

Coastal Ocean Model Coupling Applications at the NOAA National Ocean Service: Future Plans and Recent Advances

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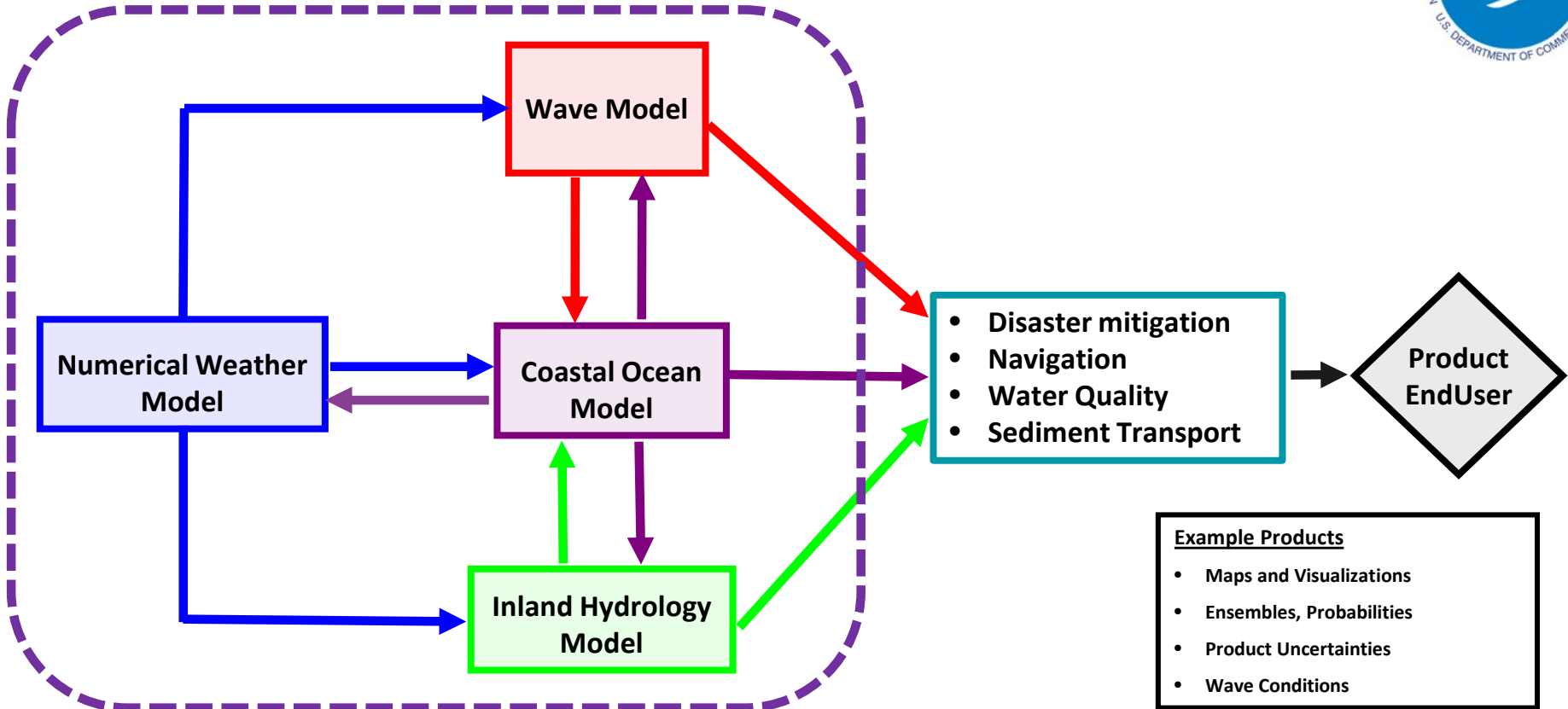
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*NOAA: National Oceanic and Atmospheric Administration; NOS: National Ocean Service; NWS:
National Weather Service; ESMF: Earth System Modeling Framework; NUOPC: National Unified
Operational Prediction Capability*



Coastal ocean models coupling framework



NOS' next generation high fidelity coastal ocean model



(5~10 year plan):

- National (i.e. basin) scale **coverage**
- Adaptive, flexible and high fidelity **resolution** (2km~25m)
- Advanced numerical and computational technology to ensure optimal **performance**
- Seamlessly switch between 2D and 3D modes (based End User need)
- Architecture agnostic (**HPC and cloud support**)
- Resolve shelf, nearshore and estuarine physics (waves, inland hydrology, Sea ice, ..)
- Full UFS/NEMS compliance
- Efficient I/O
- **Community support**

Unified Forecast System (UFS)



National Unified Operational Prediction Capability (NUOPC) Layer ESMF/NUOPC enabled models (Selected)

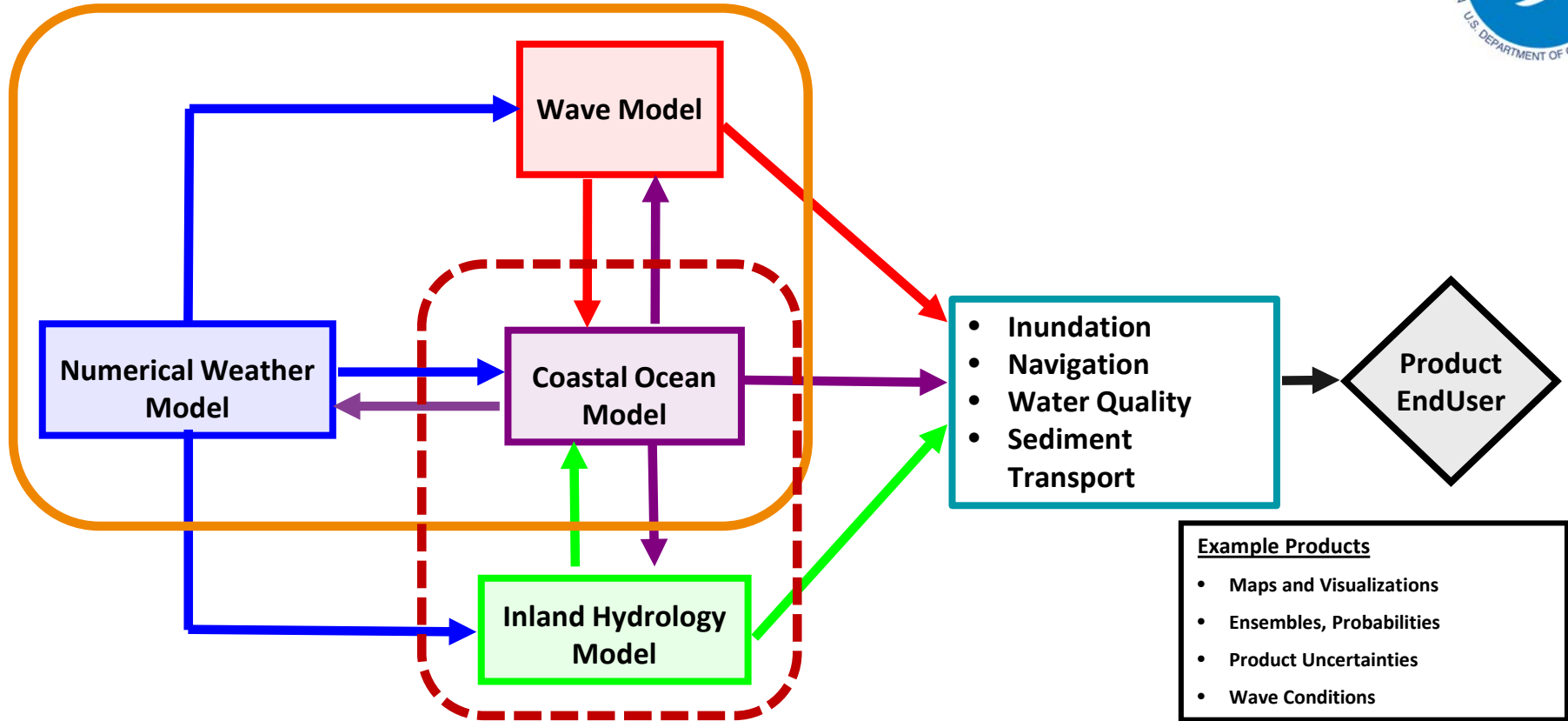
CST	Coastal ocean	ADCRIC, ROMS, FVCOM, SELFE/SCHISM
ATM	atmosphere	FV3 (Finite-Volume Cubed-Sphere Dynamical Core),
OCN	ocean	MOM5 and MOM6 (Modular Ocean Model)
WAV	wave	WWIII (WAVEWATCH III)
ICE	sea ice	CICE (Los Alamos Sea Ice Model)
HYD	hydrology	WRFHydro (Weather Research and Forecast Model Hydrology)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

Validating

In development

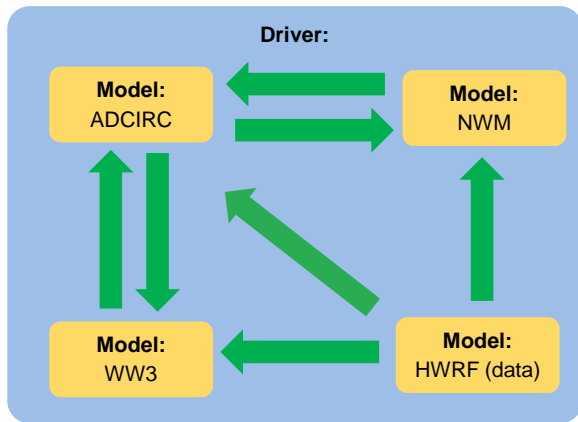
Plan to develop

Coastal ocean modeling framework



COASTAL Act application

NOAA's Environmental Modeling System (NEMS)



NUOPC components



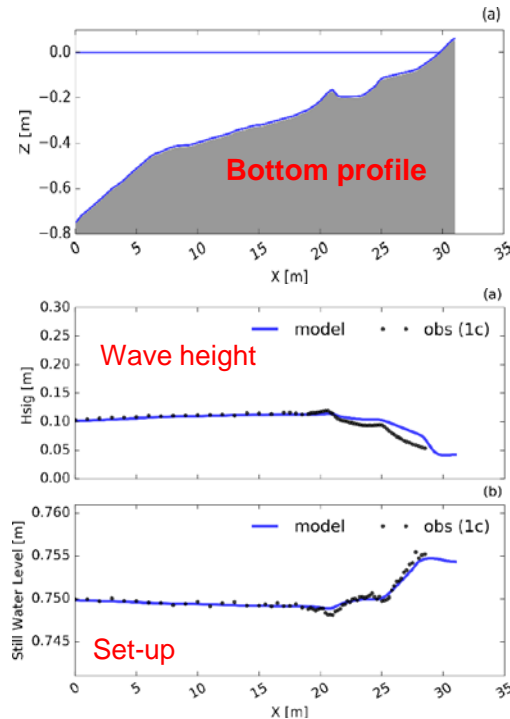
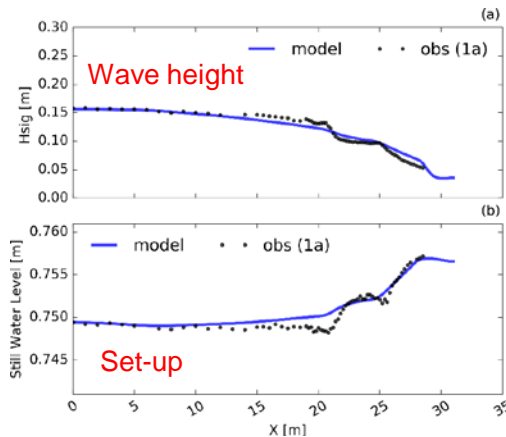
NOAA Technical Memorandum NOS CS 41

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

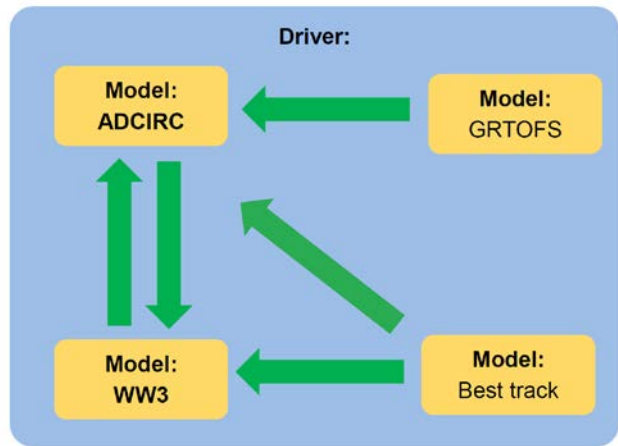
Moghimi et al, 2019;

WaveWatch III and ADCIRC subsystem validation

Boer, 1996 wave flume test case



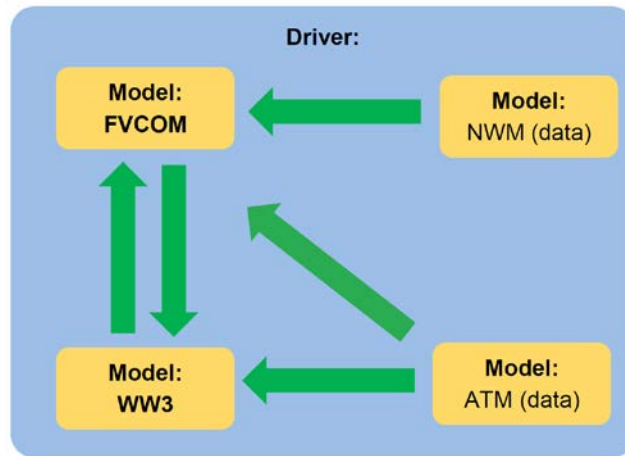
HurrSupp-HSOFS and NWI-FVCOM: NOAA's Environmental Modeling System (NEMS)



Coupled_HSOFS = ADCIRC-WW3-HollandB

Collaborators/Partners: OCS and EMC

Status: Project started recently (spin up)



NWI-FVCOM

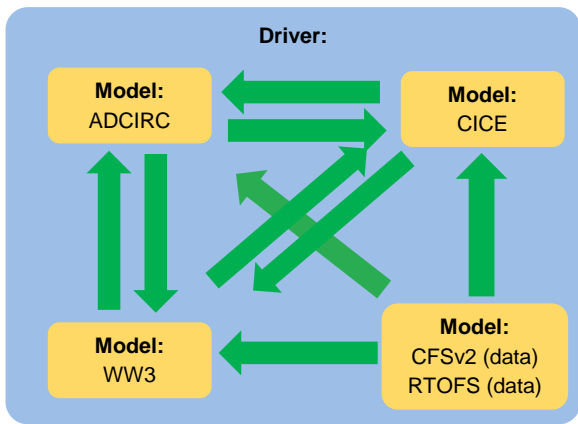
Collaborators/Partners: OCS and Umass Dartmouth

Status: FVCOM cap is being finalized

NUOPC
components



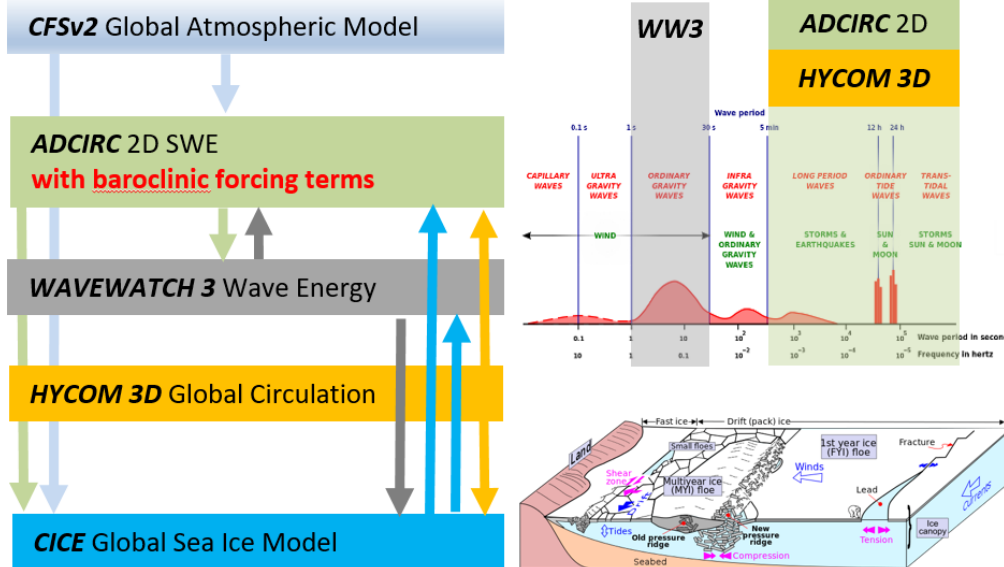
OTT- Alaska : NOAA's Environmental Modeling System (NEMS)



ALCOFS=ADCIRC-WW3-CICE-RTOFS-ATMESH

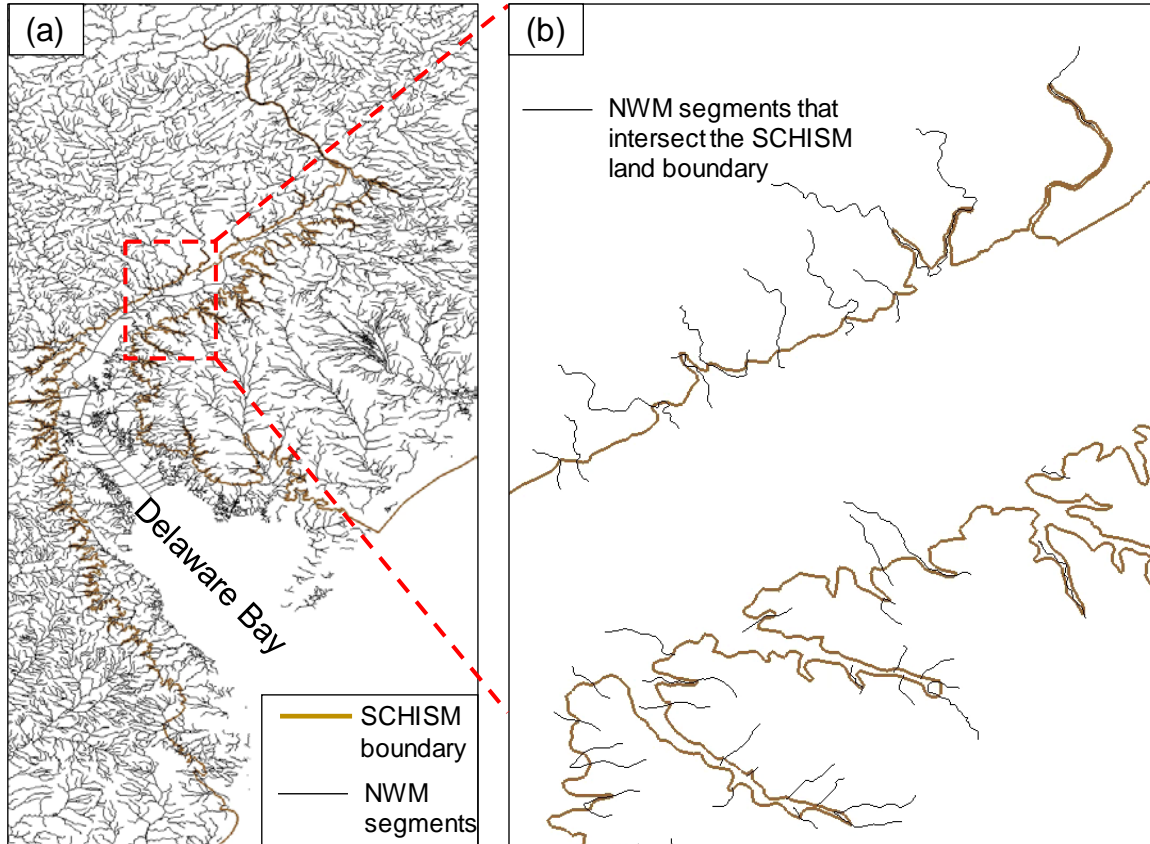
Collaborators/Partners : University of Notre Dame (UND), NOS/OCS, OAR/GLERand NWS/EMC

Status: In progress.



NWI: SELFE/SCHISM and NWM coupling

Exploring Creek-to-Ocean 3D modeling

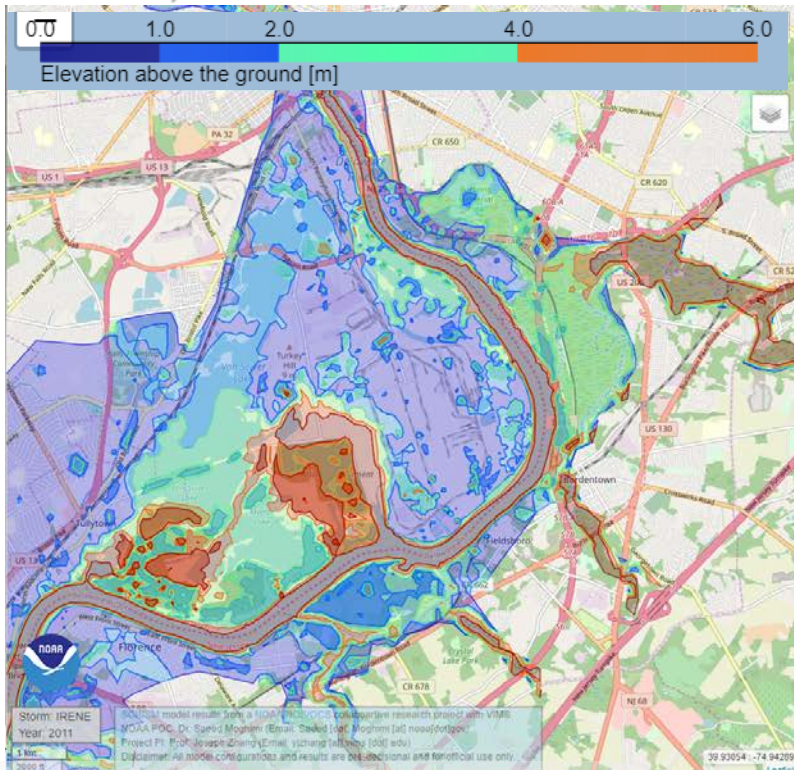


Ye et al, 2020; Ocean Modelling;
Zhang et al, 2020; Ocean Dynamics

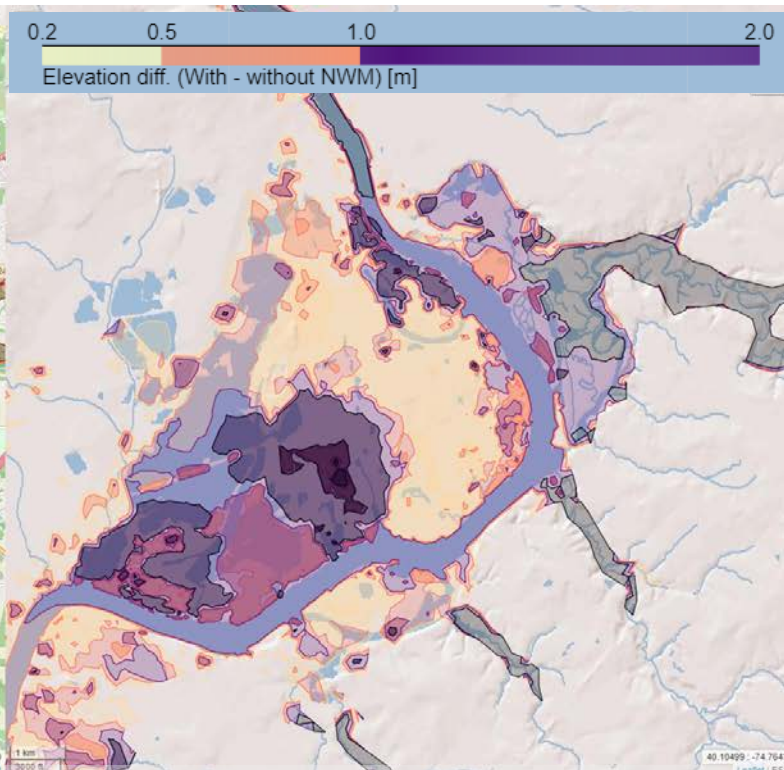
- The **intersection points** between NWM Segments and the SCHISM land boundary are determined.
- NWM **flows are directly imposed** based on the streamflow of the intersecting segments
- **One-way coupling** at the moment, from NWM to SCHISM

SCHISM and NWM coupling, Irene, 2011

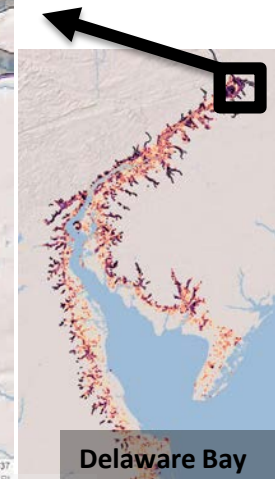
Trenton, NJ



Water Level above the ground (inundation)



Extra inundation due to NWM stream flow and precipitation



Delaware Bay

References:

Y. Zhang, F. Ye, H. Yu, W. Sun, S. Moghimi, E. Myers and others. Simulating compound flooding events in a hurricane. *Ocean Dynamics*, 2020, 101526doi: doi.org/10.1007/s10236-020-01351-x.

F. Ye, Y. Zhang, H. Yu, W. Sun, S. Moghimi, Myers, K Nunez, R. Zhang, H. Wang, A. Roland and others. Simulating storm surge and compound flooding events with a creek-to-ocean model: importance of baroclinic effects. *Ocean Modelling*, 2020, 101526doi: doi.org/10.1016/j.ocemod.2019.101526

Abdolali, A., Roland, A., van derWesthuysen, A., Meixner, J., Chawla, A., Hesser, T. J., Smith, J. M., & Sikiric, M. D. (2020). Large scale hurricane modeling using domain decomposition parallelization and implicit scheme implemented in WAVEWATCH III wave model. *Coastal Engineering*, 157, 103656doi: <https://doi.org/10.1016/j.coastaleng.2020.103656>.

Moghimi, S., A. Van derWesthuysen, A. Abdolali, E. Myers, S. Vinogradov, Z. Ma, F. Liu, A. Mehra, N. Kurkowski. Development of an ESMF Based Flexible Coupling Application of ADCIRC and WAVEWATCH III for High Fidelity Coastal Inundation Studies. *J. Mar. Sc Eng.* 2020, 8, 308. <https://doi.org/10.3390/jmse8050308>

Moghimi, S., S. Vinogradov, E. Myers, Y. Funakoshi, A. J. Van derWesthuysen, A. Abdolali, Z. Ma, F. Liu. Development of a Flexible Coupling Interface for ADCIRC Model for Coastal Inundation Studies. NOAA technical memorandum, NOS CS 41, 2019; doi: doi.org/10.25923/akzc-kc14.

Moghimi, S., E. Myers, S. Vinogradov, B. Trimble, J. Zhang, F. Ye, Calzada, A. Van derWesthuysen, Y. Funakoshi, R. Bakhtyar, K. Maitaria, A. Abdolali, D. Rosen, C. Lemmen (2020), A flexible infrastructure for coastal ocean and inland hydrology models coupling, Ocean Sciences Meeting 2020, 1621 February 2020 in San Diego, CA, USA, 2020.

Moghimi, S., E.P. Myers, S. Vinogradov, A.J. Van derWesthuysen, A. Abdolali, L. Shi, Z. Ma, A. Chawla, H. Mashriqui, T. Flowers, N. Kurkowski. Application of ESMF/NUOPC Coupled Framework for Total Water Level Studies. In AGU fall meeting 2018, DC, USA, 2018.

Moghimi, S., S. Vinogradov, E. Myers, A. Van derWesthuysen, Y. Funakoshi, F. Liu and C. Massey. Effects of waves on storm surge inundation using flexible coupling framework. In Coastal Ocean Modeling Gordon Research Conference, Maine, USA, 2017.





Thanks for your attention!

Questions?