Coastal Digital Elevation Models (DEMs) to Support Storm Surge and Wave Inundation Modeling
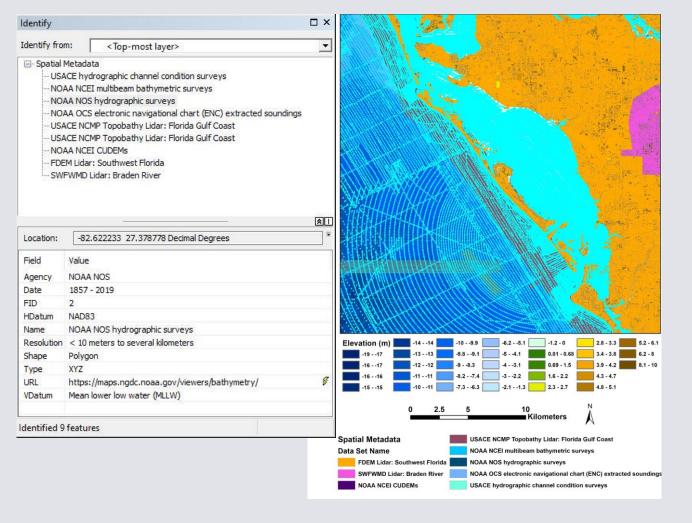
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Introduction

Coastal flooding can cause fatalities, damage to property, and economic disruption. The speed and height of ocean waves are controlled by ocean depth, and the inland extent of flooding is primarily determined by the coastal land topography. Therefore, accurate, integrated bathymetric-topographic digital elevation models (DEMs) are needed to determine the timing and extent of coastal flooding.

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI), through its partnership with the University of Colorado Boulder via the Cooperative Institute for Research in Environmental Sciences (CIRES), develops DEMs to support storm surge and wave inundation modeling for the Consumer Option for an Alternative System To Allocate Losses (COASTAL) Act and the National Tsunami Hazard Mitigation Program (NTHMP).

NCEI Coastal DEMs

A DEM is a representation of the Earth's solid surface that depicts land heights and water depths relative to established datums. NCEI DEMs seamlessly integrate bathymetry and topography in the coastal zones of the United States and in select international locations.

Elevation and depth measurements used in the development of DEMs are collected by federal, state and local governments, universities and research institutions, and private companies. The measurements are processed to ensure consistency, and used in interpolation techniques to create a seamless, gridded representation of the Earth's surface.

- Local-, regional-, and global-scale DEMs
- Telescoping DEMs with nested spatial resolutions
- Standardized products defined by common specifications (datums, coordinate systems, vertical units, etc.)

CUDEM ancillary DEM products

Spatial Metadata

Spatial Metadata is being generated to indicate locations of source measurements used in the development of DEMs and provide important information including data collection agency, year of collection, and measurement technology.
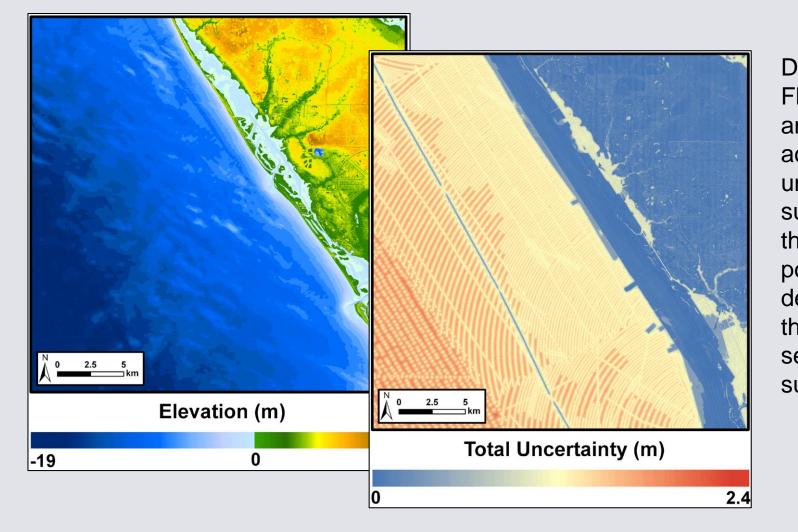
Left: Spatial Metadata for Sarasota, Florida showing source datasets overlaid on the 1/9th arc-second DEM.

Spatial Metadata available at NOAA Digital Coast:
1/9th Arc-Sec DEMs:
https://coast.noaa.gov/htdata/raster2/elevation/NCEI_ninth_Topobathy_2014_8483/ninth_spatial_meta.zip

1/3rd Arc-Sec DEMs:
https://coast.noaa.gov/htdata/raster2/elevation/NCEI_third_Topobathy_2014_8580/third_spatial_meta.zip

DEM Uncertainty

Ongoing Research: Estimating DEM Uncertainty

DEM of SW Florida (left) and accompanying uncertainty surface (right) that estimates potential DEM deviations from the actual seabed or land surface.
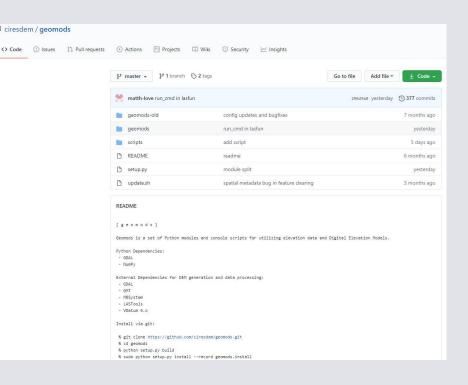
Coastal DEM development toolchain using Free Open-Source Software (FOSS)

NOAA NCEI coastal DEM development, processing and analysis utilizes a FOSS toolchain enabling an open and reproducible approach to the development of coastal DEMs.

DEM development software:
- GNU/Linux
- GMT
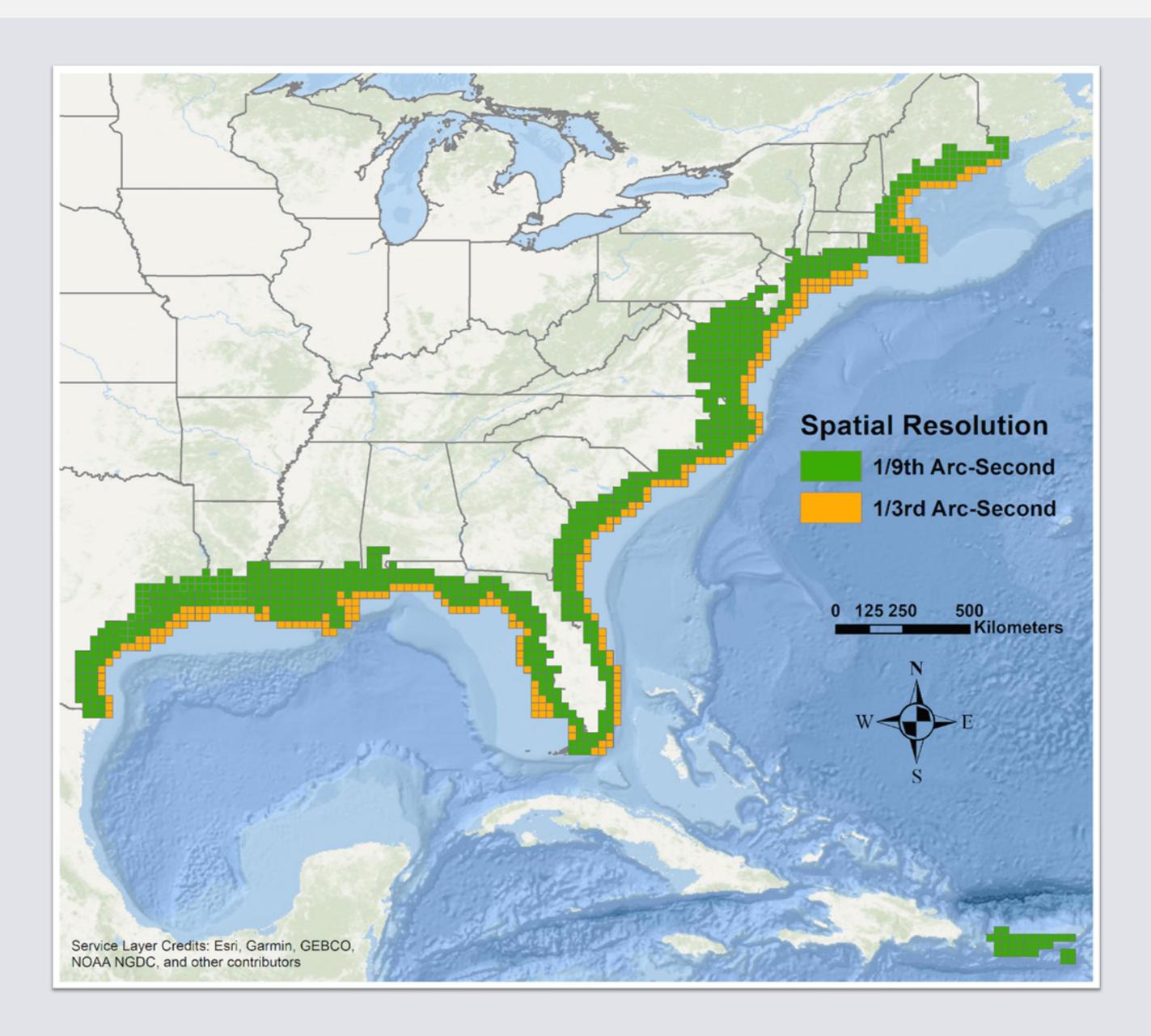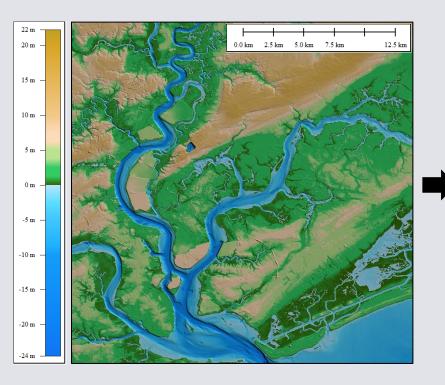- GDAL
- MB-System
- Python
- CIRES GeoMods

https://github.com/ciresdem

Spatial Resolution
- 1/9th Arc-Second
- 1/3rd Arc-Second

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors
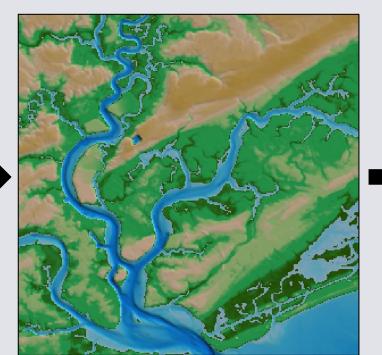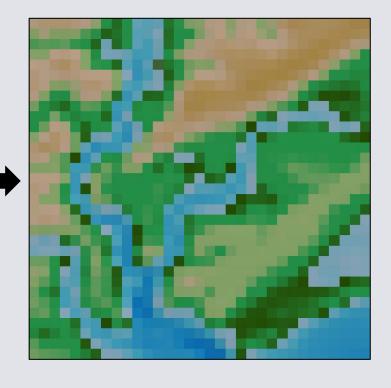
Future Work

The NCEI Coastal DEM Team is working towards a comprehensive, continuously-updated DEM (CUDEM) program with local, high resolution 1/9th and 1/3rd arc-second tiles that are incorporated into regional-scale Coastal Relief Models and into the ETOPO Global Relief Model. Regional- and global-scale products will be updated annually as new local, high resolution DEM tiles are completed.

Local, high-resolution 1/9th arc-second DEM → Regional, 3 arc-second Coastal Relief Model → Global, 27 arc-second ETOPO Model
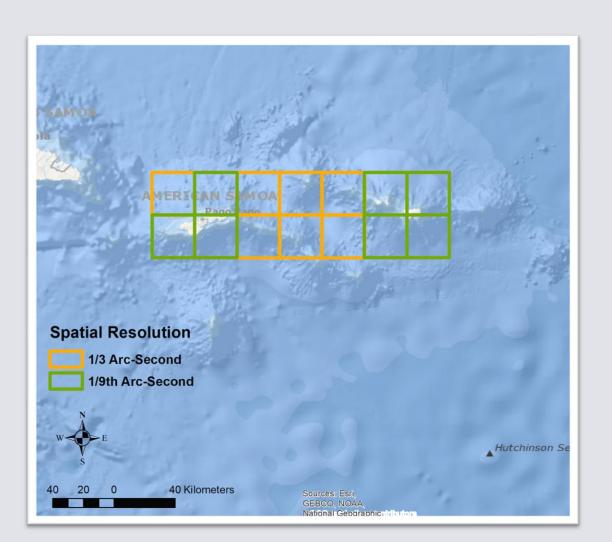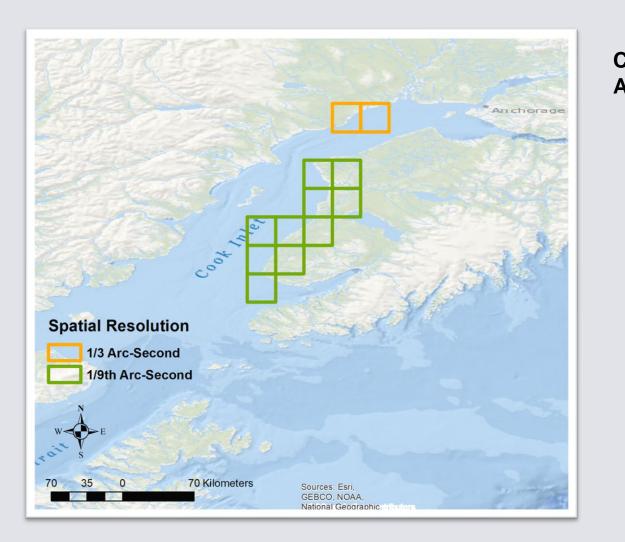
Current CUDEM coverage

Seamless DEM coverage for the Nation

NOAA NCEI is generating multi-resolution tiled coastal DEMs for the entire U.S. Atlantic and Gulf Coasts, Hawaii, Puerto Rico, U.S. Virgin Islands, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI) to support the COASTAL Act and in support of the National Tsunami Hazard Mitigation Program.

NCEI Bathymetry Viewer - Discovery and Color Shaded Relief:
https://www.ncei.noaa.gov/maps/bathymetry/?layers=DEM

NOAA OCM Data Access Viewer - Download:
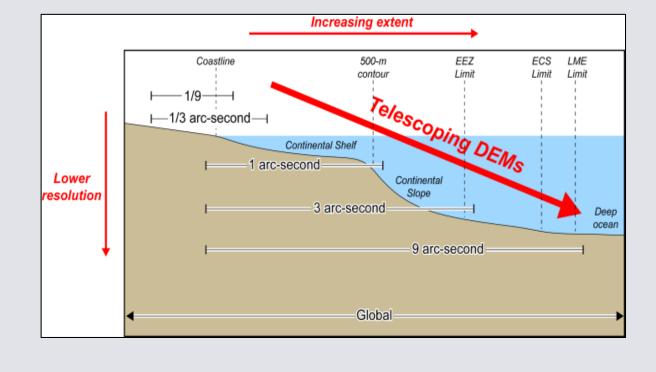https://coast.noaa.gov/digitalcoast/data/home.html

Hawaii

American Samoa

Guam

Cook Inlet, Alaska

Washington State

NOAA National Centers for Environmental Information
www.ncei.noaa.gov

CIRES Rendezvous 2022

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COASTAL DEMs