

# Digital Elevation Model of Marquesas Islands, French Polynesia

## Procedures, Data Sources, and Analysis

---

Prepared for NOAA, Pacific Marine Environmental Laboratory (PMEL) by the NOAA National Centers for Environmental Information (NCEI) December 9, 2016

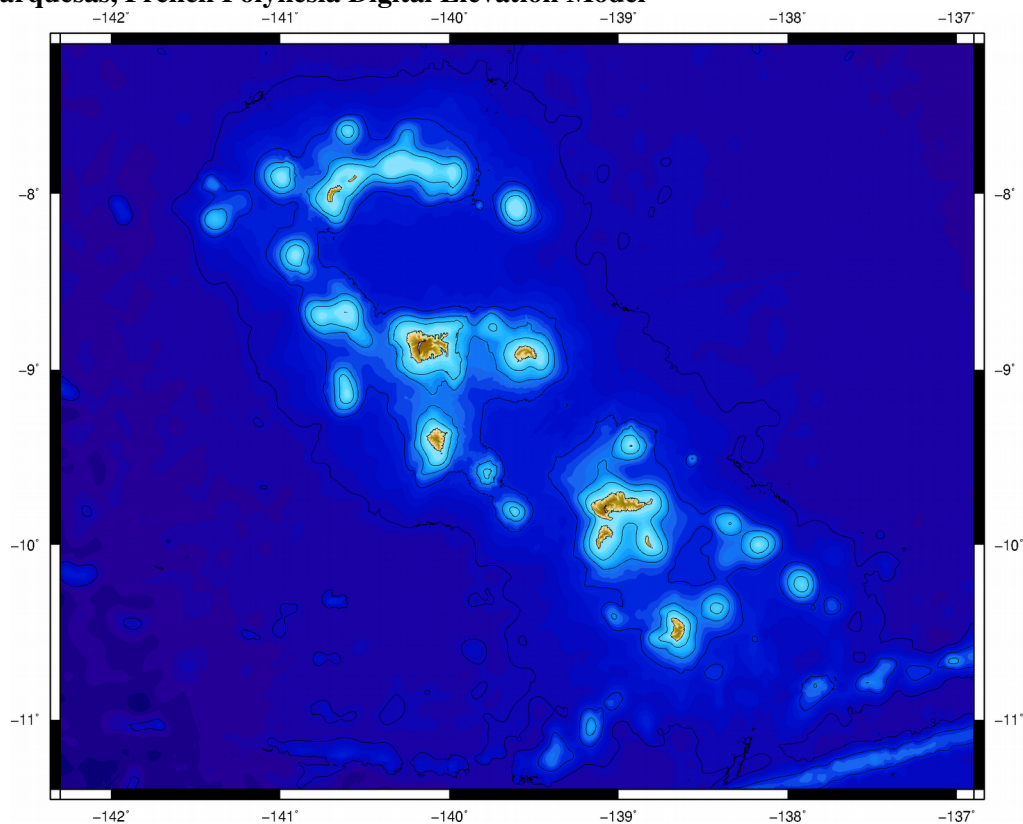
Love, M.R.<sup>1</sup>, K.S. Carignan<sup>1</sup>, B.W. Eakins<sup>1</sup>, M.G. Sutherland<sup>1</sup>, M. Lancaster<sup>1</sup>

<sup>1</sup>Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

## Summary

In December of 2016, NOAA's National Centers for Environmental Information (NCEI) developed a topographic-bathymetric digital elevation model (DEM) of Marquesas Islands, French Polynesia (Figure 1) for NOAA's Pacific Marine Environmental Laboratory (PMEL). The 3 arc-second DEM will be used to support improving the coastal tsunami inundation forecasts, storm surge modeling, community preparedness and hazard mitigation. This DEM covers the coastal area surrounding Marquesas Islands in the south pacific ocean in French Polynesia (Fig. 2). The extents of this DEM, procedures, data sources, and analysis are described below.

**Figure 1. Marquesas, French Polynesia Digital Elevation Model**



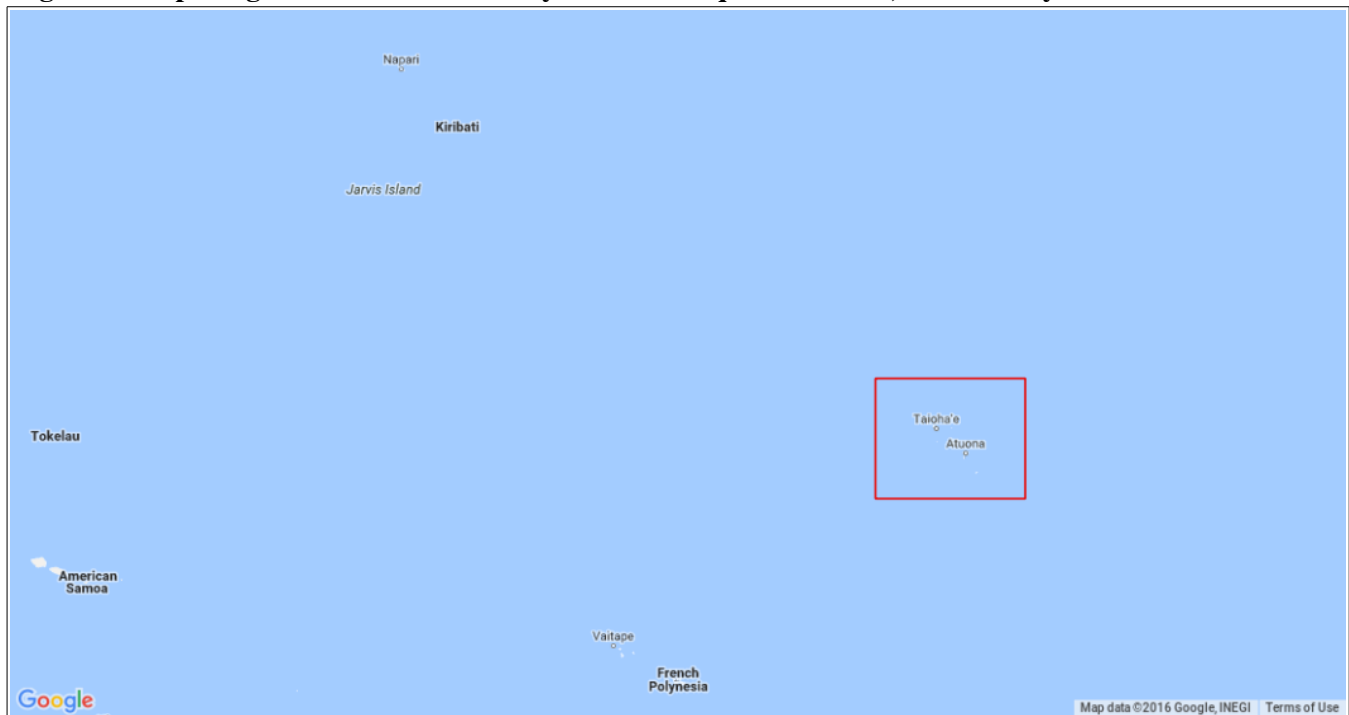
# DEM Specifications

The Marquesas Islands, French Polynesia DEM was built to the specifications listed in Table 1. Figure 2 shows the 3 arc-second boundary in red. The best available digital data were obtained by NCEI and shifted to common horizontal and vertical datums: World Geodetic System of 1984 (WGS 84) and Mean Sea Level (MSL). Data were gathered in an area slightly larger (~5%) than the DEM extents. This data “buffer” ensures that gridding occurs across rather than along the DEM boundaries to prevent edge effects. Data processing and evaluation, and the DEM assembly and assessment are described in the following subsections.

**Table 1. Specifications for the Marquesas Islands, French Polynesia DEM.**

<b>Grid Area</b>	Marquesas Islands, French Polynesia
<b>Coverage Area</b>	-142.3° to -136.9° W, -11.4° to -7.15° N
<b>Coordinate System</b>	Geographic decimal degrees
<b>Horizontal Datum</b>	World Geodetic System 1984 (WGS 84)
<b>Vertical Datum</b>	Mean Sea Level (MSL)
<b>Vertical Units</b>	Meters
<b>Cell Size</b>	3 arc-seconds
<b>Grid Format</b>	ASCII raster grid

**Figure 2. Map image of the DEM boundary for the Marquesas Islands, French Polynesia DEM in red.**



## Data Sources and Processing

The digital coastline used in developing the Marquesas Islands, French Polynesia DEM was generated by editing the Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) shoreline based on the Google satellite imagery layer. The digital coastline was converted into a polygon for use in masking topography and eliminating interpolated data artifacts.

Bathymetric data used in the compilation of the Marquesas Islands, French Polynesia DEM included multibeam sounding data from the National Oceanic and Atmospheric Administration (NOAA), digitized chart soundings from NOAA as well as gridded data from the General Bathymetric Chart of the Ocean (GEBCO) (Table 2).

Topographic data used in the compilation of the Marquesas Islands, French Polynesia DEM included SRTM data obtained from the United States Geological Survey (USGS) as well as gridded data obtained from the French Polynesian Department of Urban Planning (SAU) (Table 2).

**Table 2: Bathymetric and Topographic Data Sources used in compiling the Marquesas Islands, French Polynesia DEM.**

Source/Title	Date	Data Type	Resolution	Horizontal Datum	Vertical Datum
GEBCO World Grid	2013	Topographic Grid	30 meter	WGS84 Geographic	Assumed MSL
SRTM	2013	Topographic Grid	30 meter	WGS84 Geographic	Assumed MSL
Polynesie Francaise Service del l'Urbanisme (SAU)	2014	Topographic Grid	5 meter	UTM Zone 7 South	Assumed MSL
Multibeam Soundings	2010	Bathymetric Soundings	Variable	WGS84 Geographic	Instantaneous Water Level Height (EPSG:5829)
Digitized Chart Soundings	2017	Bathymetric Soundings	Variable	WGS84 Geographic	Assumed MSL

The bathymetric and topographic data were transformed from their original datums to a horizontal datum of WGS 84. All datasets originated with a vertical datum assumed at MSL so no vertical transformations were needed.

## DEM Development

After the bathymetric data were transformed to common horizontal and vertical datums, they were visually reviewed for consistency and errors. Where more recent, higher resolution bathymetric data existed, older data were superseded. The edited and evaluated bathymetric data were then converted to ASCII xyz format using GDAL then gridded at 3 arc-seconds using Generic Mapping Tools (GMT). The GMT 'surface' tool was used to generate a bathymetric surface which provided full data coverage of the DEM area. The surface was then clipped using the digital coastline to create the final bathymetric DEM. The final bathymetric DEM was then converted to ASCII xyz format for use as input in generating the final DEM.

After the topographic data were transformed to common horizontal datums, the areas of overlap were visually reviewed for consistency and errors.

MB-System was used to create the 3 arc-second Marquesas Islands, French Polynesia DEM. MB-System is an NSF-funded open source software application specifically designed to manipulate submarine multibeam sonar data, though it can utilize a wide variety of data types, including generic xyz data. The MB-System tool 'mbgrid' was used to apply a tight spline tension to the xyz data, and interpolate values for cells without data. The data hierarchy used in the 'mbgrid' gridding algorithm, as relative gridding weights, is listed in Table 4. The resulting binary grid was converted to an Arc ASCII grid using the GMT tool 'gdreformat' to create the final 3 arc-second Marquesas Islands, French Polynesia DEM.

**Table 4: Data hierarchy used to assign gridding weight in MB-System**

Data-set	Relative Gridding Weight
Generated Bathymetry Surface	1
Multibeam Bathymetry Data	10
GEBCO Bathymetric Grid	1
SRTM	1
SAU Topographic Grids	10
Digitized Chart Data	1

## Recommendations

Recommendations to improve the Marquesas Islands, French Polynesia 3 arc-second DEM are listed below:

- Conduct bathymetric/topographic lidar surveys of the coastal areas.
- Conduct high-resolution topographic lidar surveys of all the Marquesas Islands.
- Conduct bathymetric surveys in the region surrounding the Marquesas Islands.

## References

Wessel, P., and W. H. F. Smith, A Global Self-consistent, Hierarchical, High-resolution Shoreline Database, *J. Geophys. Res.*, 101, #B4, pp. 8741-8743, 1996.