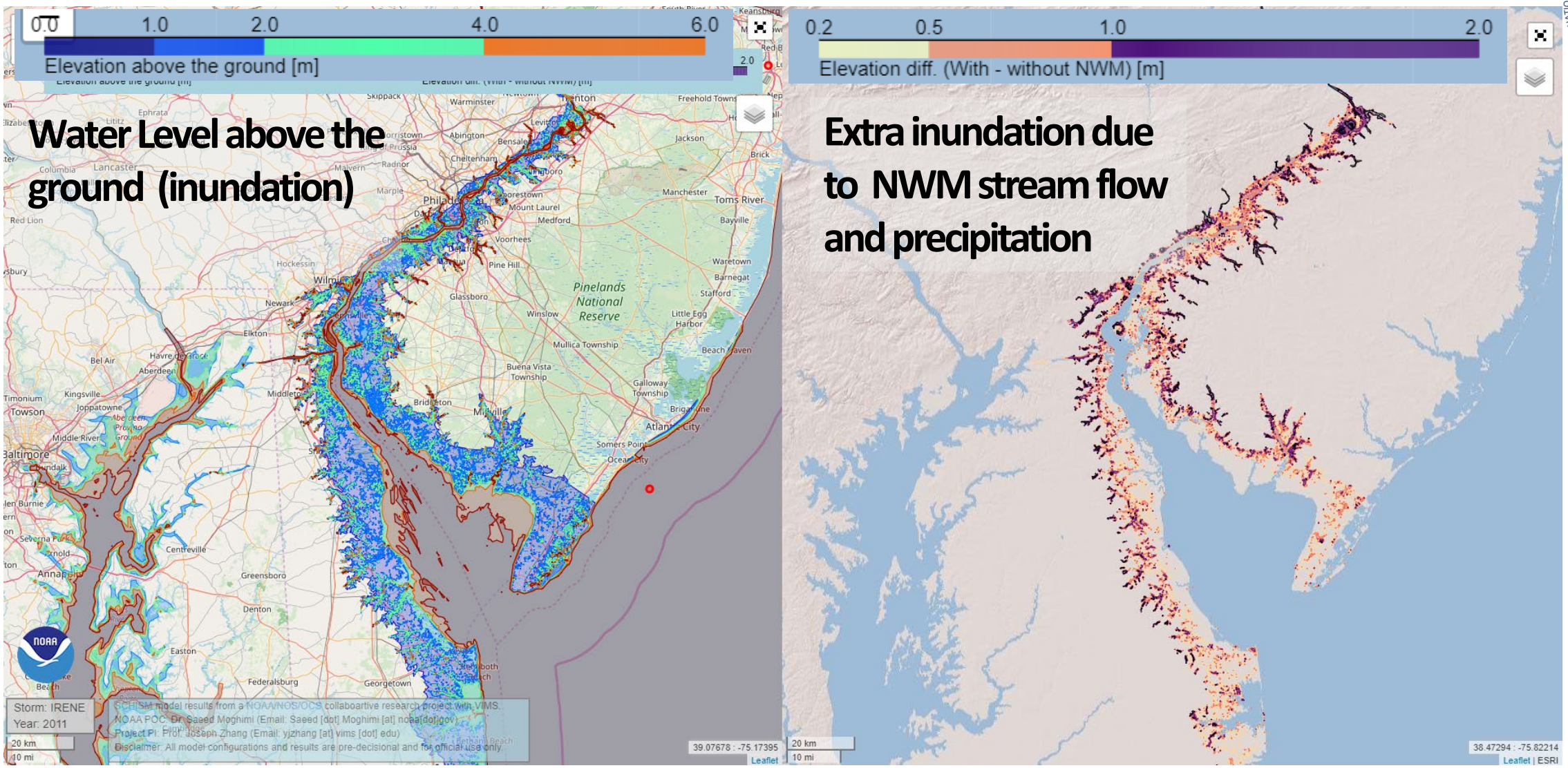
Ye et al. (Ocean Modelling 2020)

SCHISM and NWM coupling: Irene, 2011



Zhang, Ye, H.C. Yu, W. Sun, Saeed Moghimi, Ed Myers, K. Nunez, R. Zhang, H. Wang, A. Roland, K Martin, X. Bertin, J. Du, Z. Liu, In press, ***Simulating compound flooding events in a hurricane***, *Ocean Dynamics*.

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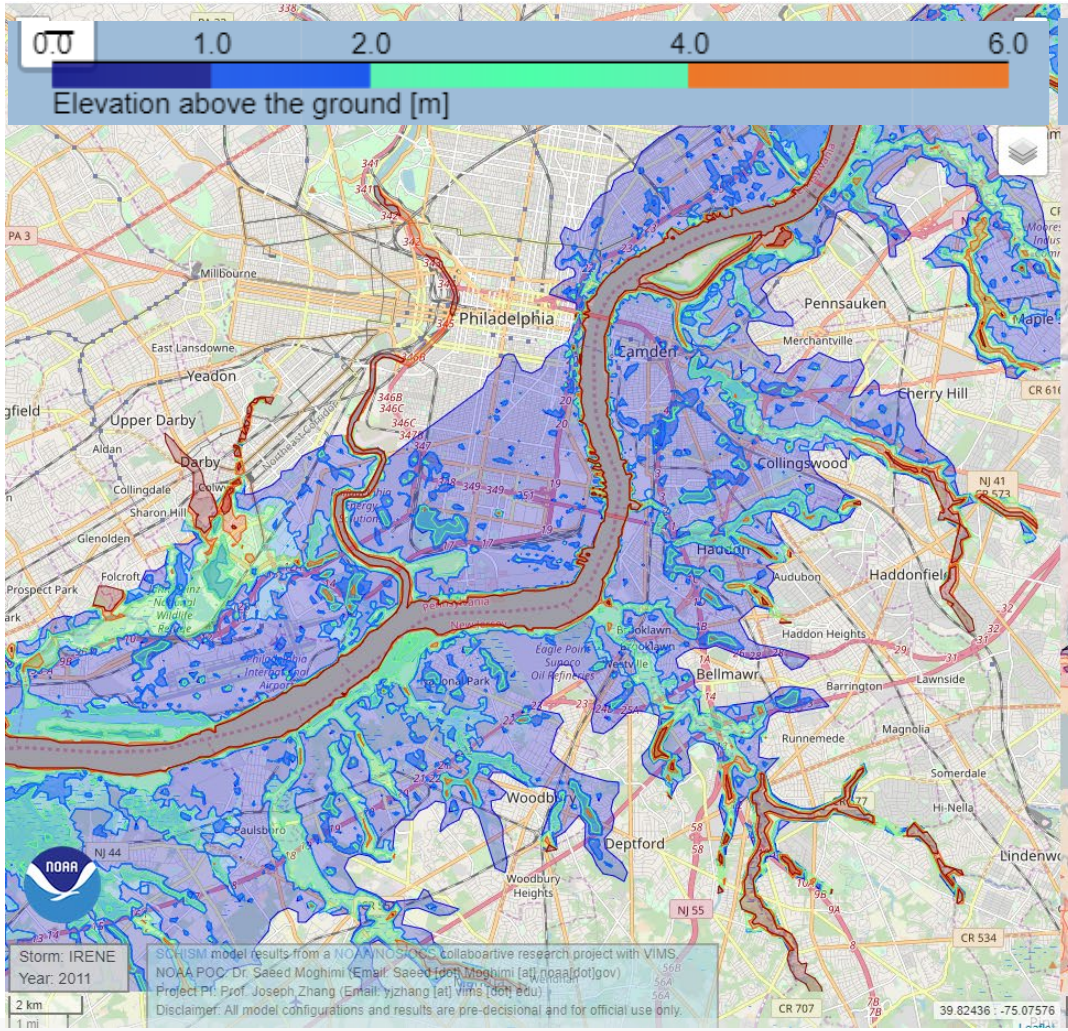
NOAA Office of Coast Survey

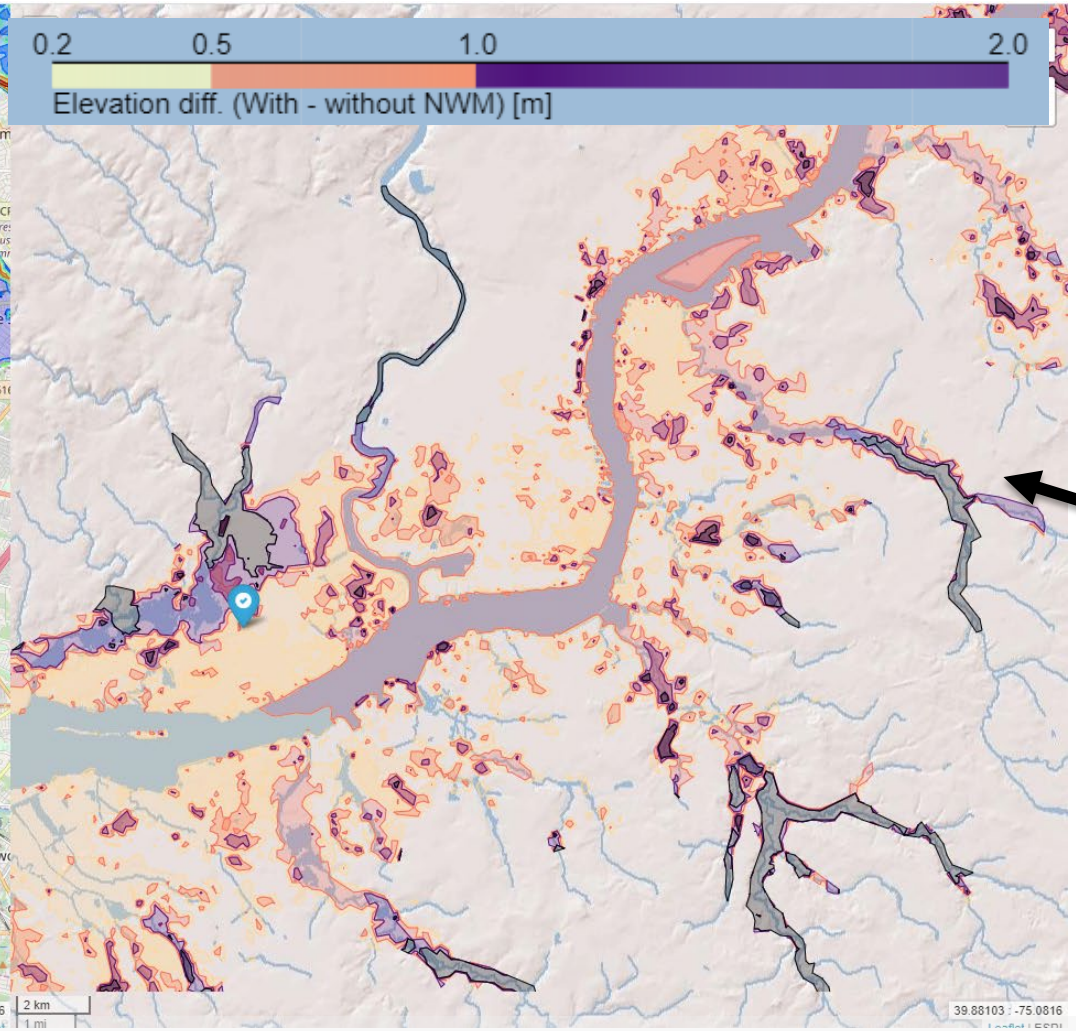
Explore the results here: www.tinyurl.com/schism-irene

SCHISM and NWM coupling: Irene, 2011

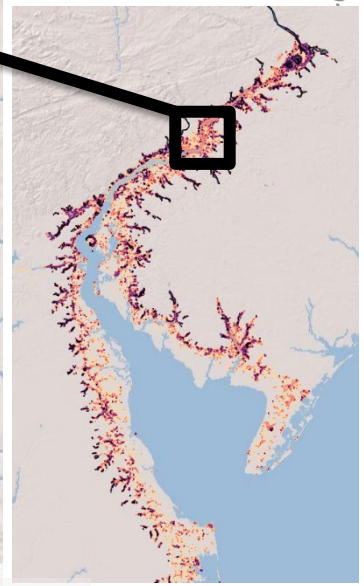
Philadelphia Airport, NJ



Water Level above the ground (inundation)



Extra inundation due to NWM stream flow and precipitation



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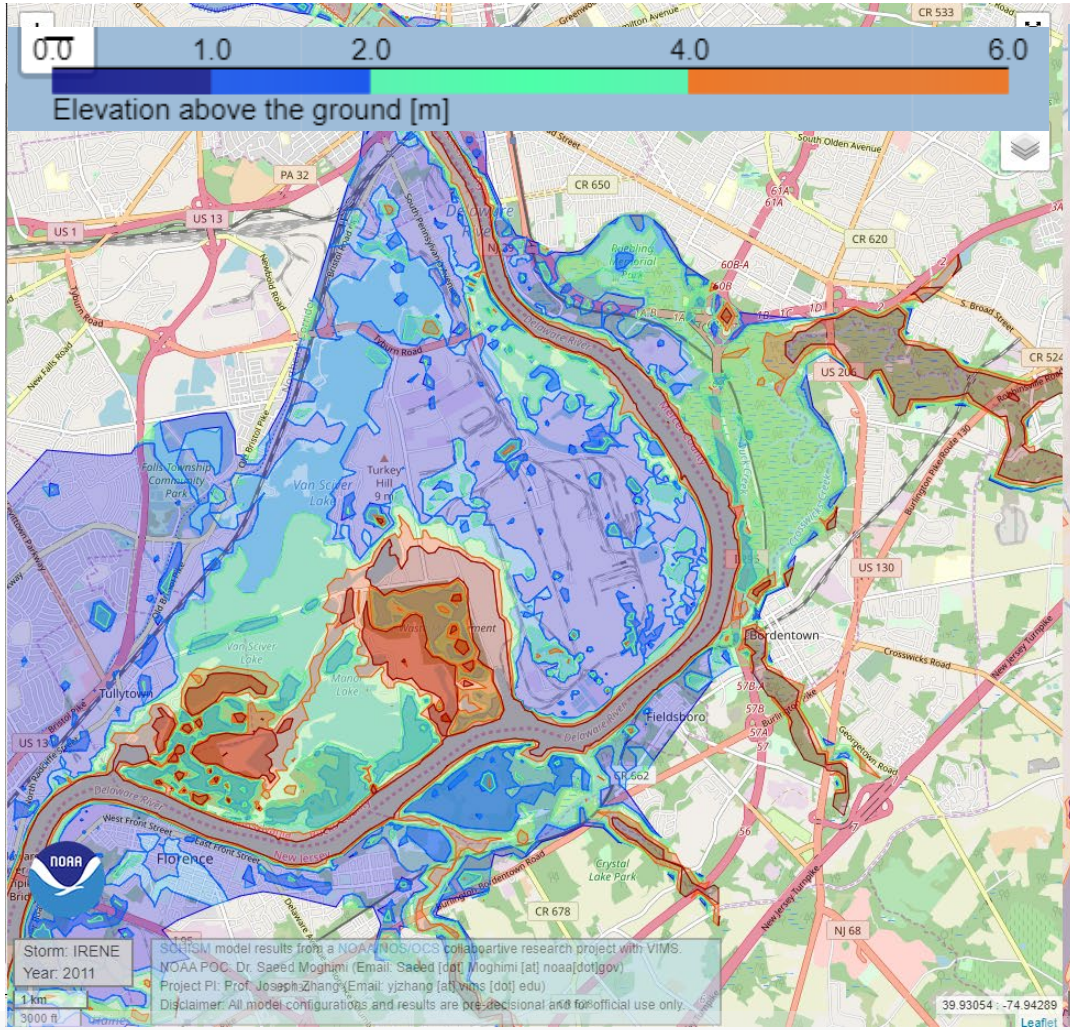
SCHISM and NWM coupling: Irene, 2011

Trenton, NJ



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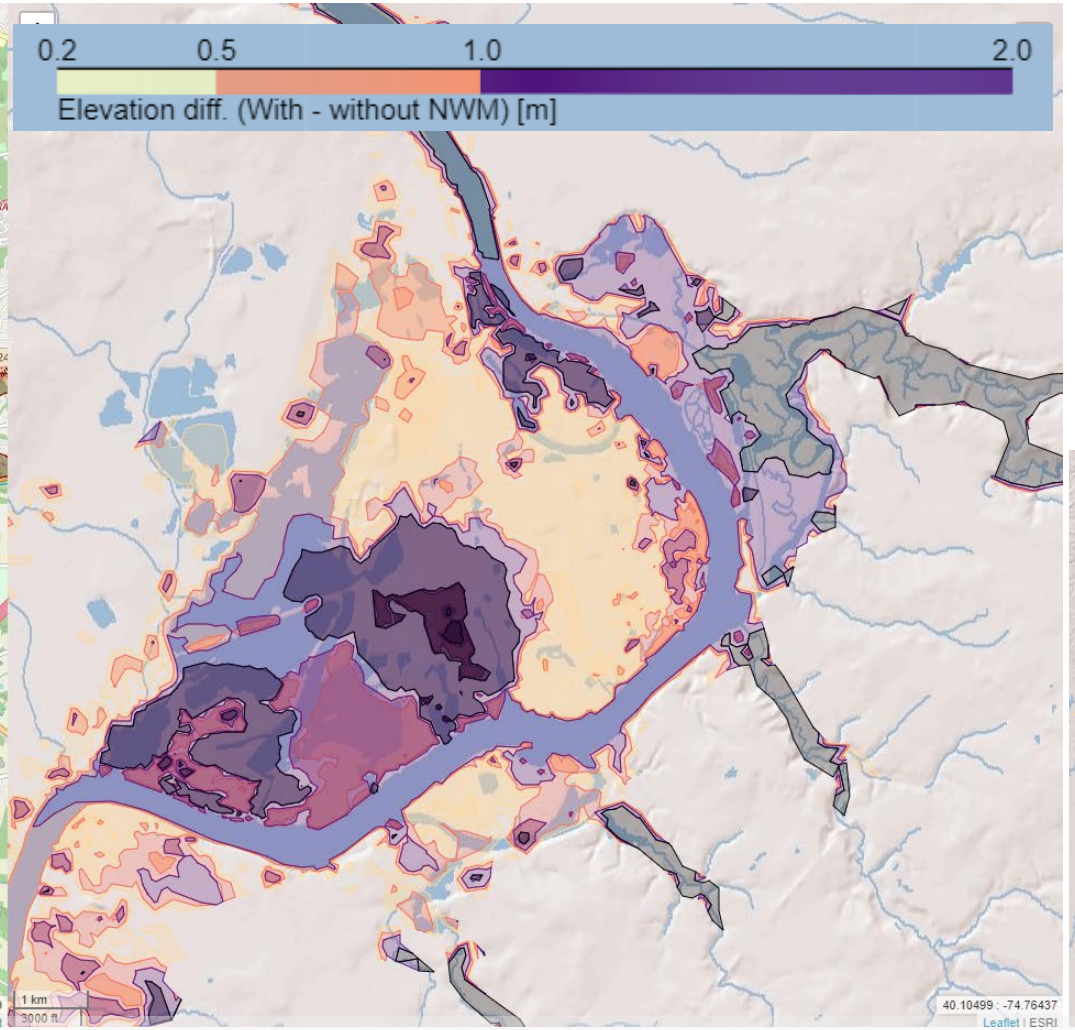

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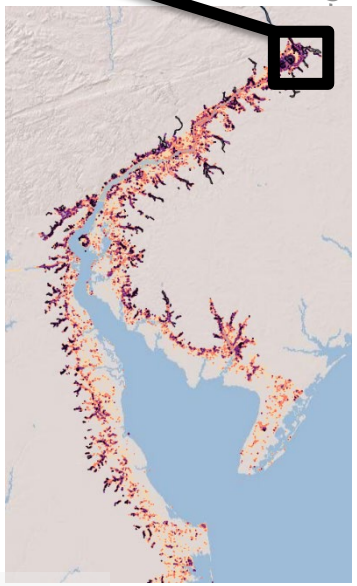

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Explore the results here: www.tinyurl.com/schism-irene

Future works

- **ADCIRC**
  - Adaptive data driven mesh generation
  - Testing strategies for freshwater variables
  - Updating ADCIRC NUOPC/ESMF interface
- **ROMS**
  - Testing NUOPC/ESMF model interface in NOAA NEMS environment
  - Implementation of flexible freshwater source terms
  - Considering open-channel type bottom roughness for rivers
- **FVCOM**
  - Developing NUOPC/ESMF model interface in NOAA NEMS environment
  - Testing flexible freshwater source terms for seamless NWM and FVCOM coupling
- **SCHISM**
  - SCHISM capabilities to investigate 3D NWM-Coastal coupling for selected region will be extended to the whole US Atlantic coastal area.

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Extreme Events in Nearshore and River Integrated Region

Guest Editor

Dr. Saeed Moghimi

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Invitation to submit

References:

- Simulating storm surge and compound flooding events with a creek-to-ocean model: Importance of baroclinic effects; F Ye, YJ Zhang, H Yu, W Sun, S Moghimi, E Myers, K Nunez, R Zhang, ..., 2020, Ocean Modelling 145, 101526; DOI: https://doi.org/10.1016/j.ocemod.2019.101526
- Moghimi, S., Vinogradov, S., Myers, E.P., Funakoshi, Y., Van der Westhuysen, A.J., Abdolali, A., Ma, Z., Liu, F., et al., 2019. Development of a Flexible Coupling Interface for ADCIRC Model for Coastal Inundation Studies. Technical Report. NOAA National Ocean Service. DOI: https://doi.org/10.25923/akzc-kc14
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- Zhang, Ye, H.C. Yu, W. Sun, Saeed Moghimi, Ed Myers, K. Nunez, R. Zhang, H. Wang, A. Roland, K Martin, X. Bertin, J. Du, Z. Liu, in press, Simulating compound flooding events in a hurricane, Ocean Dynamics.