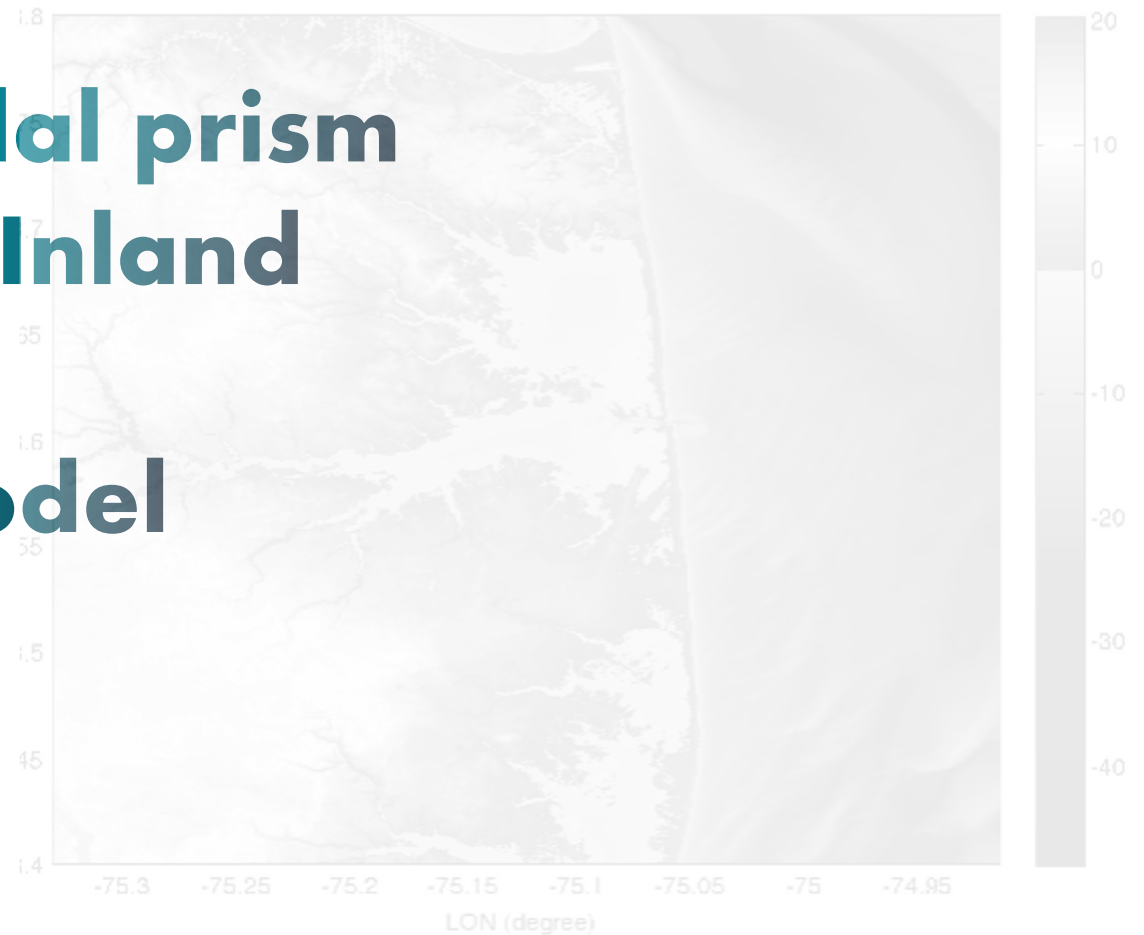# Estimating tidal prism of Delaware Inland Bays using a numerical model

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NearCoM

- Nearshore Community Model was developed during the National Oceanographic Partnership Program (NOPP)
- Wave, circulation and sediment transport components
- Tide, storm surge, wind waves, wave-induced circulation, sediment transport and morphological change
- Subgrid closure for high-resolution simulations

Inland-bays model
- TVD version (NearCoM-TVD): highest-resolution 16 m
- Subgrid version: highest-resolution is 2 m

NearCoM

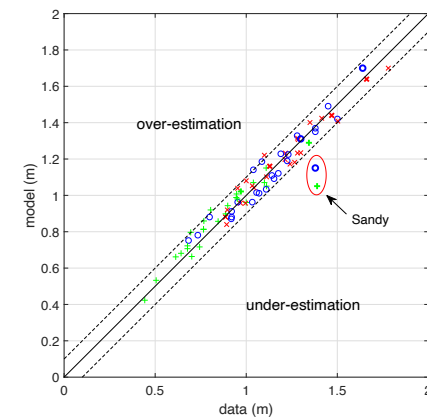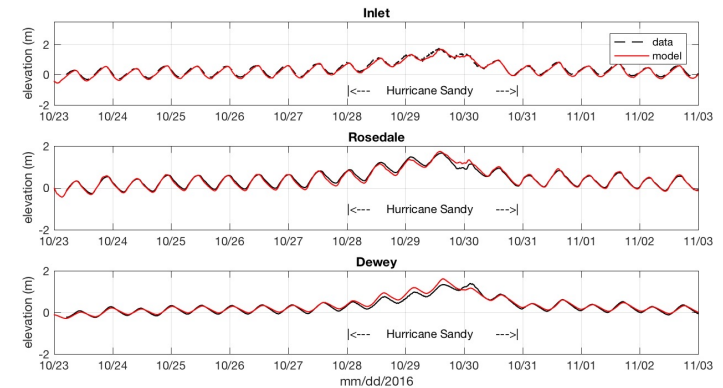

water elevation (m) at 7.08 hr

vorticity (1/s) at 7.08 hr
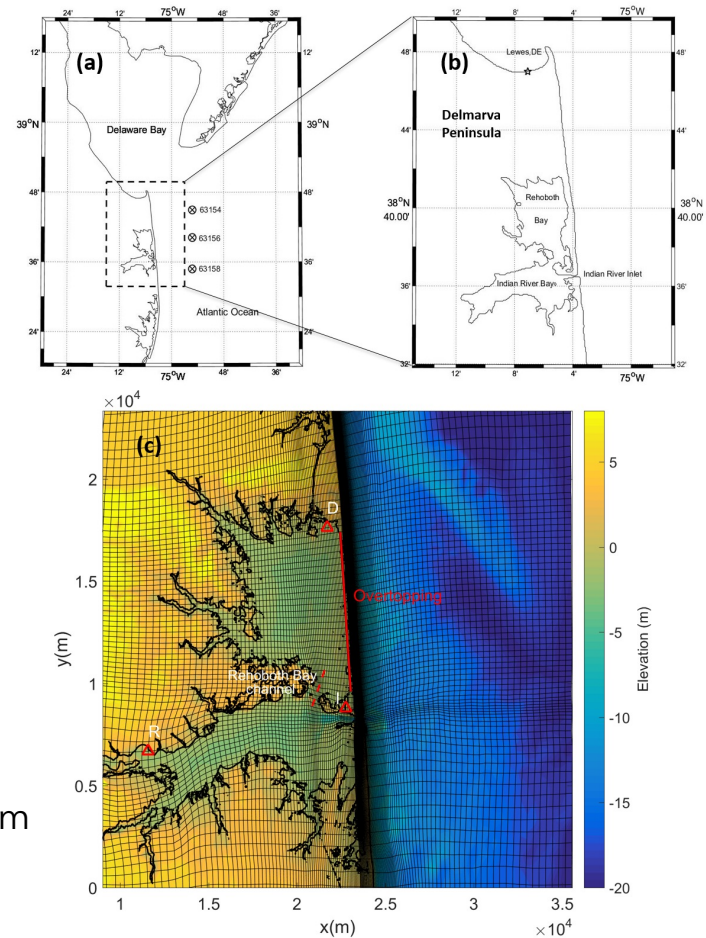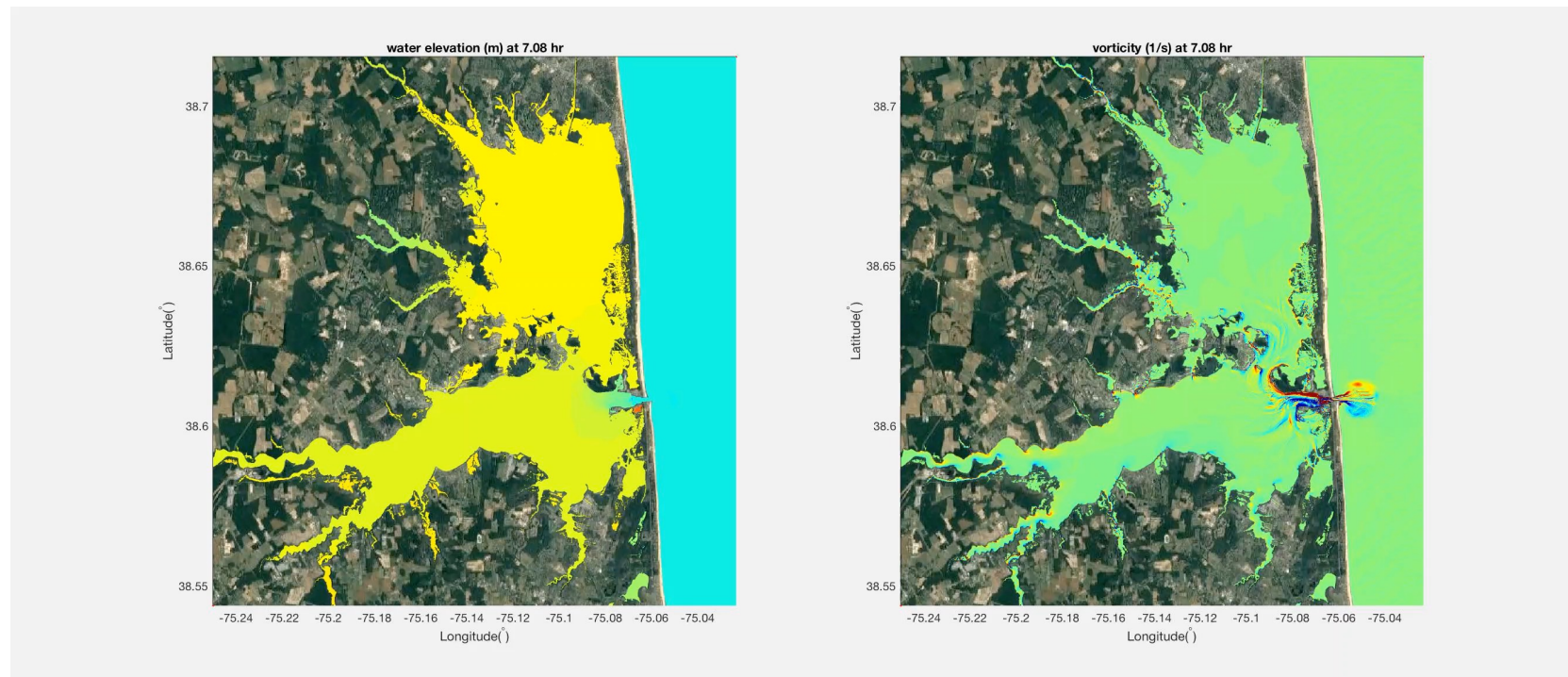
Model Validation

(Lu et al., 2018, Coastal Engineering)

- Tides (model/data comparisons at three USGS stations inside the inland bays)

- Storm surge events (9 large storm events)

- Wave overwash and overtopping (Hurricane Sandy)

Historical data (Walch, et al., 2016)

2004: outgoing: 1,682 ft^3
　　　incoming: 2,293 million ft^3
　　　average: 1,986 million ft^3

Puzzle:
- Data projection is higher than the preliminary model result under the present condition
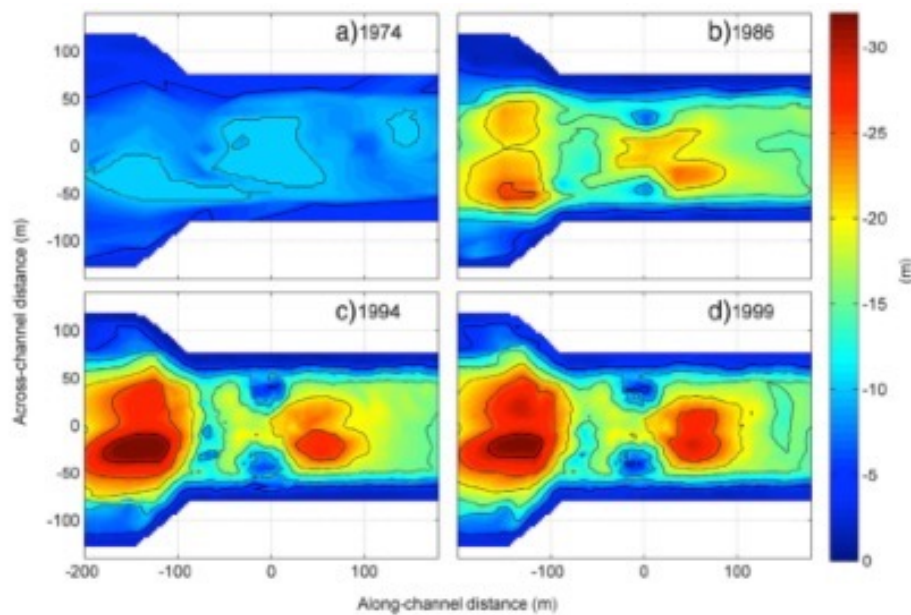
Modified Tasks:
- Investigate the relationship between tidal prism and inlet cross-sectional area
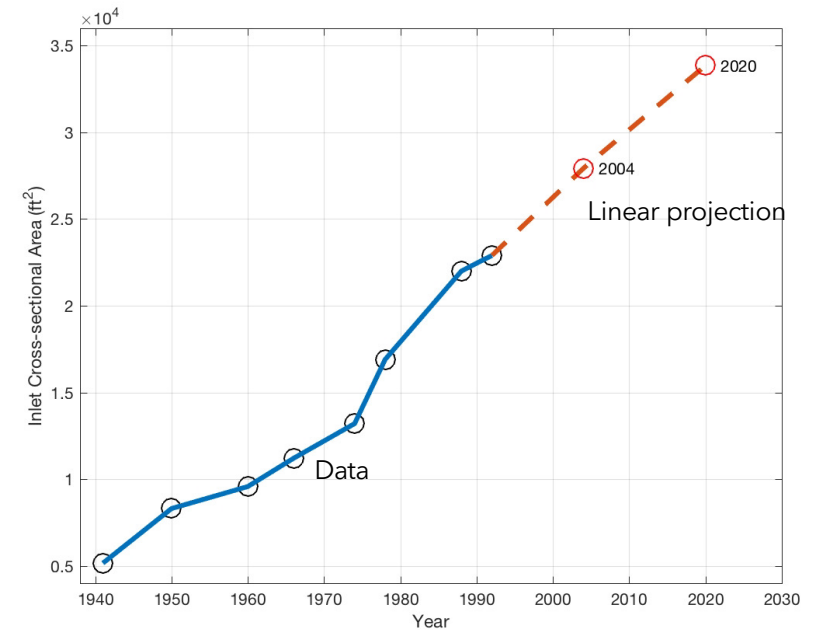- Make the best guess of tidal prism using numerical results, empirical formulas, and historical data

Indian River Inlet Flushing Over Time
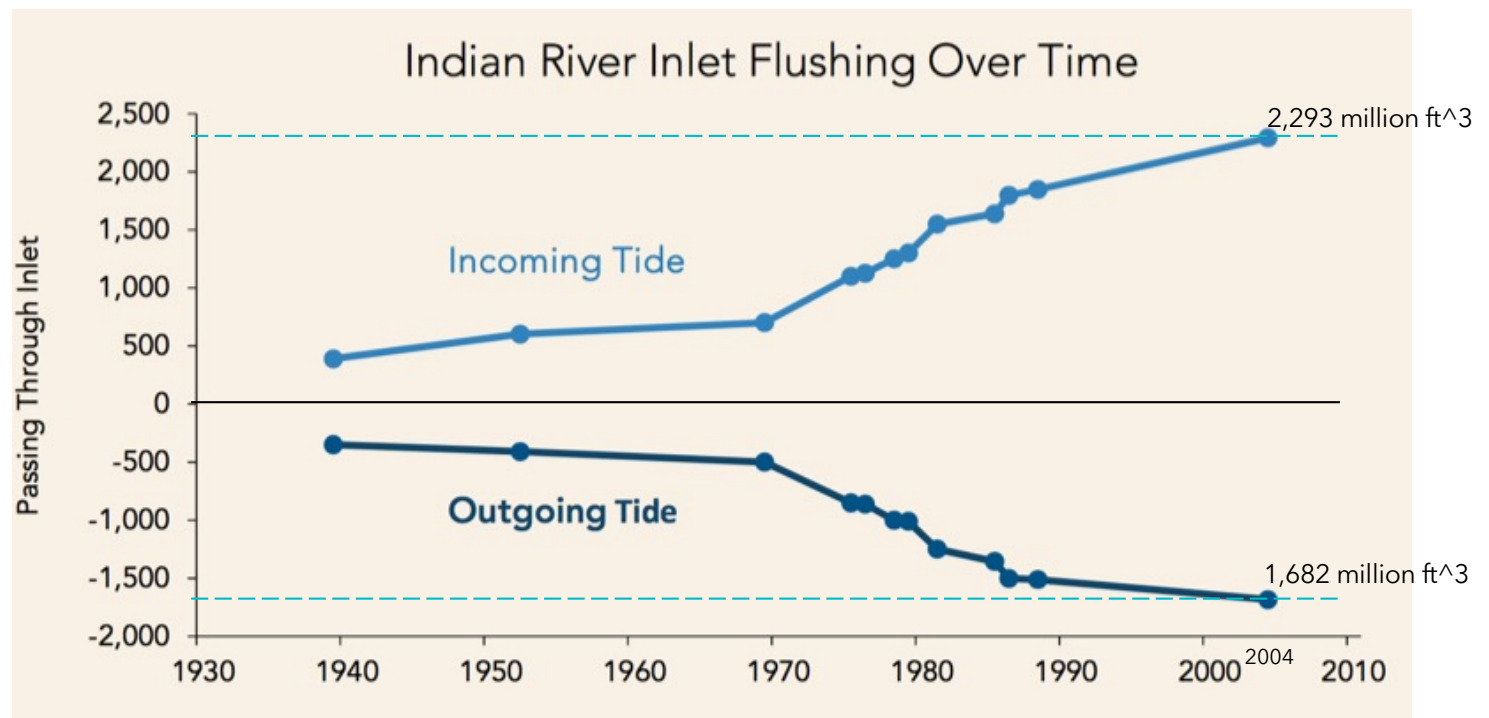
inlet cross-sectional area

Evolution of inlet bathymetry (Keshtpoor et al., 2015)

Inlet cross-sectional area versus time (USACE CTH report)

Case No.	Inlet configuration Representative depth of cross-section(ft)			Inlet Sectional Area (ft^2)	Max Prism million ft^3	Min Prism million ft^3
	South	Middle	North			
1	16.40	16.40	16.40	8452.9	1346.5	891.8
2	16.40	32.81	16.40	11096.5	1520.0	1051.9
3	22.97	32.81	22.97	13420.4	1638.6	1205.8
4	16.40	49.21	16.40	13741.2	1557.6	1061.3
5	22.97	49.21	22.97	16065.1	1695.1	1235.5
6	32.81	32.81	32.81	16905.8	1675.2	1225.5
7	22.97	65.61	22.97	18708.7	1706.6	1288.6
8	16.40	82.02	16.40	19029.5	1630.2	1111.5
9	32.81	49.21	32.81	19549.4	1704.3	1241.4
10	22.97	82.02	22.97	21353.4	1732.6	1261.3
11	32.81	65.61	32.81	22194.1	1838.7	1302.5
12	22.97	98.43	22.97	23997.0	1754.1	1271.6
13	32.81	82.02	32.81	24837.7	1757.5	1282.5
14	32.81	98.43	32.81	27482.4	1960.8	1313.0
15	49.21	65.61	49.21	28002.3	1855.7	1304.5
16	49.21	82.02	49.21	30647.0	1753.5	1297.5
17	49.21	98.43	49.21	33290.6	1975.7	1331.7
18	49.21	114.83	49.21	35935.3	2026.6	1397.5
19	65.61	82.02	65.61	36455.2	1753.1	1279.0
20	65.61	98.43	65.61	39099.9	1972.6	1338.9
21	22.0	98.43	22.0	41422.7	1837.4	1355.7
22	65.61	114.83	65.61	41743.5	2034.0	1379.2
23	22.0	114.83	22.0	44067.4	1953.5	1391.9
24	82.02	98.43	82.02	44908.1	1847.3	1368.2
25	82.02	114.83	82.02	47552.8	1962.9	1404.5

Table 1: List of test scenarios.

Test scenarios

- 25 scenarios in total
- 30-day simulation for each test (no river discharge)
- Prism calculation formula

$$P = \int_{T_f} \left(\int_S \bar{u}(h + \eta) ds \right) dt$$

Example of splits for flux integration

Test scenarios

- 25 scenarios in total
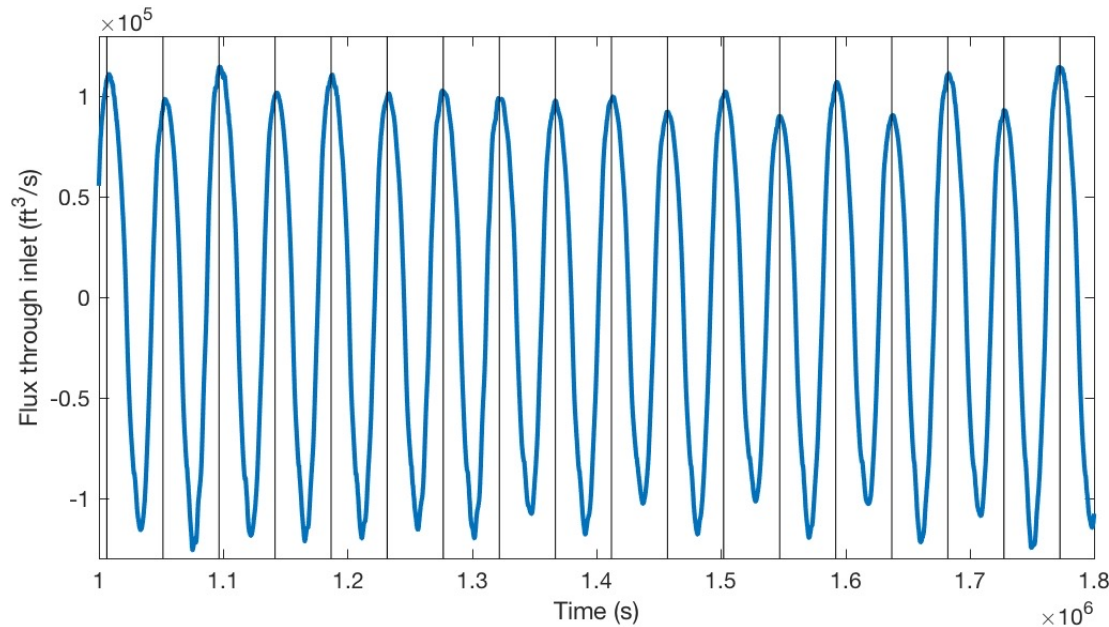- 30-day simulation for each test (no river discharge)
- Prism calculation formula

$$P = \int_{T_f} \left(\int_S \bar{u}(h + \eta) ds \right) dt$$

Modeled tidal prism with respect to the inlet sectional area

- Historical data are basically within the range of neap-spring tides
- Model overpredicted prisms for the lower values of inlet sectional area (older data)
- 2004 data is slightly higher than the model, but within 10% exceedance
- The change of tidal prism has slowed down, reaching a stable value
- Tidal prism is 2,100 million ft^3 if using the 10% exceedance curve for the present condition
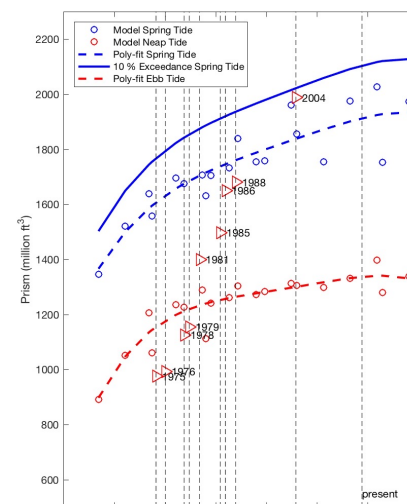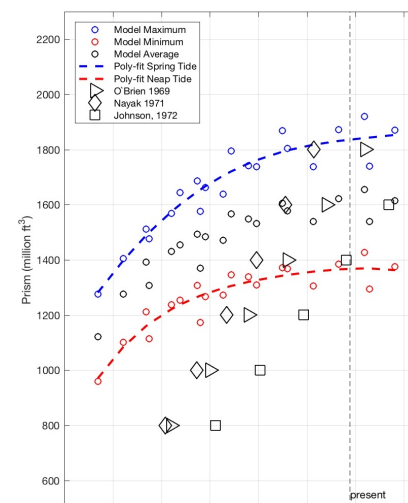
Conclusion

- NearCoM predicted an increasing trend of tidal prism, consistent with the historical data

- Model results indicated that the increase rate of the tidal prism has slowed down in recent years, and the tidal prism is reaching a stable value as the sectional area approaching the equilibrium value of 35,000 ft^2 (Hayden and Puleo, 2009)

- The 10% exceedance curve matches the upper limit of the data and is thus recommended as the prediction curve for tidal prism estimation.

- The best estimate of the maximum prism at the present time is about 2,150 million ft^3, based on the prediction curve.

- The uncertainty of the numerical results can be from the bathymetric data and model resolution.
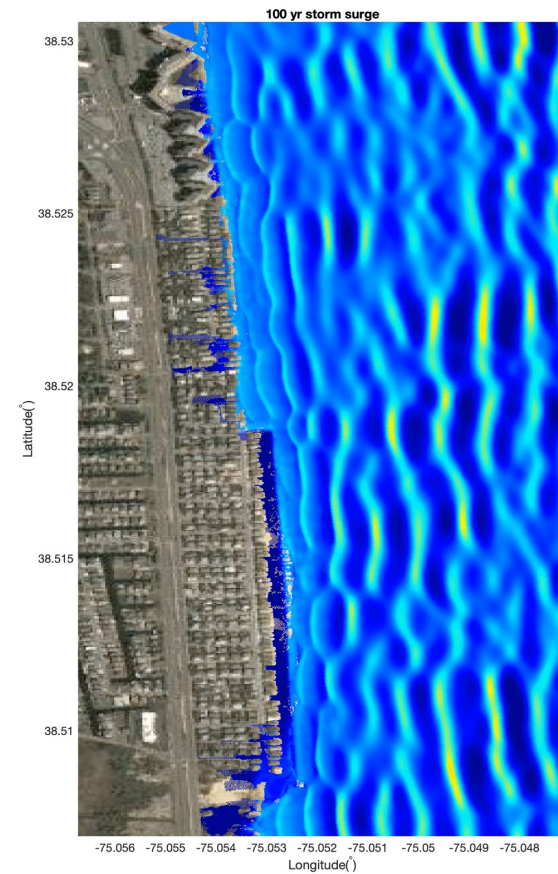
Extra info

Higher-resolution models for Inland Bays and DE coast

Inland bays steels cove area
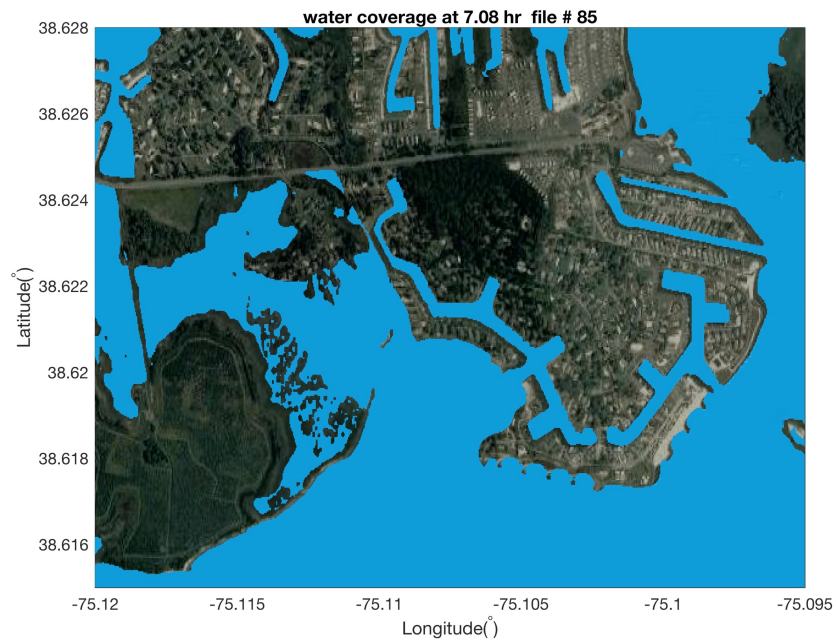
Grid resolution: 2.68 x 3.43m or 1/9 arc-sec

South Bethany Beach

Grid resolution: 2m