Center for Operational Oceanographic Products and Services
NATIONAL OCEAN SERVICE

NOAA Sea Level Calculator and CO-OPS Data Tools & Services

Dr. John A. Callahan
Ocean Associates, Inc
National Ocean Service / CO-OPS

July 31, 2026
Delaware Inland Bays STAC Meeting

CO-OPS Impact

Grow the Blue Economy

- Each year, commercial mariners move 2.3 billion short tons of goods through U.S. waterways – contributing $397 billion to the U.S. GDP
- These mariners rely daily on NOAA's network of real-time sensors to provide accurate navigation data and help ensure successful deliveries

Ensure Safe Navigation

- Since its inception in 1991, NOAA's PORTS® Program has contributed to a 33% reduction in maritime accidents and 59% reduction in groundings

Protect Coastal Communities

- 40% of the Nation's population lives within 100 miles of the coast.
- CO-OPS delivers 10+ products designed to help these regions face their unique threats, from hurricanes and tsunamis to high tide flooding

Invest In Innovation

- CO-OPS is consistently innovating – we regularly test/install cutting-edge equipment/infrastructure and research/develop new products and models to ensure our systems stay resilient, robust, and cost-effective

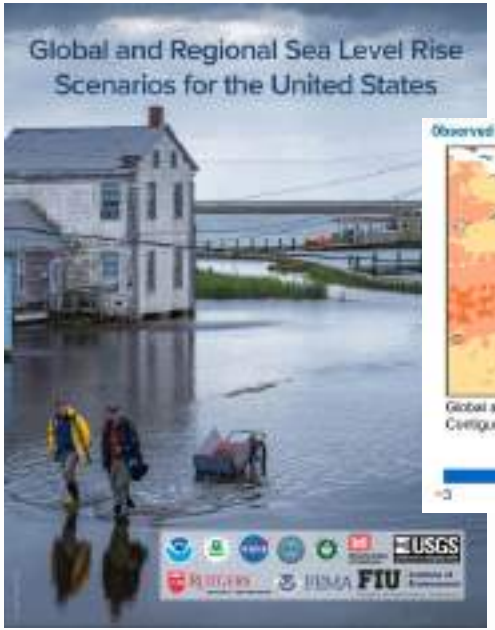
NOAA Sea Level Calculator

https://coast.noaa.gov/sealevelcalculator/

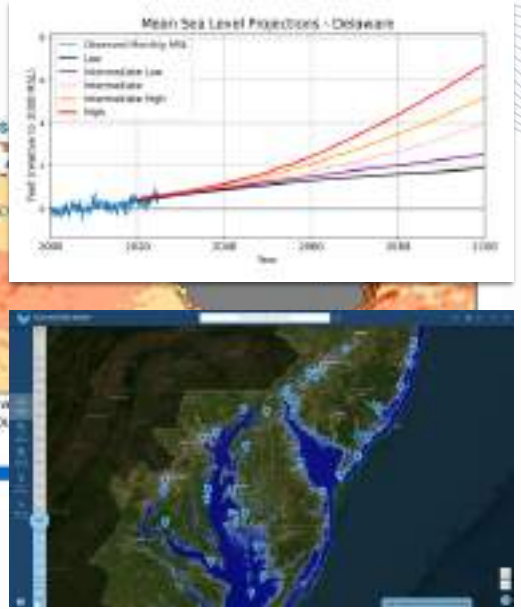
Sea Level Calculator

Goals

- Provide useful and actionable information on how sea level and flood frequency are changing over time
- Integrate numerous water level data sets from multiple sources based on the latest science and projections



Federal Interagency Task Force Sea Level Rise Technical Report (2022)



Delaware Sea Level Projections (2025)

Co-Development

NOAA National Ocean Service

- Center for Operational Oceanographic Products and Services (CO-OPS) is the operational and authoritative source for NOAA's coastal water level data
- Office for Coastal Management (OCM) has expertise in user engagement and geospatial tool development and hosting
- A true team effort!

Service Delivery

Gathering Input

- Coastal Inundation Needs Assessment
- 6 use cases developed from detailed interviews with 14 diverse stakeholders
- 2 design review workshops with stakeholders to gather input on layout, accessibility, and function
- Continued engagement throughout development

Incorporating Needs

- Allow users to set thresholds appropriate to their location and management issue
- Provide multiple types of data visualization, guidance on use

Example Use Case: Planner

“As a **Chief Resilience Officer**, I need to know how many times flooding has happened over XX timeframe and how much it is increasing, so I can show the data to city council members to justify funding.”

“As a **Coastal Planner**, I need sea level rise projections and graphics in a report format, so I can develop a climate action plan or state coastal plan and guide policy. I need to develop a sea level rise strategy. I want a spatial layer data to overlay with our own GIS data.”

“As a **Land Use Planner**, I need to define spatial areas of future flood risk to look at development of new place based policies for Sustainability planning that mitigates or minimizes flood hazards risk.”

Practical Needs

- Charts/graphs of SLR rise rates, trajectories, SLR projections, number of HTF days, changes in flood frequency
- Data tables and reporting capability (similar to SW assess tool) to “build your own” report out.
- Links to relevant references
- Top 10 flood events, how HTF has increased
- Needed freeboard amount based on 50 years out most likely scenario (ex. 2-3 FT)

Technical Needs

- Provide historical information
- User entered thresholds (existing NWS thresholds/NOS thresholds)
- Report out option (customized elements)
- Enter in time period (ex. 50 years) to extract scenarios (most likely).
- Links to references/resources
- Wants access to download spatial data to use in their own GIS maps

Audience

NOAA Coastal Inundation Planning Tools

- **Basic Users:**
  Homeowner, Congressional Staffer, Journalist
- **Intermediate Users:**
  Chief Resilience Officer, Floodplain Administrator, Land Use Planner
- **Advanced Users:**
  Engineer, Restoration Practitioner

Data

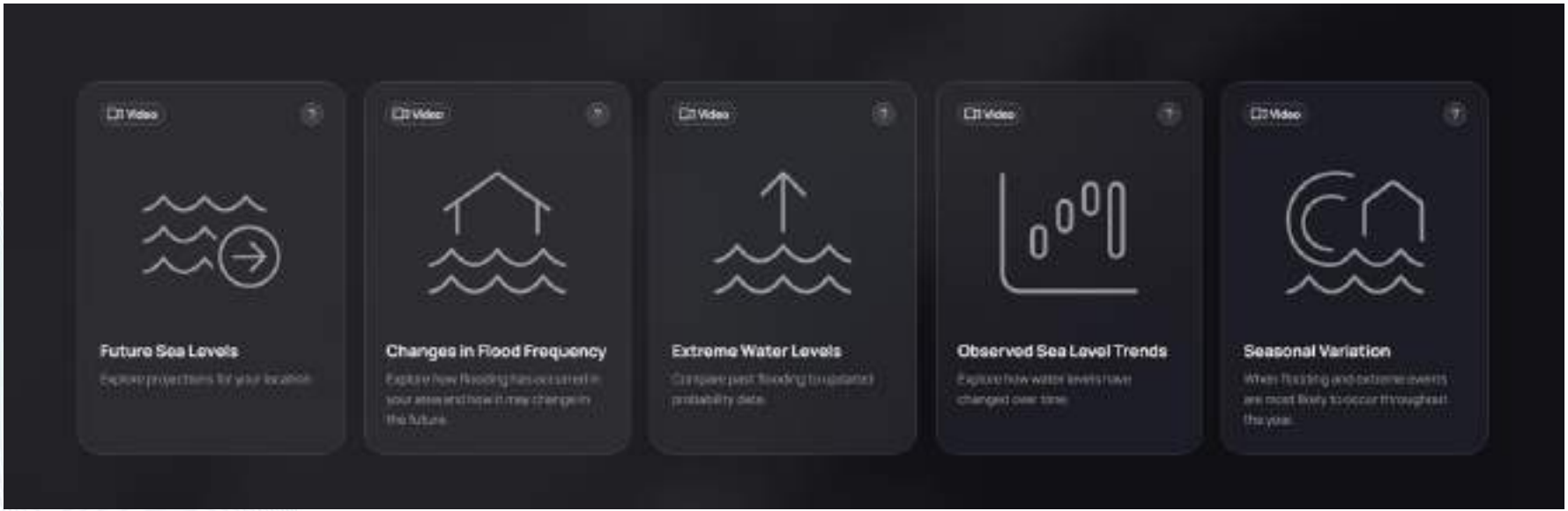
- Dashboard-like interface
- Interconnected sections/cards each dashboard
- Tool provides
  - additional historical and seasonal data
  - geospatial mapping functionality
  - the ability to set user-defined thresholds
  - Five SLR projection scenarios
  - customizable datums, units, vertical land motion

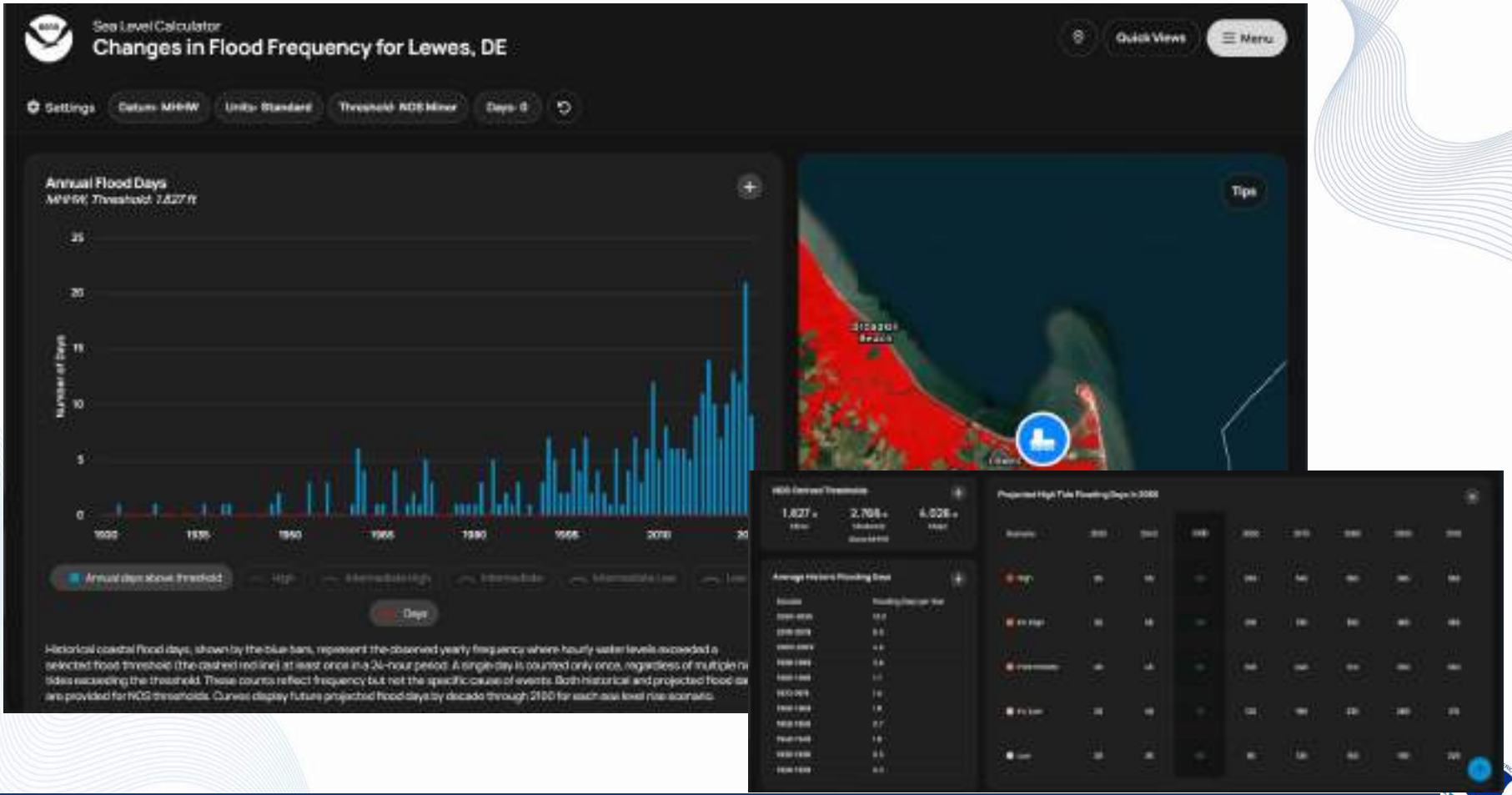
Data sources: NOAA CO-OPS, NOAA OCM, and 2022 Interagency Task Force SLR Tech Report

Future Sea Levels

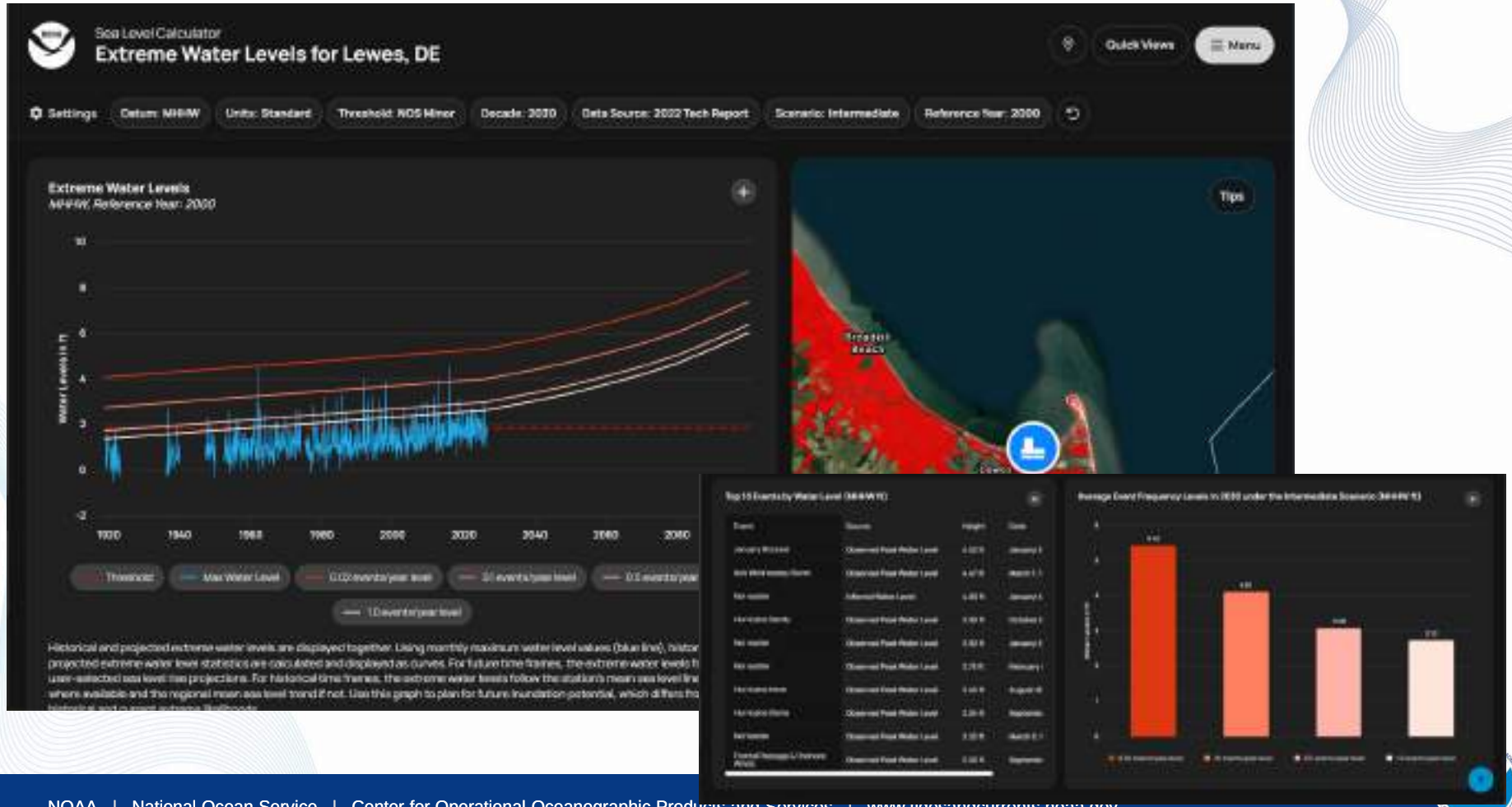
Quick Views

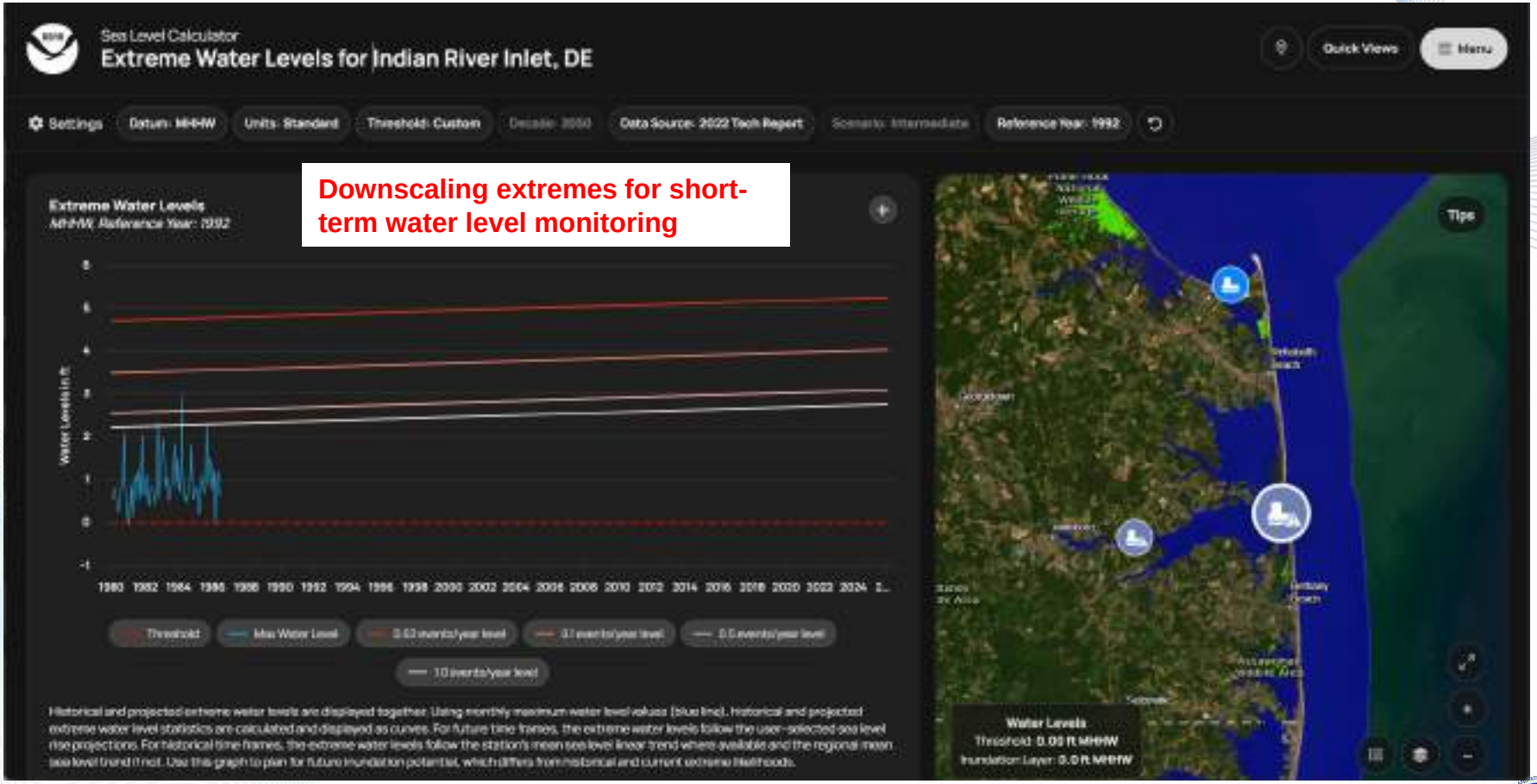
The Sea Level Calculator uses ***Quick Views*** to present curated sets of data and interactive visualizations that focus on different dimensions of coastal inundation and sea level rise.




Sea Level Calculator
Changes in Flood Frequency for Lewes, DE
Quick Views
Menu
Settings
Annual Flood Days
Tips
Annual days above threshold
Days


Sea Level Calculator
Observed Sea Level Trends for Lewes, DE
Quick Views
Menu
Settings
Datum: MSL
Units: Standard
Reference Year: 2000
Sea Level Trends
MSL, Reference Year: 2000
Water Level (ft)
2
1
0
-1
-2
1920
1940
1960
1980
2000
2020
2040
Monthly Mean Sea Level
Regional Trajectory
Annual Mean Sea Level (Regional)
Linear Relative Sea Level Trend
Tide gauge observations are displayed to show how sea levels are changing over time. The blue line represents
period of record. A linear fit to the observations is shown as a red line. Note: The linear fit may not capture more
rise and thus may underestimate the present rate. The jagged purple line shows the regional annual mean sea l
smoothed purple curve shows the Northeast Coast regional trajectory, which is based on a best fit curve of the
to 2050. The shaded areas around the linear trend and regional trajectory denotes the likely range (17th–83rd p
Tide
Station Trends
Long-Term Sea Level Change (1919 - 2025)
1.31 ft
Amount
0.15 ft/yr
Rate
Contribution of Vertical Land Motion (1919 - 2025)
0.70 ft
Amount
0.080 ft/yr
Rate
Regional Trends
Sea Level Change in Northeast Coast (1965–2025)
0.58 ft
Amount
0.22 ft/yr
Rate
Sea Level Change in Northeast Coast (2025 - 2050)
0.75 ft
Amount
0.36 ft/yr
Rate
Global Trends
Global Mean Sea Level Change (1993 - 2025)
0.34 ft
Amount
0.13 ft/yr
Rate


Sea Level Calculator
Extreme Water Levels for Lewes, DE
Quick Views
Menu
Settings
Datum: MHHW
Units: Standard
Threshold: NOS Minor
Decade: 2030
Data Source: 2022 Tech Report
Scenario: Intermediate
Reference Year: 2000
Extreme Water Levels
MHHW, Reference Year: 2000
Water Levels (in ft)
10
8
6
4
2
0
-2
1920
1940
1960
1980
2000
2020
2040
2060
2080
Threshold
Max Water Level
0.02 events/year level
0.1 events/year level
0.5 events/year level
1.0 event/year level
Historical and projected extreme water levels are displayed together. Using monthly maximum water level values (blue line), histor
projected extreme water level statistics are calculated and displayed as curves. For future time frames, the extreme water levels f
user-selected sea level rise projections. For historical time frames, the extreme water levels follow the station's mean sea level lin
where available and the regional mean sea level trend if not. Use this graph to plan for future inundation potential, which differs fro
Tips
Top 15 Events by Water Level (MHHW ft)
Average Event Frequency Levels in 2030 under the Intermediate Scenario (MHHW ft)

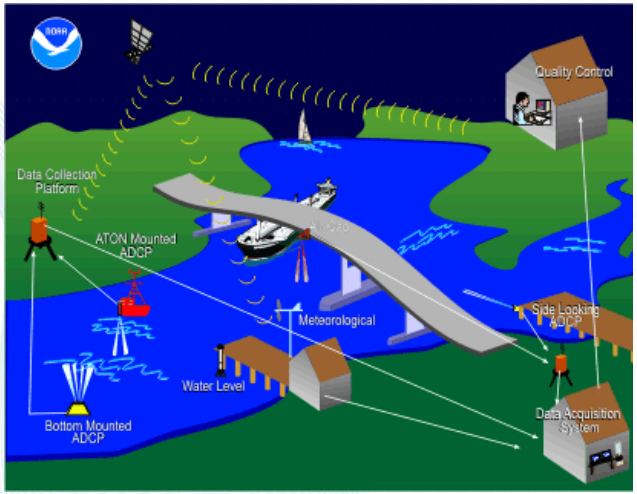


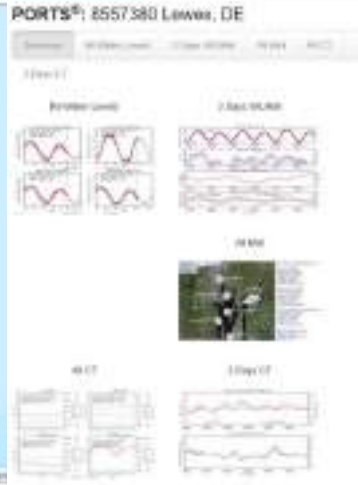
Downscaling extremes for short-term water level monitoring

CO-OPS Data Tools and Services

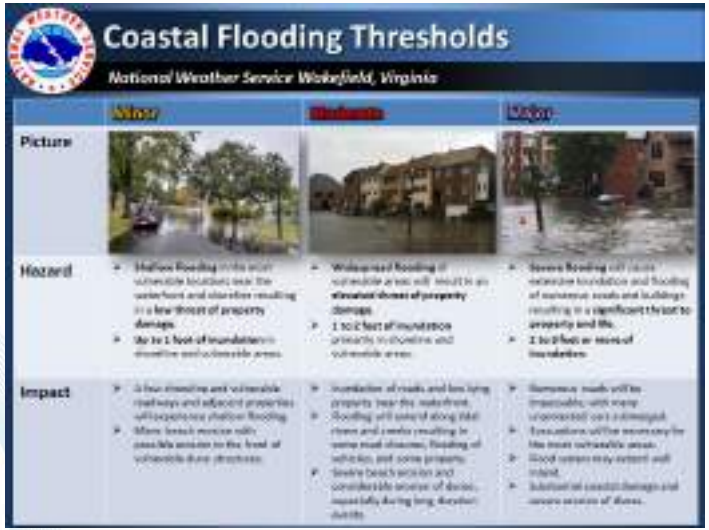
Real-time Monitoring: Delaware River and Bay PORTS

- Physical Oceanographic Real-Time System (PORTS)
- Decision support tool. Measures and disseminates observations and predictions of water levels, currents, salinity, and meteorological parameters (e.g., winds, atmospheric pressure, air and water temperatures)



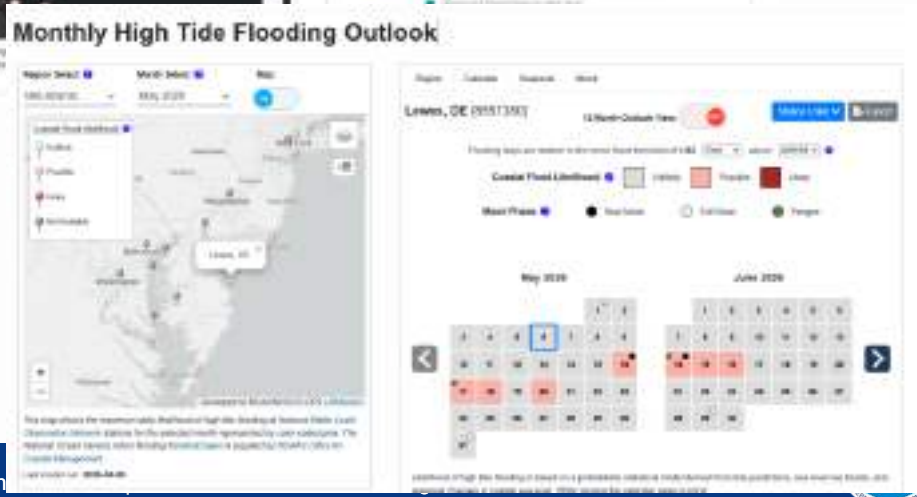


Subseasonal to Annual Outlooks: High Tide Flooding



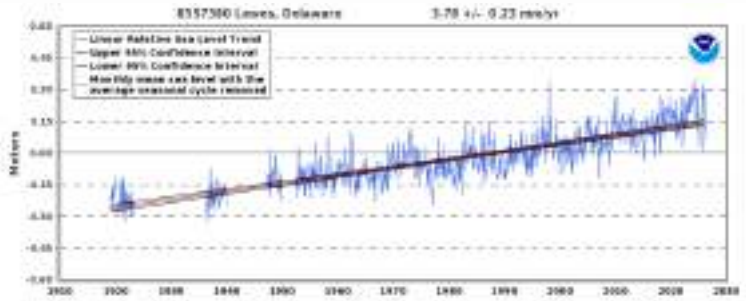
Lewes Thresholds: 1.83, 2.77, 4.03 ft above MHHW

DE Inland Bays may have different thresholds but times of flooding would be similar.



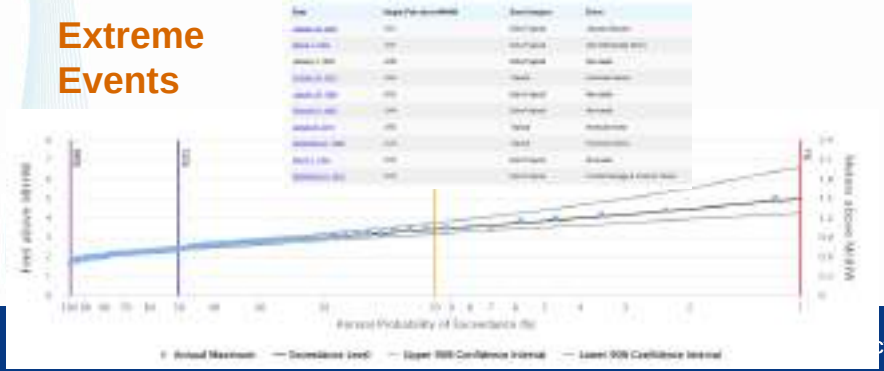
Climate Metrics from Historical Data

Mean Sea Level Trends

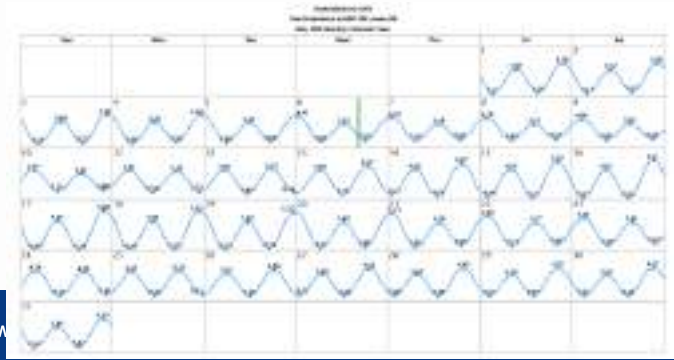


Tidal Datums

Extreme Events



Tide Predictions



Delaware Inland Bays Stations

Tidal Datums

Delaware

8551762 Delaware City, DE	8551910 Reedy Point, DE	8554399 Mahon River Entrance, DE
8555889 Brandywine Shoal Light, DE	8557380 Lewes, DE	8558690 INDIAN RIVER INLET, DE
8558814 Rosedale Beach, Indian River, DE	8559957 Little Assawoman Bay, DE	

+ 8570283 Ocean City Inlet, MD

Tide Predictions

DELAWARE, outer coast

Rehoboth Beach	8557863	+38.7200	-75.0833	Subordinate
Indian River Inlet (Coast Guard Station)	8558690	+38.6100	-75.0700	**Harmonic**
Rosedale Beach, Indian River	8558814	+38.5915	-75.2116	**Harmonic**
Little Assawoman Bay	8559957	+38.4550	-75.0583	**Harmonic**

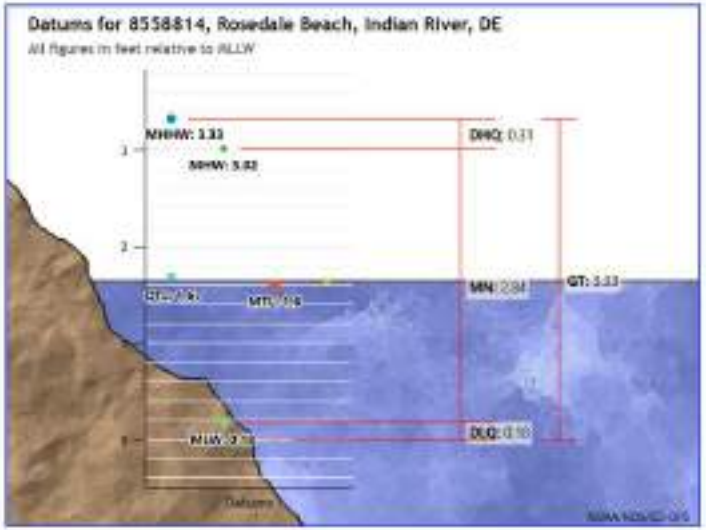
Example: Delaware Inland Bays – Rosedale Beach, DE

Tidal Datums

Elevations on Mean Lower-Low Water

Station: 8558814, Rosedale Beach, Indian River, DE
Status: Accepted (Aug 02 2021)
Units: Feet
Control Station: 8570283 Ocean City Inlet, MD
T.M.: 75
Epoch: 1983-2001
Datum: MLLW

Datum	Value	Description
MHHW	3.33	Mean Higher-High Water
MHW	3.02	Mean High Water
MTL	1.80	Mean Tide Level
MSL	1.64	Mean Sea Level
DTL	1.67	Mean Diurnal Tide Level
MLW	0.58	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAVD88		
STND	1.46	Station Datum
GT	3.33	Great Diurnal Range
MN	2.84	Mean Range of Tide
DHQ	0.31	Mean Diurnal High Water Inequality
DLQ	0.18	Mean Diurnal Low Water Inequality
HWI	3.29	Greenwich High Water Interval (in hours)
LWI	9.94	Greenwich Low Water Interval (in hours)
Max Tide	6.26	Highest Observed Tide
Max Tide Date & Time	10/30/2021 02:42	Highest Observed Tide Date & Time
Min Tide	-1.21	Lowest Observed Tide
Min Tide Date & Time	03/14/2022 09:30	Lowest Observed Tide Date & Time
HAT	3.93	Highest Astronomical Tide



Showing datums for

8558814 Rosedale Beach, In...

Datum

MLLW

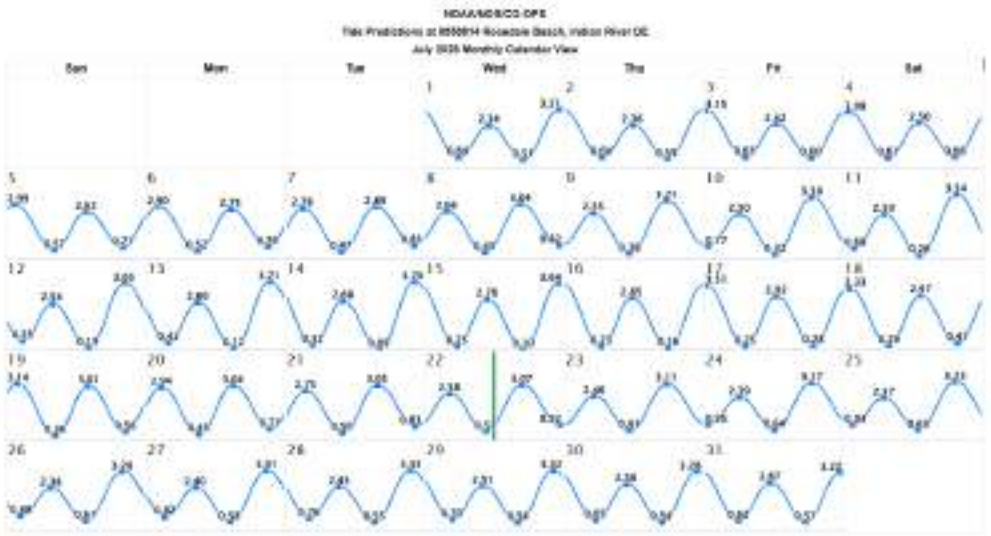
Data Units ● Feet ○ Meters

Tidal Datum Analysis Periods

05/01/2020 - 04/30/2021

Example: Delaware Inland Bays – Rosedale Beach, DE

Tide Prediction Calendar



Tide Harmonic Constituents

Constituent #	Name	Amplitude	Phase	Speed	Description
1	[illegible]	1.11	177.7	28.9841042	Principal lunar semidiurnal constituent
2	S2	0.10	180.0	30.0	Principal solar semidiurnal constituent
3	N2	0.09	160.0	28.43973	Larger lunar elliptic semidiurnal constituent
4	K1	0.20	155.7	15.041069	Lunar diurnal constituent
5	[illegible]	0.00	90.7	57.96821	Shallow water overtides of principal lunar constituent
6	[illegible]	0.01	140.0	13.943035	Lunar diurnal constituent
7	[illegible]	0.04	128.8	86.95232	Shallow water overtides of principal lunar constituent
8	MK3	0.00	205.3	44.025173	Shallow water terdiurnal
9	[illegible]	0.0	90.0	90.0	Shallow water overtides of principal solar constituent
10	[illegible]	0.00	17.5	57.423832	Shallow water quarter diurnal constituent
11	MU2	0.00	147.8	27.968208	Larger lunar evectional constituent
12	[illegible]	0.0	90.0	30.0	Shallow water overtides of principal solar constituent
13	[illegible]	0.00	128.8	27.968208	Variational constituent
14	2N2	0.00	256.4	27.895355	Lunar elliptical semidiurnal second-order constituent
15	[illegible]	0.0	125.2	15.041069	Lunar diurnal
16	LAM2	0.00	205.1	29.455625	Smaller lunar evectional constituent
17	S1	0.00	89.7	15.0	Solar diurnal constituent
18	M4	0.04	128.8	57.968208	Shallow water overtides of principal lunar constituent

Tidal Harmonic Constants Source: Vector Average of 2 years LSQHA (2021-2022). Sa and SSa from 8557380

CO-OPS Services: Application Programming Interface

Data API

- Water levels at 6-minute, hourly, High/Low, daily max/min, monthly mean
- OFS models, tides, water temps, etc…

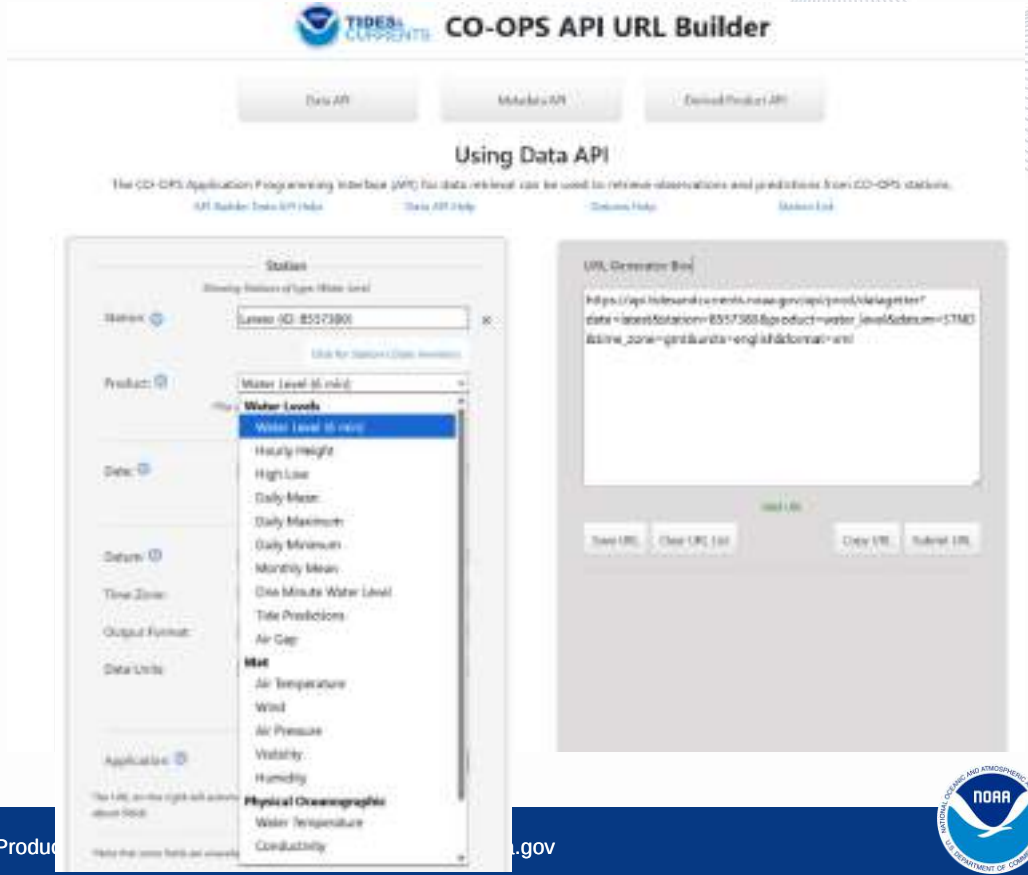
Derived Product API

- Trends, Extremes, HTF Outlooks…

Metadata API

- Station location info, metadata, etc…

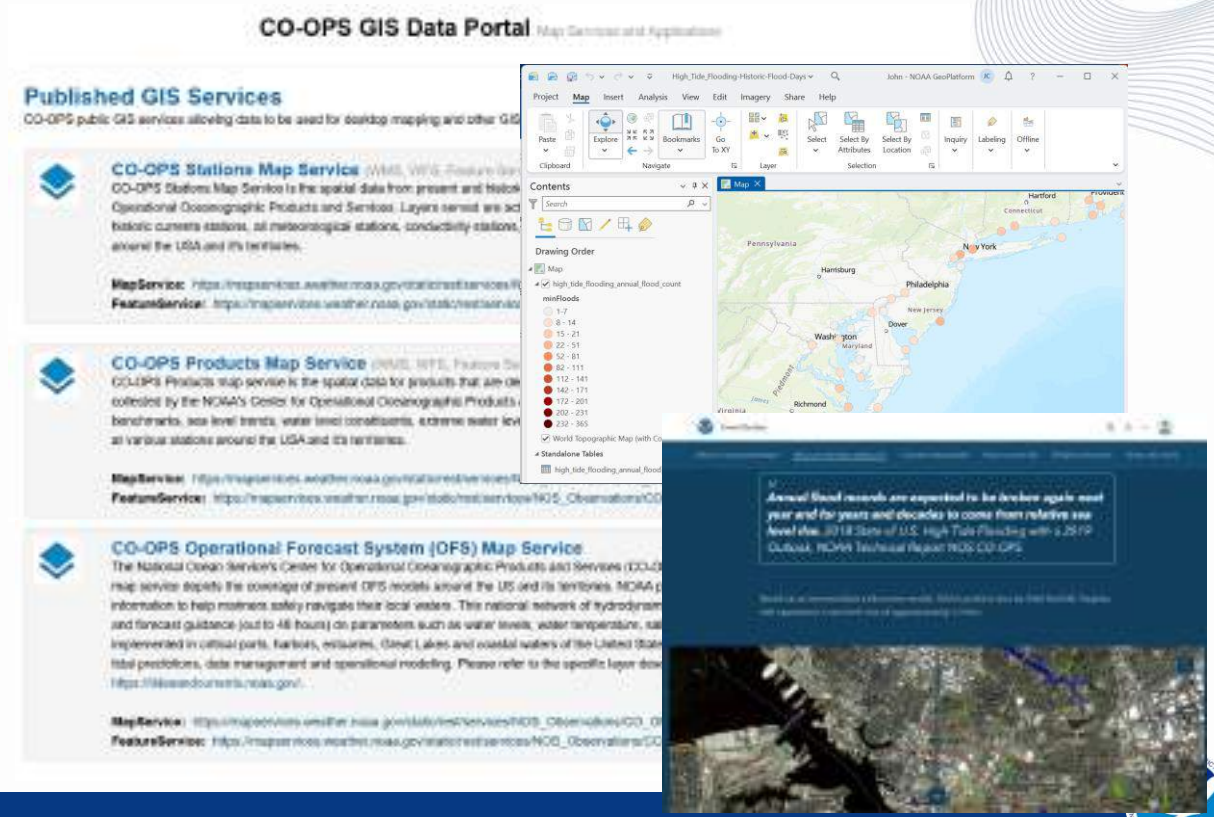
- JSON, XML, CSV formats
- CO-OPS API URL Builder



CO-OPS Services: Geospatial Mapping

CO-OPS GIS Data Portal

- Station data products map services
- OFS model and HTF Outlook map services
- ArcGIS Story Maps



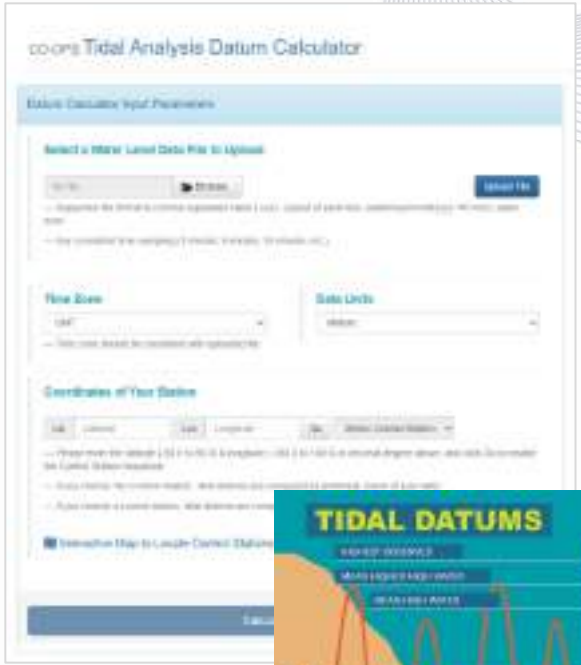
CO-OPS Tools: Datums

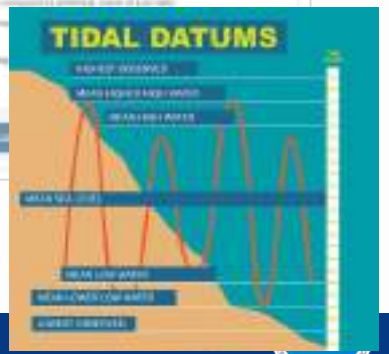
VDatum

- Conversion among geodetic and tidal vertical datums
- Web tool and API

Tidal Analysis Datum Calculator

- Compute datums using your own data.
- Web tool and python package

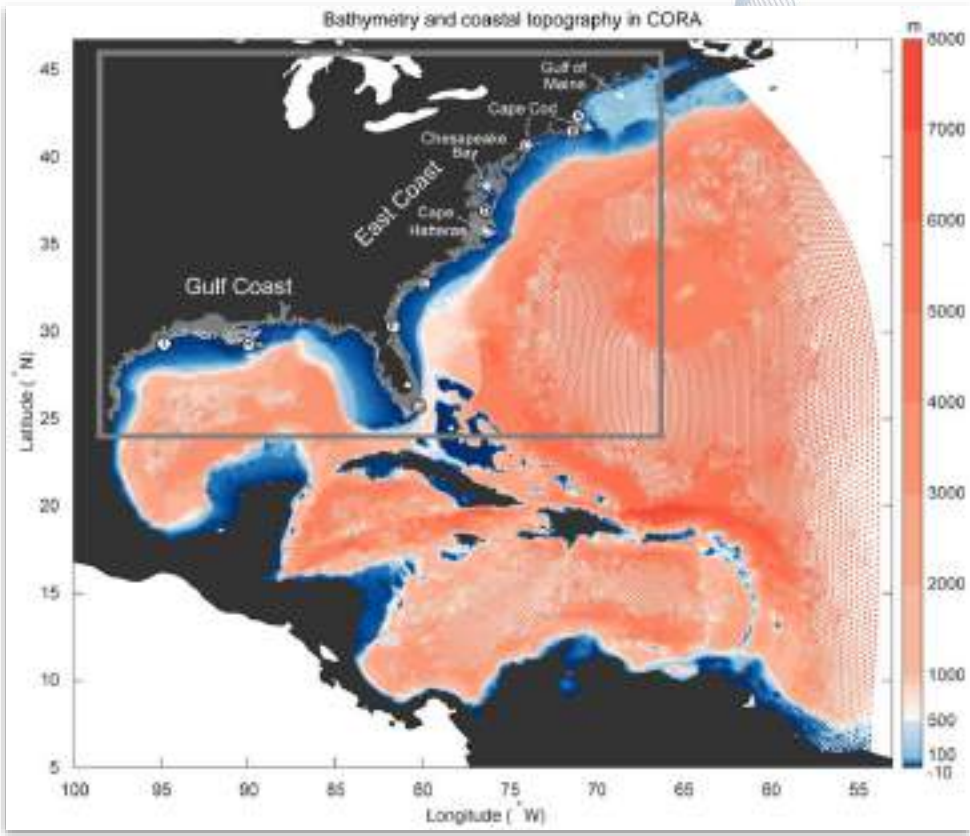




NOAA CORA
Coastal Ocean ReAnalysis

- Collaborative, community modelling effort
- Tides + ADCIRC + SWAN modeling
- Forced by ERA5 (reanalysis) meteorology
- Data assimilation from CO-OPS tide gauges

1979 – 2022 (44 years) of hourly water level and wave data every ~300-500m



https://tidesandcurrents.noaa.gov/cora.html

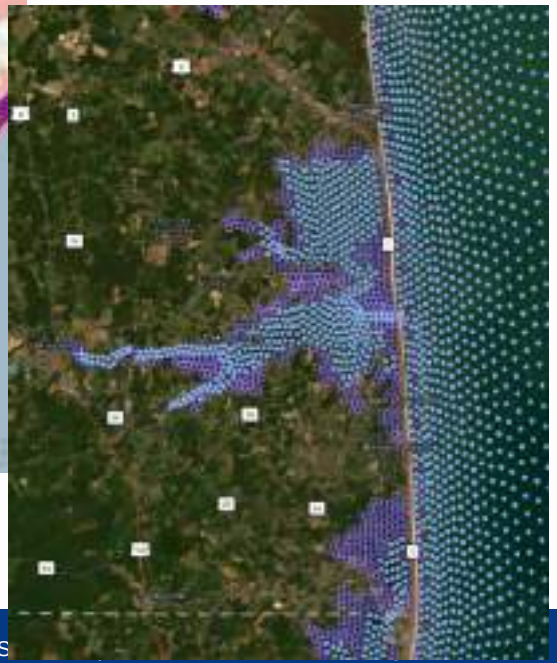
NOAA CORA

Coastal Ocean ReAnalysis

- NOAA Open Data Dissemination (NODD) platform, AWS command line interface, or Globus software interface.
- Time series and spatial subsets through python Jupiter Notebooks

CORA 500-meter grid and shoreline

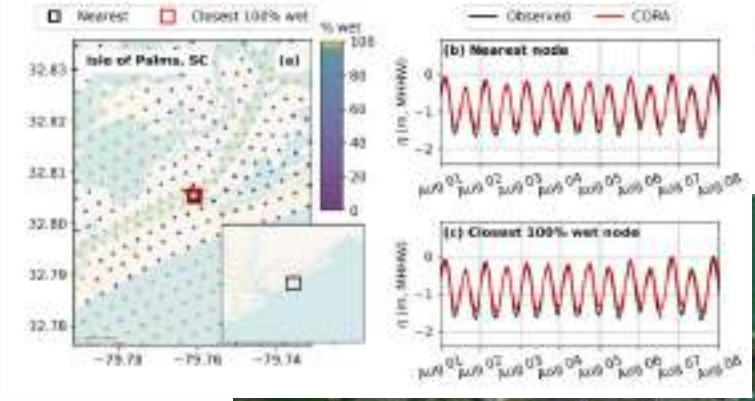
Delaware Inland Bays

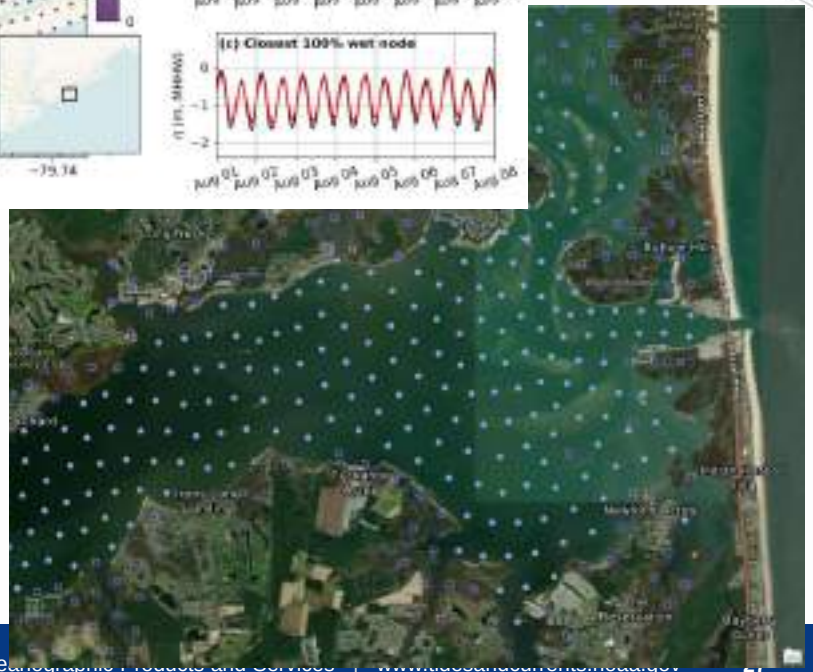


NOAA CORA + Tidal Datum Analysis Calculator

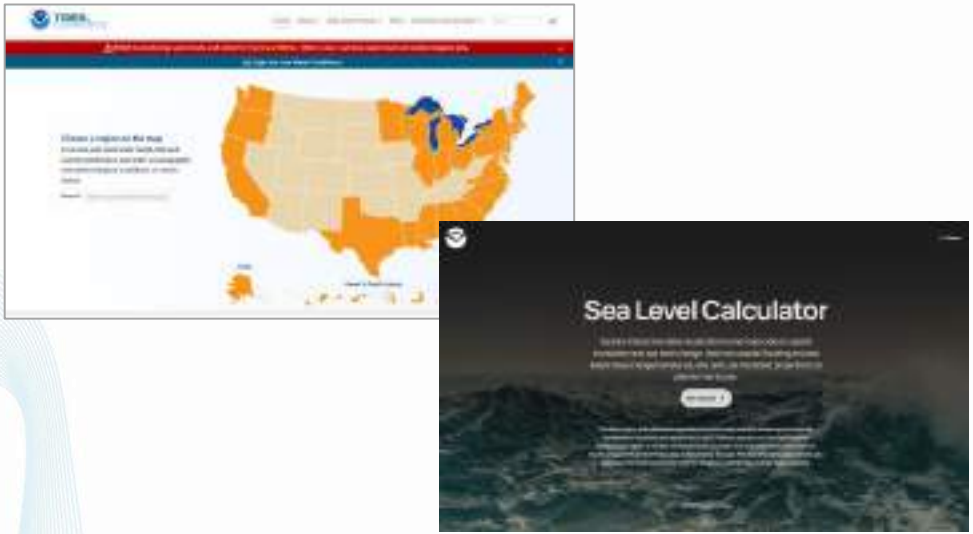
- Start with your own data time series.
- Access CORA data extraction and TADC scripts from CO-OPS Github
- Compare your data to nearest CORA node!

Example plot from upcoming paper (Conlin et al., 202x)





Thank you!



Contact CO-OPS:

john.callahan@noaa.gov
analise.keeney@noaa.gov (CORA)
tide.predictions@noaa.gov (General)

https://tidesandcurrents.noaa.gov

https://coast.noaa.gov/sealevelcalculator/

Summary of CO-OPS URLs

- NOAA Sea Level Calculator - https://coast.noaa.gov/sealevelcalculator/
- Delaware River and Bay PORTS - https://tidesandcurrents.noaa.gov/ports/index.html?port=db
- Coastal Inundation Dashboard - https://tidesandcurrents.noaa.gov/inundationdb/
- CORA Ocean Reanalysis - https://tidesandcurrents.noaa.gov/cora.html
- Coastal Forecasts - https://tidesandcurrents.noaa.gov/forecast_info.html
- Tidal Datum Calculator - https://access.co-ops.nos.noaa.gov/datumcalc/
- VDatum - https://vdatum.noaa.gov/
- Inundation Analysis Tool - https://tidesandcurrents.noaa.gov/inundationanalysis/station_list.html

- User Guides - https://tidesandcurrents.noaa.gov/news_posts/article.html?post=2517
- Web and GIS services – https://tidesandcurrents.noaa.gov/web_services_info.html
- Github Repository - https://github.com/NOAA-CO-OPS
  - CORA, TADC, OFS Skill, Coastal Hazards (HTF, Trends, Extremes)