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

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Introduction

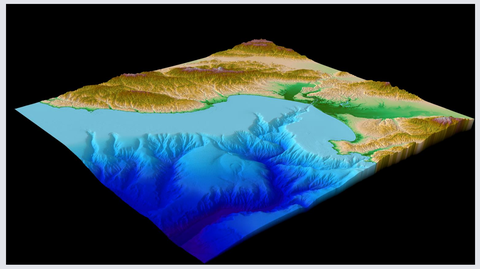
Coastal flooding can cause fatalities, damage to property, and economic disruption. The speed and height of ocean waves are controlled by ocean depth, and the inland extent of flooding is primarily determined by the coastal land topography. Therefore, accurate, integrated bathymetric-topographic digital 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 CUDEM Framework

"The CUDEM framework consists of systematic tiled geographic extents, spatial resolutions, and horizontal and vertical datums to facilitate rapid updates of targeted areas with new data collections, especially post-storm and tsunami events. The CUDEM framework also enables the rapid incorporation of high-resolution data collections ingested into local-scale DEMs into NOAA NCEI's suite of regional and global DEMs."

Amante, C.J.; Love, M.; Carignan, K.; Sutherland, M.G.; MacFerrin, M.; Lim, E. Continuously Updated Digital Elevation Models (CUDEMs) to Support Coastal Inundation Modeling. Remote Sens. 2023, 15, 1702. https://doi.org/10.3390/rs15061702

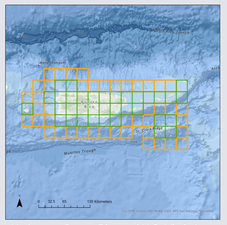


Perspective view of the Monterey, CA DEM

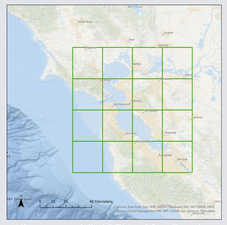
https://www.mdpi.com/2072-4292/15/6/1702

Seamless DEM coverage of the Nation

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

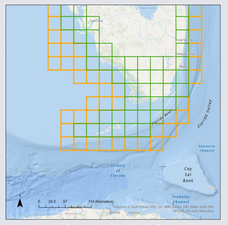


Updates to Puerto Rico and U.S. Virgin Is.

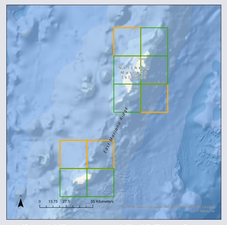


1/9 arc-second tiled DEMs of San Francisco Bay

1/3 arc-second tiled DEMs of Prince of Wales Is., AK



Updates to Southern FL tiled DEMs

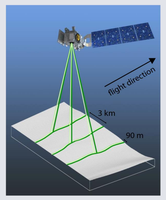


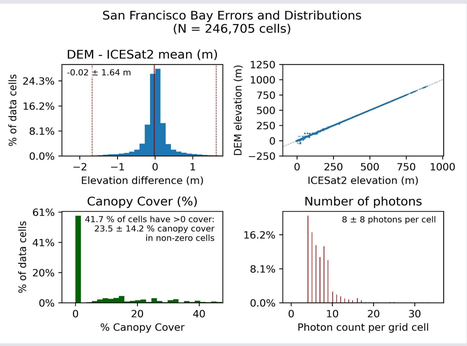
1/9 and 1/3 arc-second tiled DEMs of Commonwealth of the Northern Mariana Is.

DEM validation tool

NASA's Ice, Cloud and land Elevation 2 Satellite (ICESat-2)

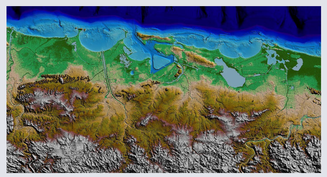
- Photon-counting, point clouds over orbital passes
- Filter photons not passing QC checks
- Filter out non-land photons

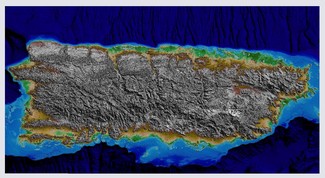




Example of the validation results for the San Francisco Bay DEM tiles.

Local > Regional > Global





ETOPO 2022!
See Mike MacFerrin's poster for more details!

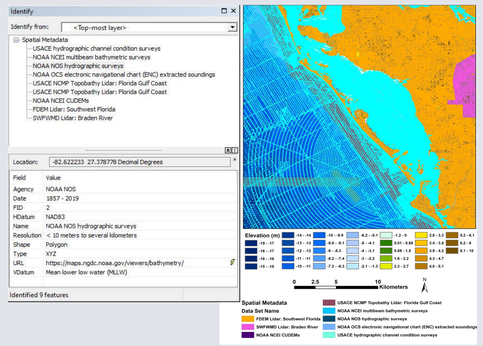
The NCEI Coastal DEM Team is working towards a comprehensive, continuously-updated DEM (CUDEM) program with local, high resolution 1/9th and 1/3rd arc-second tiles that are incorporated into regional-scale Coastal Relief Models and into the ETOPO Global Relief Model. Regional and global-scale products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

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/dataviewer/index.html#/lidar/search/

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.



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

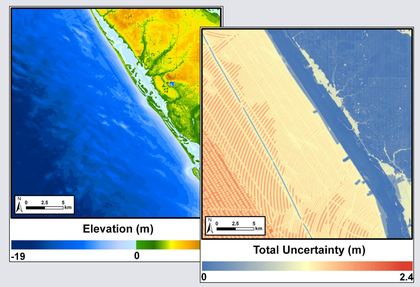
1/3rd Arc-Sec DEMs:
https://coast.noaa.gov/htdata/raster2/elevation/NCEI_third_Topobathy_2014_8580/third_spatial_meta.zip

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.

NCEI is collaborating with the USGS on estimating DEM uncertainty.



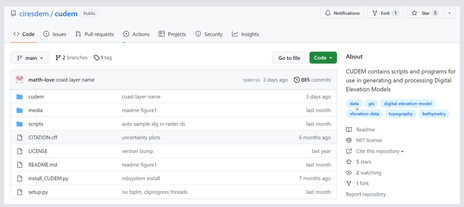
Coastal DEM development toolchain using Free Open-Source Software (FOSS)

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



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