



Center for Operational Oceanographic Products and Services
NATIONAL OCEAN SERVICE



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

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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

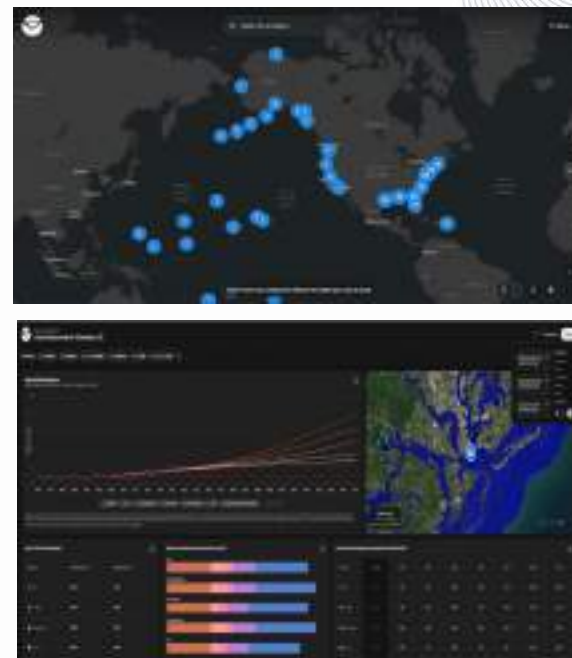
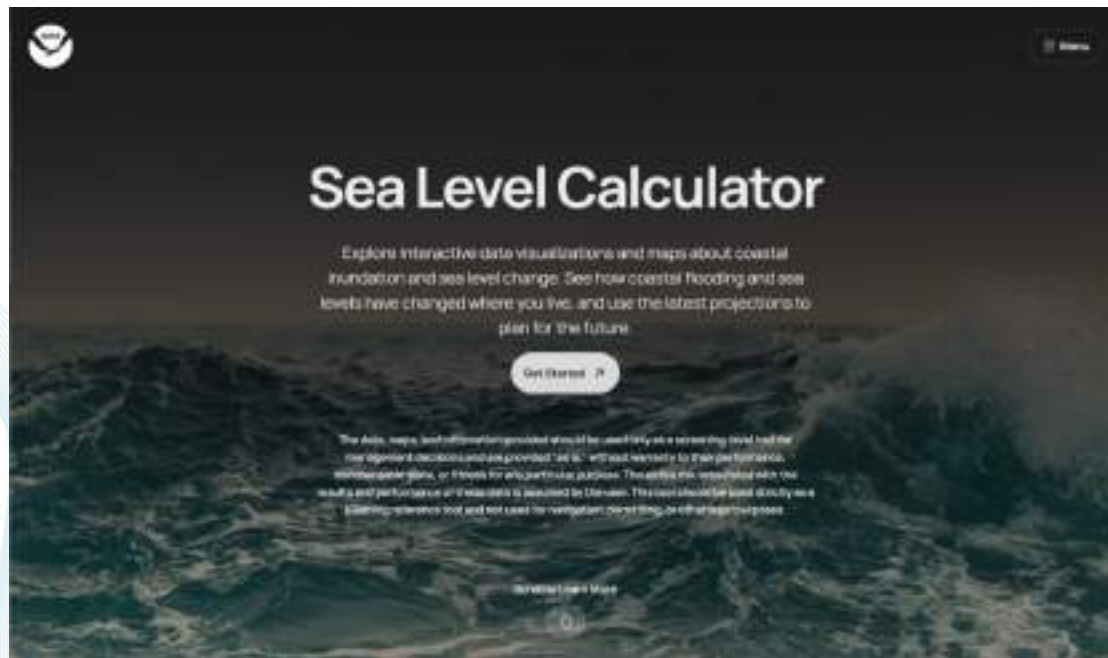
Protect Coastal Communities

- 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

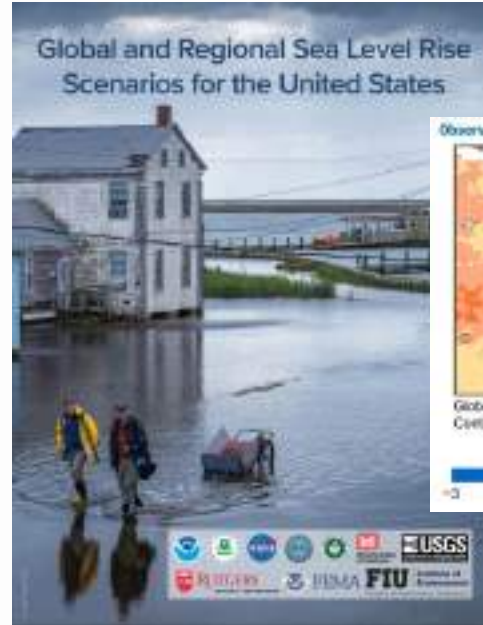


<https://coast.noaa.gov/sealevelcalculator/>

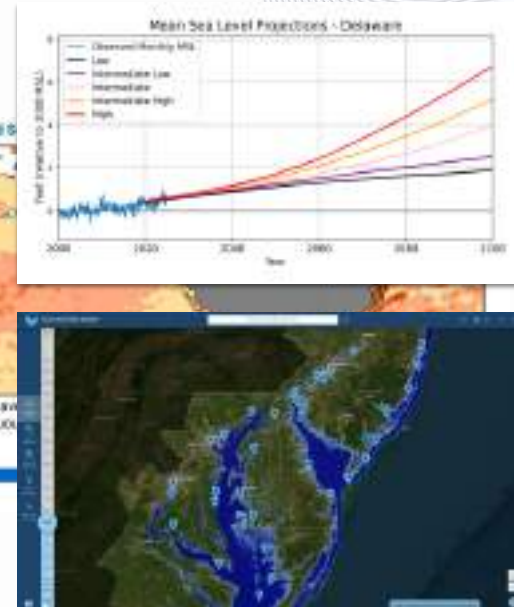
Sea Level Calculator

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

**National Sea Level Explorer
Sea Level Rise Viewer**

Sea Level Calculator

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

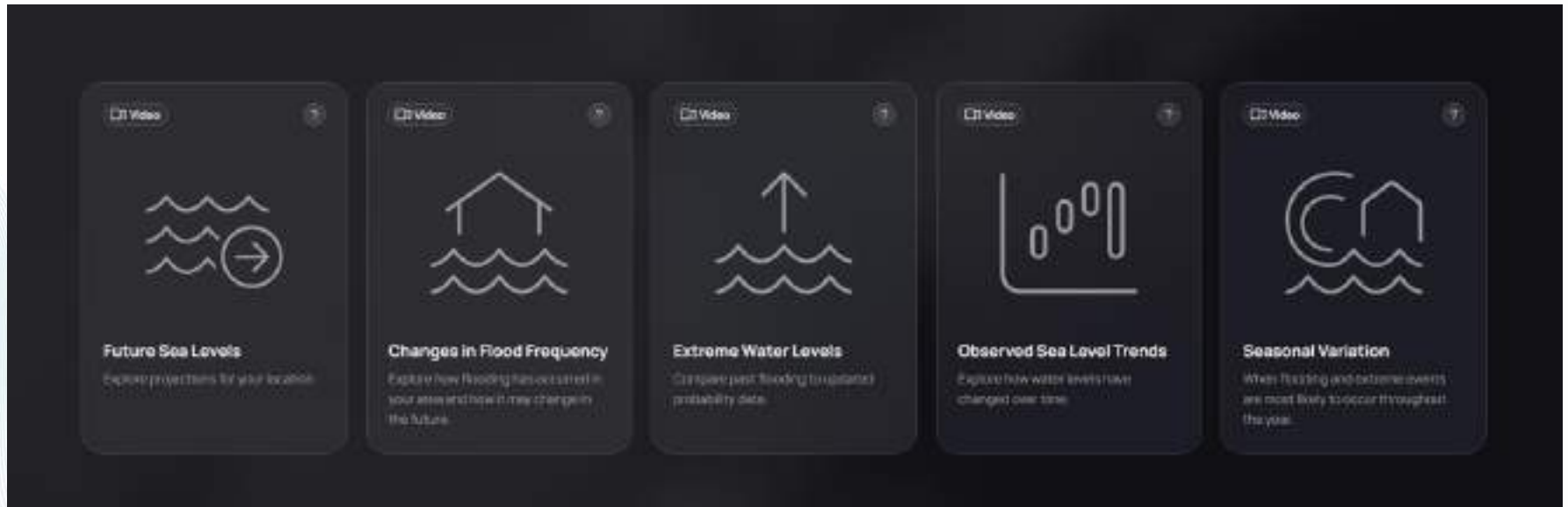
Data sources: NOAA CO-OPS, NOAA OCM, and 2022 Interagency Task Force SLR Tech Report

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

Custom MHW

Units: Standard

Threshold: RGS Minor

Days: 0



Annual Flood Days

MHW Threshold: 1.627 ft



Historical coastal flood days, shown by the blue bars, represent the observed yearly frequency where hourly water levels exceeded a selected flood threshold (the dashed red line) at least once in a 24-hour period. A single day is counted only once, regardless of multiple tides exceeding the threshold. These counts reflect frequency but not the specific cause of events. Both historical and projected flood are provided for RGS thresholds. Curves display future projected flood days by decade through 2150 for each sea level rise scenario.



RGS Current Threshold

1.627 ft
MHW
Threshold
Scenario RGS

Average Historic Flooding Days

Scenario	Flooding Days per Year
1920-1929	1.0
1930-1939	0.0
1940-1949	0.0
1950-1959	0.0
1960-1969	1.0
1970-1979	1.0
1980-1989	0.0
1990-1999	0.0
2000-2009	0.0

Projected High Tide Flooding Days by 2150

Scenario	2020	2030	2040	2050	2060	2070	2080	2090	2100
High	10	10	10	10	10	10	10	10	10
Ext High	10	10	10	10	10	10	10	10	10
Intermediate	10	10	10	10	10	10	10	10	10
Ext Low	10	10	10	10	10	10	10	10	10
Low	10	10	10	10	10	10	10	10	10





Sea Level Calculator

Observed Sea Level Trends for Lewes, DE



Quick Views

Menu



Settings

Datum: MSL

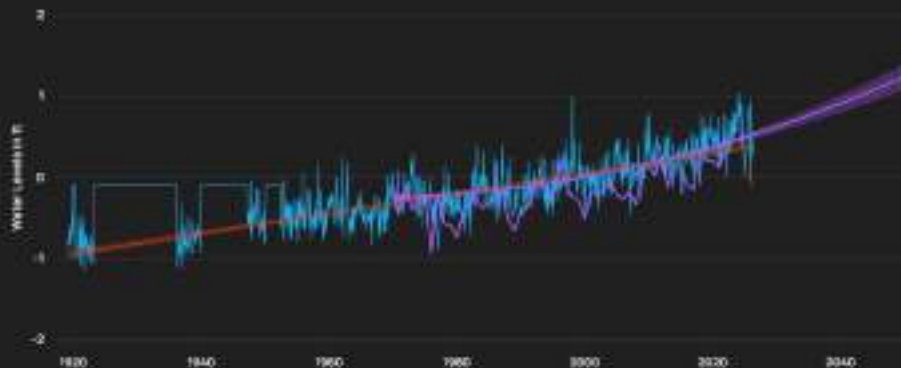
Units: Standard

Reference Year: 2020



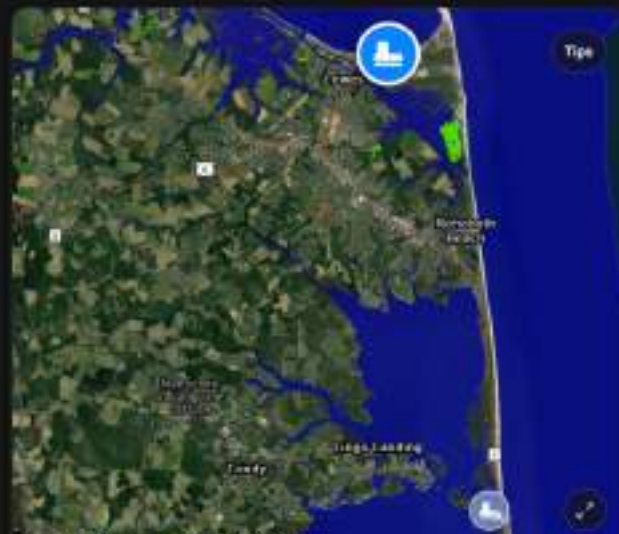
Sea Level Trends

MSL, Reference Year: 2020



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 nuance and thus may underestimate the present rate. The jagged purple line shows the regional annual mean sea level 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 [1717-8392].



Tide

Station Trends



Long-Term Sea Level Change (1829 - 2020)

+ 1.31 ft
Amount

+ 0.15 in/yr
Rate

Contribution of Springs (Land Motion) (1993 - 2008)

+ 0.70 ft
Amount

+ 0.080 in/yr
Rate

Regional Trends



Sea Level Change in Northeast Coast (1993 - 2020)

+ 0.58 ft
Amount

+ 0.22 in/yr
Rate

Sea Level Change in Northeast Coast (2026 - 2050)

+ 0.75 ft
Amount

+ 0.36 in/yr
Rate

*Values are projections

Global Trends



Global Mean Sea Level Change (1993 - 2020)

+ 0.34 ft
Amount

+ 0.13 in/yr
Rate





Sea Level Calculator

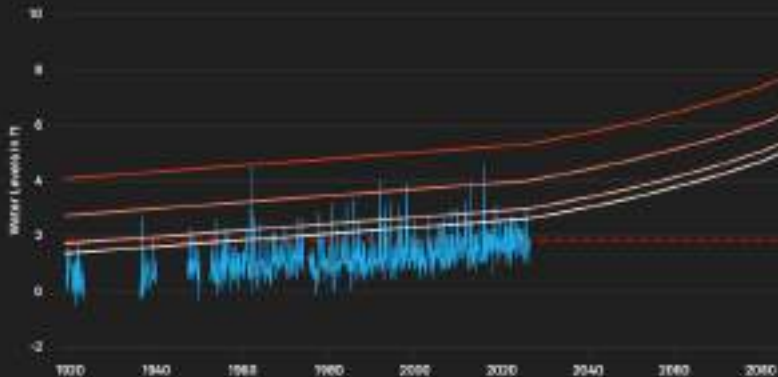
Extreme Water Levels for Lewes, DE



Quick Views

Menu

Settings Datum: MHW Units: Standard Threshold: NOS Miner Decade: 3030 Data Source: 2022 Tech Report Scenario: Intermediate Reference Year: 2030

Extreme Water Levels
MHW Reference Year: 2030

Threshold: — Max Water Level — 100 events/year level — 50 events/year level — 25 events/year level — 10 events/year level — 5 events/year level

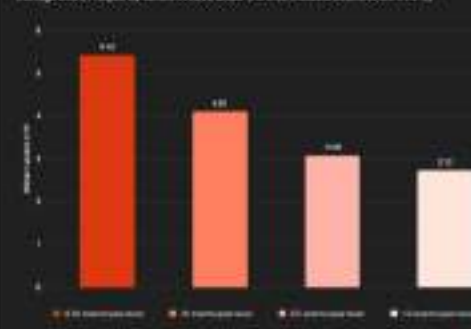
Historical and projected extreme water levels are displayed together. Using monthly maximum water level values (blue line), historical extreme water level statistics are calculated and displayed as curves. For future time frames, the extreme water levels fit user-selected sea level rise projections. For historical time frames, the extreme water levels follow the station's mean sea level line where available and the regional mean sea level trend if not. Use this graph to plan for future inundation potential, which differs from historical and current extreme flood flooding.



Top 15 Events by Water Level (MHW)

Event	Source	Height	Date
January 1930	Observed Peak Water Level	2.82 ft	January 1
July 1930	Observed Peak Water Level	2.67 ft	March 1
Feb 1930	Observed Peak Water Level	2.62 ft	January 1
March 1930	Observed Peak Water Level	2.59 ft	October 1
Feb 1930	Observed Peak Water Level	2.52 ft	January 1
Feb 1930	Observed Peak Water Level	2.50 ft	February 1
March 1930	Observed Peak Water Level	2.48 ft	August 10
March 1930	Observed Peak Water Level	2.38 ft	September
March 1930	Observed Peak Water Level	2.35 ft	March 10
March 1930	Observed Peak Water Level	2.30 ft	September

Average Event Frequency Levels in 2030 under the Intermediate Scenario (MHW)





Sea Level Calculator

Extreme Water Levels for Indian River Inlet, DE



Quick Views

Menu

Settings

Station: MRHW

Units: Standard

Threshold: Custom

Decade: 2050

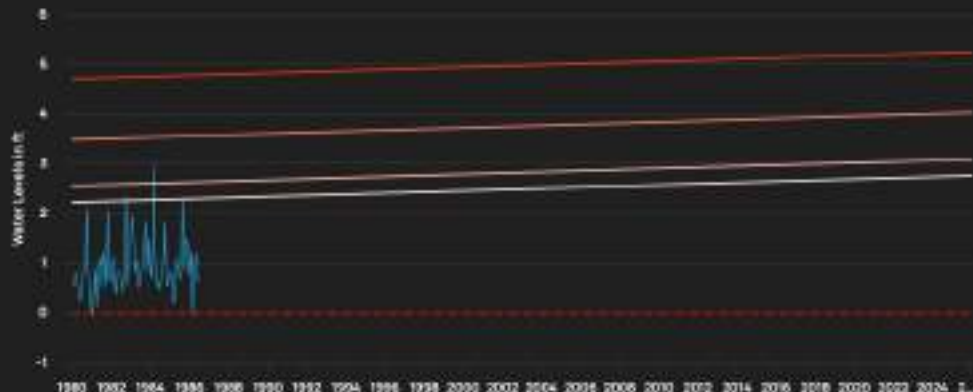
Data Source: 2022 Tech Report

Scenario: Intermediate

Reference Year: 1992



Extreme Water Levels MRHW, Reference Year: 1992



Threshold

Max Water Level

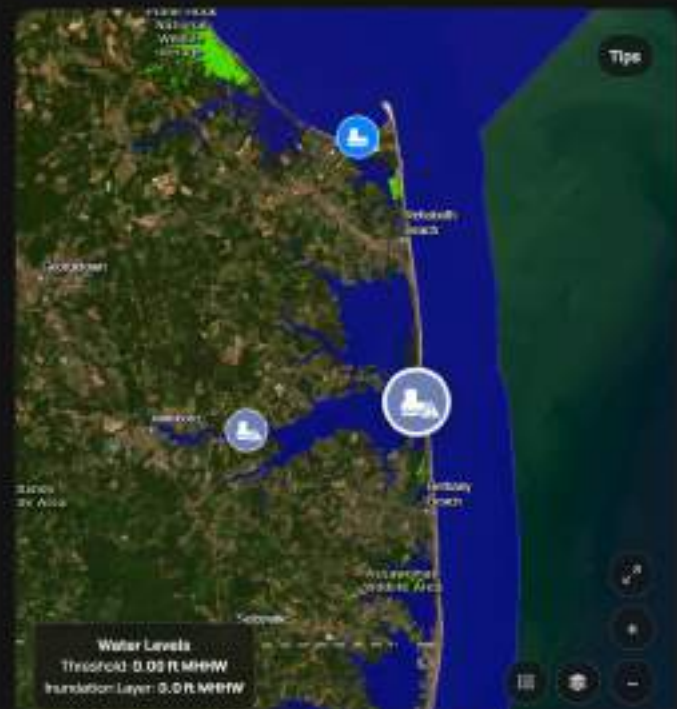
0.2 events/year level

0.5 events/year level

1.0 events/year level

10 events/year level

Historical and projected extreme water levels are displayed together. Using monthly maximum water level values (blue line), historical and projected extreme water level statistics are calculated and displayed as curves. For future time frames, the extreme water levels follow the user-selected sea level rise projections. For historical time frames, the extreme water levels follow the station's mean sea level linear trend where available and the regional mean sea level trend if not. Use this graph to plan for future inundation potential, which differs from historical and current extreme thresholds.



Water Levels

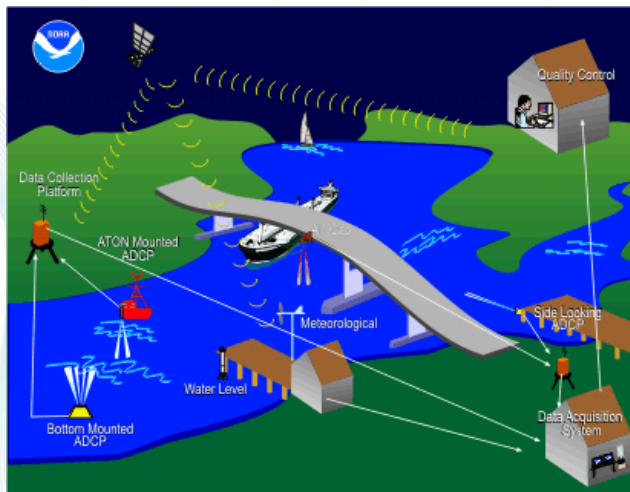
Threshold: 5.50 ft MRHW

Inundation Layer: 0.50 ft MRHW

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.

Annual High Tide Flooding Outlook

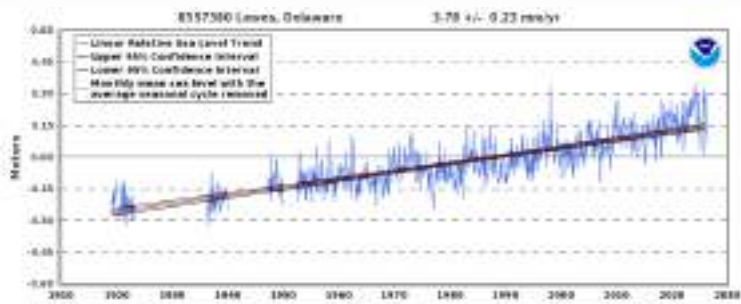


Monthly High Tide Flooding Outlook



Climate Metrics from Historical Data

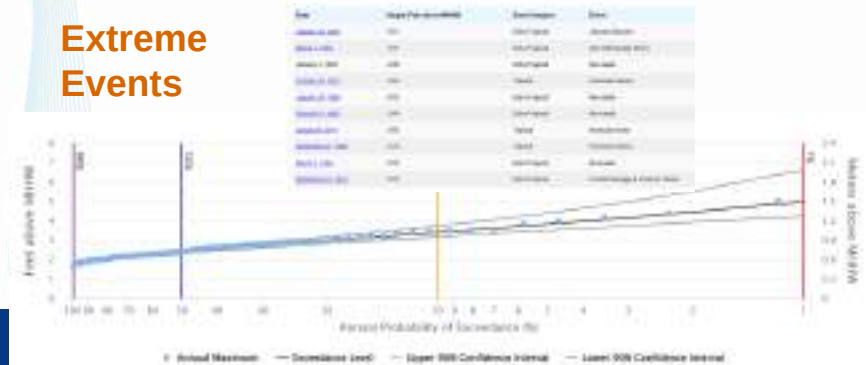
Mean Sea Level Trends



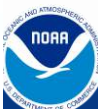
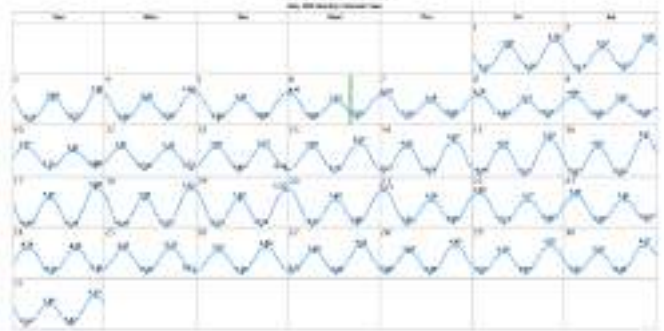
Tidal Datums



Extreme Events



Tide Predictions



Delaware Inland Bays Stations

Tidal Datums



Delaware

8551762 Delaware City, DE

8555889 Brandywine Shoal Light, DE

8558814 Rosedale Beach, Indian River, DE

8551910 Reedy Point, DE

8557380 Lewes, DE

8559957 Little Assawoman Bay, DE

8554399 Mahon River Entrance, DE

8558680 INDIAN RIVER INLET, 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

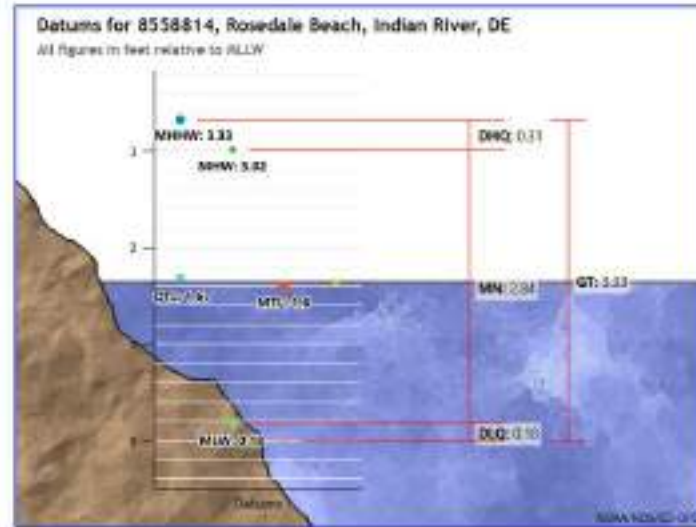
Example: Delaware Inland Bays – Rosedale Beach, DE

Tidal Datums

Elevations on Mean Lower-Low Water

Station: 8558814, Rosedale Beach, Indian River, DE
River, DE
Status: Accepted (Aug 02 2021)
Units: Feet
Control Station: 0570283 Ocean City Inlet, MD
Tide: TD
Epoch: 1983-2003
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	1.04	Mean Sea Level
DTL	1.87	Mean Diurnal Tide Level
MLW	0.18	Mean Low Water
MLLW	0.00	Mean Lower-Low Water
NAD83		
STND	1.40	Station Datum
OT	3.33	Great Diurnal Range
MR	2.84	Mean Range of Tide
DH0	0.31	Mean Diurnal High Water Inequality
DL0	0.18	Mean Diurnal Low Water Inequality
HW	3.29	Greenwich High Water Interval (in hours)
LW	9.94	Greenwich Low Water Interval (in hours)
Max Tide	6.26	Highest Observed Tide
Max Tide Date & Time	10/03/2021 09:42	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

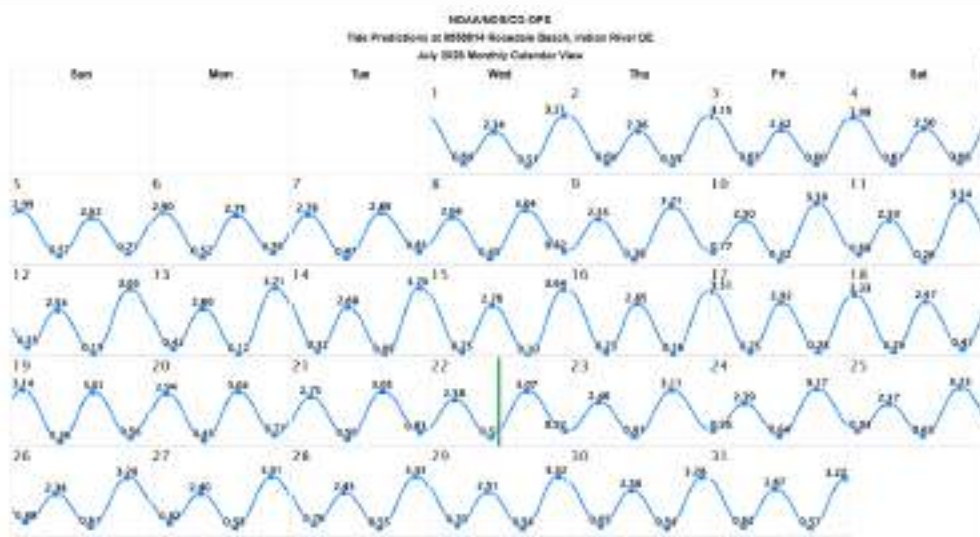
☐ Meters

Tidal Datum Analysis Periods

05/01/2020 - 04/30/2021

Example: Delaware Inland Bays – Rosedale Beach, DE

Tide Prediction Calendar



Tide Harmonic Constituents

Please refer to the [Tide and Current Dictionary](#) for definitions of terms, amplitudes and to the [Phases](#) and [Offsets](#) for local [SLR](#) and [CIR](#)

Constituent #	Name	Amplitude	Phase	Speed	Description
1	M2	1.11	379.7	20.884136	Principal lunar semidiurnal constituent
2	S2	0.19	187.8	38.0	Principal solar semidiurnal constituent
3	M4	0.18	382.0	20.43975	Larger lunar elliptic semidiurnal constituent
4	M1	0.05	115.7	35.041588	Lunar diurnal constituent
5	M8	0.00	90.7	57.98014	Shallow water override of principal lunar constituent
6	-O4	0.11	148.0	31.443030	Lunar diurnal constituent
7	M6	0.04	128.8	38.85222	Shallow water override of principal lunar constituent
8	M3	0.00	388.0	44.029175	Shallow water override
9	S4	0.00	38.0	80.0	Shallow water override of principal solar constituent
10	M14	0.00	17.8	57.413830	Shallow water override of principal lunar constituent
11	M18	0.00	141.8	28.112500	Larger lunar evanescent constituent
12	S6	0.00	307.2	80.0	Shallow water override of principal solar constituent
13	M22	0.00	138.0	27.988338	Shallow water override
14	S14	0.00	258.4	27.985355	Larger solar evanescent second-order constituent
15	-O14	0.00	125.2	36.109430	Lunar diurnal
16	L.M2	0.00	388.1	26.814828	Shallow water override of principal lunar constituent
17	S1	0.00	89.7	70.0	Solar diurnal constituent
18	S8	0.00	329.8	34.490034	Shallow water override of principal solar 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

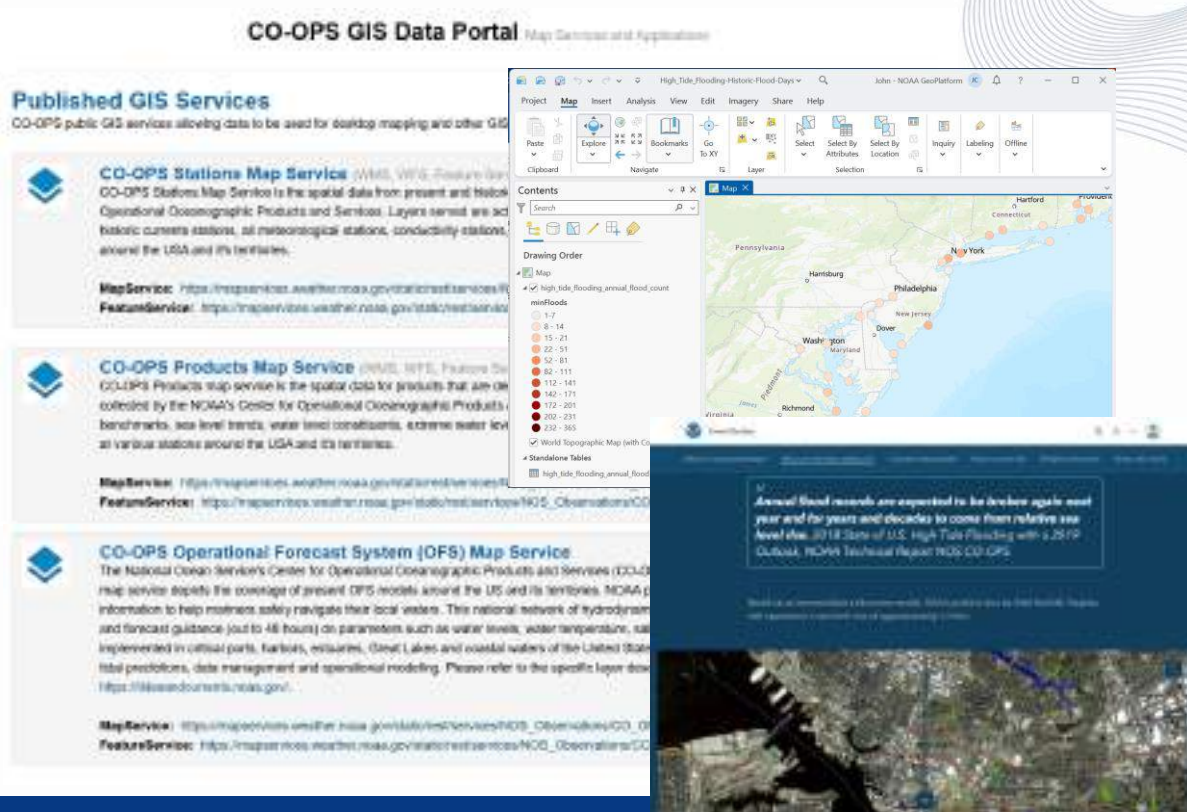
The screenshot displays the 'CO-OPS API URL Builder' web application. At the top, there are three tabs: 'Data API', 'Metadata API', and 'Derived Product API'. The 'Data API' tab is selected. Below the tabs, a heading reads 'Using Data API', followed by a descriptive sentence: 'The CO-OPS Application Programming Interface (API) for data retrieval can be used to retrieve observations and predictions from CO-OPS stations.' Navigation links for 'API Builder: Data API Index', 'Data API Help', 'Data API Help', and 'Data API' are provided.

The main interface is divided into two panels. The left panel, titled 'Station', contains a 'Station' dropdown menu with 'Lanero (ID: 8557380)' selected. Below it is a 'Product' dropdown menu with 'Water Level (6 min)' selected. A 'Date' dropdown menu is also present. The 'Default' dropdown is set to 'JSON'. The 'Time Zone' is set to 'UTC'. The 'Output Format' is set to 'JSON'. The 'Data Units' dropdown is set to 'm'. The 'Application' dropdown is set to 'Physical Oceanography'. A list of products is shown, including 'Water Level (6 min)', 'Hourly Height', 'High/Low', 'Daily Mean', 'Daily Maximum', 'Daily Minimum', 'Monthly Mean', 'Data Minute Water Level', 'Tide Predictions', 'Air Gap', 'Air Temperature', 'Wind', 'Air Pressure', 'Visibility', 'Humidity', 'Water Temperature', and 'Conductivity'. The right panel, titled 'URL Generator Box', displays the generated URL: `https://api.tidesandcurrents.noaa.gov/api/product/v2/parameter?data=latest&station=8557380&product=water_level&datum=STMS&time_zone=gmt&units=m&format=json`. Below the URL, there are buttons for 'Copy URL', 'Clear URL', 'Copy XML', and 'Submit URL'.

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

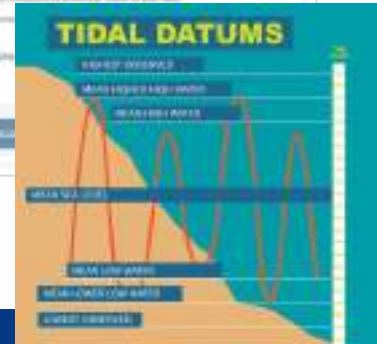
- Conversion among geodetic and tidal vertical datums
- Web tool and API

Tidal Analysis Datum Calculator

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

The screenshot shows the NOAA Online Vertical Datum Transformation web interface. It features a header with the NOAA logo and navigation links. The main content area is divided into sections for 'Geographic Information', 'Reference Frame', and 'Datum Information'. The 'Reference Frame' section includes dropdown menus for 'Reference Frame' (set to 'Geoid 1988') and 'Datum' (set to 'Geoid 1988'). The 'Datum Information' section includes a table with columns for 'Datum', 'Height', and 'Standing'. Below this, there are input fields for 'Latitude', 'Longitude', and 'Height', and a 'Calculate' button. At the bottom, there is a map of the United States with a red dot indicating the location of the datum calculation.

The screenshot shows the co-ops Tidal Analysis Datum Calculator web interface. It features a header with the title 'co-ops Tidal Analysis Datum Calculator'. The main content area is divided into sections for 'Datum Calculator Input Parameters', 'Time Zone', 'Datum Units', and 'Coordinates of Your Station'. The 'Datum Calculator Input Parameters' section includes a dropdown menu for 'Select a Water Level Data File to Upload' and a 'Calculate' button. The 'Time Zone' section includes a dropdown menu for 'Time Zone' (set to 'GMT') and a 'Calculate' button. The 'Datum Units' section includes a dropdown menu for 'Datum Units' (set to 'Feet') and a 'Calculate' button. The 'Coordinates of Your Station' section includes input fields for 'Latitude' and 'Longitude', and a 'Calculate' button. At the bottom, there is a map of the United States with a red dot indicating the location of the datum calculation.

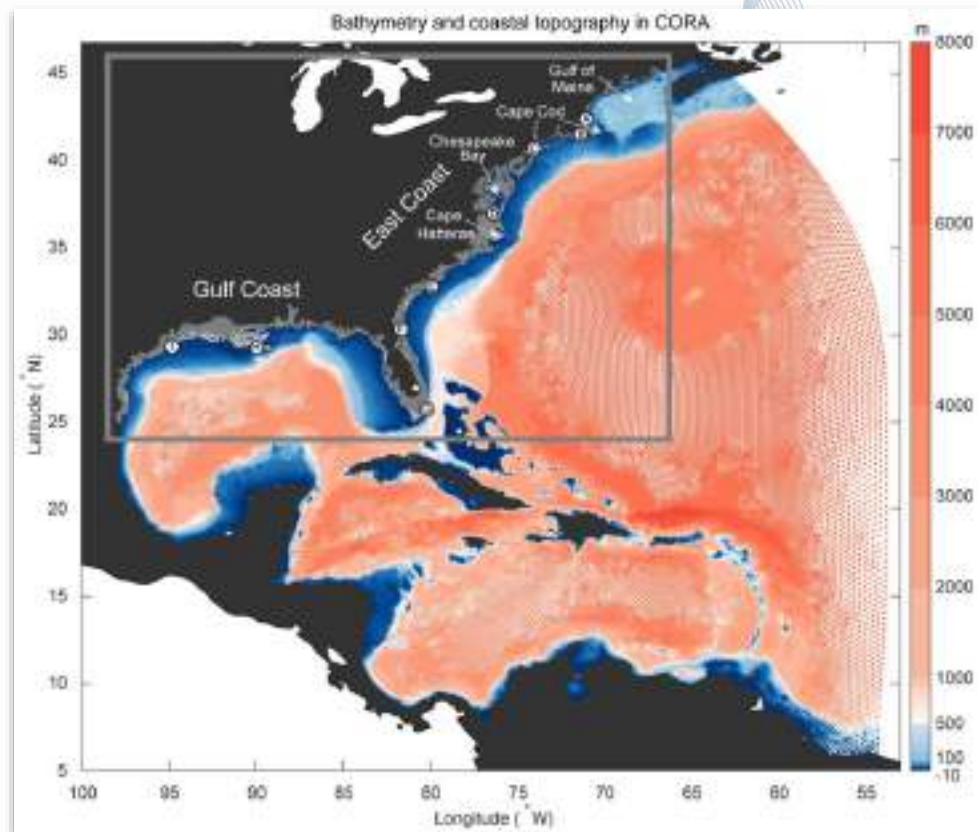


NOAA CORA

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

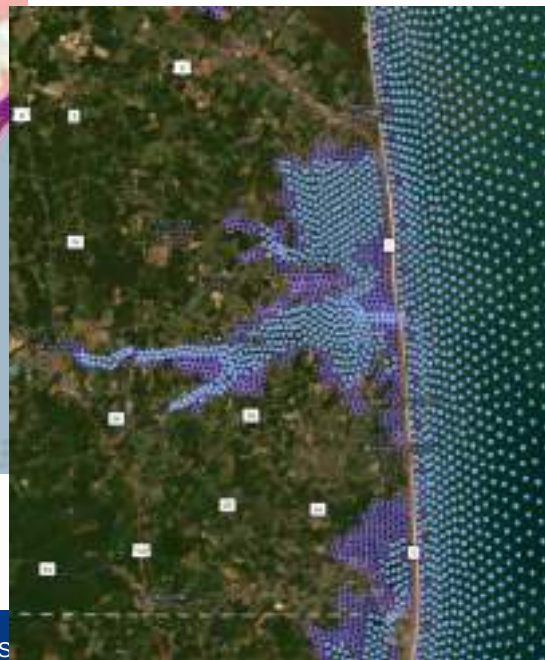
- NOAA Open Data Dissemination (NODD) platform, AWS command line interface, or Globus software interface.
- Time series and spatial subsets through python Jupiter Notebooks



CORA 500-meter grid and shoreline



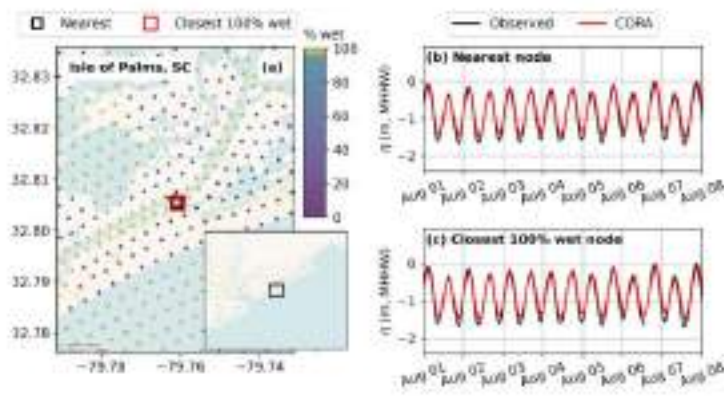
Delaware Inland Bays



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)



NOAA
TIDES & CURRENTS

<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)