

Digital Elevation Models of Akhiok, Karluk, and Old Harbor, Alaska: Procedures, Data Sources, and Analysis

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Carignan, K.S., Amante, C.J., Love M.R., and Sutherland M.G.

Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado, Boulder, CO
NOAA National Centers for Environmental Information, Boulder, CO

Summary

In February of 2019, NOAA’s National Centers for Environmental Information (NCEI) developed three integrated bathymetric–topographic digital elevation models (DEMs) supporting the State of Alaska’s tsunami hazard mitigation efforts. The 8/15 arc-second DEMs cover the area immediately surrounding the communities of Akhiok, Karluk, and Old Harbor on the southern half of Kodiak Island. The extents of these DEMs, procedures, data sources, and analysis are described below.

DEM Specifications

The Akhiok, Karluk, and Old Harbor DEMs were built to the specifications listed in Table 1. Figure 1 shows the 8/15 arc-second DEM boundaries.

Table 1. Specifications for the DEM.

<i>Grid Area</i>	<i>Akhiok</i>	<i>Karluk</i>	<i>Old Harbor</i>
Coverage Area	154.08° to 154.28° W, 56.88° to 56.99° N	154.36° to 154.56° W, 57.54° to 57.62° N	153.14° to 153.34° W, 57.16° to 57.27° N
Coordinate System	Geographic decimal degrees	Geographic decimal degrees	Geographic decimal degrees
Horizontal Datum	World Geodetic System 1984 (WGS 84)	World Geodetic System 1984 (WGS 84)	World Geodetic System 1984 (WGS 84)
Vertical Datum	Mean Higher High Water (MHHW)	Mean Higher High Water (MHHW)	Mean Higher High Water (MHHW)
Vertical Units	Meters	Meters	Meters
Cell Size	8/15 arc-second or ~15 m	8/15 arc-second or ~15 m	8/15 arc-second or ~15 m

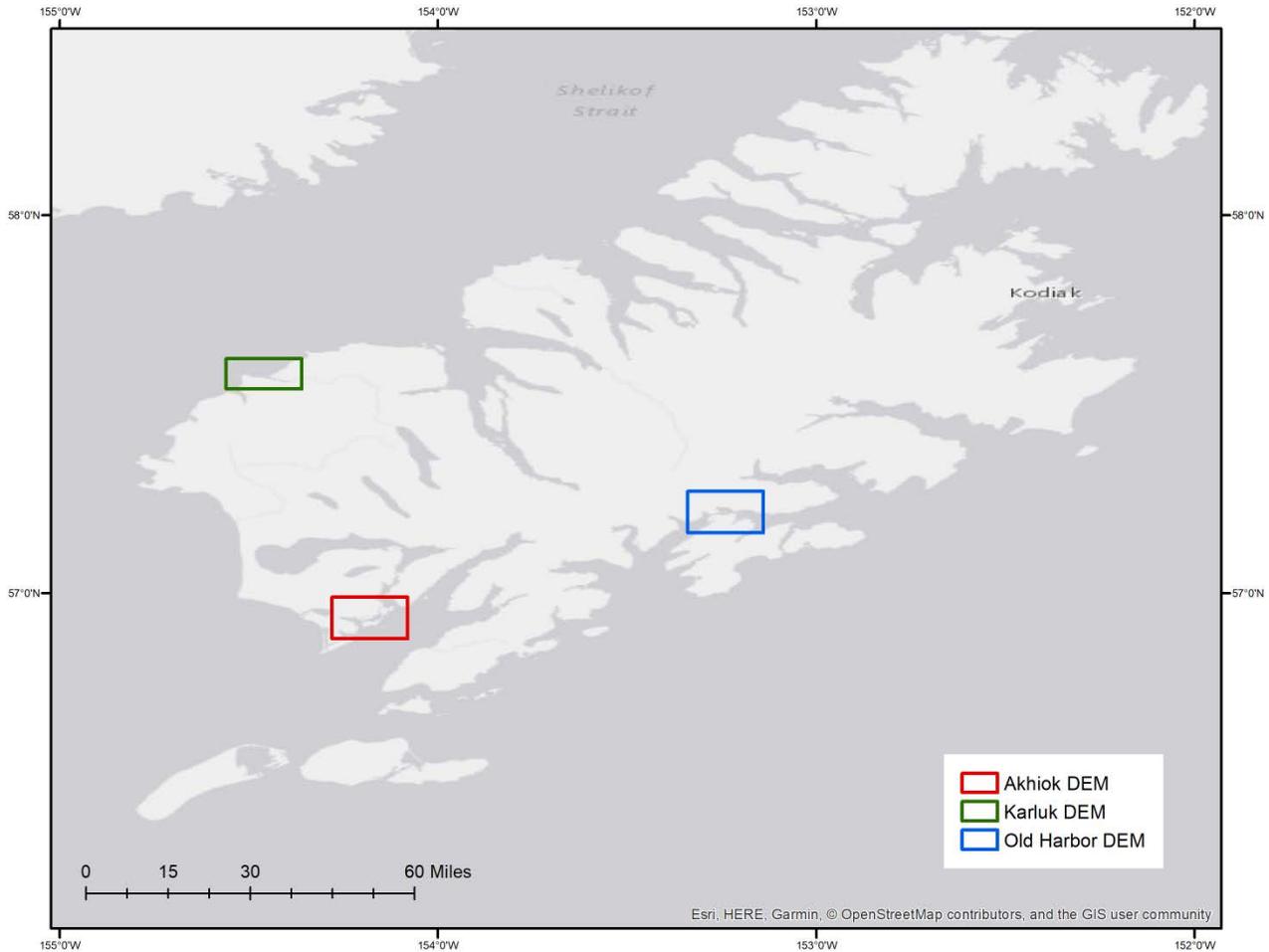


Figure 1. Map image of the 8/15 arc-second DEM boundaries on Kodiak Island, Alaska.

Data Sources and Processing

NOAA electronic nautical chart (ENC) digital coastlines for the three Kodiak Island communities were extracted via ENC Direct to GIS application and edited based on high resolution imagery and topographic contour data from the DCRA. The coastlines were used as source data and to generate data masks for both bathymetric and topographic data.

Bathymetry data used in the compilation of the Akhiok, Karluk, and Old Harbor DEMs included NOS hydrographic surveys, NOAA Electronic Navigational Chart (ENC) soundings, and USACE project survey multibeam data (Tables 2-3).

Table 2: Bathymetric data sources used in DEM development.

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
NOAA NOS	1929 to 1933	Hydrographic survey soundings	1:10,000 to 1:100,000	unknown	undetermined
NOAA OCS	2002 to 2014	Extracted chart soundings	50 to several hundred meters	WGS 84 geographic	MLLW

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
USACE	2014	Harbor condition surveys	Map soundings binned at 15 feet and shoal biased, volume soundings binned at 3 feet and mean value	NAD 83 Alaska State Plane 10 (feet)	MLLW

Table 3: NOS hydrographic surveys used in DEM development.

<i>Survey ID</i>	<i>Date</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>	<i>Scale</i>
H04970	1929	undetermined	undetermined	10000
H04971	1929	undetermined	undetermined	20000
H04972	1929	undetermined	undetermined	20000
H04947	1929	undetermined	undetermined	20000
H04954	1929	undetermined	undetermined	20000
H04969	1929	undetermined	undetermined	100000
H04854	1928	undetermined	undetermined	20000
H05151	1931	undetermined	undetermined	20000
H05226	1933	undetermined	undetermined	20000

Bathymetric data were transformed to WGS 84 and MHHW as needed and where more recent, higher resolution data existed, older data were edited. Vertical datum transformations were based on the NOAA tide stations (Table 4). As no survey data were available for Karluk Lagoon aside from the GPS points provided by UAF, NCEI assigned estimated depths to points further up the river channel based on NOAA Technical Memorandum NMFS-F/SPO-125 (Gard et. al., 2014).

Table 4: Relationship between vertical datums in meters for the DEM regions.

<i>Vertical Datum</i>	<i>Old Harbor #9457527</i>	<i>Alitak, Lazy Bay #9457804</i>	<i>Takli Island #9456992</i>	<i>Larson Bay # 9457724</i>	<i>Paule Bay # 9458209</i>	<i>Uyak #9457728</i>
MHHW	2.534	3.578	4.142	4.189	3.628	2.855
MHW	2.340	3.333	3.855	3.907	-	-
MTL	1.355	1.906	2.187	2.199	-	-
MSL	1.348	1.884	-	2.176	-	-
MLW	0.369	0.480	0.519	0.492	-	-
NAVD88	-	-	-	-	-	-
MLLW	0.000	0.000	0.000	0.000	-0.233	-1.451

Table 5 lists the topographic data used in developing the DEM were used in the Akhiok, Karluk, and Old Harbor DEMs. The ArcticDEM mosaic tiles were downloaded and provided full coverage of the both regions. Closer to the communities of Akhiok, Karluk, and Old Harbor, GPS points collected by UAF and topographic point data from DCRA were used. Lidar data provided by the Kodiak Island Borough for Akhiok was classified using LAsTools 'lasground'. The resulting 'las' files were converted to 'xyz' and MHHW with the constant value of

3.41384 m (Table 6). Converting the ArcticDEM data to MHHW was completed using the average difference between UAF GPS points and the DEM for each community.

Table 5: Topographic data sources used in DEM development.

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
DCRA	2008	Vector contours and SPOT elevation points	10 foot contour interval	NAD 83 State Plane Alaska 1 FIPS 5001 feet	MLLW
UAF	-	GPS elevation points	varies	WGS 84 geographic	MHHW
Kodiak Island Borough	2014/2015	Unclassified Lidar points - Akhiok	2 m	NAD 83 Alaska State Plane Zone 5 US feet	NAVD 88

Table 6: Comparison of UAF GPS to DCRA topography in meters for the DEM communities.

<i>NAVD88 (Geoid 06) to MHHW (m)</i>	<i>Akhiok</i>	<i>Karluk</i>	<i>Old Harbor</i>
	3.47	3.9182	2.8268
	3.2036	3.8	3.0584
	3.3036	3.5018	2.5764
	3.4652	3.7658	2.39
	3.2776	3.8856	3.246825
	3.238	4.0085	2.556
	4.0028	3.517	2.8576
	3.7076	3.72781	2.568
	3.16	3.7234	2.586208
	3.31	3.5016	2.761265
Average	3.41384	3.734971	2.7427498
Standard Deviation	0.249000575	0.171110063	0.248263502

DEM Development

The DEMs were developed in two stages. GMT ‘surface’ command was used to generate a bathymetric pre-surface at the same resolution as the final DEM from the processed bathymetry data along with a coastline data file consisting of data points at 2 meter intervals set to zero elevation. The pre-surface bathy grid was smoothed using a Gaussian Blur python script before converting to an xyz data point file in the final DEM. The pre-surface data file, bathymetry data, and topographic data were gridded using MB-System ‘mbgrid’ with data gridding weight set to values in Table 7. ENC soundings and NOS hydrographic survey data were not used in final gridding process for Akhiok, but were used in creating the bathymetric surface for all three DEMs.

Table 7: Data hierarchy used to assign gridding weight in MB-System.

<i>Dataset</i>	<i>Relative Gridding Weight</i>
USACE hydrographic condition survey (Old Harbor only)	1000
Lidar (Akhiok only)	100
DCRA topographic contours	100
UAF GPS points	100
Coastline	1

<i>Dataset</i>	<i>Relative Gridding Weight</i>
NOS surveys (Karluk and Old Harbor only)	1
Extracted ENC soundings (Karluk and Old Harbor only)	10
Arctic DTM	1
Bathymetric pre-surface	1

DEM Analysis

Once the Akhiok, Karluk, and Old Harbor DEMs were generated, the grids were compared to the contour data, GPS points and NGA monuments for this area. Inconsistencies were evaluated and resolved based on most reliable data available.

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Reference

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