Tsunami Hazard Assessment Special Series: Vol. 3
Tsunami hazard assessment of the Commonwealth of the Northern Mariana Islands
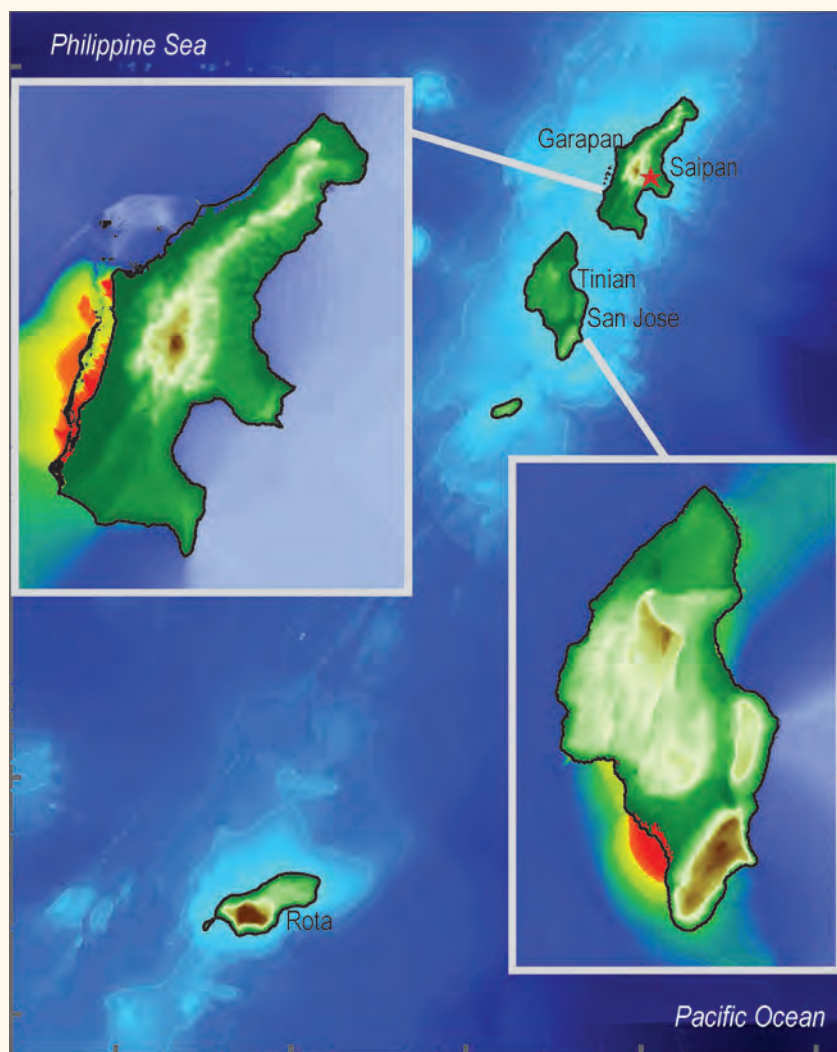
Burak Uslu
Marie Eble
Diego Arcas
Vasily Titov

NOAA OAR Special Report

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Tsunami hazard assessment of the Commonwealth of the Northern Mariana Islands

B. Uslu[1,2], M. Eble[2], D. Arcas[1,2], and V.V. Titov[2]

1 Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington, Seattle, WA
2 NOAA/Pacific Marine Environmental Laboratory (PMEL), Seattle, WA

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Contents

List of Figures

List of Tables

Acknowledgments

Executive Summary

SEVERAL PACIFIC OCEAN BASIN tsunamis occurred in the mid-twentieth century, causing destruction to United States coastal communities over a wide spatial scale. The destruction and unprecedented loss of life following the December 2004 Sumatra tsunami provided a reminder of the potential hazard posed to coastal communities and served as the catalyst for the formation of a partnership between the Pacific Risk Management 'Ohana and the National Oceanic and Atmospheric Administration Center for Tsunami Research. The March 2011 Tohoku tsunami reinforced the reality of hazard potential and thus the resolve of the partnership to conduct comprehensive tsunami hazard assessments for Pacific communities within the United States and its territories. The overall goal of these assessments is to support hazard mitigation efforts that leverage multi-level agency collaboration for the benefit of the Pacific community 'Ohana (family). Specific communities were identified for tsunami hazard assessment at the onset, with the island of Guam selected for the pilot study to identify earthquake sources with the greatest potential for impact on the population and economies of each of five communities encircling the island. The Commonwealth of Northern Mariana Islands (CNMI) is the focus of this second Pacific Islands hazard assessment, which characterizes the potential risk of tsunami vulnerability along the coastlines of Saipan, Tinian, and Rota, for which 725 probable earthquake scenarios are considered. Assessment results will be incorporated into warning and evacuation products for planning and education of local communities.

A comprehensive tsunami hazard assessment was conducted for Saipan, Tinian, and Rota to identify the vulnerability of each to large tsunami events. Five earthquakes and subsequent tsunami events of historic proportion that occurred within the last decade provided the case scenarios for this study: 2004 Sumatra, 2005 Sumatra, 2009 Samoa, 2010 Chile, and 2011 Japan. Four of these events are among the top ten instrumentally recorded largest magnitude earthquakes, and all triggered devastating tsunamis in terms of loss of life and infrastructure damage. With these historic cases in mind, a sensitivity study was conducted using the NOAA Tsunami Forecast Propagation Database to model tsunami impact along the coastlines of Saipan, Tinian, and Rota from tsunamis originating from 349 discrete earthquake sources. Results show that a total of 26 potential earthquake scenarios (5 from Western Aleutian sources, 3 from Cascadia, 2 from the Philippines, 2 from Japan, 4 from the Marianas, 2 from Manus Trench, 2 from New Guinea, and 6 from the Ryukyu-Nankai Trench) pose a tsunami hazard to the CNMI. Specifically, model results predict that a M_w 9.0 earthquake originating from a source south of Japan could result in wave amplitudes exceeding 11 m in Saipan, and a M_w 9.0 earthquake occurring in the East Philippines could trigger tsunami wave amplitudes exceeding 3 m at Rota and 4 m at Saipan

and Tinian. Numerical modeling to investigate the barrier reef's effect in dissipating tsunami energy shows that the Saipan barrier reef offshore Garapan, with an extended shallow shelf, appears to have a damping effect that reduces tsunami wave amplitudes. This finding was not confirmed for fringing reefs offshore Rota or Tinian, or along other coastal areas of Saipan. Maximum tsunami wave and current amplitude, a combined envelope of all 26 scenarios, and normalized reef study results are provided in this report.

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1. Introduction

A partnership between the Pacific Risk Management 'Ohana (PRiMO) and the National Oceanic and Atmospheric (NOAA) Center for Tsunami Research (NCTR) was initiated with the establishment of PRiMO in 2003 as a coalition of organizations focused on hazard risk management in the Pacific region. The partnership was officially formed during a meeting held in 2006 at which goals were set to conduct comprehensive tsunami hazard assessments for Pacific communities within the United States and its territories. Following the widespread destruction from the 2004 Sumatra tsunami, the specific intention of this partnership was to complete a comprehensive tsunami hazard assessment for the Pacific island communities of Guam, the Commonwealth of the Northern Mariana Islands (CNMI), and American Samoa. Guam was selected for the pilot study and, upon completion, included 725 scenarios potentially posing a threat to communities around the island. High-resolution inundation models for the coastlines of Tumon, Apra Harbor, Agana, Pago, and Inarajan bays for inclusion in the warning systems and evacuation maps (Uslu et al., 2010) were additionally completed. The Apra Harbor study was extended to provide a real-time tsunami forecast model to be included as part of NOAA's tsunami forecast system (Uslu et al., *in press*). This follow-up study includes the three largest islands of the CNMI, all located to the north of Guam.

The initial motivation for the partnership-directed hazard assessments was the 2004 Sumatra tsunami, but applicability and timeliness of the effort is clear from the subsequent 2009 Samoa, 2010 Chile, and 2011 Tohoku tsunamis. The 2009 Samoa earthquake, which occurred approximately 200 km from the island of Tutuila, accounted for 189 fatalities in the Samoan Islands, 34 of whom were American Samoa inhabitants (Fritz et al., 2009; Okal et al., 2010). The 2011 Tohoku tsunami flooded Saipan, triggered surges in Apra Harbor that caused damage to U.S. Navy vessels in port, and reached CNMI in less than 3.5 hours. The tsunami wave height was observed to be 130 cm at the Saipan tide gauge and 50 cm at the Pago Bay tide gauge.

1 Joint Institute for the Study of the Atmosphere and Ocean (JISAO), University of Washington, Seattle, WA
2 NOAA/Pacific Marine Environmental Laboratory (PMEL), Seattle, WA

A tsunami hazard assessment for each of the three islands of Saipan, Tinian, and Rota was conducted first by investigating the sensitivity of each island to tsunami impact from 349 M_w 9.0 earthquake-triggered tsunami scenarios. Model results show that maximum wave amplitudes occur from sources along the Marianas, Ryukyu-Nankai (RNSZ), Eastern Philippines (EPSZ), Japan Trench (KISZ), Manus Trench (MOSZ), New Guinea (NGSZ), Western Aleutians (ACSZ) and Cascadia (ACSZ) subduction zones. Earthquakes in these regions, therefore, pose the greatest tsunami hazard potential in the Northern Marianas. Of special note, the predicted tsunami hazard from an earthquake occurring along the Marianas is similar in scale for all three islands. For tsunamis generated by distant earthquakes, it is Saipan that appears to be most vulnerable, followed by Rota, for which model results predict a somewhat smaller hazard when compared with Saipan.

Subsequent to the sensitivity study, 26 earthquake scenarios along the most hazardous source segments as identified in the sensitivity analysis were selected and modeled at the highest possible resolution of 1/3 arc sec. Scenario results, all of which are provided in **Appendices B**, **C**, and **D** of this report, confirm sensitivity analysis results that the greatest tsunami hazards to the CNMI are from tsunamis triggered by earthquakes along the Western Aleutians, Cascadia, the Philippines, Japan, the Marianas, Manus Trench, New Guinea, and the Ryukyu-Nankai Trench. Predicted wave amplitudes at Saipan and Tinian would exceed 13 m and would be greater than over 7 m along the Rota coastline should a M_w 9.0 earthquake occur in the Marianas.

2. Background

Through a partnership between the Pacific Risk Management ʻOhana (PRiMO) and the NOAA Center for Tsunami Research (NCTR), a pilot tsunami hazard assessment of Guam was completed prior to this study and reported in Uslu et al. (2010). As a follow-up to this study, the work presented here is a Commonwealth of the Northern Mariana Islands (CNMI) tsunami hazard assessment for the islands of Saipan, Tinian, and Rota. The same procedure outlined in the Guam hazard assessment report has been followed for development and modeling of the high-resolution grids constructed for conducting this second hazard assessment study. The unique location of the three islands, with very steep relief spanning the deepest part of the ocean up to 400 m above sea level coupled with fringing and barrier reefs surrounding the islands, provides an opportunity to augment the sensitivity analysis and hazard assessment with characterization of tsunami hydrodynamics around coral reefs.

2.1 The tsunami history of the western Pacific Ocean and Marianas

Tsunami catalogues (Soloviev and Go, 1974; Iida, 1984; Lander et al., 1993, 2002) list five credible tsunamis that were observed in the Mariana Islands well before the 2011 Tohoku earthquake: in the years 1837, 1849, 1892, 1990, and 1993. The source of the 1837 tsunami event remains unknown, but unusual oceanic activity was observed on two of the Caroline Islands and in the region that includes Guam. The 1849, 1892, 1990, and 1993 tsunamis were each generated by earthquakes local to the Mariana Islands, and each are noteworthy. The 1849 tsunami is believed to be the only one of these tsunamis to have caused a fatality in the region. The 1892 tsunami manifested itself as an initial withdrawal of water in Agana Harbor, Guam. The 1990 tsunami was reported and confirmed by eyewitnesses, but no quantifiable measurements were made. The 1993 tsunami was recorded as a contemporary event but it was, unfortunately, overlooked due to Typhoon Steve, which, posing an immediate threat, was the primary focus of attention at the time (Lander et al., 2002). By comparison, the distantly generated 2010 Chile tsunami was observed only at the Apra Harbor tide gauge in Guam, while the 2011 Tohoku tsunami caused flooding in Saipan and Tinian, as well as minor flooding in parts of Guam (Uslu et al., 2010).

The United States Geological Survey (USGS) and the National Geophysical Data Center (NGDC) each provide a public database of all earthquakes. These databases include notations as to which earthquakes triggered tsunamis. The USGS (2009) and NGDC (2007) data include fatalities and tsunami runup information from the classical catalogues (Soloviev and Go, 1974; Iida, 1984; Lander et al., 1993, 2002). A search result of earthquakes in the western Pacific with a $M_w \geq 8.0$ from 1900 to present yields the 14 historical earthquakes listed in **Table 2.1** as having the potential of triggering a local tsunami that could have impacted the vicinity of CNMI.

Table 2.1: Earthquakes with $M_w \geq 8.0$ in the western Pacific.

Year	Longitude	Latitude	Depth	M_w	Location
1902	146	18	60	8.1	Agana, Guam
1906	138	34	340	8.4	Honshu, Japan
1909	142.5	31.5	80	8.3	Honshu, Japan
1909	145	12.5	100	8.0	Guam
1910	122.5	25.5	200	8.3	Taiwan
1911	131	28	160	8.7	Ryukyu Islands, Japan
1916	131.5	29.5	60	8.0	Duda, Japan
1918	125.2	5.4	33	8.3	Mindanao Island, Philippines
1920	122	23.5	10	8.3	Taiwan
1924	126.5	6.5	60	8.3	Mindanao Island, Philippines
1944	136	33.7	25	8.1	Kii, Japan
1946	135.6	33	30	8.1	Japan
1948	122	10.5	25	8.3	Panay, Philippines
1976	124.023	6.262	33	8.1	Mindanao Island, Philippines
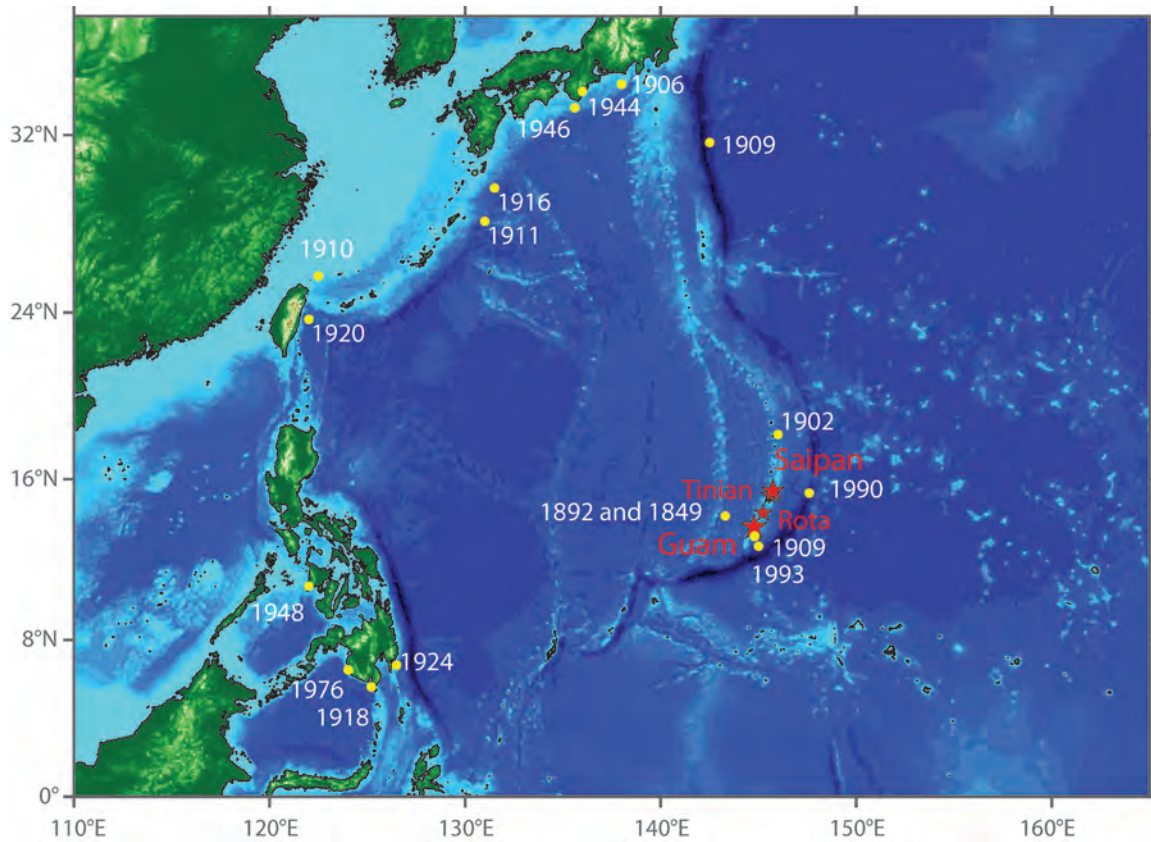
Figure 2.1: Earthquakes with $M_w \geq 8.0$ identified as occurring in the western Pacific from USGS database and tsunami catalogues (Soloviev and Go, 1974; Iida, 1984; Lander et al., 1993, 2002).
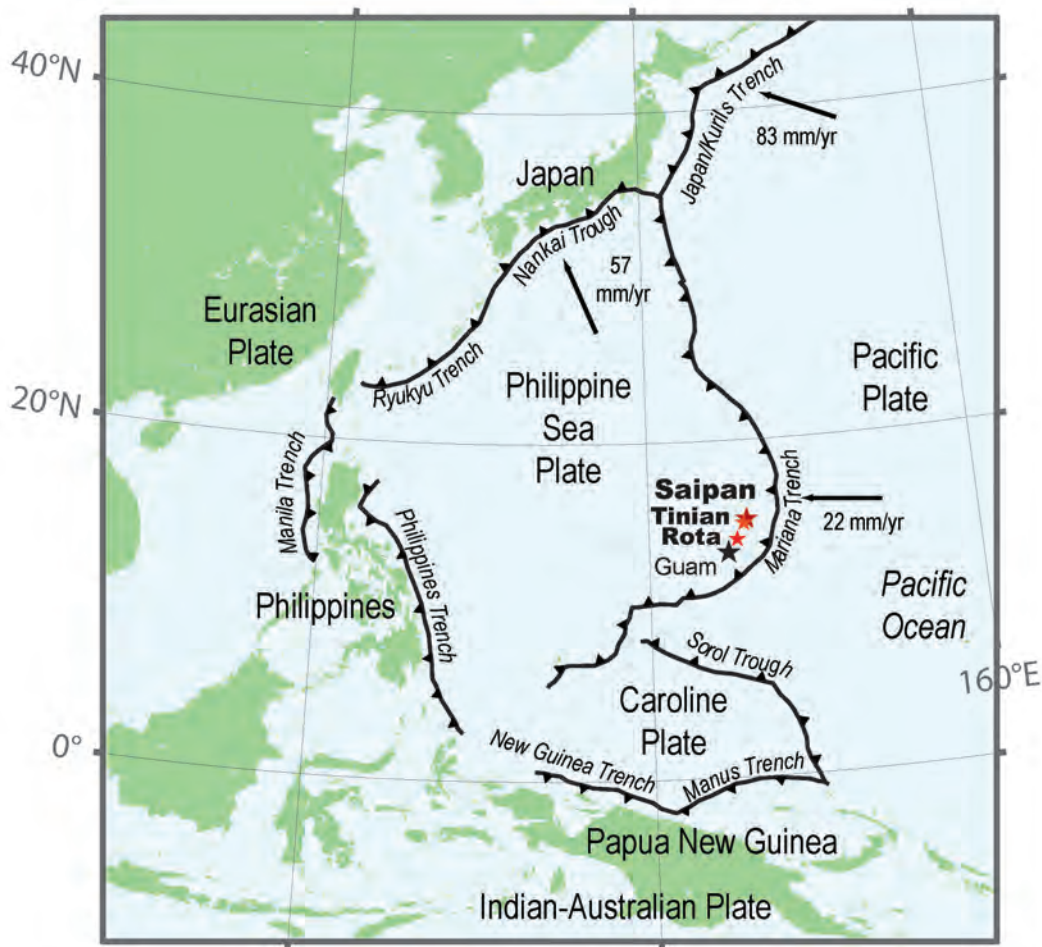
Figure 2.2: Regional setting showing the islands of Saipan, Tinian, and Rota in relation to Guam and major subduction zones including the near-field Mariana Trench (Hall, 1997, 2002; Stein and Okal, 2007).

The location of the CNMI and vicinity, relative to the geological setting of the western Pacific region and surrounding active subduction zones, is shown in **Figure 2.2**. To the east, the Mariana Trench is formed by the Pacific Plate moving toward and colliding with the Philippines Sea Plate at a rate of approximately 22 mm/yr. The Mariana Trench extends northward to a triple junction with the Nankai and Japan/Kuril trenches, one of the highest stress-accumulating areas with 83 mm/yr at northeast Japan (Stein and Okal, 2007). The Nankai Trench extends further south, accommodating movement at a rate of 57 mm/yr, and is followed by the Manila Trench between Taiwan and the Philippines. The Philippines Trench to the east and New Guinea and Manus trenches to the south complete the circle of subduction zones around the island of Guam and Saipan.

2.2 Study areas

The early inhabitants of the Mariana Islands, the Chamorros, are well known for their construction skills, and are believed to have sailed to the Marianas from Southeast Asia. Magellan explored and began colonizing the islands for Spain in 1512. The Mariana Islands stayed under Spanish control until the German purchase in 1899, during which time most of the native population died out and was replaced by people from Truk and the eastern Carolines (The CNMI Guide, 2011). At the start of World War I, Japan forced Germany out of the Mariana Islands. Control of the islands went to the League of Nations, with the United States, Great Britain, and France having administrative authority over them, but by 1935, Japan had assumed full control. The islands experienced one the most severe battles of World War II with the American assault, which resulted in the retaking of Tinian by the United States in 1944. The following year, the B-29 aircraft carrying the atomic bomb that was dropped on Hiroshima took off from an air base on the island of Tinian (The CNMI Guide, 2011).

The CNMI extends to the south from Rota through four islands, and to the north for 460 miles to Farallon de Pajaros (The CNMI Guide, 2011). The most populated of the Commonwealth islands are Saipan, Tinian, and Rota. These islands lie in relatively close proximity to Guam, with Rota only 80 km north and Saipan approximately 200 km NNW of Apra Harbor, Guam. All three islands are mountainous with high topographic relief. At approximately 458 m above sea level, Mt. Tapotchau is the highest point on Saipan. On Rota, the smallest of the three islands investigated in this study, the elevation reaches up to 495 m above sea level at Mt. Manira (The CNMI Guide, 2011). Garapan and Chalan Kanoa are the most urbanized areas of Saipan, and Songsong is the principal community on Rota. While a large portion of Tinian is leased to the U.S. military, San Jose is its major settlement.

3. Method

High-resolution inundation models were constructed from the best available elevation data to ensure the accurate representation of bathymetric and topographic features that affect the impact of tsunamis on Saipan, Tinian, and Rota. A high-resolution digital elevation model (DEM) for the CNMI was constructed by combining several data sources into a 1/3-arc-sec resolution grid with vertical datum set to local mean high water and the horizontal datum set to WGS84. The best available bathymetric and topographic data from LIDAR (Light Detection and Ranging) provided by the National Ocean Service, multibeam data from NOAA's National Geophysical Data Center (NGDC), Pacific Islands Benthic Habitat Mapping Center (PIBHMC), and Shuttle Radar Topography Mission 30 arc sec (SRTM30-PLUS) were all combined to generate three high-resolution reference data sets for the islands of Saipan, Tinian, and Rota. These reference data sets, or grids, were used for the modeling of the three tsunami-vulnerable islands included in the CNMI. A total of 1047 high-resolution runs were determined to be computationally prohibitive, so 349 potential earthquake scenarios were modeled using 3 arc sec numerical grids that were developed to perform within computational time constraints while still accurately predicting time histories at selected numerical locations (Tang et al., 2006; Uslu et al., 2010). These models were used to consider all possible scenarios and to ensure that a complete sensitivity study was carried out. Twenty-five of the 349 scenarios were identified as potentially hazardous scenarios and further modeled at a grid resolution of 1/3 arc sec. Model results are presented in **Appendices B**, **C**, and **D**.

The Method of Splitting Tsunamis (MOST) model was used for modeling the three stages of tsunami evolution: initial sea surface displacement, wave propagation, and tsunami inundation (Titov and Synolakis, 1997, 1998). MOST is a suite of numerical codes that solves the nonlinear shallow water equations with an explicit finite difference scheme. Tsunamis from far-field or distant sources were modeled by coupling the MOST model with the NOAA propagation database (Gica et al., 2008; Tang et al., 2008a,b), both of which have been extensively tested against a number of laboratory experiments, real-time events, and pre-established benchmarks (Synolakis et al., 2008; Wei et al., 2008). The method used for this study has been successfully applied for simulation of historical tsunami events.

3.1 Propagation database

A pre-computed propagation database consisting of water level and flow velocities at all grid points for potential seismic unit sources has been developed for the world ocean basins by the NOAA Center for Tsunami Research (Gica et al., 2008). Subduction zones have been broken into finite fault segments, or unit sources, each measuring 100 km long by 50 km wide. The propagation database represents a composite from each of these discrete earthquake rupture segments by computing wave propagation throughout the entire Pacific Basin. There are 403 unit sources from earthquakes of 100 km × 50 km and 1 m rupture. **Figure 3.1** shows forecast propagation database locations with respect to the CNMI island

of Saipan, the largest of the three islands considered in this study. Wave heights and currents were computed along the coastlines of all three islands, Saipan, Tinian, and Rota, identified by red dots in **Figure 3.1**.

The largest earthquake, in terms of seismic magnitude, having occurred since the turn of the twentieth century was recorded off of southern Chile. Several large earthquakes occurred along the Alaska/Aleutian Islands subduction zone in the mid-twentieth century, the largest being the 1964 Great Alaska earthquake, which occurred in Prince William Sound. All earthquakes modeled for this study represent a thrust fault mechanism, with the exception of the 2007 Kuril Islands event. This earthquake was due to a normal fault mechanism, yet was successfully modeled with a negative slip applied to the propagation database. Larger events are modeled by combining unit sources. A M_w 9.0 event, therefore, can be successfully modeled as a 700 km × 100 km rupture with a 20 m slip, effectively a combination of 14 M_w 7.5 events scaled up 20 times. Detailed source information for each specific subduction zone identified in the NOAA propagation database and used for this study is provided in **Appendix E**.
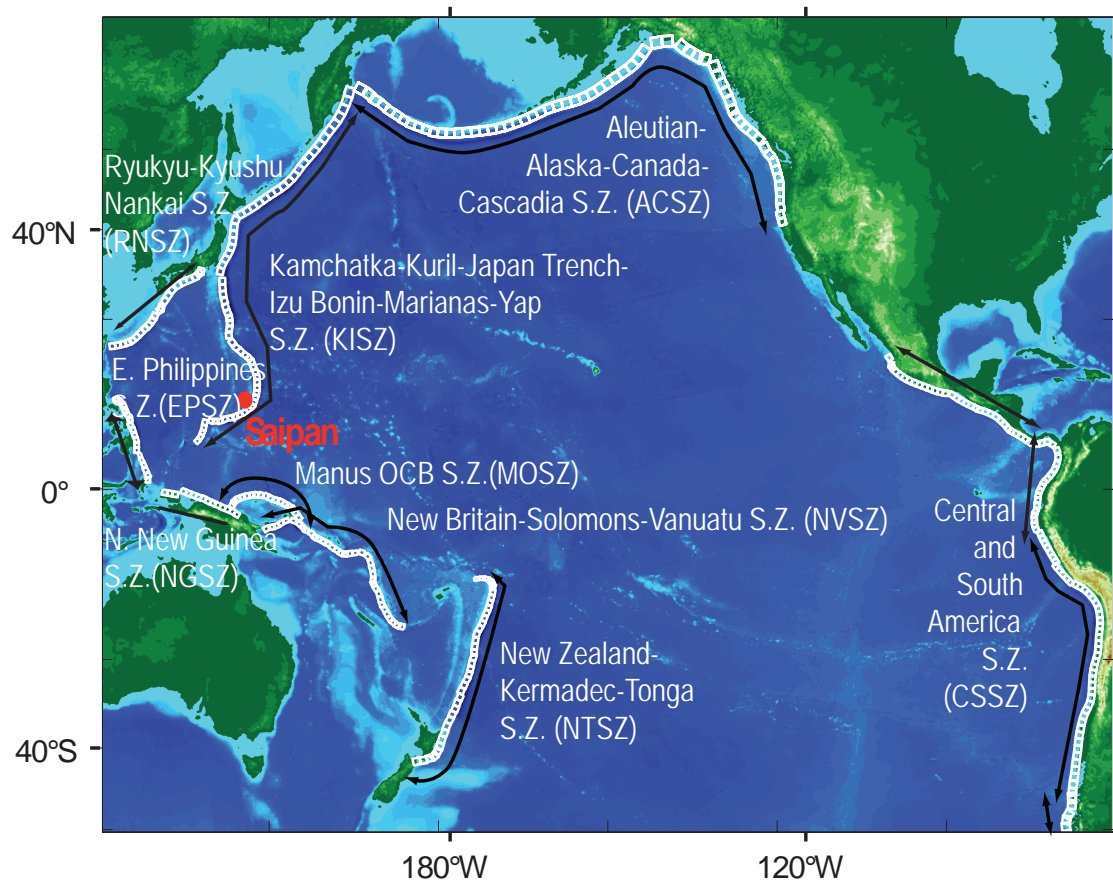
Figure 3.1: Pacific Basin unit sources that comprise the NOAA propagation database used as the basis for this numerical study. The Commonwealth Island of Saipan is shown in relation to the database subduction zones labeled in white on the map.

3.2 Numerical grids

Modeling tsunamis in the Northern Mariana Islands is accomplished by developing sets of three nested grids referred to as A-, B-, and C-grids. These grids telescope down from a larger spatial extent to a grid that finely defines the details of the coastline. The A-grid covers extents from the coast to beyond the continental shelf, if one exists, or to a depth deeper than 1500 m, with coarser resolution, whereas the grids become successively finer in resolution as they telescope from offshore into the coastlines. The grid setup for Saipan, Tinian, and Rota is shown in **Figure 3.2** and the details of the nested grids extents are listed in **Table 3.1**. Tsunami waves pass through each of the two outermost nested grids, arriving at the innermost nested grid where inundation distances are computed.

Table 3.1: Grid extents and time steps for high resolution and optimized models for Guam and CNMI.

High Resolution (1/3 Arc Sec)

Grid	Region	Longitude (deg)	Latitude (deg)	Time Steps (sec)
A	Saipan	144.8499°E–146.0474°E	13.9421°N–15.4096°N	0.96
B	Saipan	145.4829°E–145.9271°E	14.7629°N–15.3113°N	0.48
C	Saipan	145.6700°E–145.8500°E	15.0750°N–15.3050°N	0.06
A	Tinian	144.8499°E–146.0474°E	13.9421°N–15.4096°N	1.08
B	Tinian	145.4829°E–145.9271°E	14.7629°N–15.3113°N	0.36
C	Tinian	145.5650°E–145.6999°E	14.9058°N–15.1129°N	0.09
A	Rota	144.8499°E–146.0474°E	13.9421°N–15.4096°N	0.96
B	Rota	145.0357°E–145.4549°E	14.0632°N–14.4849°N	0.48
C	Rota	145.1051°E–145.3150°E	14.0900°N–14.2120°N	0.06

Optimized Model (3 Arc Sec)

Grid	Region	Longitude (deg)	Latitude (deg)	Time Steps (sec)
A	Saipan	144.8499°E–146.0424°E	13.9421°N–15.4046°N	3.6
B	Saipan	145.4829°E–145.9246°E	14.7629°N–15.3088°N	2.4
C	Saipan	145.6700°E–145.8500°E	15.0750°N–15.3050°N	0.6
A	Tinian	144.8499°E–146.0424°E	13.9421°N–15.4046°N	2.7
B	Tinian	145.4829°E–145.9246°E	14.7629°N–15.3088°N	1.8
C	Tinian	145.5650°E–145.6991°E	14.9058°N–15.1124°N	0.9
A	Rota	144.8499°E–146.0424°E	13.9421°N–15.4046°N	3.6
B	Rota	145.0357°E–145.4524°E	14.0632°N–14.4840°N	2.4
C	Rota	145.1051°E–145.3150°E	14.0900°N–14.2117°N	0.6
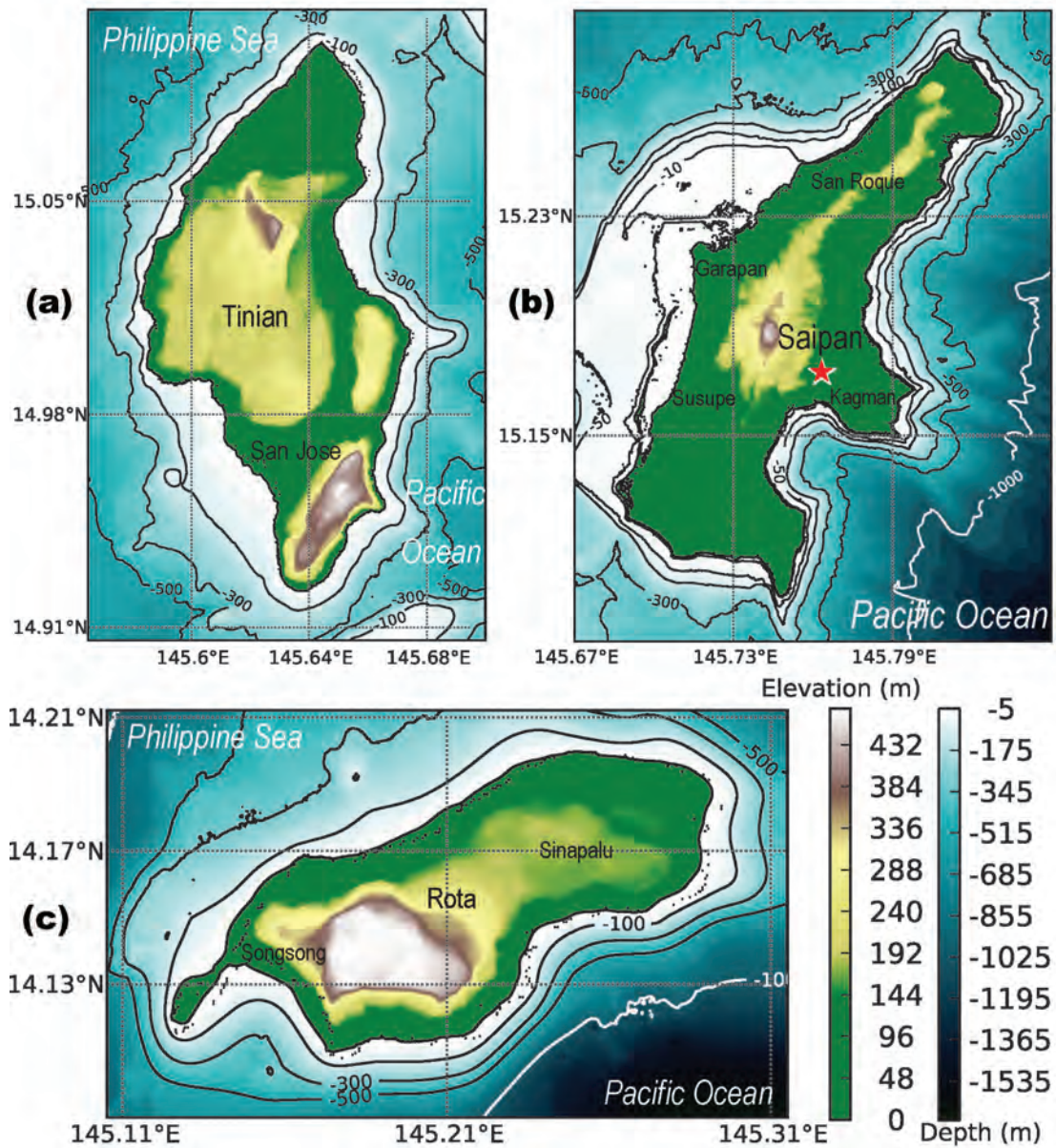
Figure 3.2: Topographic and bathymetric reliefs of the islands of Saipan, Tinian, and Rota in grids that were constructed for this study are shown. The red star denotes the Commonwealth's center of government on Saipan.

Two sets of model grids are used for this study: one for the high-resolution model and another for the optimized forecast model. The high-resolution model has an outer 9-arc-sec grid, an intermediate 3-arc-sec grid, and an inner 1/3-arc-sec grid. The optimized forecast models are constructed to provide efficient computational run time, and have been benchmarked against high-resolution models and compared with available tide gauge records. The outer grid resolution is 45 arc sec, the intermediate grid is 15 arc sec, and the inner grid is 3 arc sec. A detailed discussion of grid preparation is provided by Tang et al. (2008a,b) and this report follows the methodology in Uslu et al. (2010).

3.3 Model validation

The Saipan tide gauge is the only CNMI location at which the 2011 Tohoku tsunami was recorded. Both the 2010 Chile and the 2011 Tohoku tsunamis were recorded at Guam but not at the islands of Saipan, Tinian, or Rota. The comparisons of 2010 at Apra Harbor, Guam and 2011 at Pago Bay, Guam are shown in **Figure 3.3**. **Table 3.2** provides information on the 2010 and 2011 earthquakes along with the scaling parameters used for the NOAA propagation database. The 2011 tsunami caused flooding in Saipan and triggered currents in Apra Harbor that caused damage by breaking moorings. The computed maximum wave heights and current speeds from the 2011 tsunami are shown in **Figure 3.4**. The rapid currents shown at the middle part of the harbor in **Figure 3.4b** could be related to and responsible for the broken moorings.

Table 3.2: Parameters of the 2010 and 2011 earthquakes.

Date (UTC)	Time	Location	Epicenter	M_w	Tsunami Source
2011-02-27	06:34	Chile	35.909°S 72.733°W	8.8	$17.24 \times a88 + 8.82 \times a90 + 11.86 \times b88 + 18.39 \times b89 + 16.75 \times b90 + 20.78 \times z88 + 7.06 \times z90$
2011-03-11	05:46	Japan	38.322°N 142.369°E	9.0	$4.66 \times kiszb24 + 12.23 \times kiszb25 + 26.31 \times kisza26 + 21.27 \times kiszb26 + 22.75 \times kisza27 + 4.98 \times kiszb27$
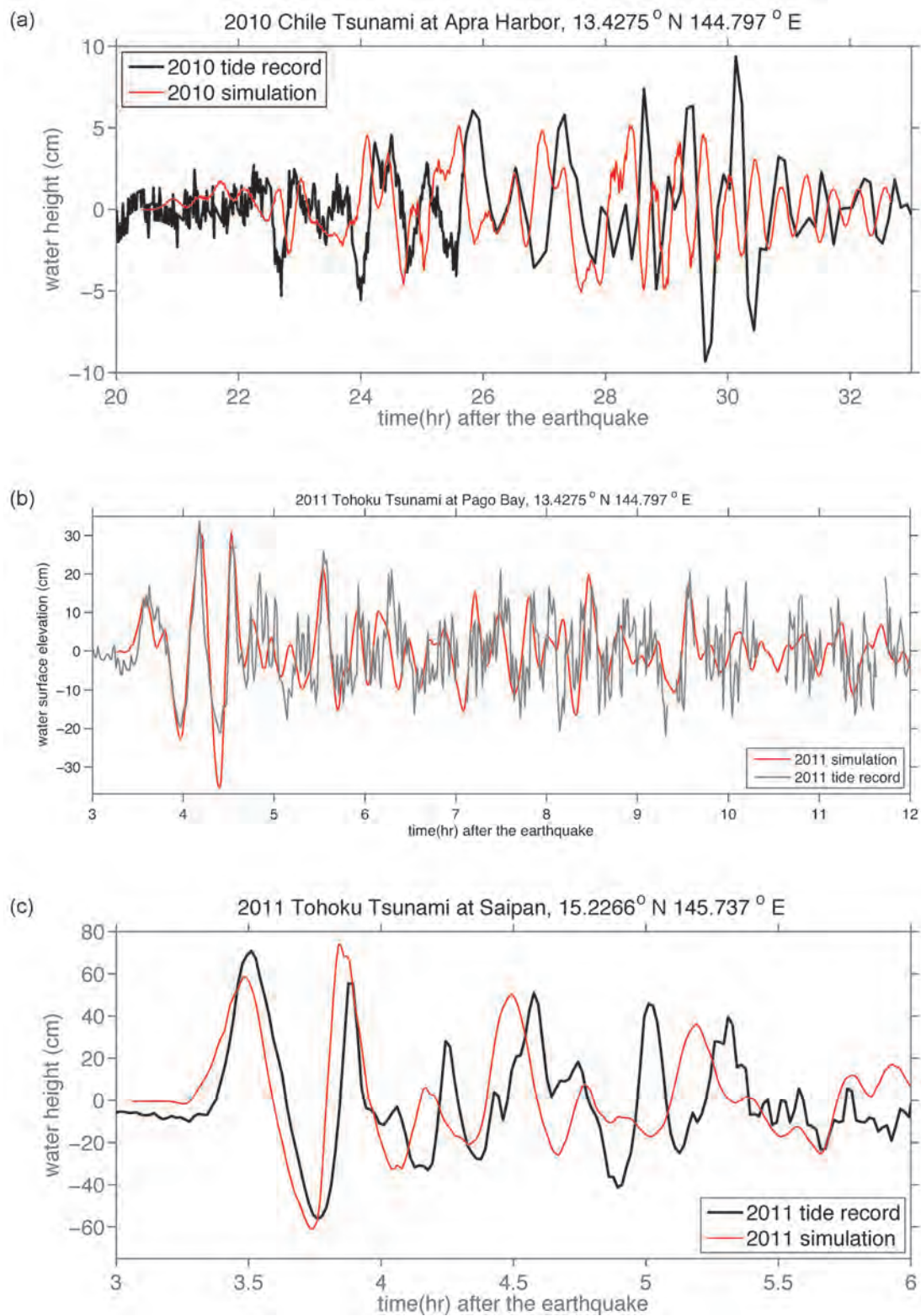
Figure 3.3: Comparison of numerical results with tide gauge time series recorded during (a) 2010 Chile tsunami at Apra Harbor, Guam; (b) 2011 Tohoku, Japan tsunami at Pago Bay, Guam; and (c) 2011 Tohoku, Japan tsunami at the Port of Saipan, north of Garapan.
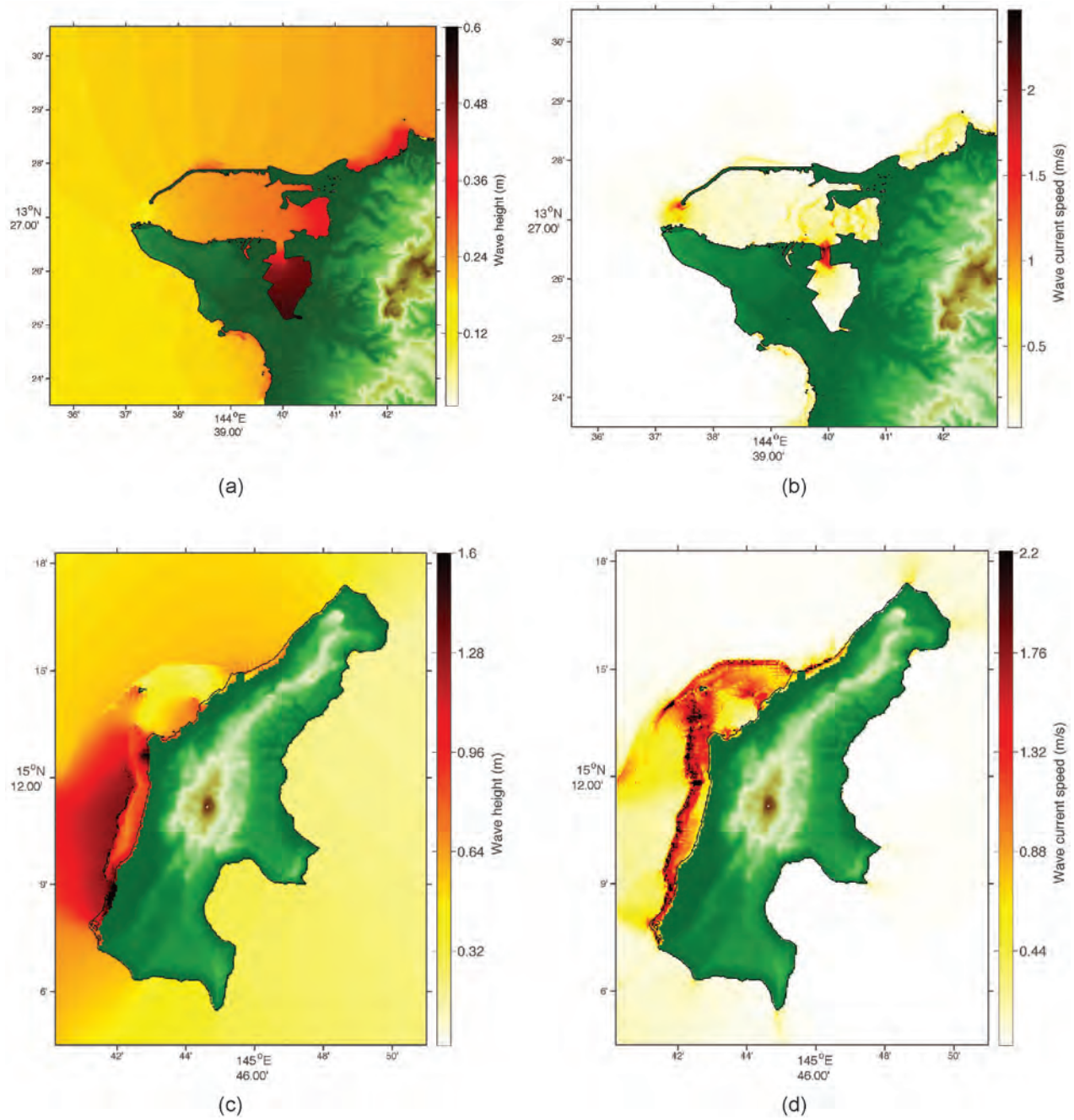
Figure 3.4: Modeled maximum tsunami wave height and current results for the 2011 Tohoku, Japan tsunami at Apra Harbor, Guam and Saipan.

4. Results

Tsunami energy radiating away from a source is highly directional, showing dependency on source characteristics. During propagation across variable ocean bathymetry, a complex pattern of tsunami amplitudes, arrival times, and frequency decay emerges, specific to each event. For example, previous studies have shown that tsunamis triggered by similar magnitude earthquakes along different subduction zone sources may have substantially different impacts on the same site, as discussed by Uslu (2008) and Dengler et al. (2008). With this source dependency in mind, a comprehensive sensitivity study was performed for the Commonwealth of the Northern Mariana Islands (CNMI) to determine potential earthquake-generated tsunami source regions of greatest concern to the islands of Saipan, Tinian, and Rota. Of the 349 scenarios modeled, 26 were identified as potential worst-case scenarios for impact on all three islands, providing the specific case studies for tsunami hazard assessment. Reef systems fringing each island were included in the overall hazard assessment to determine the extent to which they play a role in tsunami energy dissipation. Sensitivity study results, specific details of the 26 worst-case scenarios, and the effect of reefs in remediating tsunami impact on the islands of Saipan, Tinian, and Rota are discussed.

4.1 Tsunami sensitivity study for the CNMI coastlines of Saipan, Tinian, and Rota

A sensitivity study focused on maximum computed wave amplitude and current speed was performed to identify potentially hazardous tsunami sources following the methodology described in Uslu et al. (2010). A total of 349 M_w 9.0 synthetically generated tsunami source scenarios from around the Pacific Basin were modeled with computationally optimized grids. **Figures 4.1**, **4.2**, and **4.3** show the maximum computed wave amplitudes and current speeds at each grid along the coastlines of Saipan, Tinian, and Rota, respectively, for all 349 M_w 9.0 scenarios. Numerical computations suggest that a potential tsunami hazard to CNMI exists from a large earthquake originating in the near-field Mariana Trench (KISZ), as well as from the Ryukyu-Nankai (RNSZ), Eastern Philippines (EPSZ), Japan Trench (KISZ), Manus Trench (MOSZ), New Guinea (NGSZ), western Aleutians (ACSZ), and Cascadia (ACSZ) subduction zones. The largest wave amplitude computed as part of the sensitivity study is 11.9 m predicted for Onyan Beach (145.7383°E, 15.1050°N) along the southern side of Saipan from a synthetically generated event originating in the Mariana Trench (KISZ). A 10 m tsunami wave amplitude is predicted for the west side of Saipan at Chalan Kanoa (145.6941°E, 15.1458°N) from an event in the Ryukyu-Nankai Trench (RNSZ) and a 7.8 m wave amplitude is predicted from an earthquake in the Eastern Philippines (EPSZ) for Garapan (145.7058°E, 15.2000°N) on the west side of Saipan. The locations of these three maximum amplitudes predicted for Saipan are shown in **Figure 4.4**. On Tinian, a 12.1 m amplitude tsunami wave originating in the near-field is predicted to arrive at San Jose (145.6175°E, 14.9616°N). The largest impact on Tinian, from a far-field source in the EPSZ, is predicted to be a 9.7 m wave at San Jose (145.6275°E, 14.9533°N), as shown in
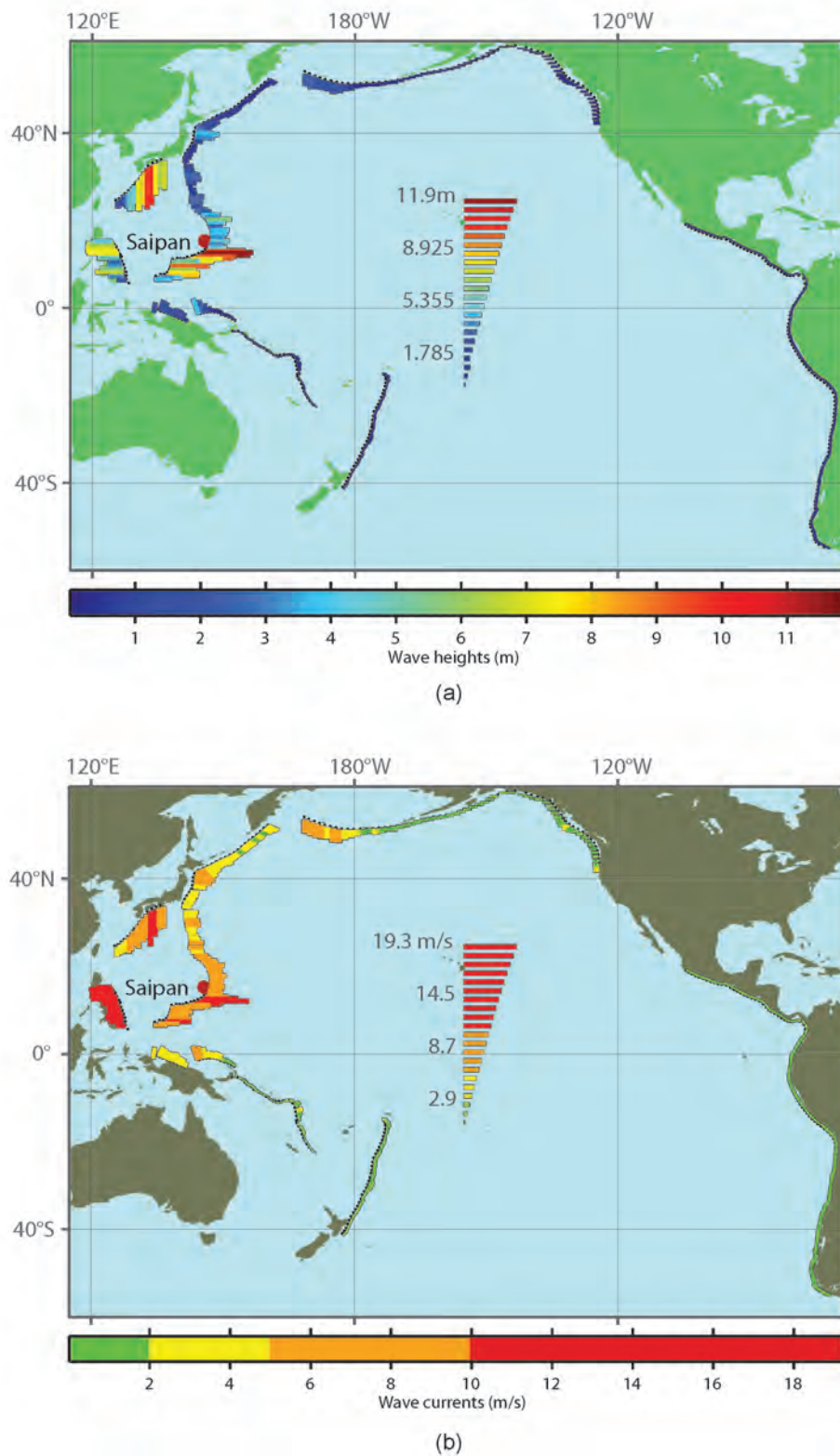
Figure 4.1: Maximum amplitude (a) and current speed (b) computed for the island of Saipan from tsunamis triggered by synthetic M_w 9.0 earthquakes along Pacific Basin subduction zones. The optimized tsunami forecast model was used for all model runs.
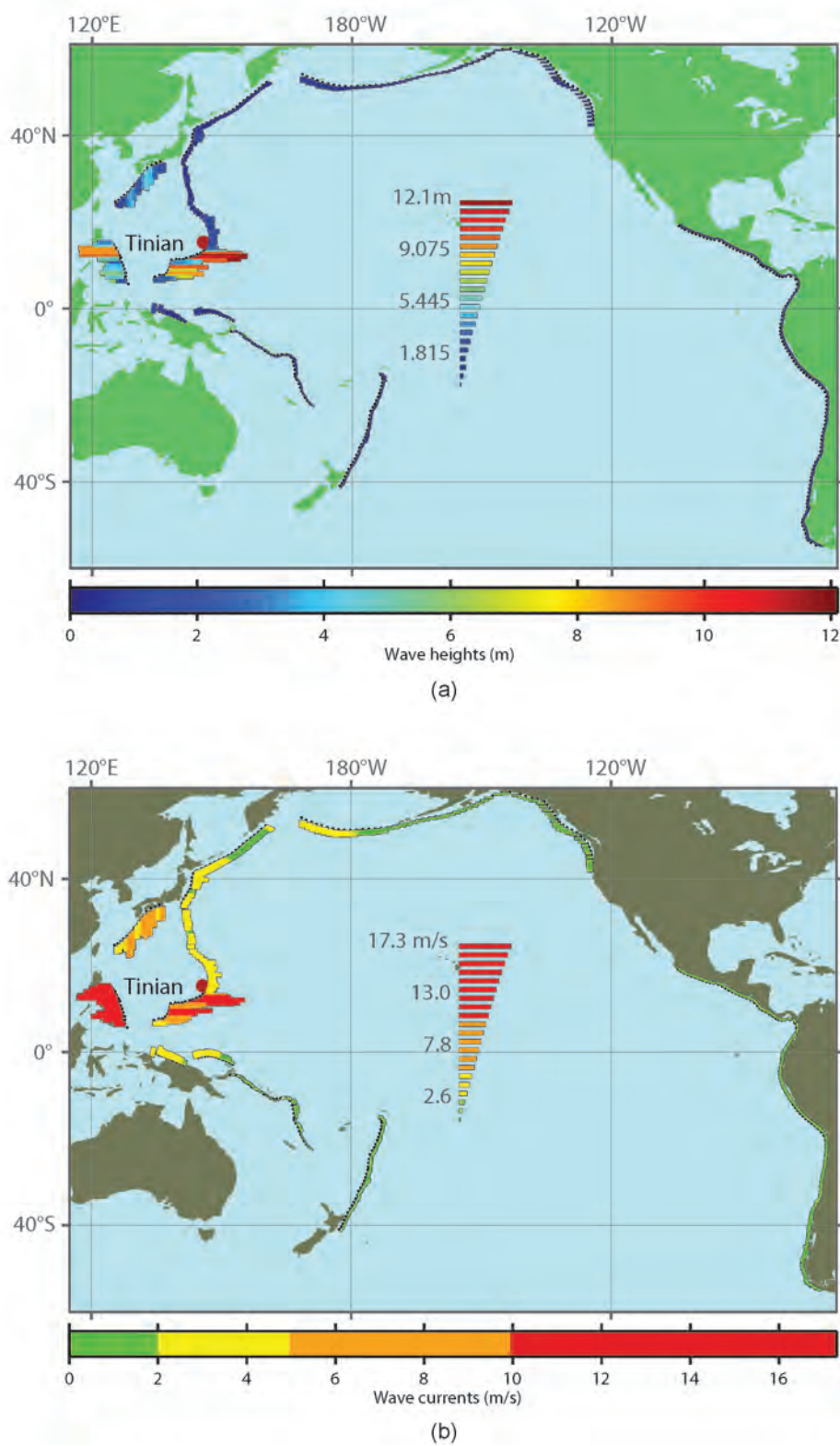
Figure 4.2: Maximum amplitude (a) and current speed (b) computed for the island of Tinian from tsunamis triggered by synthetic M_w 9.0 earthquakes along Pacific Basin subduction zones. The optimized tsunami forecast model was used for all model runs.
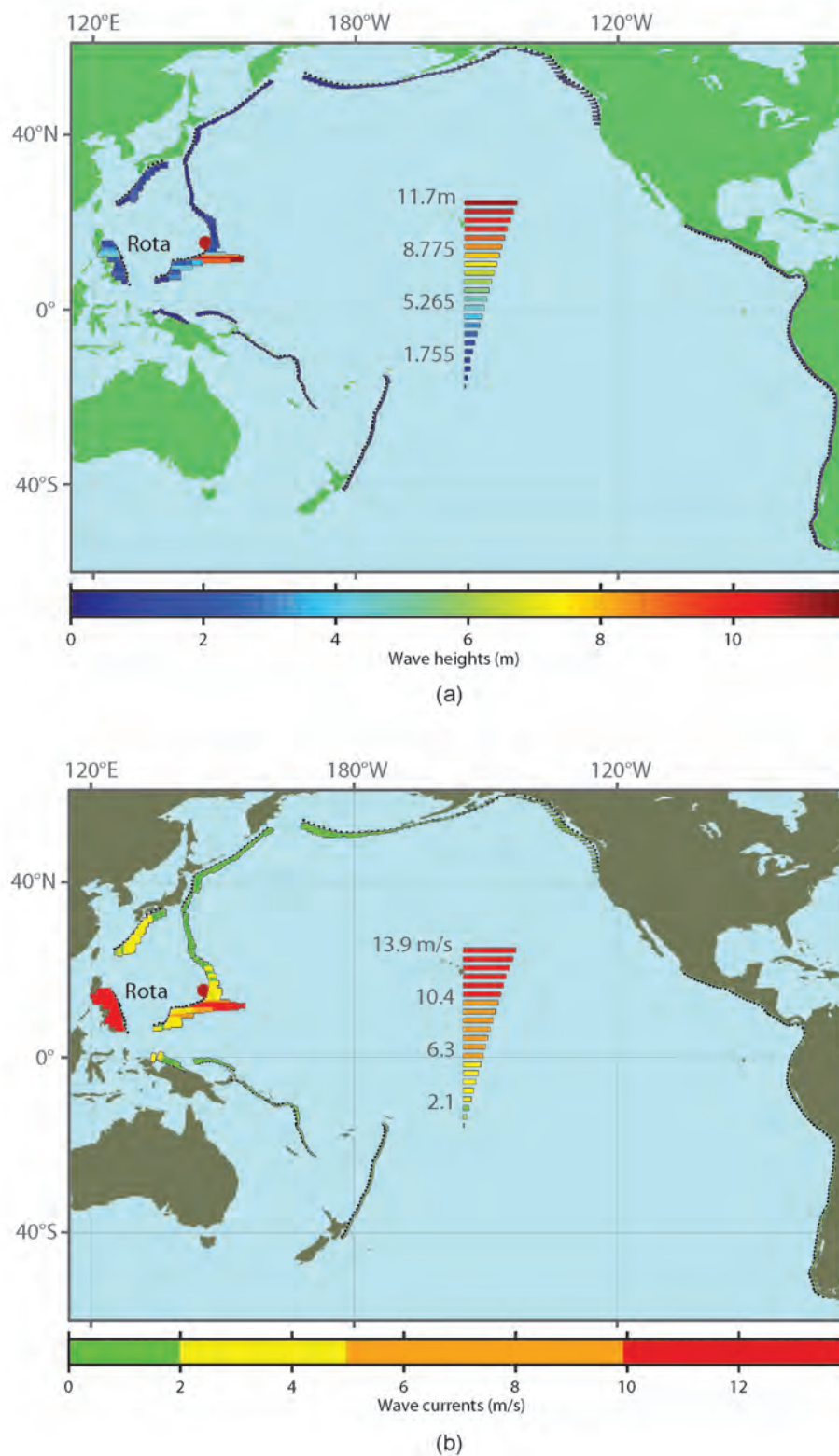
Figure 4.3: Maximum amplitude (a) and current speed (b) computed for the island of Rota from tsunamis triggered by synthetic M_w 9.0 earthquakes along Pacific Basin subduction zones. The optimized tsunami forecast model was used for all model runs.

Figure 4.5. On Rota, an 11.7 m wave is predicted in Sasanhaya Bay (145.1434°E, 14.1342°N) from a KISZ source. The tsunami hazard on Rota from a far-field source, however, is predicted to be less severe when compared with results for Saipan and Tinian. A 5.3 m wave amplitude from the EPSZ is predicted and shown for Rota in **Figure 4.6** at grid location 145.1426°E, 14.1342°N. Locations where numerical computations and comparison with historical observations (when available) were made are shown in **Figures 4.4**, **4.5**, and **4.6** for Saipan, Tinian, and Rota, respectively.

For convenience of interpretation, current velocities presented in **Figures 4.1**, **4.2**, and **4.3** have been categorized into four groups:

1. Less than 2 m/s, green, corresponds with least risk

2. Range of 2–5 m/s, yellow, identifies potentially hazardous currents

3. Range of 5–10 m/s, orange, identifies high risk

4. Greater than 10 m/s, red, reserved for dangerously high risk

Tsunamis from the Western Aleutians (ACSZ), Japan (KISZ and RNSZ), the Eastern Philippines (EPSZ), and Manus (MOSZ) subduction zones are expected to generate currents that exceed 5 m/s at Saipan. The Cascadia (ACSZ) and New Guinea (NGSZ) source regions are predicted to produce tsunamis with currents exceeding 2 m/s at Saipan. Similarly, Tinian may experience tsunami currents larger than 5 m/s from events originating in the Marianas (KISZ), Japan (RNSZ), and Eastern Philippines (EPSZ) source regions and currents larger than 2 m/s from events originating from New Guinea (NGSZ) and Manus (MOSZ) sources. Hazard to the island of Rota is more directionally dependent. As a result, currents exceeding 5 m/s are only expected from the Eastern Philippines and Marianas, while currents between 2 and 5 m/s are expected from Japan (RNSZ) and New Guinea (NGSZ) source regions.

A comparison of maximum amplitudes and currents predicted from each scenario with respect to the three individual islands suggests that each island is particularly sensitive to tsunamis generated from a specific direction. For these specific directionally significant events, large amplitudes and currents are expected. In contrast, the impact of scenarios from neighboring segments is relatively small. Even though near-field results are very similar for all islands, Saipan has a wider distribution of high amplitudes and is more exposed to waves from Pacific-wide tsunamis, while Rota is predicted to have comparably smaller hazard from far-field tsunamis. Results obtained from all 349 synthetic case scenarios computed identify the 26 synthetic scenarios shown in **Table 4.1**. as posing a significant risk to the CNMI's vulnerable locations. Of the 26 scenarios, 5 are from the Western Aleutians, 3 from Cascadia, 2 from the Philippines, 2 from Japan, 4 from the Marianas, 2 from Manus Trench, 3 from New Guinea, and 5 from Ryukyu-Nankai. A summary of maximum computed amplitudes and currents at Saipan, Tinian, and Rota are provided in **Table 4.1**.

Table 4.1: The list of 26 tsunami sources considered for potential worst-case scenarios at the CNMI out of 349 $M_w = 9.0$ scenarios tested in the sensitivity study. Each scenario is produced from NOAA propagation database earthquake by a rupture of a 20 m horizontal slip over an area of 700 km × 100 km. Predicted maximum amplitudes and currents at Saipan, Tinian, and Rota are also listed next to each scenario. Note that these results from the sensitivity study differ from the high-resolution model computations.

Scenarios	Subduction Zone	Tsunami Source	Saipan Amplitude (m)	Saipan Current (m/s)	Tinian Amplitude (m)	Tinian Current (m/s)	Rota Amplitude (m)	Rota Current (m/s)
ACSZ 01	Aleutians–Cascadia	A01–07, B01–07	2.8	5.3	1.2	2.4	0.7	1.6
ACSZ 02	Aleutians–Cascadia	A02–08, B02–08	3.0	5.4	1.3	2.4	0.7	1.7
ACSZ 03	Aleutians–Cascadia	A03–10, B03–10	2.6	5.4	1.0	2.5	0.7	1.8
ACSZ 04	Aleutians–Cascadia	A04–10, B04–10	2.3	5.2	1.2	2.4	0.7	1.8
ACSZ 06	Aleutians–Cascadia	A06–12, B06–12	2.4	5.5	1.0	2.5	0.6	1.4
ACSZ 45	Aleutians–Cascadia	A45–51, B45–51	0.6	1.5	0.4	0.7	0.2	0.4
ACSZ 47	Aleutians–Cascadia	A47–53, B47–53	0.7	2.1	0.5	1.6	0.3	0.5
ACSZ 59	Aleutians–Cascadia	A59–65, B59–65	0.7	2.1	0.5	1.7	0.3	0.3
EPSZ 08	East Philippines	A8–14, B8–14	7.8	10.7	3.2	6.5	1.3	2.0
EPSZ 09	East Philippines	A9–15, B9–15	7.7	10.4	9.7	13.8	5.3	6.7
KISZ 20	Kuril-Kamchatka–Japan	A20–27, B20–27	4.4	6.3	1.9	4.2	0.7	1.3
KISZ 21	Kuril-Kamchatka–Japan	A21–28, B21–28	3.6	5.3	1.6	2.5	0.6	1.4
KISZ 53	Kuril-Kamchatka–Japan	A53–59, B53–59	11.9	13.5	9.8	10.3	4.8	7.4
KISZ 54	Kuril-Kamchatka–Japan	A54–60, B54–60	11.9	19.3	11.9	16.3	9.0	10.3
KISZ 55	Kuril-Kamchatka–Japan	A55–61, B55–61	9.3	10.4	10.6	15.8	10.8	13.9
KISZ 56	Kuril-Kamchatka–Japan	A56–62, B56–62	9.5	11.0	12.1	17.3	11.7	13.1
MOSZ 10	Manus OCB	A10–16, B10–16	3.2	5.2	1.4	2.4	0.6	1.1
MOSZ 11	Manus OCB	A11–17, B11–17	4.0	6.0	1.3	2.4	0.7	1.4
NGSZ 04	New Guinea	A04–10, B04–10	1.9	3.9	4.0	2.4	0.8	1.5
NGSZ 08	New Guinea	A08–10, B08–14	2.6	4.3	1.6	3.2	0.7	2.4
NGSZ 09	New Guinea	A09–15, B09–15	2.4	4.5	2.4	3.3	0.7	2.4
RNSZ 06	Ryukyu–Nankai	A06–12, B06–12	5.5	6.7	4.2	8.3	3.0	4.5
RNSZ 07	Ryukyu–Nankai	A07–13, B07–13	4.6	5.6	3.4	6.9	2.9	4.9
RNSZ 12	Ryukyu–Nankai	A12–18, B12–18	10.0	9.6	4.9	8.8	2.1	2.5
RNSZ 13	Ryukyu–Nankai	A13–19, B13–19	9.8	13.9	4.3	8.9	2.0	2.2
RNSZ 14	Ryukyu–Nankai	A14–20, B14–20	7.8	10.7	3.2	6.5	1.3	2.0
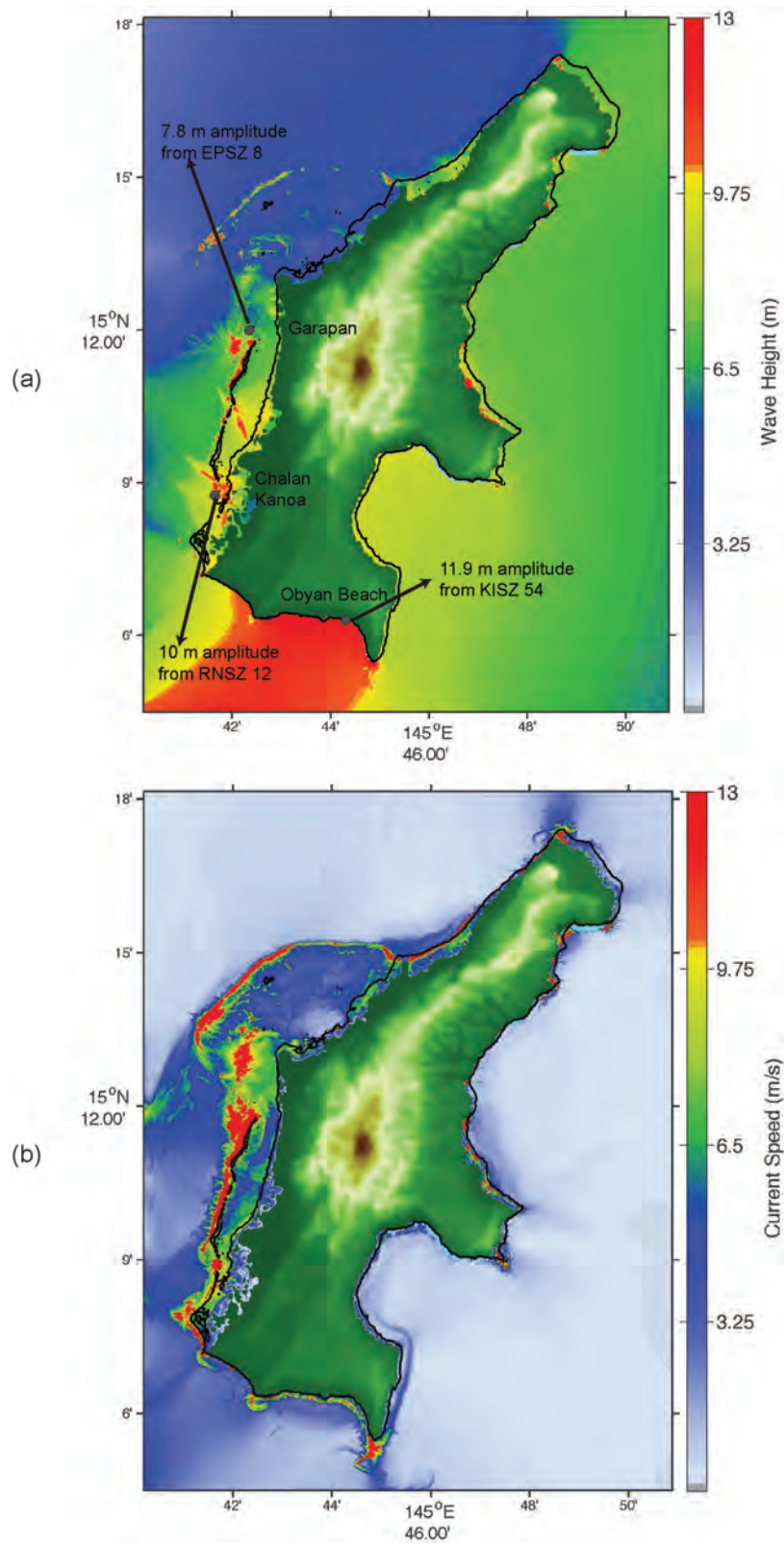
Figure 4.4: Maximum tsunami amplitudes (a) and currents (b) at Saipan computed using the high-resolution model for the 26 potential worst-case scenarios listed in **Table 4.1**.
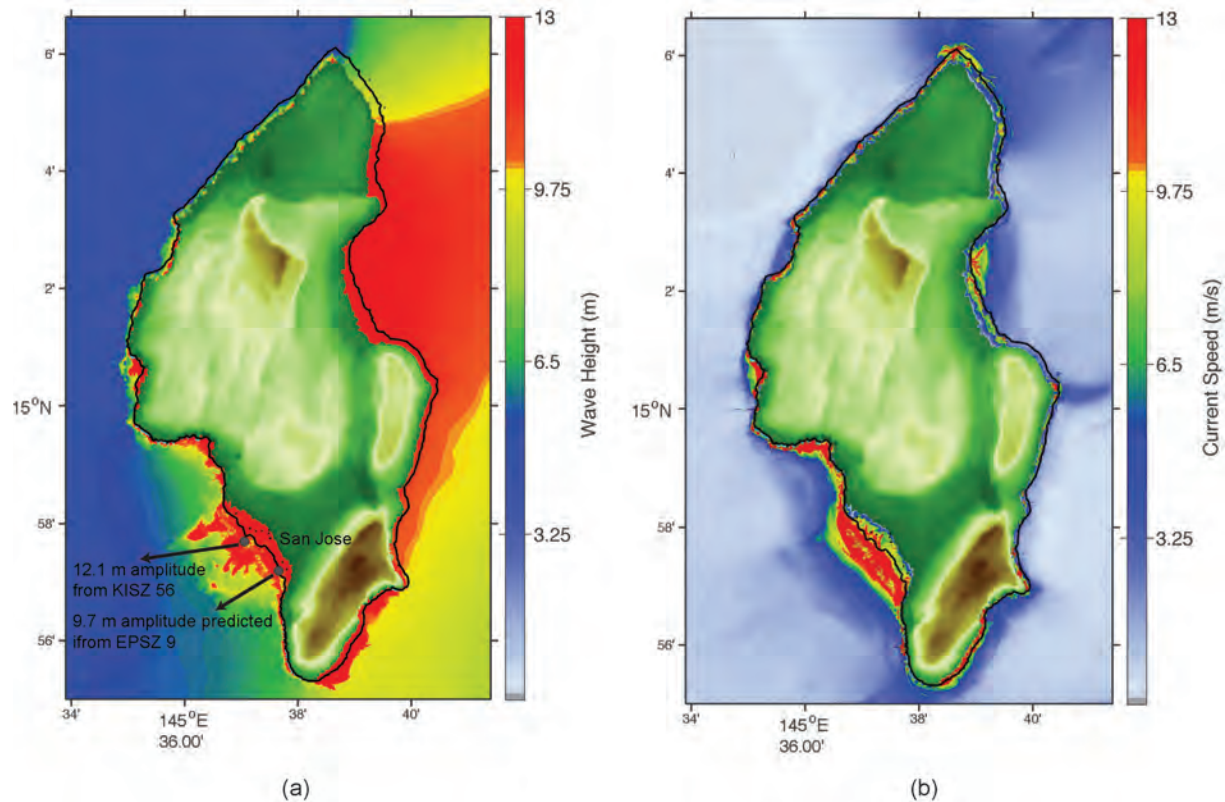
Figure 4.5: Maximum tsunami amplitudes (a) and currents (b) at Tinian computed using the high-resolution model for the 26 potential worst-case scenarios listed in **Table 4.1**.

4.2 Potential maximum amplitudes and currents

The tsunami scenario identified as KISZ 54 is predicted to be the worst M_w 9.0 near-field scenario for Saipan, with tsunami wave amplitudes of 11.9 m possible. KISZ 56 provides the worst-case source for both Tinian and Rota, with 12.1 and 11.7 m predicted amplitudes, respectively. In the far field, the worst-case scenarios for Saipan are RNSZ 12, with 10 m tsunami wave amplitudes predicted, followed by EPSZ 8, from which a maximum amplitude of 7.8 m is predicted. With respect to the far field, Tinian and Rota may experience 9.7 m and 5.3 m tsunami waves, respectively, from EPSZ 9, as listed on **Table 4.1**.

The sensitivity and hazard studies show results consistent with one another, although a slightly different maximum amplitude distribution is noted. This is most likely the result of more complete maximum amplitude resolution by the high-resolution model used for hazard assessment. For the purpose of establishing combined inundation distances for the CNMI mapping project, inundation extents from each of the 26 scenarios were combined for every study site on Saipan, Tinian, and Rota where 1/3-arc-sec high-resolution inundation computations were available. **Figures 4.4**, **4.5**, and **4.6** depict the envelope of maximum amplitudes, currents, and inundation heights from all 26 scenarios listed on **Table 4.1**. These figures also show the numerical gauge locations of the maximum predicted amplitudes from the sensitivity study. For example,
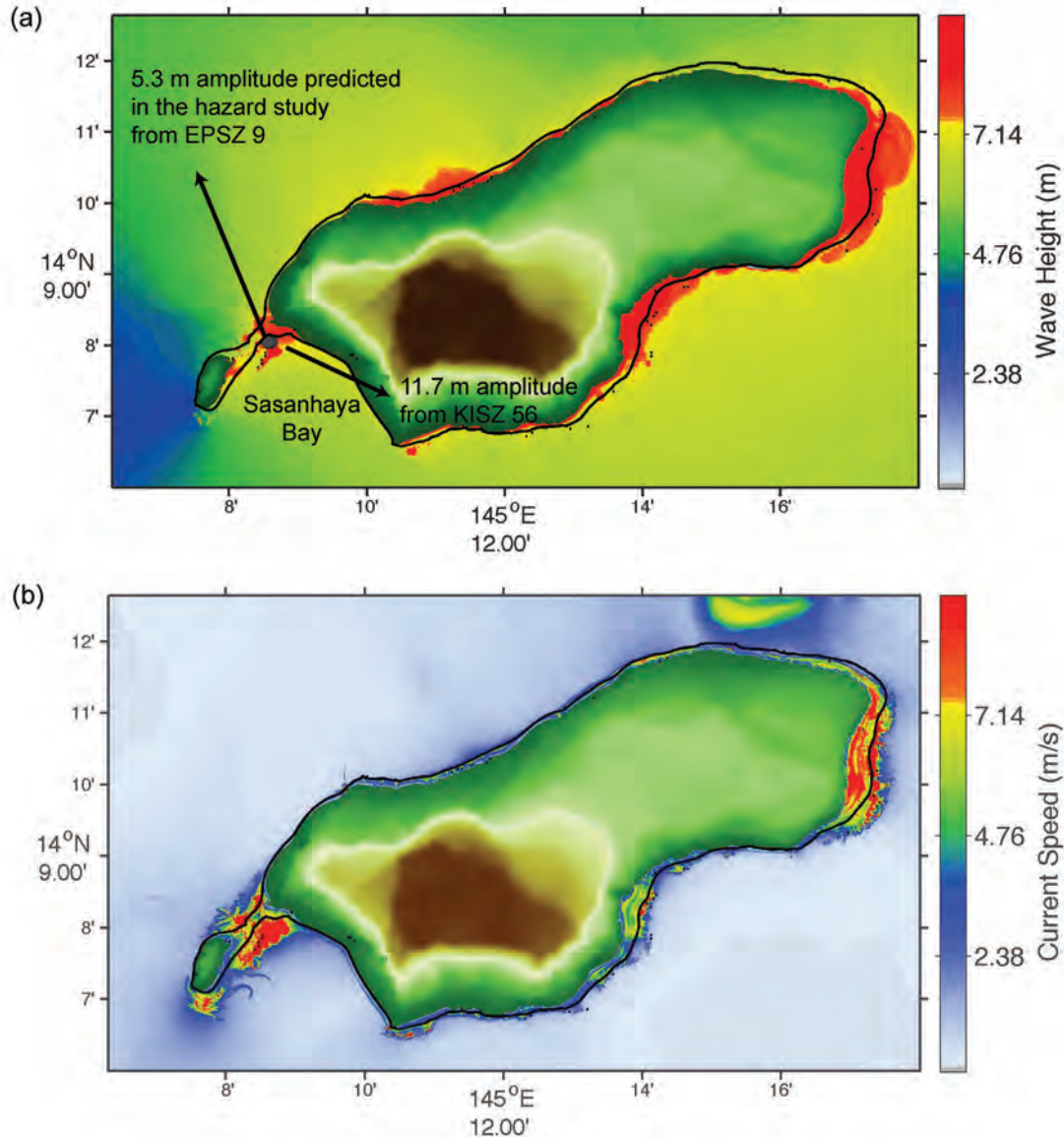
Figure 4.6: Maximum tsunami amplitudes (a) and currents (b) at Rota computed using the high-resolution model for the 26 potential worst-case scenarios listed in **Table 4.1**. Note that for sensitivity and high-resolution results predicted for all areas, Rota in particular may be slightly different due to grid resolution effects.

the sensitivity study predicted 11.9 m from KISZ 54, 10 m from RNSZ 12, and 7.8 m from EPSZ 8 for Saipan, as shown in **Figure 4.4**. The maximum amplitude distribution along Saipan's coastline exceeds 13 m. On Tinian, the maximum wave amplitudes predicted by the sensitivity study was 12.1 m from KISZ 56 and 9.7 m from EPSZ 9, as presented in **Figure 4.5**. On Tinian, the maximum amplitude distribution as determined from the high-resolution study exceeds 13 m. The sensitivity study conducted for Rota predicted a 11.7 m wave from KISZ 56 and a 5.3 m wave from EPSZ 9, as shown in **Figure 4.6**. These results are similar to the wave amplitudes of up to 12 m from the hazard assessment.

4.3 Case study on the role of coral reefs during tsunami impact

The islands of Saipan, Rota, and Tinian are each oriented differently from one another, relative to local and distant source regions, and have quite different geomorphology. These inherent differences cause each island to experience the dynamics of tsunami impact independent of one another. To investigate and gain insight into these dynamics,, the coastline of Saipan was divided into 5 segments, that of Tinian into 12 segments, and Rota into 7 coastal segments, all of which are shown in **Figure 4.7**.

The Saipan segments are shown in **Figure 4.7a**. Along the coastline, the wide barrier reef off Garapan is identified as area 1, and the fringing reef off Susupe is area 2. The transformation from barrier reef to fringing reef between Susupe and Garapan is designated as area 3, and the very narrow reef offshore of the southwest region of the island is area 4. Completing the Saipan segments is area 5, established as the very steep shelf on the east side of the island.

The island of Tinian has much steeper geomorphology than Saipan. The only visible shelf appearing on bathymetric maps is off of San Jose on the southwest part of the island (**Figures 4.7b** and **3.2**) so the coastline was divided into geographically convenient segments. On the southwest, Turtle Cove to Leprosarium Beach is designated as location 1, San Jose is 2, and Taga to Tachonga Beach is 3. From the southeastern tip of Tinian to the northernmost Ushi Point, the segments break down as follows: Carolinas Point to Marpo Point is 4, Marpo Point to Masalog Point is 5, Masalog Point to Asiga Point is 6, and Asiga Point to Tahgong Point (Blow Holes) is 7. The relatively long segment 8 runs from NNW Ushi Point (Tahgong Point) to south of Chulu Beach along Tinian's northwest coast. Completing the island divisions are the four westernmost segments, 9, 10, 11, and 12, from north to south, which are approximately equal in area and aligned with bays.

The CNMI island of Rota is situated roughly equidistant from Guam and Tinian, just 80 km north of Apra Harbor, and 100 km south of San Jose. Unlike the meridional orientation of Tinian, Saipan, and Guam, Rota is oriented zonally. For this study, Rota was divided into seven geographically based coastal segments. Shown in **Figure 4.7c**, Sasanhaya Bay is segment 1, Gaonan is 2, and Point Haiña to Saguagahga is 3. The eastern segment, Point Saguagahga to Fina Atkos, is 4. Along the northern coast, Point Fina Atkos to the northern tip of Rota is 5, and from the northern tip to Point Sailigai is 6. West of Mount Taipingot (also known as Wedding Cake Mountain) is designated segment 7.

Figure 4.8 shows the predicted maximum wave amplitudes from 349 M_w 9.0 scenarios impacting the 5 pre-defined coastal segments of Saipan, the 12 segments along the coast of Tinian, and the 7 pre-defined segments circumnavigating Rota. **Figure 4.9** shows a subset of the same predicted maximum amplitudes with the exclusion of the 24 near-field tsunamis generated by scenarios from the Marianas. From **Figure 4.8**, the east coasts of all three islands are impacted heavily, with 12 m waves predicted at segment 5 on Saipan and segments 6 and 7 on Tinian, and 11 m waves predicted at segment 4 on Rota (note that the maximum predicted wave at Rota is 12 m along its southwestern segment 1). For

case scenarios of tsunamis generated in the far field, the maximum amplitudes, as shown in **Figure 4.9**, is 10 m along both segments 2 and 4 of Saipan, 10 m at Tinian's segment 2, and 5 m along Rota's segment 1. The maximum predicted current speeds for all segments encircling each island are shown on **Figure 4.10** (all source scenarios) and **Figure 4.11** (far-field source scenarios only). Full scenario suite results show that current speed variance is significantly greater than amplitude, with a maximum of 19 m/s along Saipan segment 5, 17 m/s along segment 2 at Tinian, and 14 m/s at Rota's segment 1.

The greatest expected impact on Saipan is predicted along the southwest coast of the island, where both amplitude and current speeds are predicted to be islandwide maximums. Similarly, the greatest impacts expected along Tinian and Rota's coastlines are predicted for San Jose on southwest Tinian and Sasan-haya Bay located along the southern portion of Rota. **Figure 4.12** shows a linear correlation of computed wave amplitudes at each location on the island to the selected maximum amplitudes locations (Reef 4 at Saipan, Reef 2 at San Jose in Tinian, and Reef 1 at Sasanhaya Bay in Rota). Note that each value is normalized by the maximum computed amplitude on that island and 26 Marianas scenarios are excluded in **Figure 4.12**.

The role of reefs in dissipating tsunami energy was investigated using results of these scenario studies. **Figure 4.12** shows composite, normalized results for all reef segments encircling each island. For Saipan, **Figure 4.12a**, wave ampli-tude is highly correlated with the distinct reefs. Wave amplitudes predicted at the island's barrier reef (Reef 1) are 48% of the amplitudes predicted in the narrowest reef on the west coast (Reef 4). Even though the relatively long reefs along the west coast (Reefs 2 and 3) seemed to interfere with the wave dynamics, the computed wave heights were still as high as 91–99% of those computed at Reef 4.

Observed distribution of amplitude at reef segments on Tinian and Rota was more scattered than that displayed for Saipan, as shown in **Figures 4.12b** and **c**. Wave amplitudes are highest along Tinian reefs 1–4) where correlation was greatest along these beaches from San Jose to Masalog Point. Coinciden-tally, the only shelf on Tinian is around these reefs. Very steep cliffs characterize the remainder of the island's coastline. Amplitudes predicted for Rota from far-field source scenarios are considerably less than those predicted for both Saipan and Tinian. Interestingly, the overall correlation distribution of amplitude to reef at Rota shown in **Figure 4.12c** is more defined than that noted for Tinian in **Figure 4.12b**.
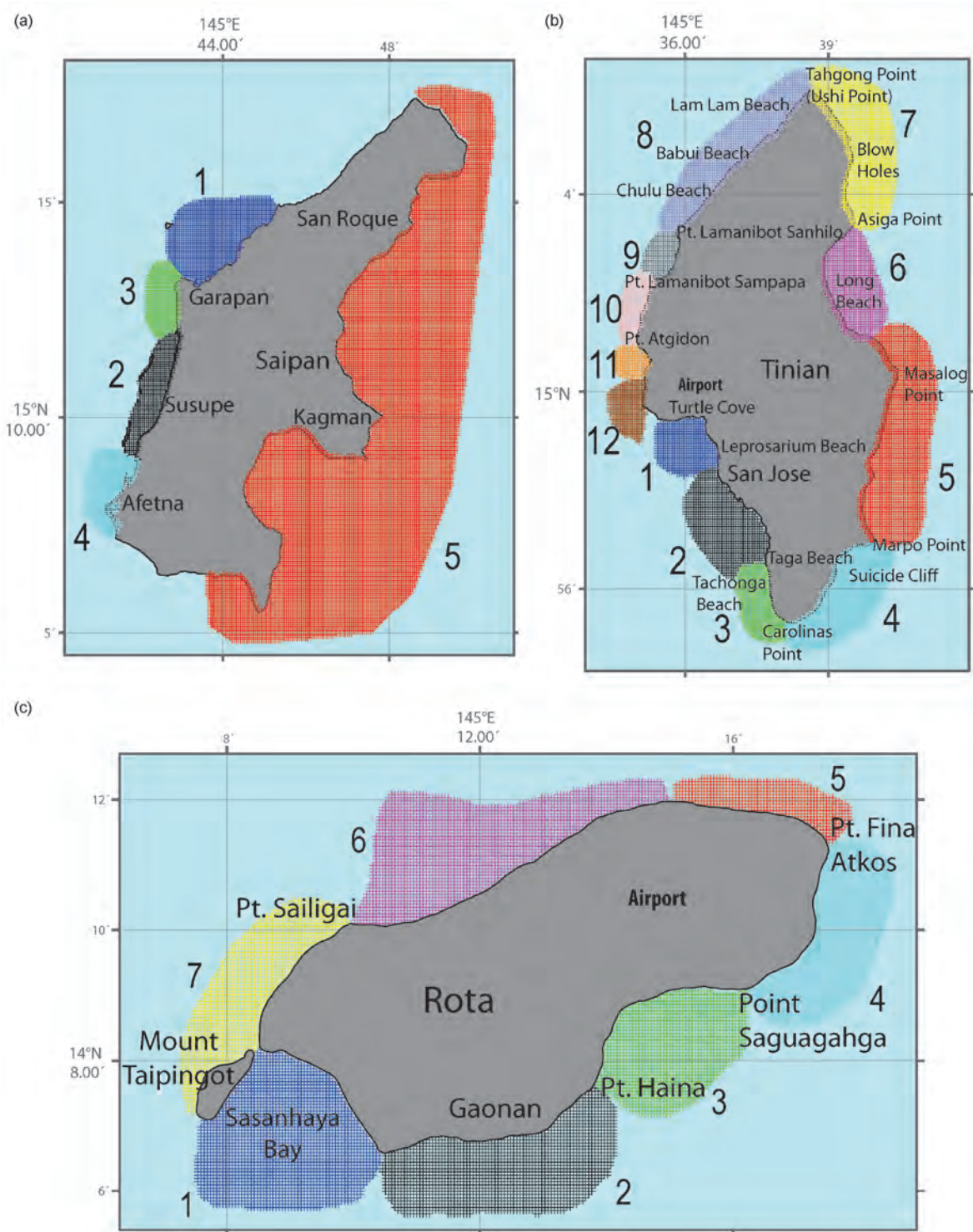
Figure 4.7: Outlines showing the reef segments on (a) Saipan, (b) Tinian, and (c) Rota selected for numerical computations at the color coded grid locations. Saipan's coastline was divided into 5 reefs, Tinian with 12, and Rota with 7 reef segments.
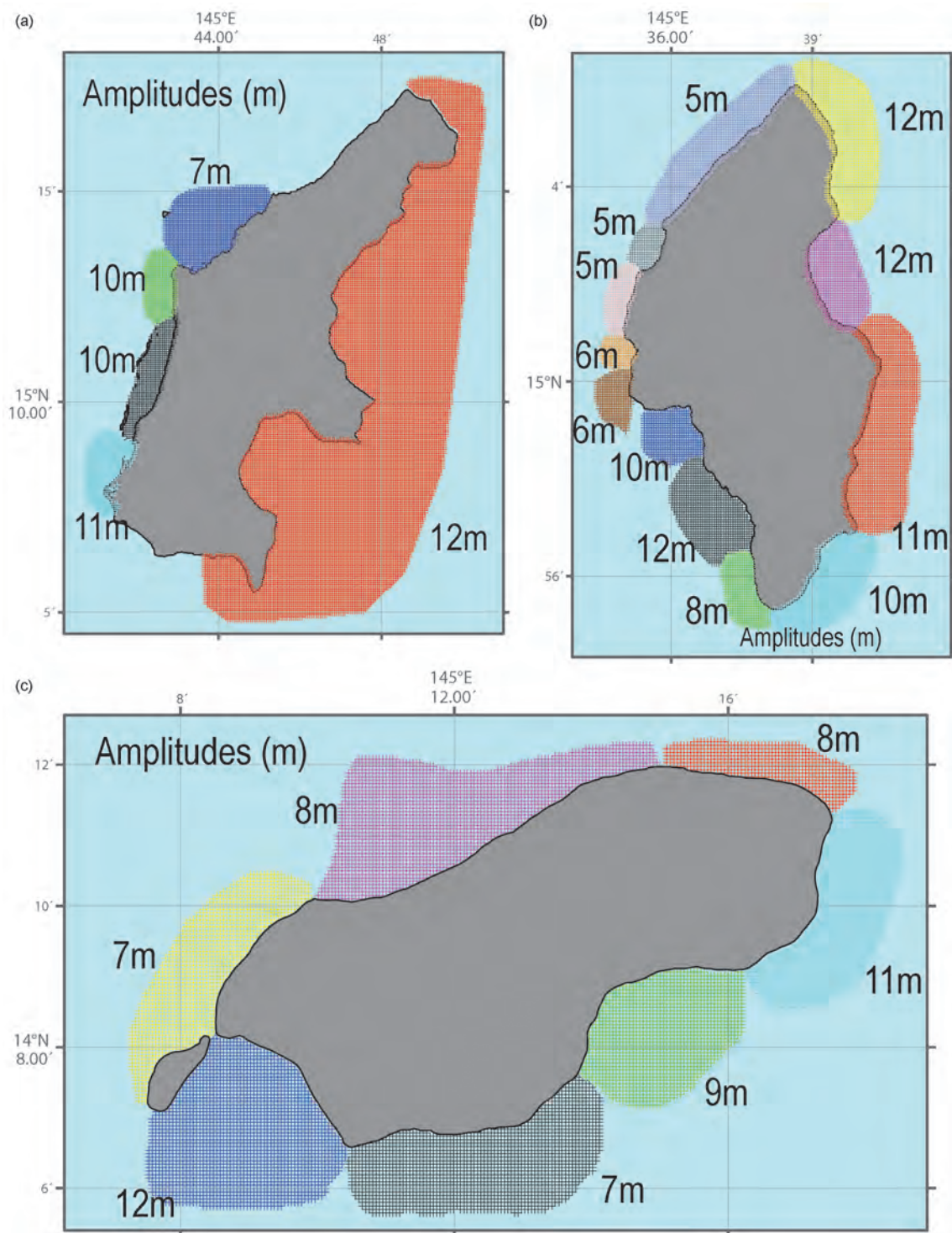
Figure 4.8: Predicted maximum tsunami amplitudes from 349 M_w 9.0 scenarios along the coasts of (a) Saipan, (b) Tinian, and (c) Rota. Tsunami amplitudes were computed for 5 Saipan locations, 12 Tinian locations, and 7 Rota locations.
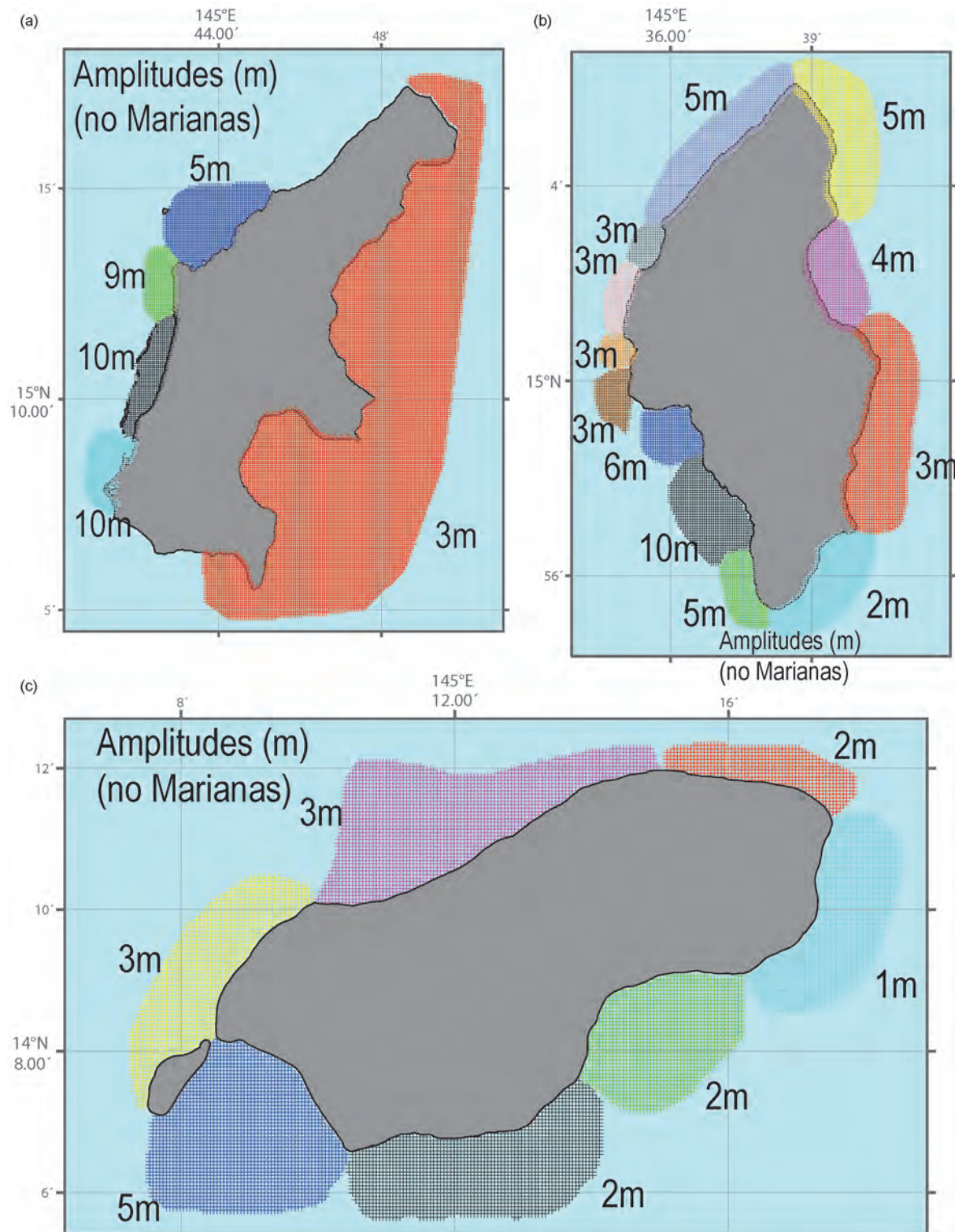
Figure 4.9: Predicted maximum tsunami wave amplitudes from 325 M_w 9.0 scenarios, near-field Marianas sources excluded from the full set, along the coasts of (a) Saipan, (b) Tinian, and (c) Rota. Tsunami amplitudes were computed for 5 Saipan locations, 12 Tinian locations, and 7 Rota locations.
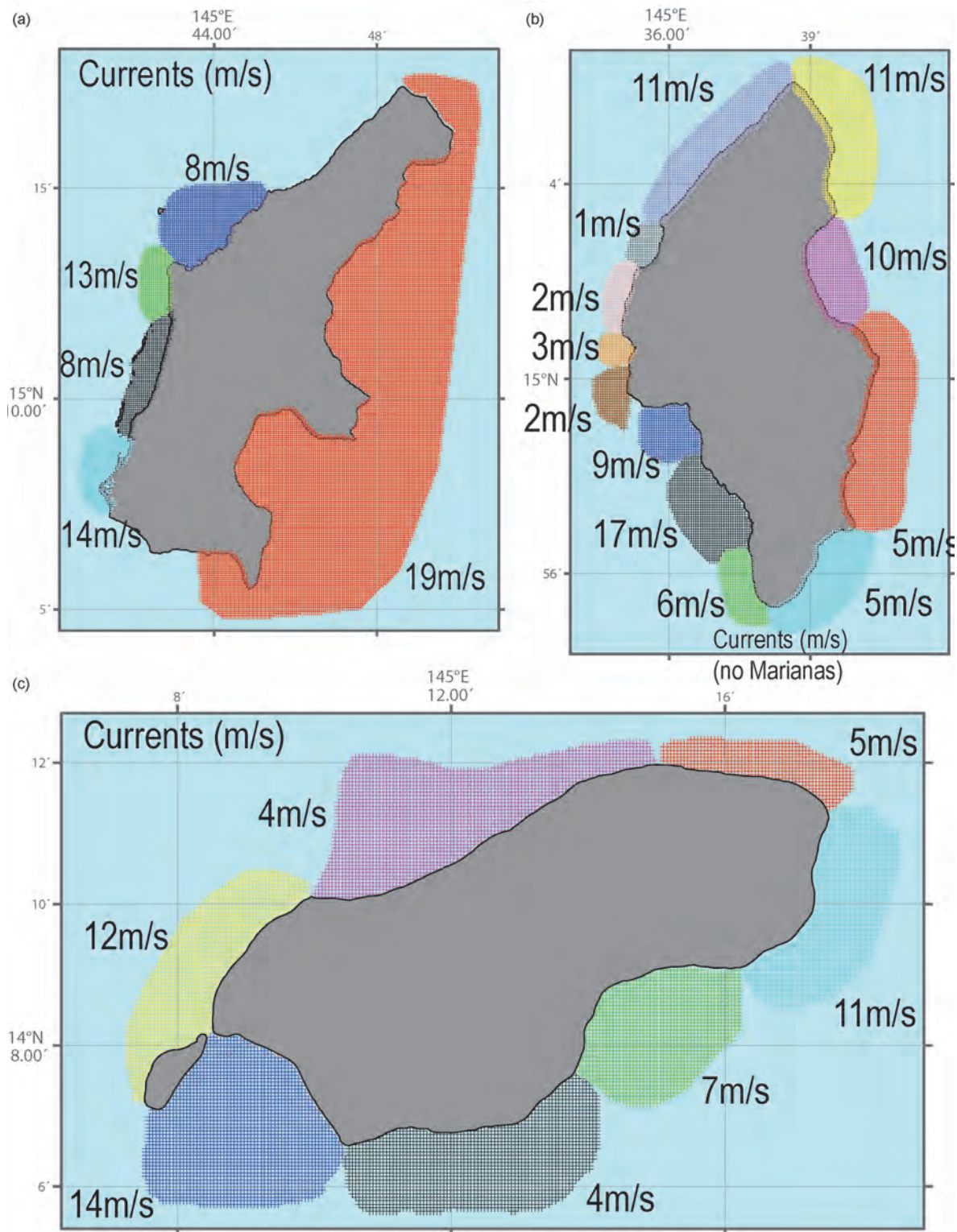
Figure 4.10: Predicted maximum tsunami currents from 349 M_w 9.0 scenarios along the coasts of (a) Saipan, (b) Tinian, and (c) Rota. Current speeds were computed for 5 Saipan locations, 12 Tinian locations, and 7 Rota locations.
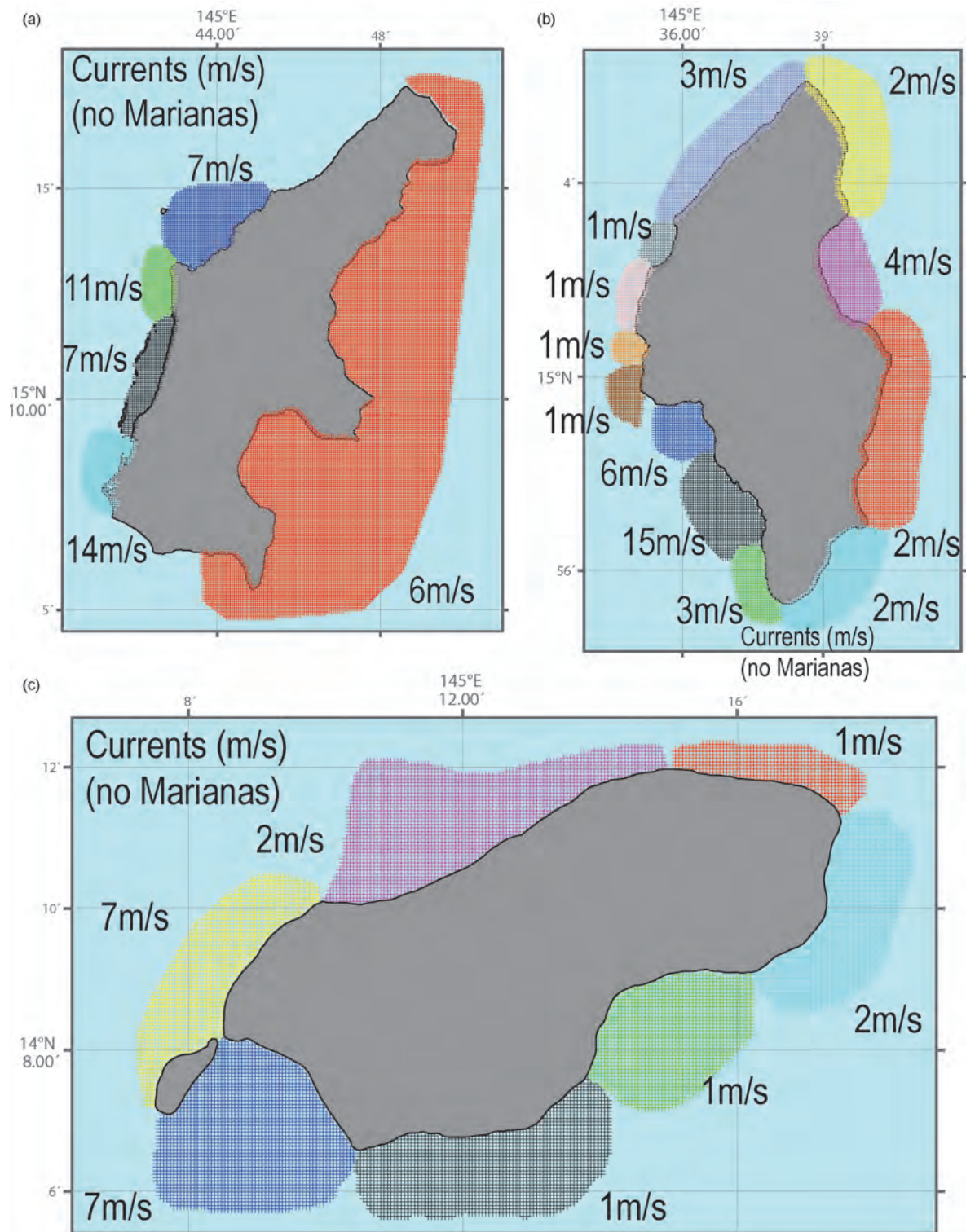
Figure 4.11: Predicted maximum tsunami currents from 325 M_w 9.0 scenarios, near-field Marianas sources excluded from full set, along the coasts of (a) Saipan, (b) Tinian, and (c) Rota. Current speeds were computed for 5 Saipan locations, 12 Tinian locations, and 7 Rota locations.
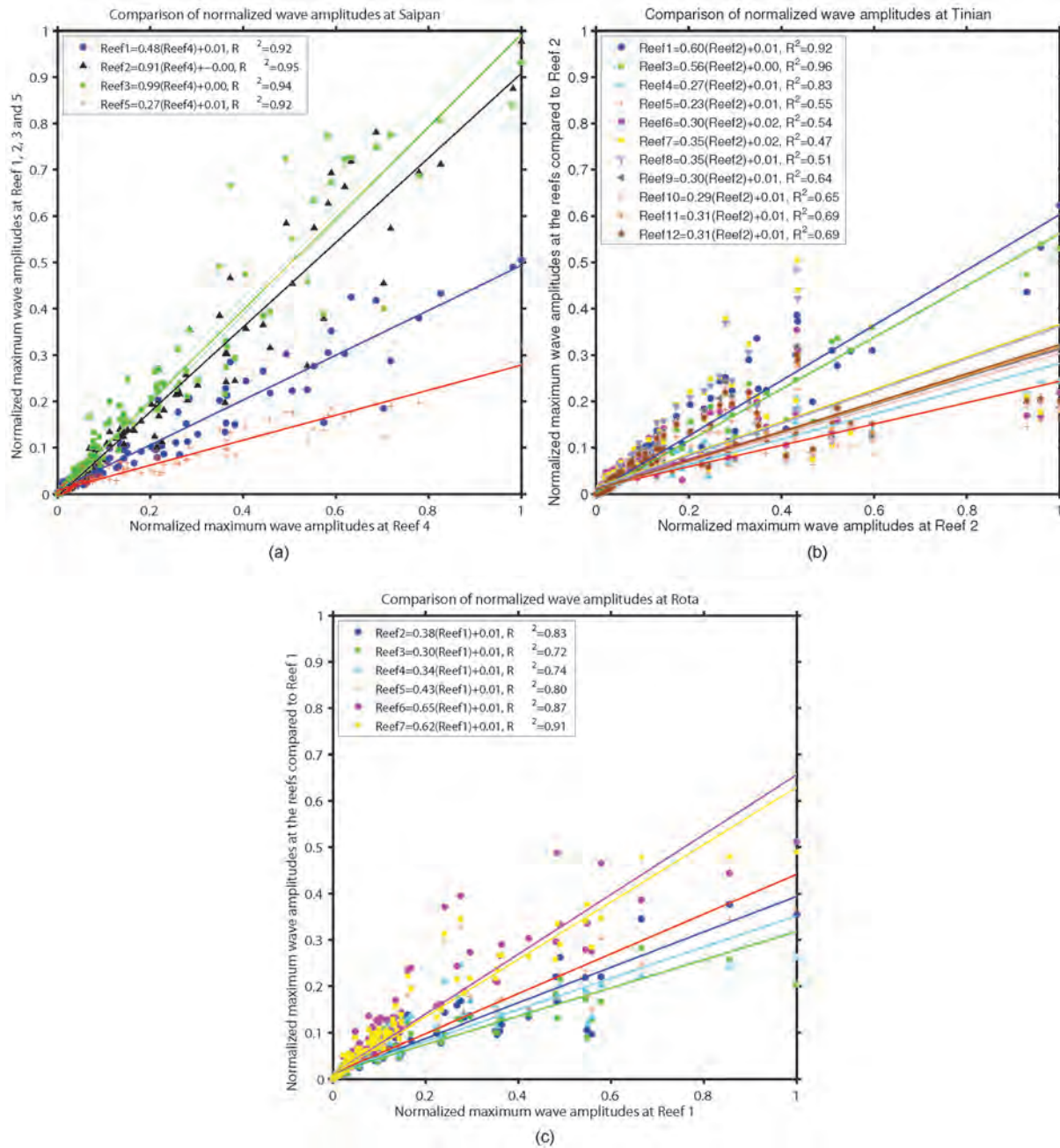
Figure 4.12: Comparison of computed wave amplitudes at the different reef segments encircling the coasts of Saipan, Tinian, and Rota. Note that each value is normalized by the maximum computed amplitude on that island and 26 scenarios from the Marianas are not included in this plot. (a) Predicted maximum amplitude from each scenario in different reefs compared to Reef 4 at Saipan. (b) Predicted maximum amplitude from each scenario in different reefs compared to Reef 2 at Tinian, and (c) Predicted maximum amplitude from each scenario in different reefs compared to Reef 1 at Rota.

5. Conclusion

A hazard assessment study conducted for the Commonwealth of the Northern Mariana Islands shows that the impact on the Commonwealth islands of Saipan, Tinian, and Rota would be disastrous in terms of lives, infrastructure, and property should a great earthquake occur in the near-field along the Mariana Trench. A tsunami from this near-field region would arrive at the islands in a relatively very short period of time after generation, so education, planning, and preparedness are fundamentally necessary. A large earthquake occurring elsewhere in the western Pacific also poses a great concern for the islands, but the time for reaction would be greater. The comprehensive sensitivity performed by modeling 349 M_w 9.0 earthquake-generated tsunamis with optimized grids resulted in identification of 26 hazardous scenarios. Results of this study suggest that a tsunami originating in the Western Aleutians, the Eastern Philippines, Japan, the Manus Trench, New Guinea, or Ryukyu-Nankai subduction zones could pose a significant hazard for the islands of Saipan, Tinian, and Rota.

Maximum wave heights and current speeds representing the envelope of maximum amplitudes from the subset of 26 most hazardous scenarios indicate that the western coastlines of the Commonwealth islands are particularly vulnerable to tsunamis generated in the far field. Sources along the Eastern Philippines subduction zone are thought to pose the greatest potential hazard to Tinian and Rota, as was previously determined for Guam. A tsunami with amplitudes exceeding 3 m may impact Rota, and a maximum tsunami amplitude exceeding 4 m may impact Tinian as a result of a tsunami generated by a M_w 9.0 earthquake in the Eastern Philippines. Saipan, while also impacted by a tsunami generated in the Eastern Philippines with amplitudes in excess of 4 m, may experience a tsunami exceeding 11 m in amplitude from a tsunami originating along the Ryukyu-Nankai subduction zone. Overall, sources along the Eastern Philippines and offshore southern Japan pose the highest potential for generating tsunamis with great impact along Northern Mariana Island coasts. Travel time for a tsunami originating in Japan or the Eastern Philippines is sufficient to allow for hazard mitigation.

The island of Rota, in contrast to Saipan and Tinian, and even Guam, is inherently different in terms of orientation, but orientation of all three islands coupled with their remote location in the Pacific Ocean is advantageous for warning. Tsunami waves tend to arrive relatively sooner at the eastern shores of the islands due to the orientation-guided inundation distance from a wide array of sources. Rota is closer to Guam than it is to Saipan and Tinian, and, correspondingly, the predicted impact in Rota turns out to be less than what is predicted for Saipan and Tinian from far-field tsunamis. Tinian has a uniformly steep shoreline with the exception of the area that includes San Jose, where most tsunami energy appears to focus, coincident with the location of much of the island's population. Saipan, Tinian, and Rota are not predicted as being at great hazard from Central or South American sources, nor from the majority of sources ringing Alaska and the Aleutian Islands.

Reefs appear to have the potential of mitigating the impact of tsunamis at some locations. The western side of Saipan, surrounded by fringing and barrier reefs, provided the opportunity to investigate the roles these reefs play in the protection of the island by dissipating wave energy. Wave amplitudes numerically computed for segments encircling Saipan as well as Tinian and Rota were compared as a means of evaluating reef interaction. Results indicate clearly that barrier reefs with an extended shallow shelf can reduce wave amplitude by approximately 48% when compared with amplitudes impacting coastlines at which no or short reef systems exist. Wave heights at locations with minimal offshore reef systems show little reduction, on order 1–9%. The fringing reef offshore Saipan appears to be too narrow to provide significant protection. The wider barrier reef, however, shows significant reduction in the computed wave amplitudes impacting Saipan's adjacent coastline. Still, significant wave energy is observed inside the reef and the possibility of significant impact exists, particularly from a tsunami originating in the western Pacific. The mitigating effect of the reefs offshore Tinian and Rota were not as conclusive as that for Saipan. The reef systems offshore these islands were not as pronounced or developed.

Models developed for this work have been proven robust and so may be considered for incorporation into the NOAA tsunami forecast system to enhance future warning capability. The Saipan model, in particular, successfully modeled the 2011 Tohoku tsunami impact on the island in real-time.

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Appendix A. Glossary

Arrival time   The time when the first tsunami wave is observed at a particular location, typically given in local and/or universal time, but also commonly noted in minutes or hours relative to the time of the earthquake.

Bathymetry   The measurement of water depth of an undisturbed body of water.

Cascadia Subduction Zone   Fault that extends from Cape Mendocino in Northern California northward to mid-Vancouver Island, Canada. The fault marks the convergence boundary where the Juan de Fuca tectonic plate is being subducted under the margin of the North America plate.

Current speed   The scalar rate of water motion measured as distance/time.

Current velocity   Movement of water expressed as a vector quantity. Velocity is the distance of movement per time coupled with direction of motion.

Digital Elevation Model (DEM)   A digital representation of bathymetry or topography based on regional survey data or satellite imagery. Data are arrays of regularly spaced elevations referenced to a map projection of the geographic coordinate system.

Epicenter   The point on the surface of the earth that is directly above the focus of an earthquake.

Focus   The point beneath the surface of the earth where a rupture or energy release occurs due to a buildup of stress or the movement of Earth's tectonic plates relative to one another.

Inundation   The horizontal inland extent of land that a tsunami penetrates, generally measured perpendicularly to a shoreline.

Marigram   Tide gauge recording of wave level as a function of time at a particular location. The instrument used for recording is termed a marigraph.

Method of Splitting Tsunamis (MOST)   A suite of numerical simulation codes used to provide estimates of the three processes of tsunami evolution: tsunami generation, propagation, and inundation.

Moment magnitude (M_w)   The magnitude of an earthquake on a logarithmic scale in terms of the energy released. Moment magnitude is based on the size and characteristics of a fault rupture as determined from long-period seismic waves.

Near–field   A particular location at which the earth's deformation due to energy release affects the modeling solution.

Propagation database   A basin-wide database of pre-computed water elevations and flow velocities at uniformly spaced grid points throughout the world oceans. Values are computed from tsunamis generated by earthquakes with a fault rupture at any one of discrete 100 × 50 km unit sources along worldwide subduction zones.

Runup   Vertical difference between the elevation of tsunami inundation and the sea level at the time of a tsunami. Runup is the elevation of the highest point of land inundated by a tsunami as measured relative to a stated datum, such as mean sea level.

Short-term Inundation Forecasting for Tsunamis (SIFT)   A tsunami forecast system that integrates tsunami observations in the deep ocean with numerical models to provide an estimate of tsunami wave arrival and amplitude at specific coastal locations while a tsunami propagates across an ocean basin.

Subduction zone   A submarine region of the Earth's crust at which two or more tectonic plates converge to cause one plate to sink under another, over-riding plate. Subduction zones are regions of high seismic activity.

Synthetic event   Hypothetical events based on computer simulations or theory of possible or even likely future scenarios.

Tele–tsunami or **distant tsunami** or **far–field tsunami**   Most commonly, a tsunami originating from a source greater than 1000 km away from a particular location. In some contexts, a tele-tsunami is one that propagates through deep ocean before reaching a particular location without regard to distance separation.

Tidal wave   Term frequently used incorrectly as a synonym for tsunami. A tsunami is unrelated to the predictable periodic rise and fall of sea level due to the gravitational attractions of the moon and sun (see **Tide**, below).

Tide   The predictable rise and fall of a body of water (ocean, sea, bay, etc.) due to the gravitational attractions of the moon and sun.

Tide gauge   An instrument for measuring the rise and fall of a column of water over time at a particular location.

Travel time   The time it takes for a tsunami to travel from the generating source to a particular location.

Tsunami   A Japanese term that literally translates to "harbor wave." Tsunamis are a series of long-period shallow water waves that are generated by the sudden displacement of water due to subsea disturbances such as earthquakes, submarine landslides, or volcanic eruptions. Less commonly, meteoric impact to the ocean or meteorological forcing can generate a tsunami.

Tsunami hazard assessment   A systematic investigation of seismically active regions of the world oceans to determine their potential tsunami impact at a particular location. Numerical models are typically used to characterize tsunami generation, propagation, and inundation, and to quantify the risk posed to a particular community from tsunamis generated in each source region investigated.

Tsunami propagation   The directional movement of a tsunami wave outward from the source of generation. The speed at which a tsunami propagates depends on the depth of the water column in which the wave is traveling. Tsunamis travel at a speed of 700 km/hr (450 mi/hr) over the average depth of 4000 m in the open deep Pacific Ocean.

Tsunami source   Location of tsunami origin, most typically an underwater earthquake epicenter. Tsunamis are also generated by submarine landslides, underwater volcanic eruptions, or, less commonly, by meteoric impact of the ocean.

Wave amplitude   The maximum vertical rise or drop of a column of water as measured from wave crest (peak) or trough to a defined mean water level state.

Wave crest or peak   The highest part of a wave or maximum rise above a defined mean water level state, such as mean lower low water.

Wave height   The vertical difference between the highest part of a specific wave (crest) and its corresponding lowest point (trough).

Wavelength   The horizontal distance between two successive wave crests or troughs.

Wave period   The length of time between the passage of two successive wave crests or troughs as measured at a fixed location.

Wave trough   The lowest part of a wave or the maximum drop below a defined mean water level state, such as mean lower low water.

Appendix B. Saipan
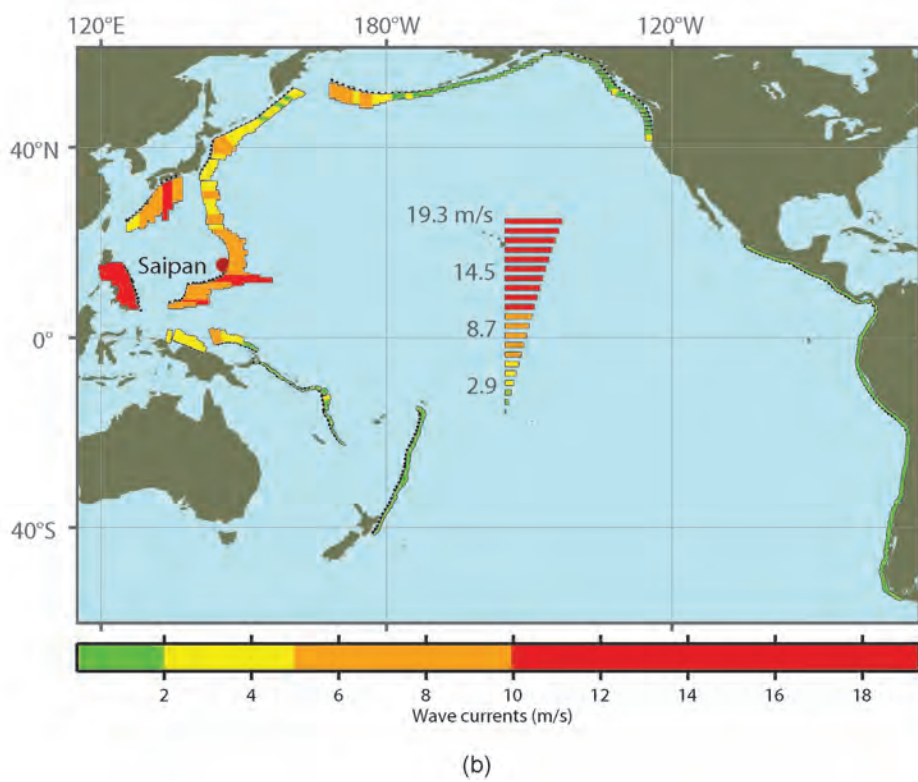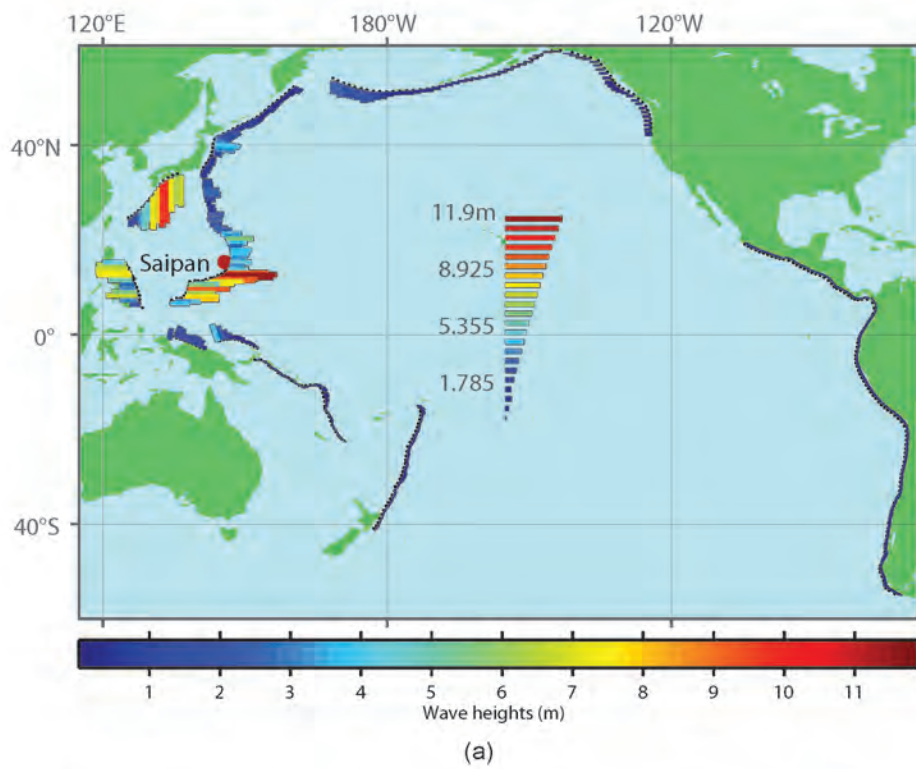
Figure B1: Computed maximum tsunami amplitude (a) and current speed (b) predicted to impact the island of Saipan from tsunamis triggered by synthetic M_w 9.0 earthquakes along subduction zones around the Pacific Basin. The optimized tsunami forecast model was used for all model runs.
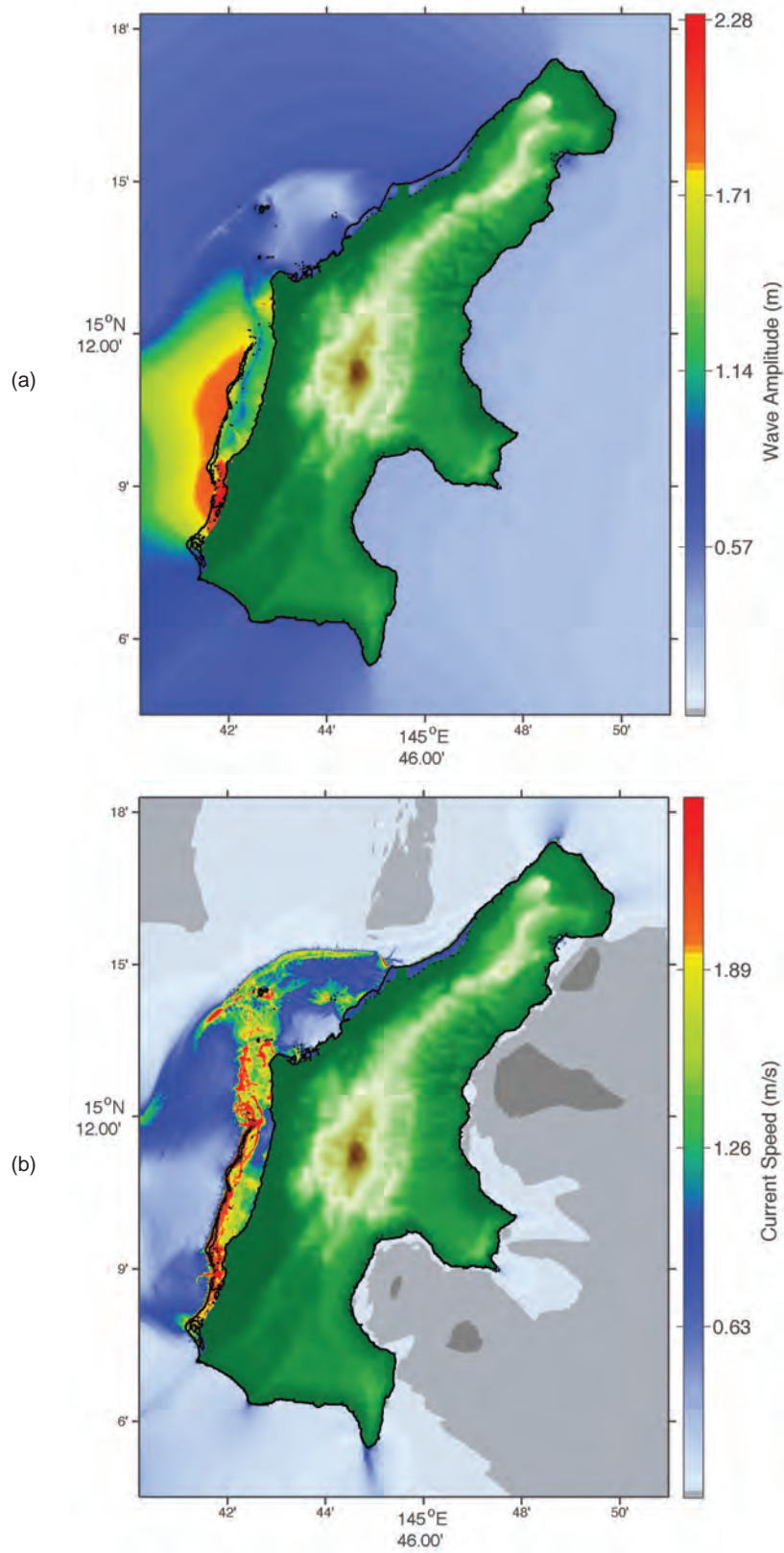
Figure B2: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 01 scenario.
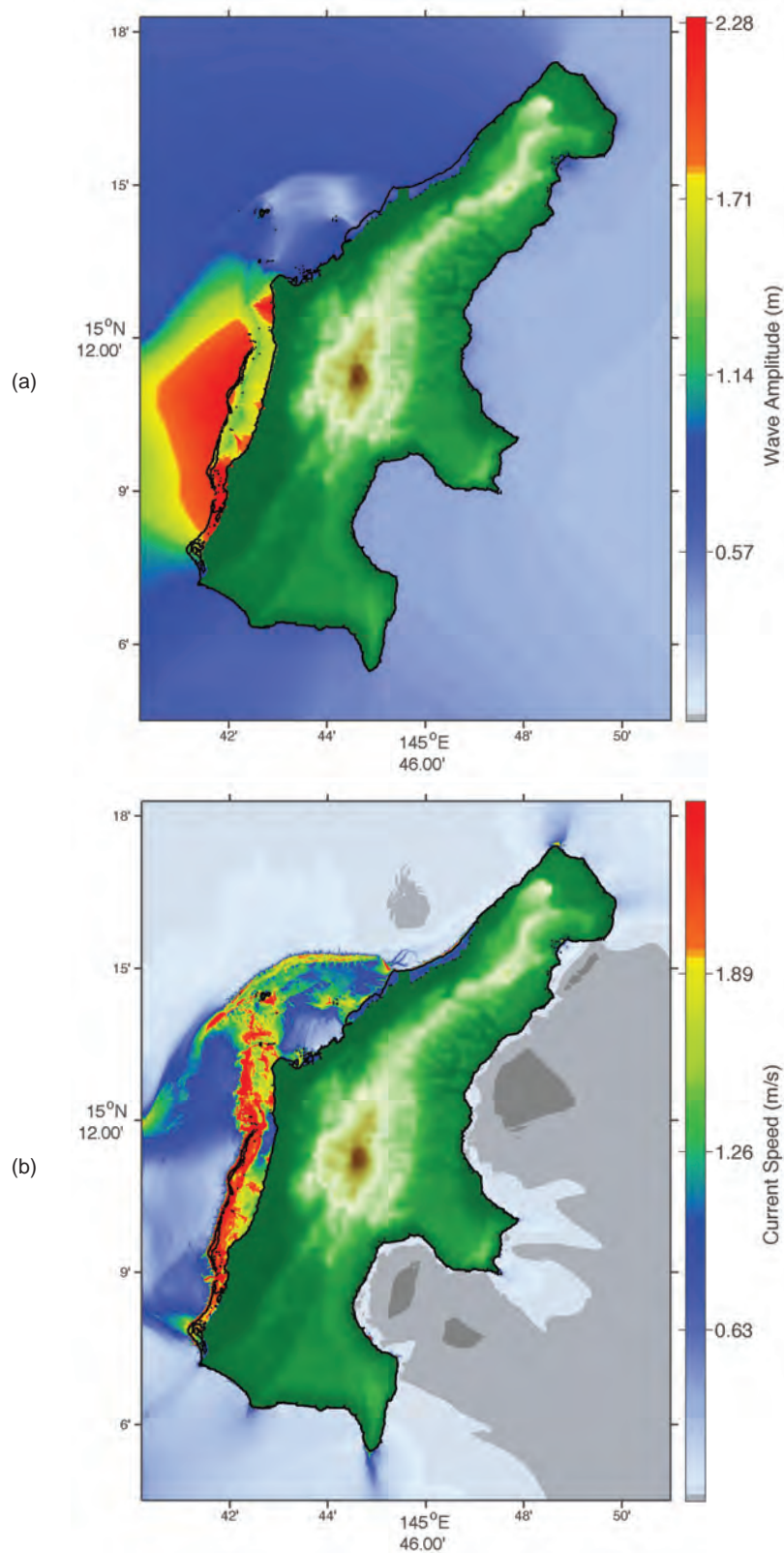
Figure B3: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 02 scenario.
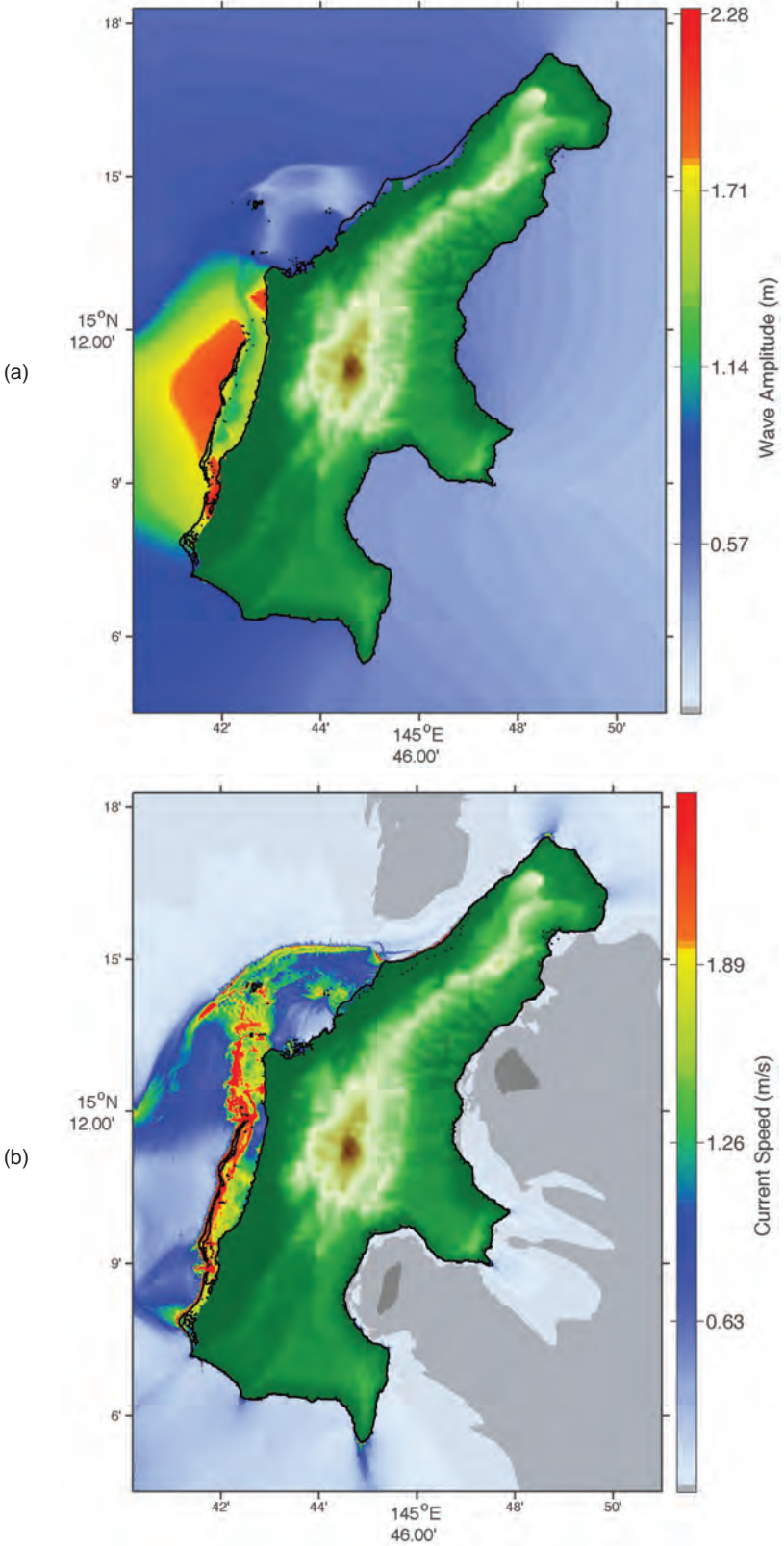
Figure B4: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 03 scenario.
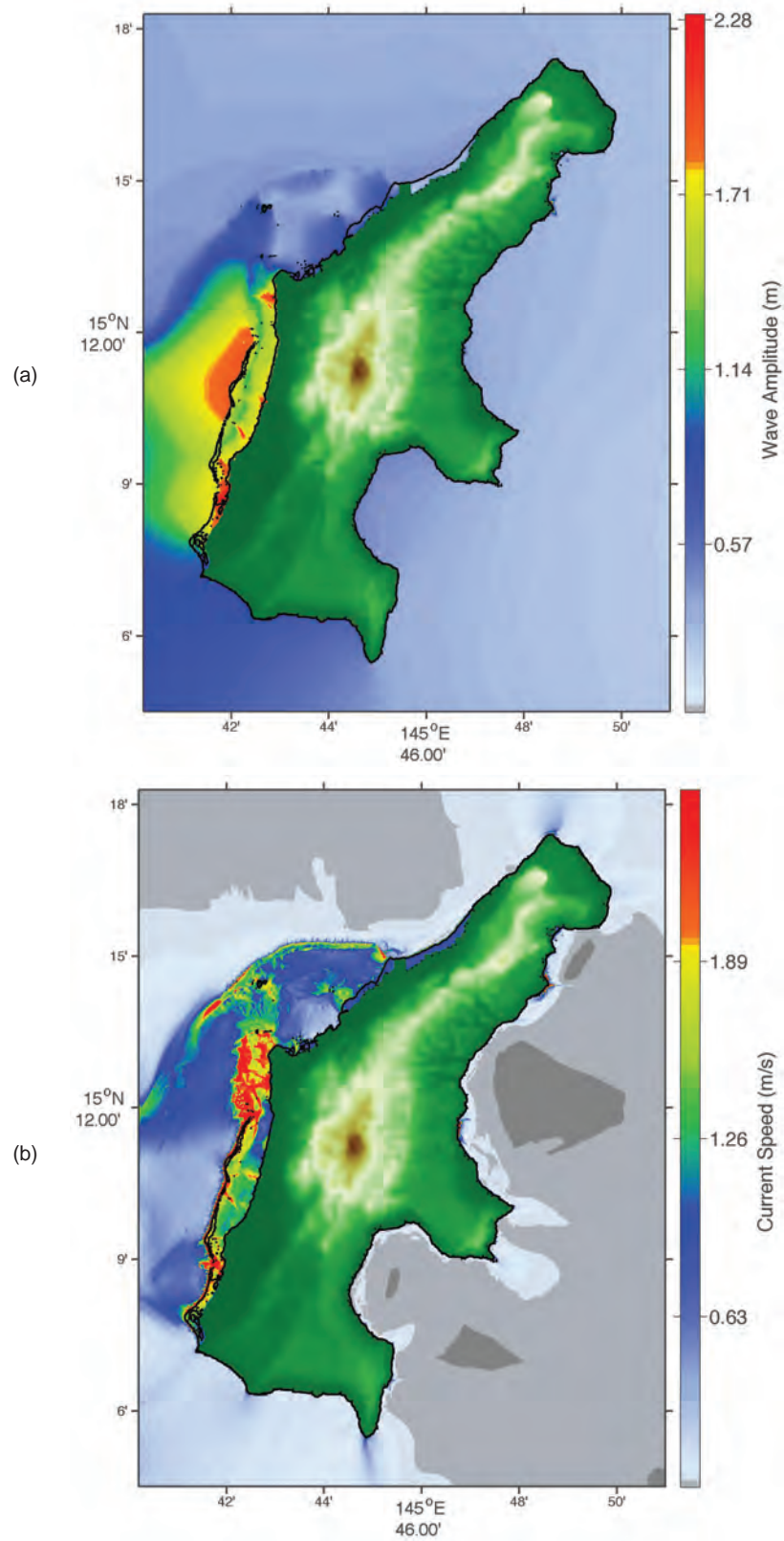
Figure B5: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 06 scenario.
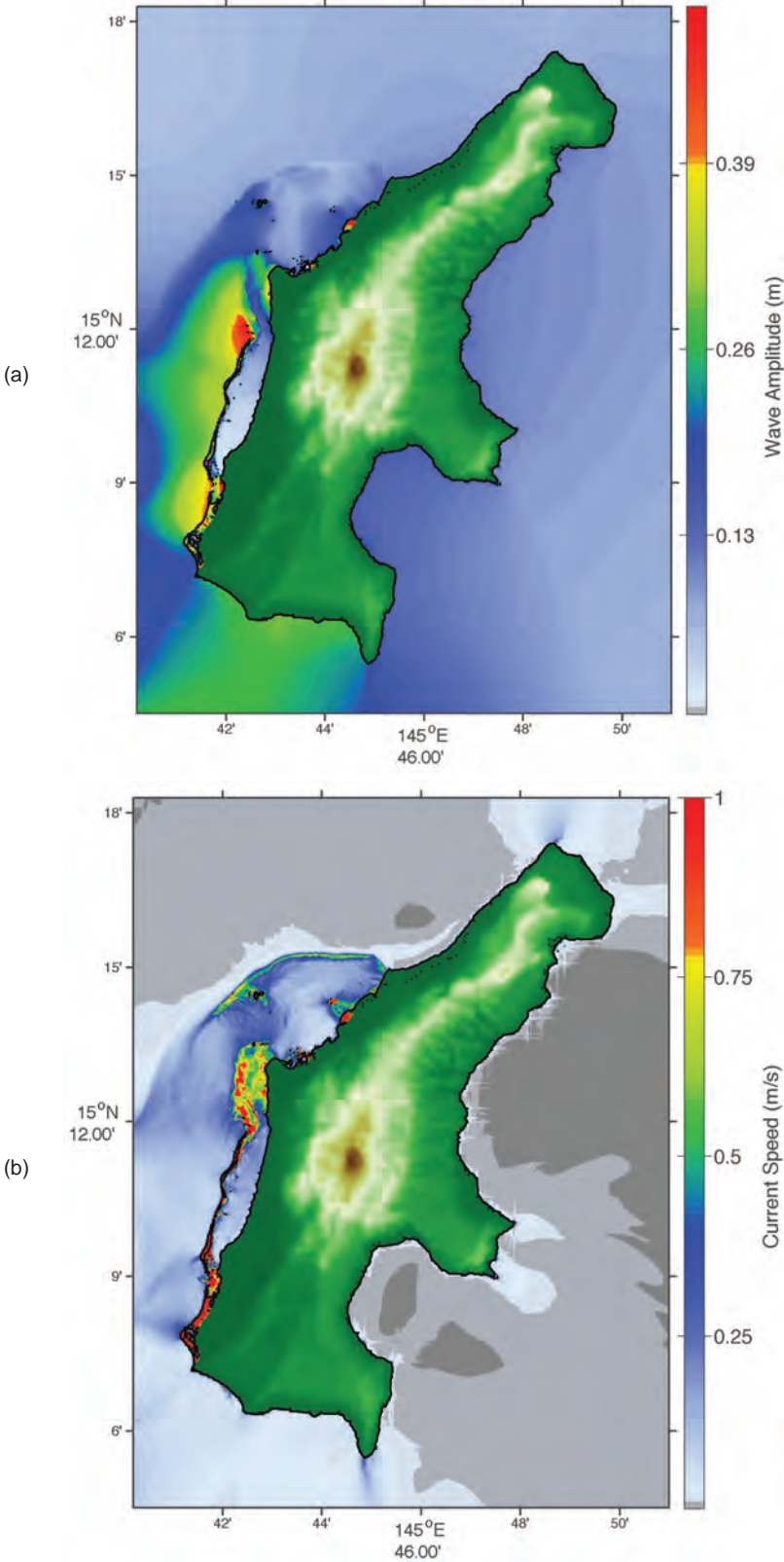
Figure B6: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 45 scenario.
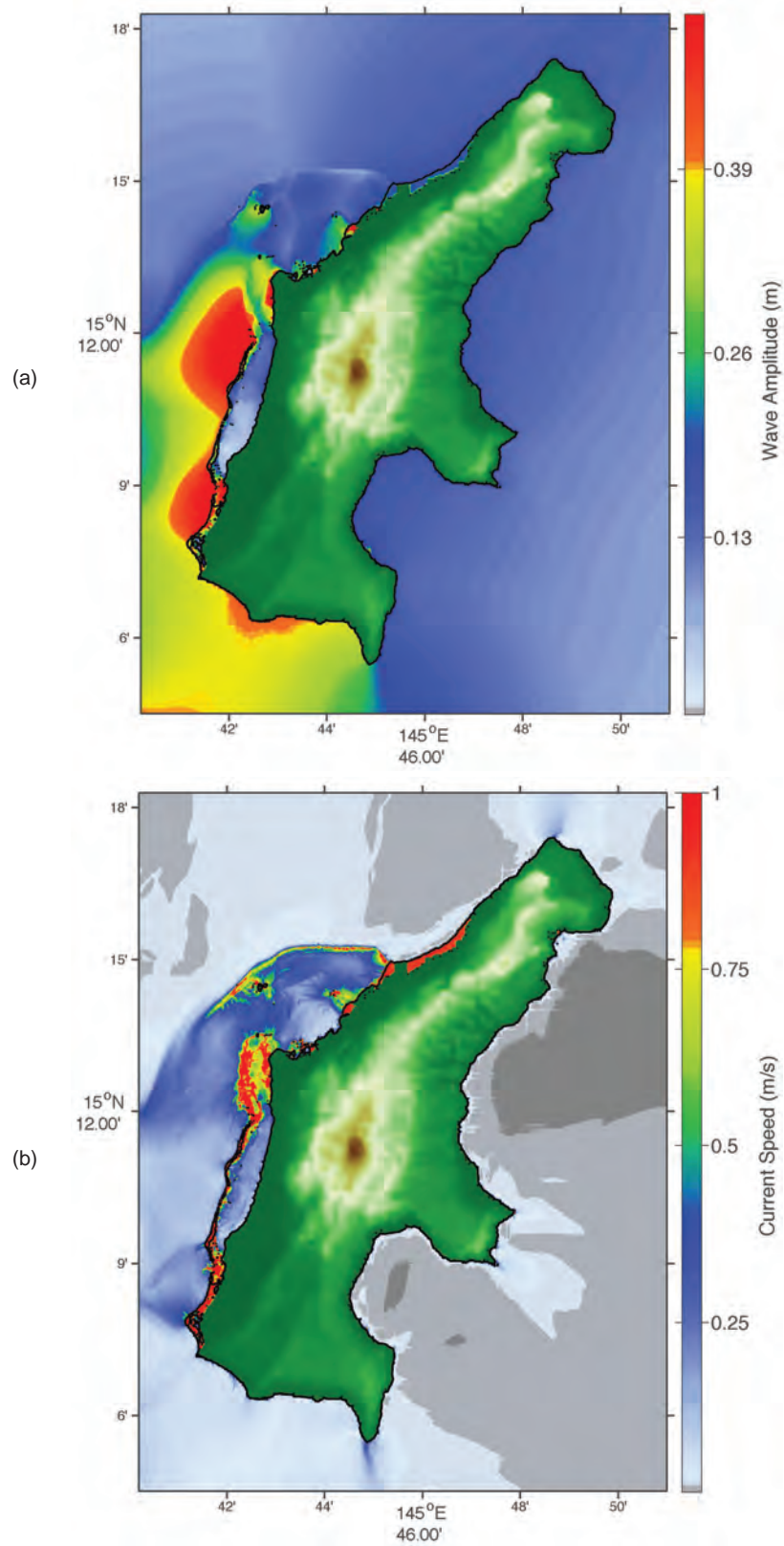
Figure B7: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 47 scenario.
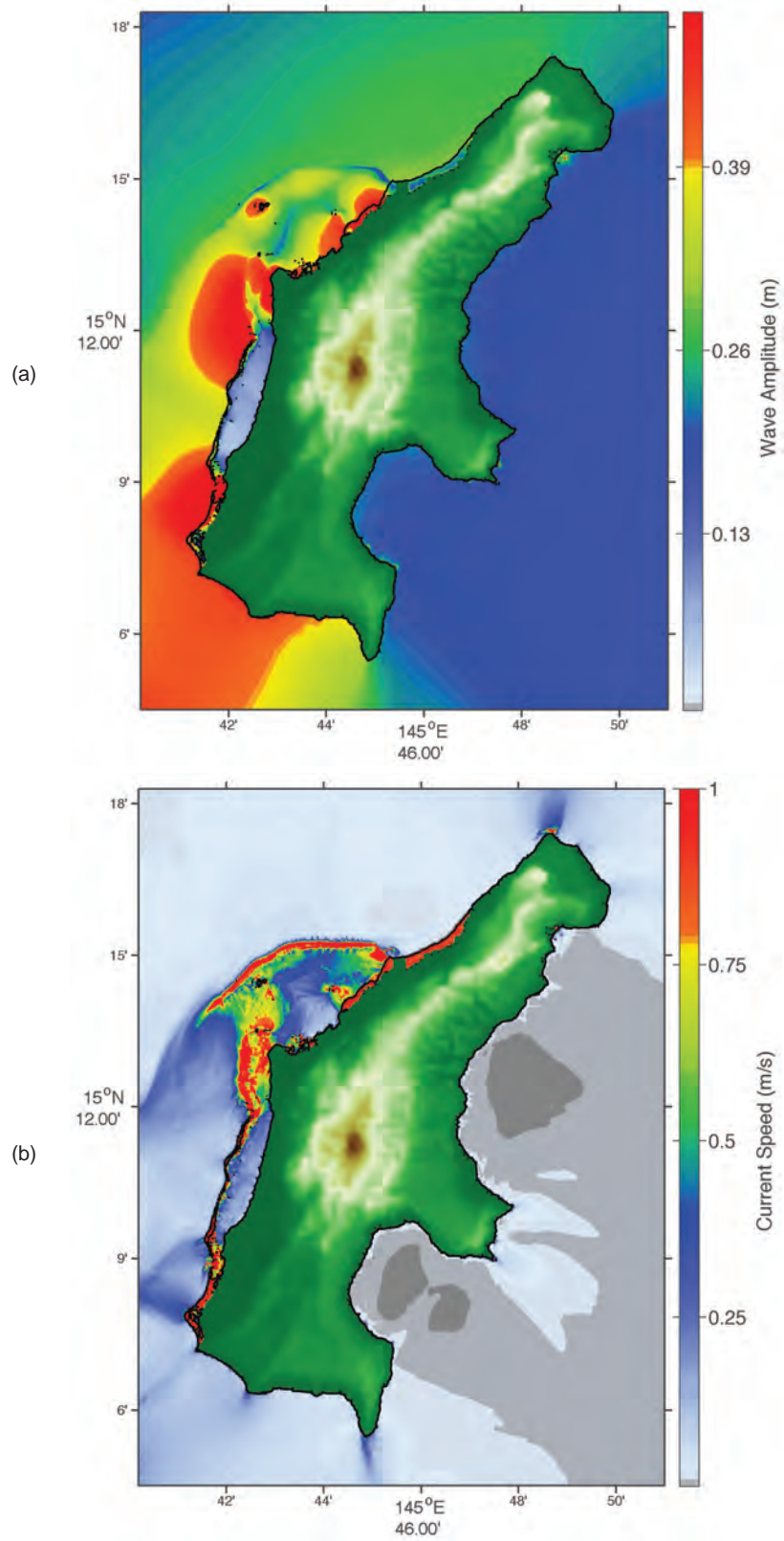
Figure B8: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the ACSZ 59 scenario.
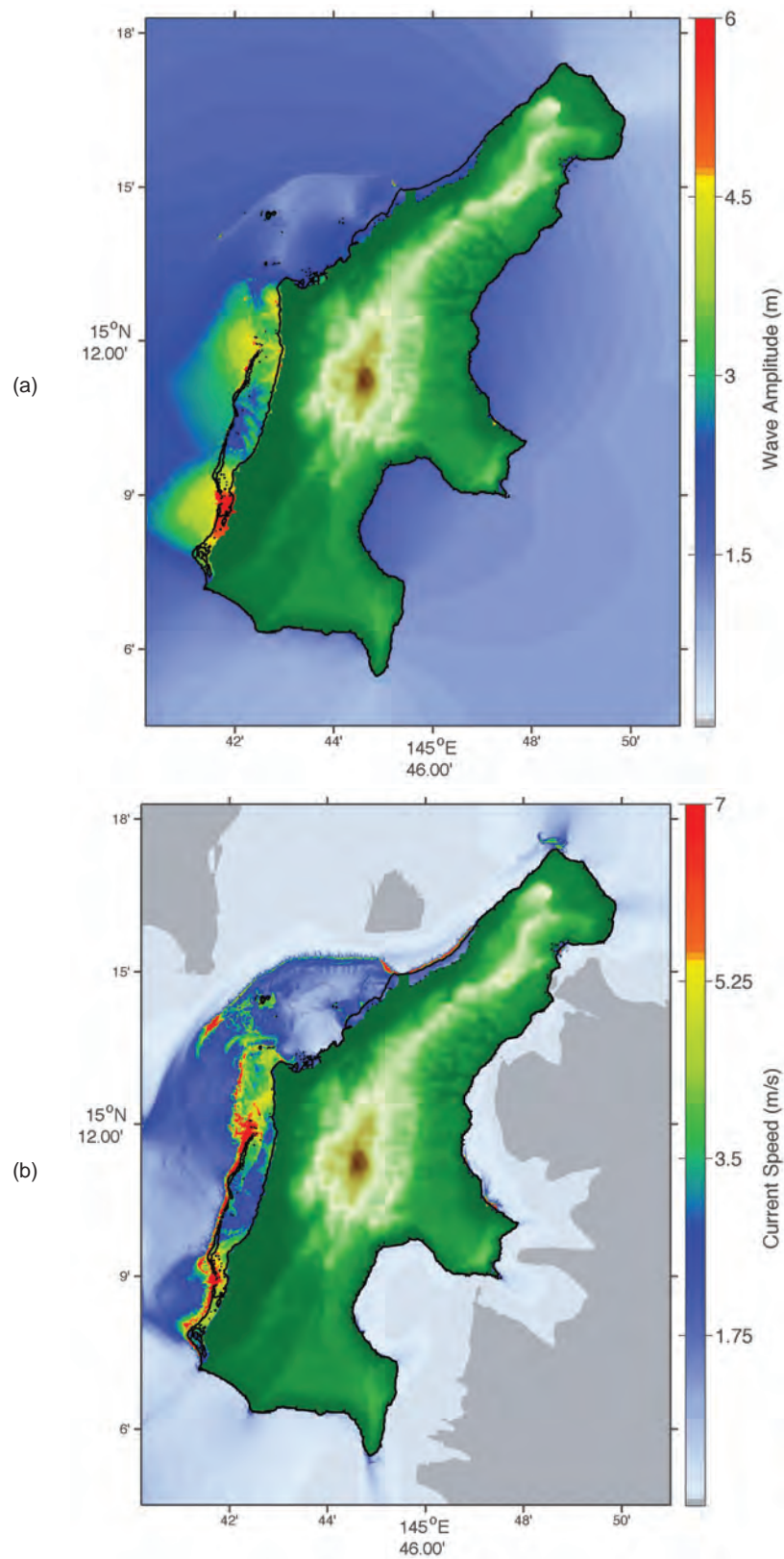
Figure B9: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the EPSZ 08 scenario.
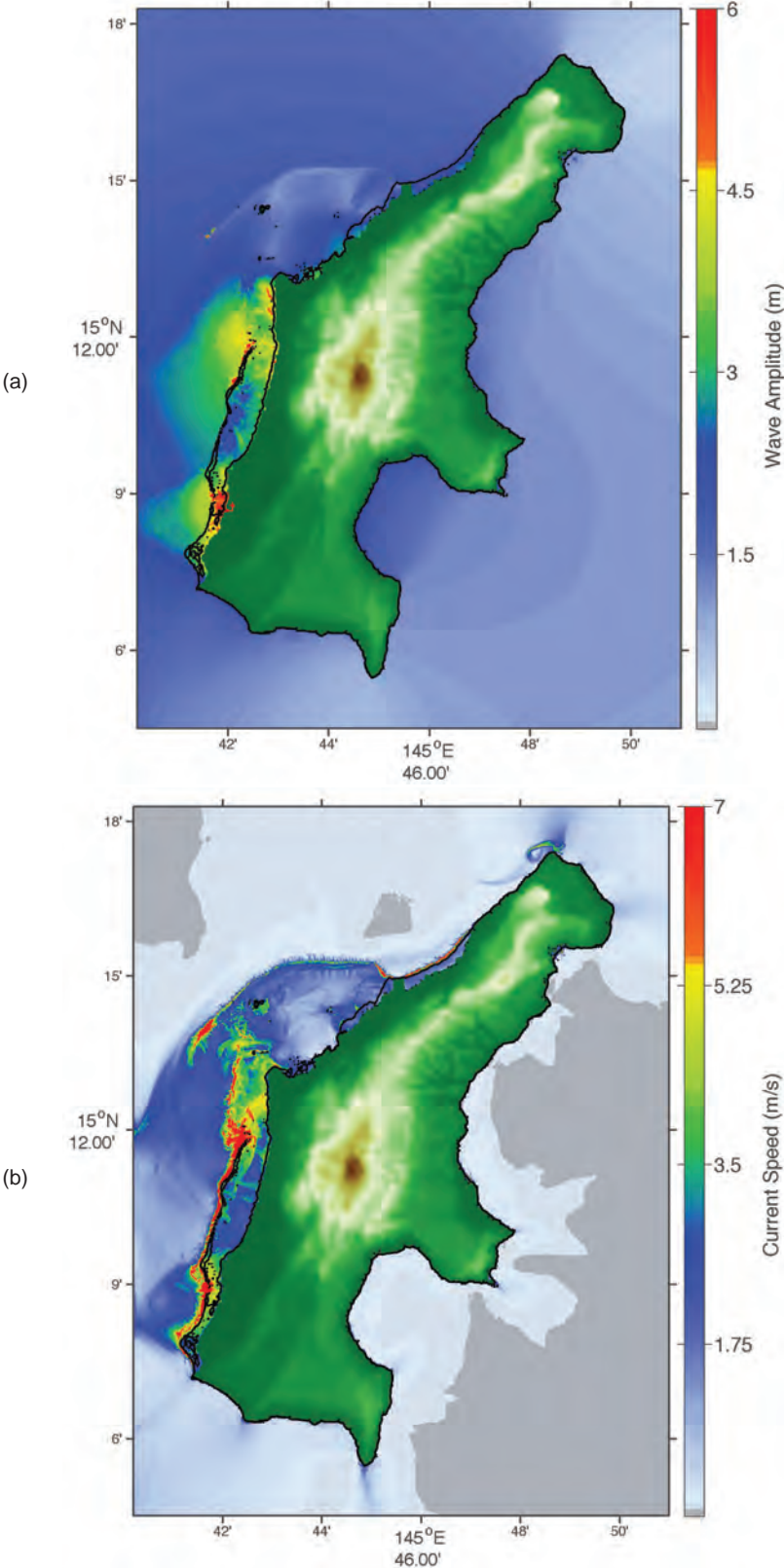
Figure B10: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the EPSZ 09 scenario.
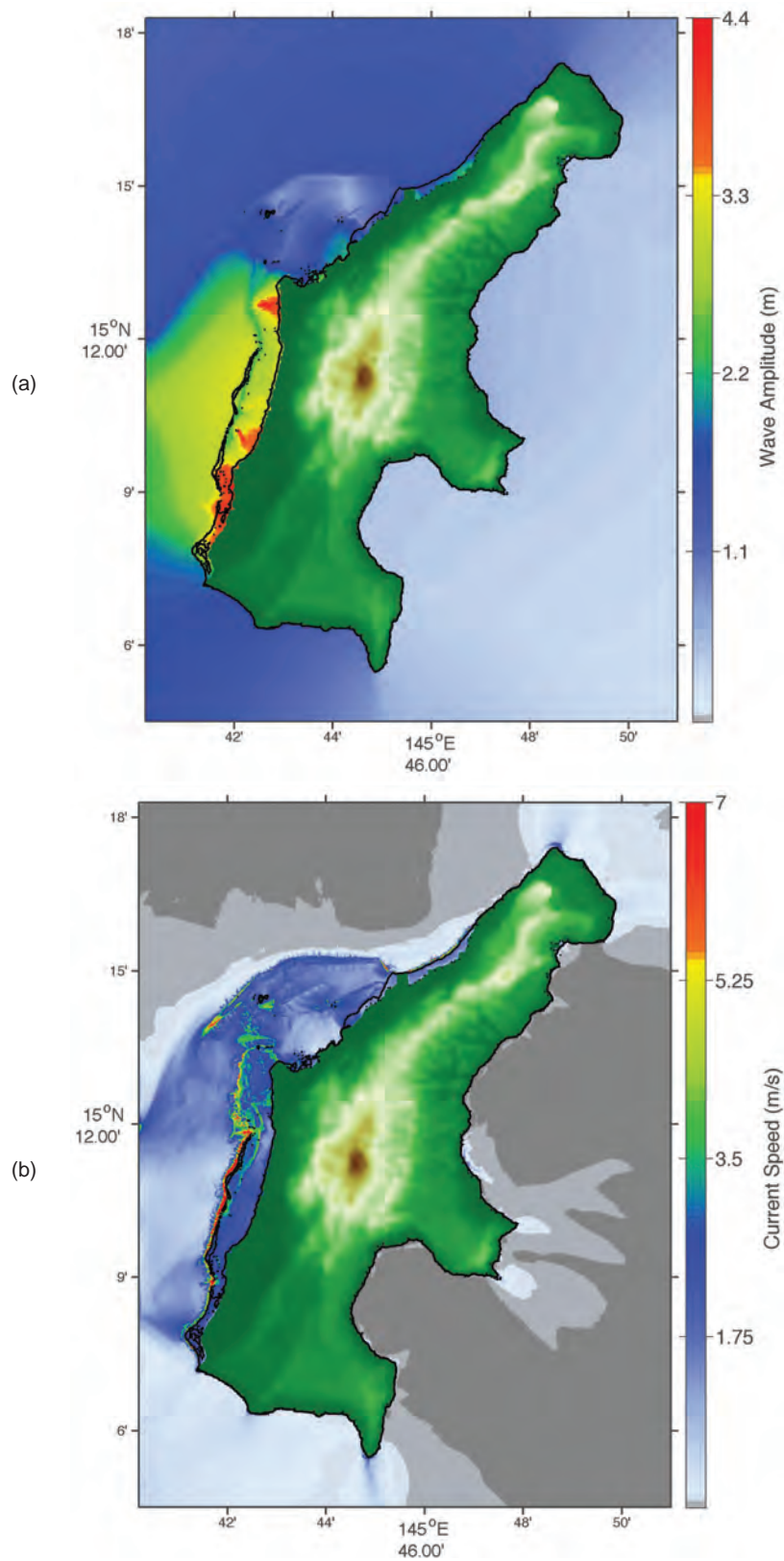
Figure B11: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 20 scenario.
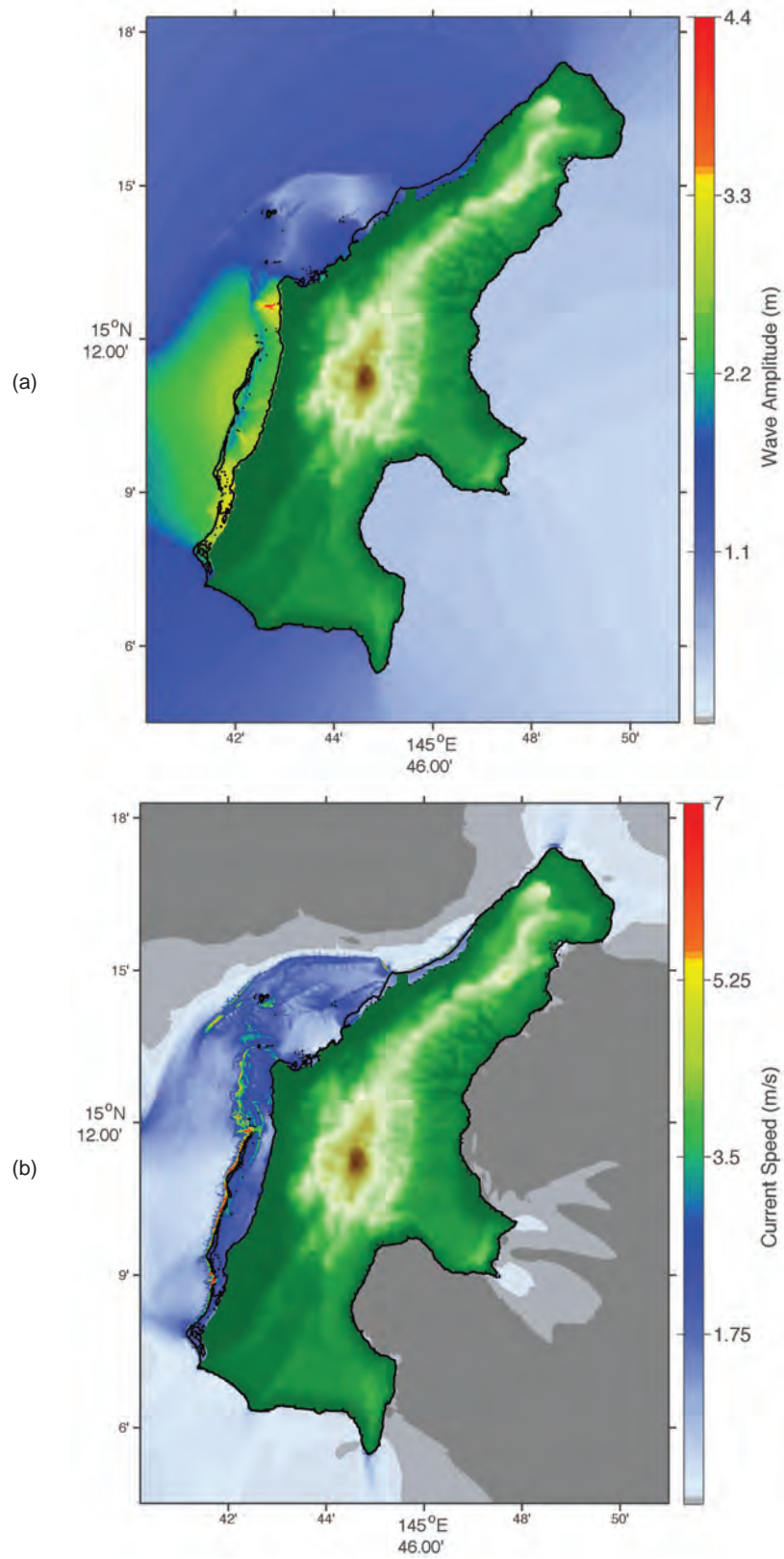
Figure B12: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 21 scenario.
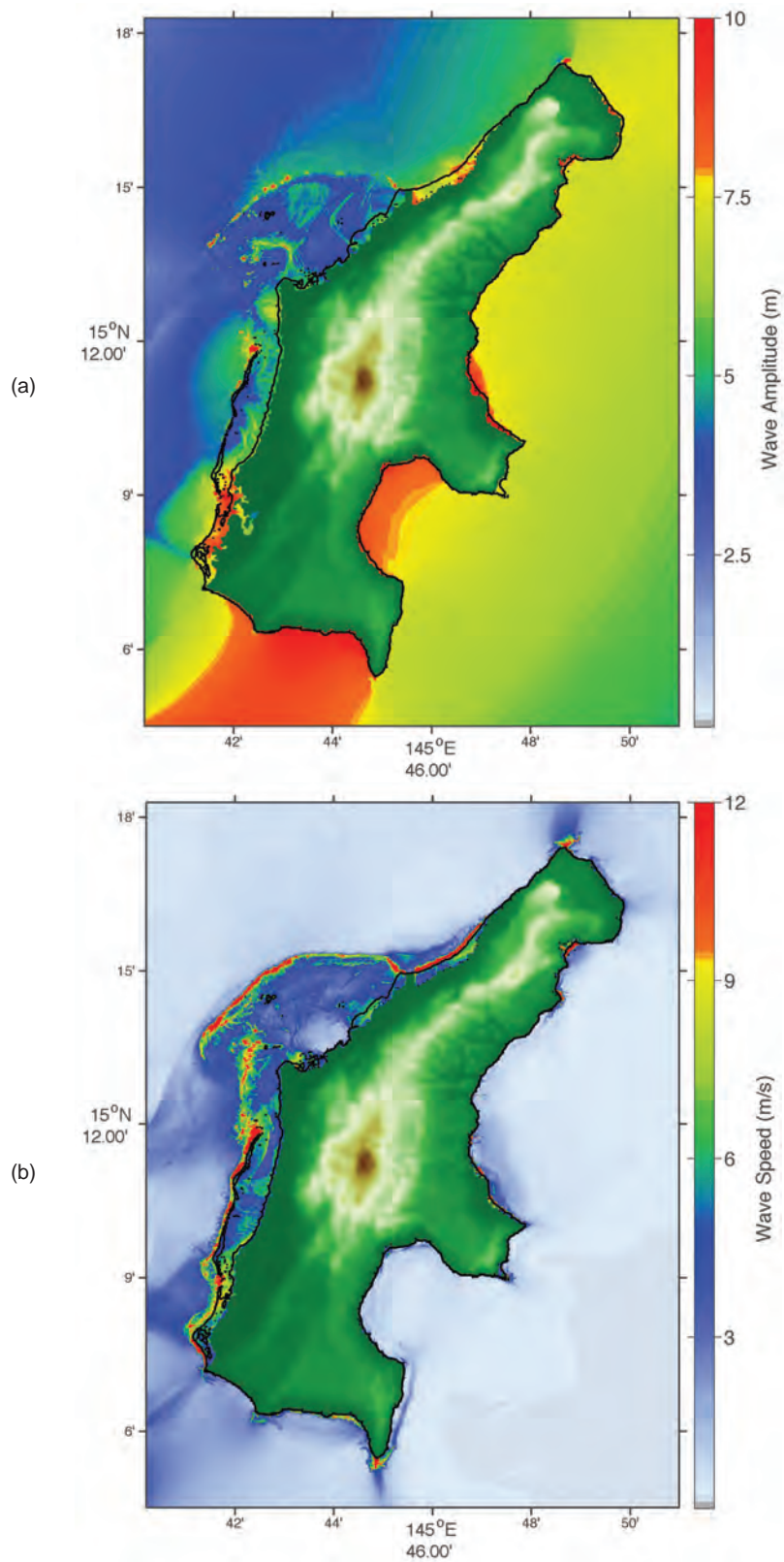
Figure B13: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 53 scenario.
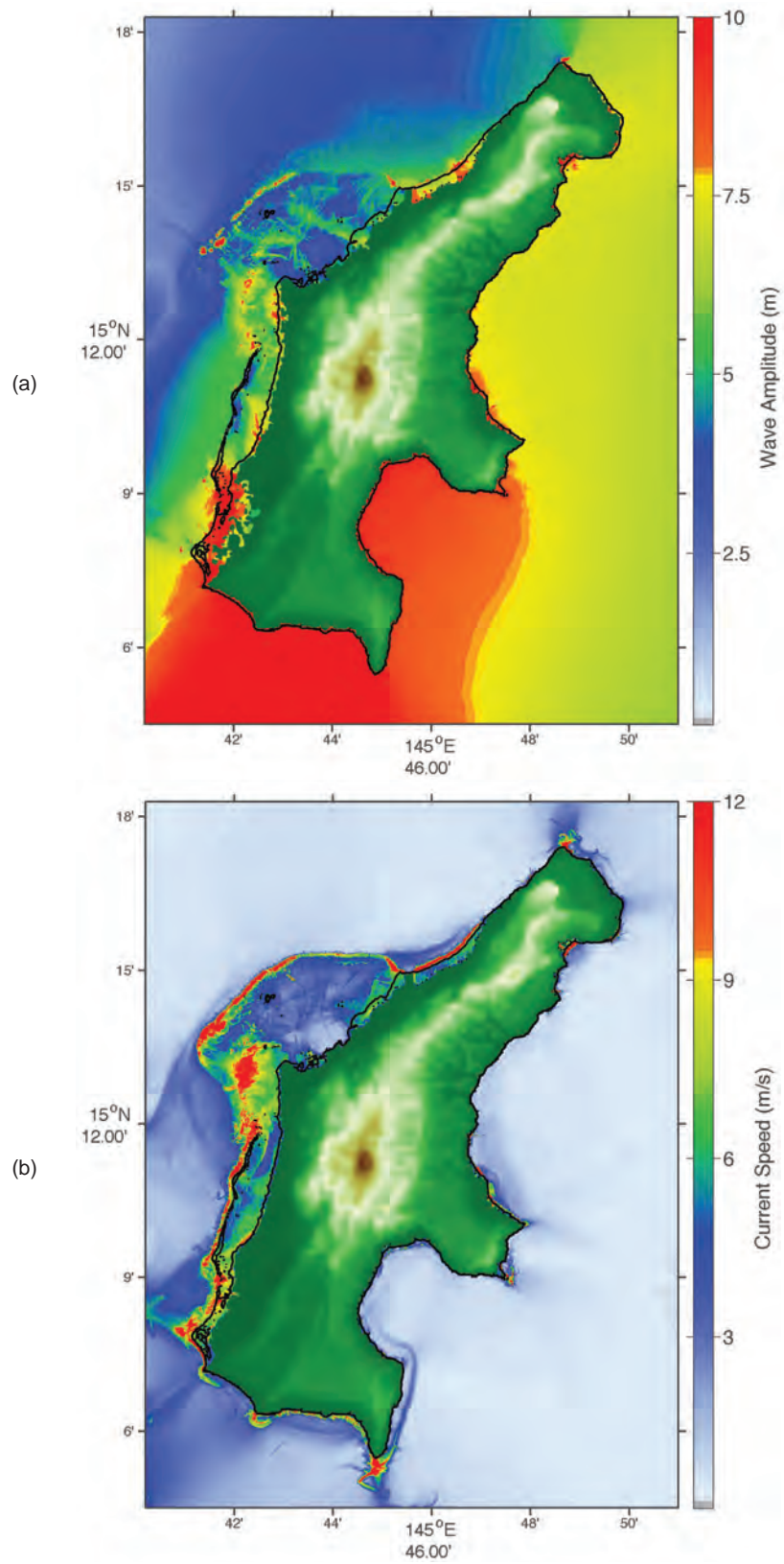
Figure B14: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 54 scenario.
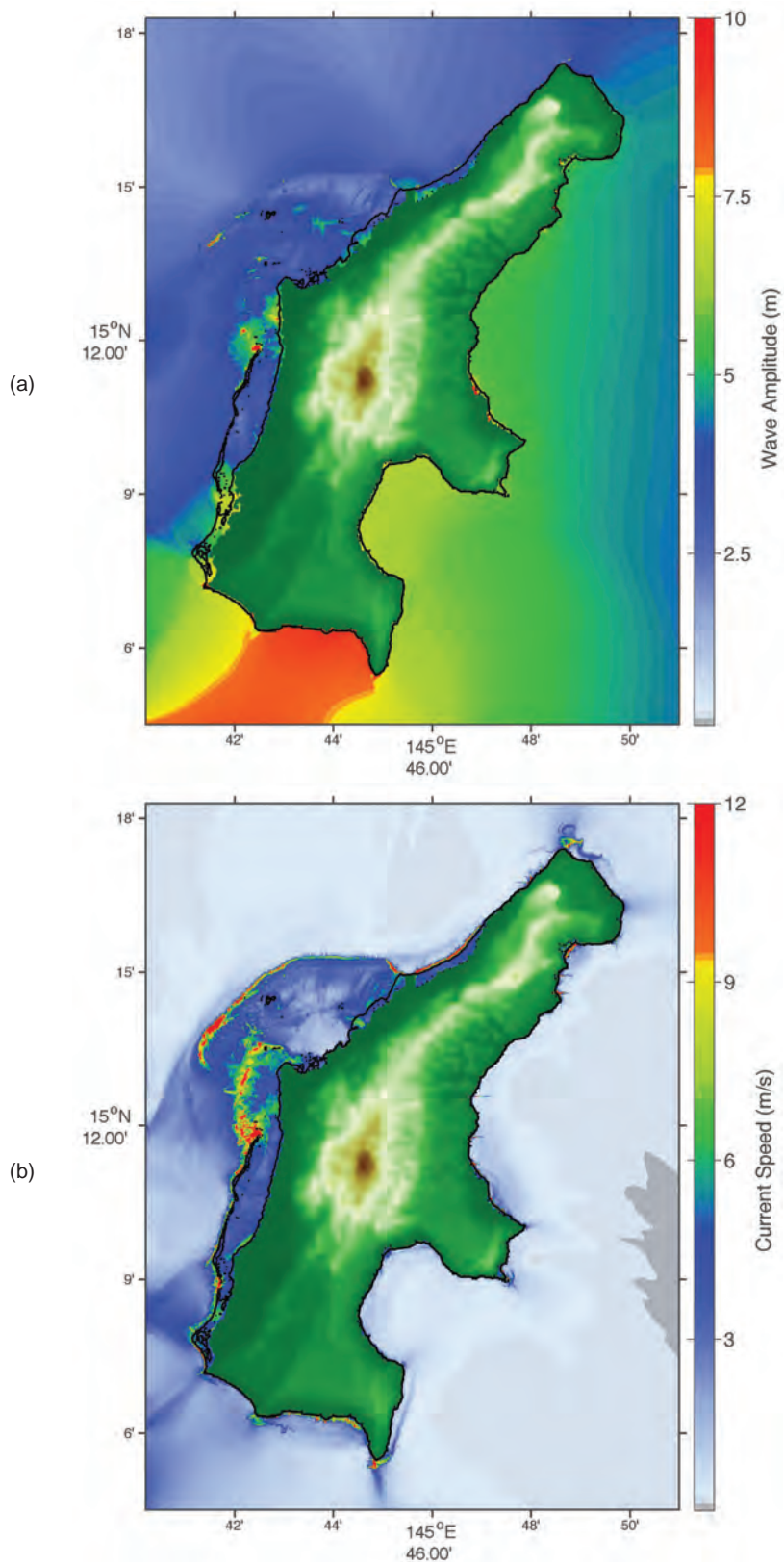
Figure B15: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 55 scenario.
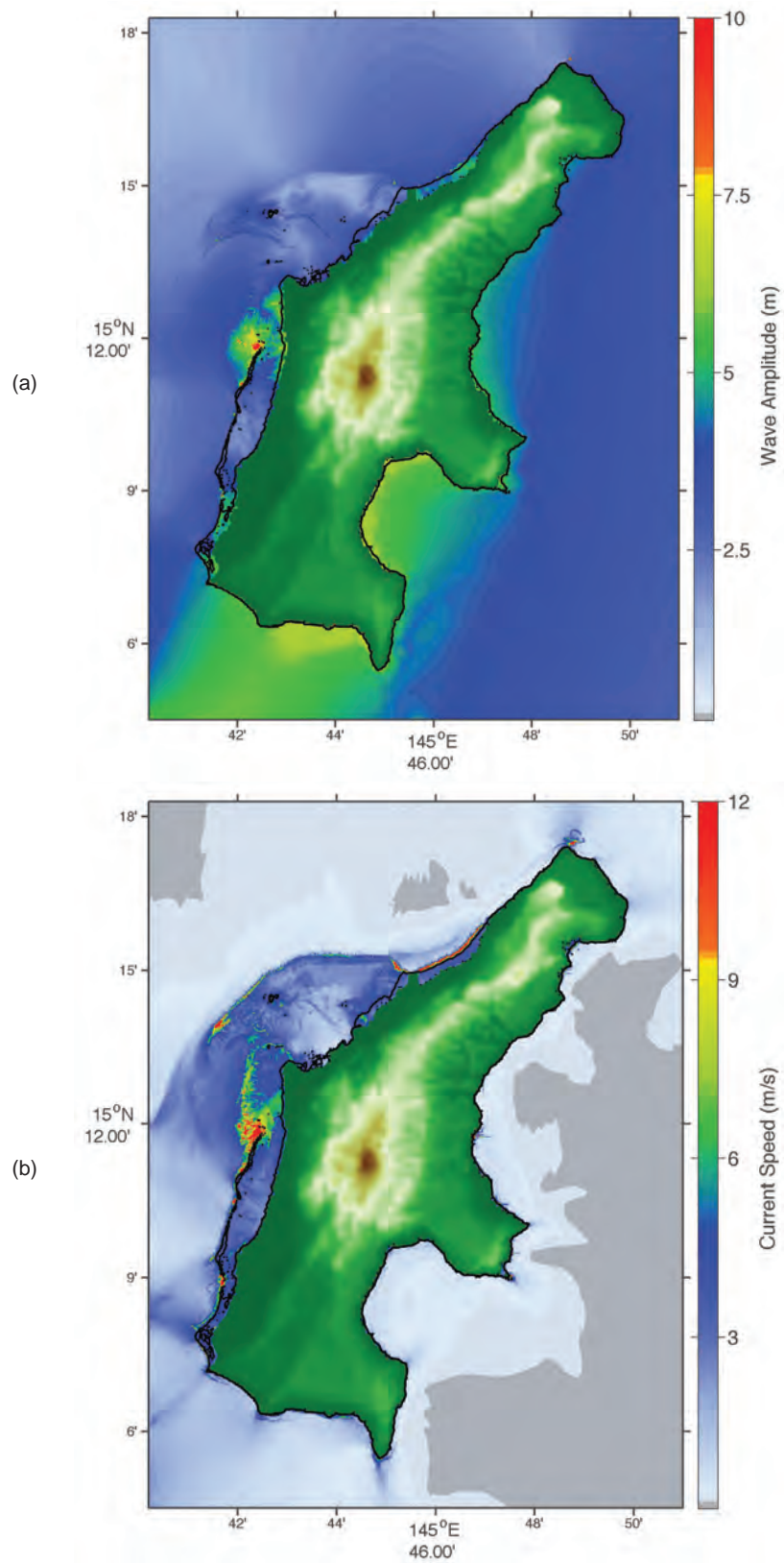
Figure B16: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the KISZ 56 scenario.
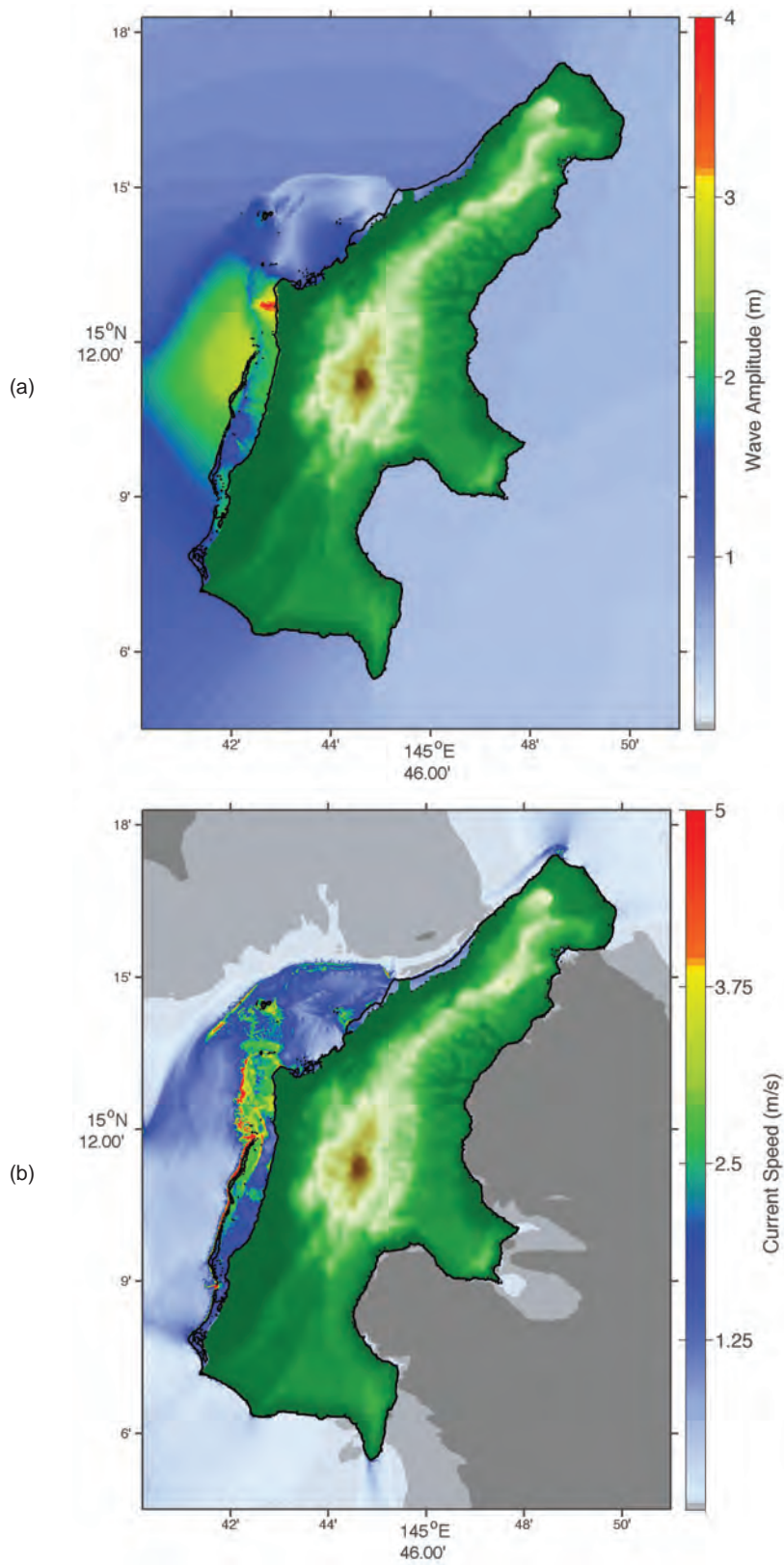
Figure B17: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the MOSZ 10 scenario.
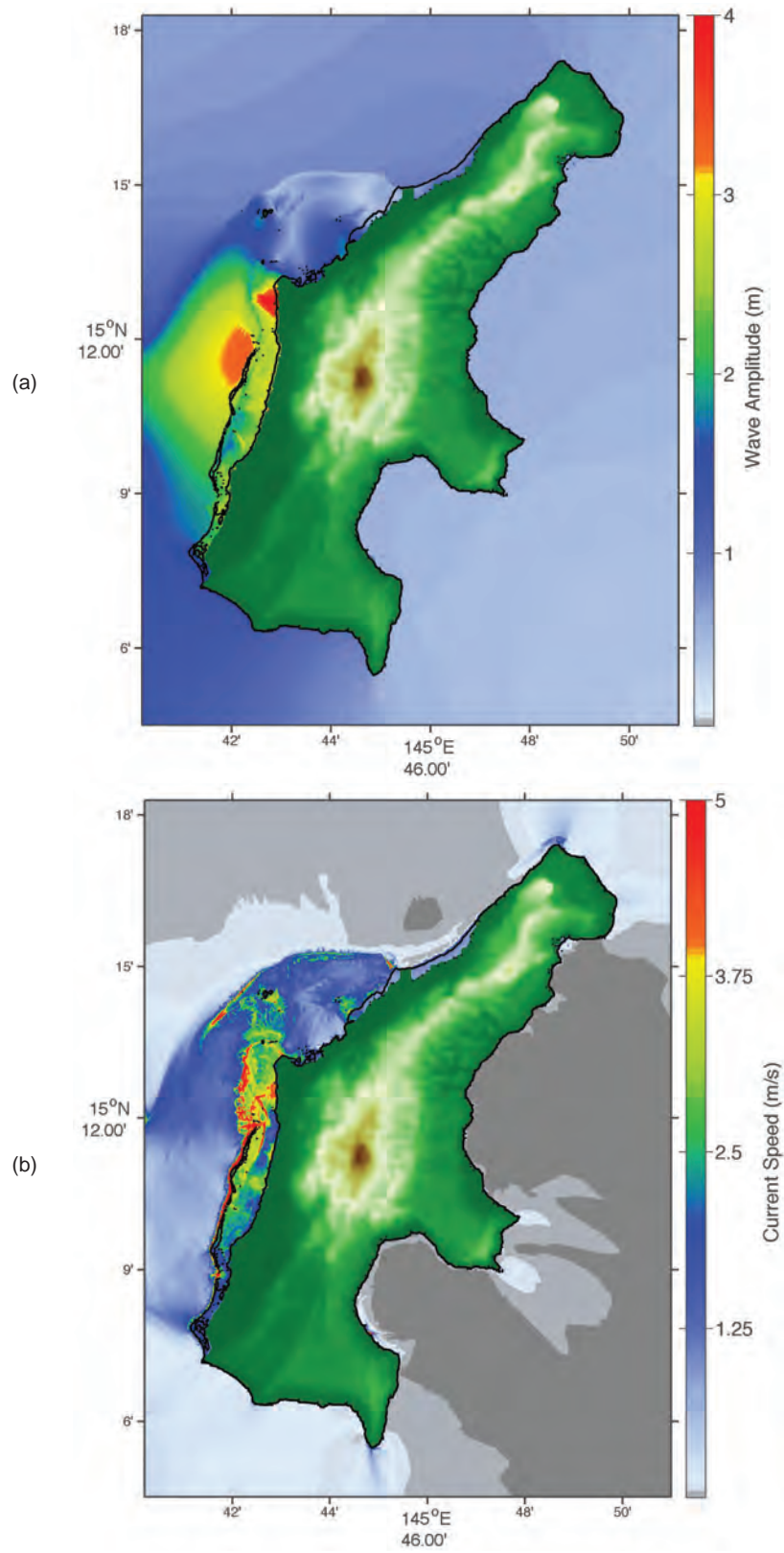
Figure B18: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the MOSZ 11 scenario.
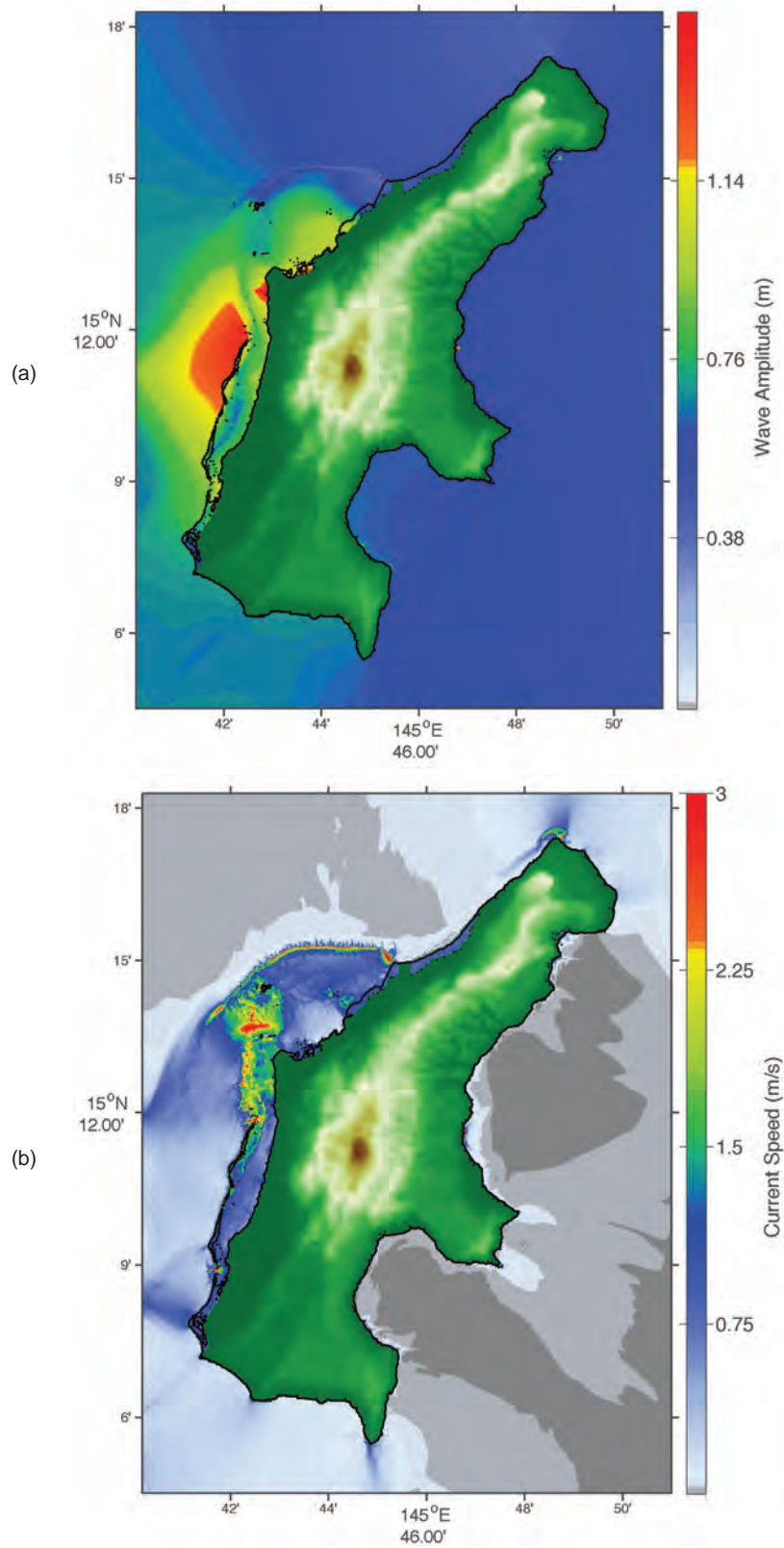
Figure B19: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the NGSZ 04 scenario.
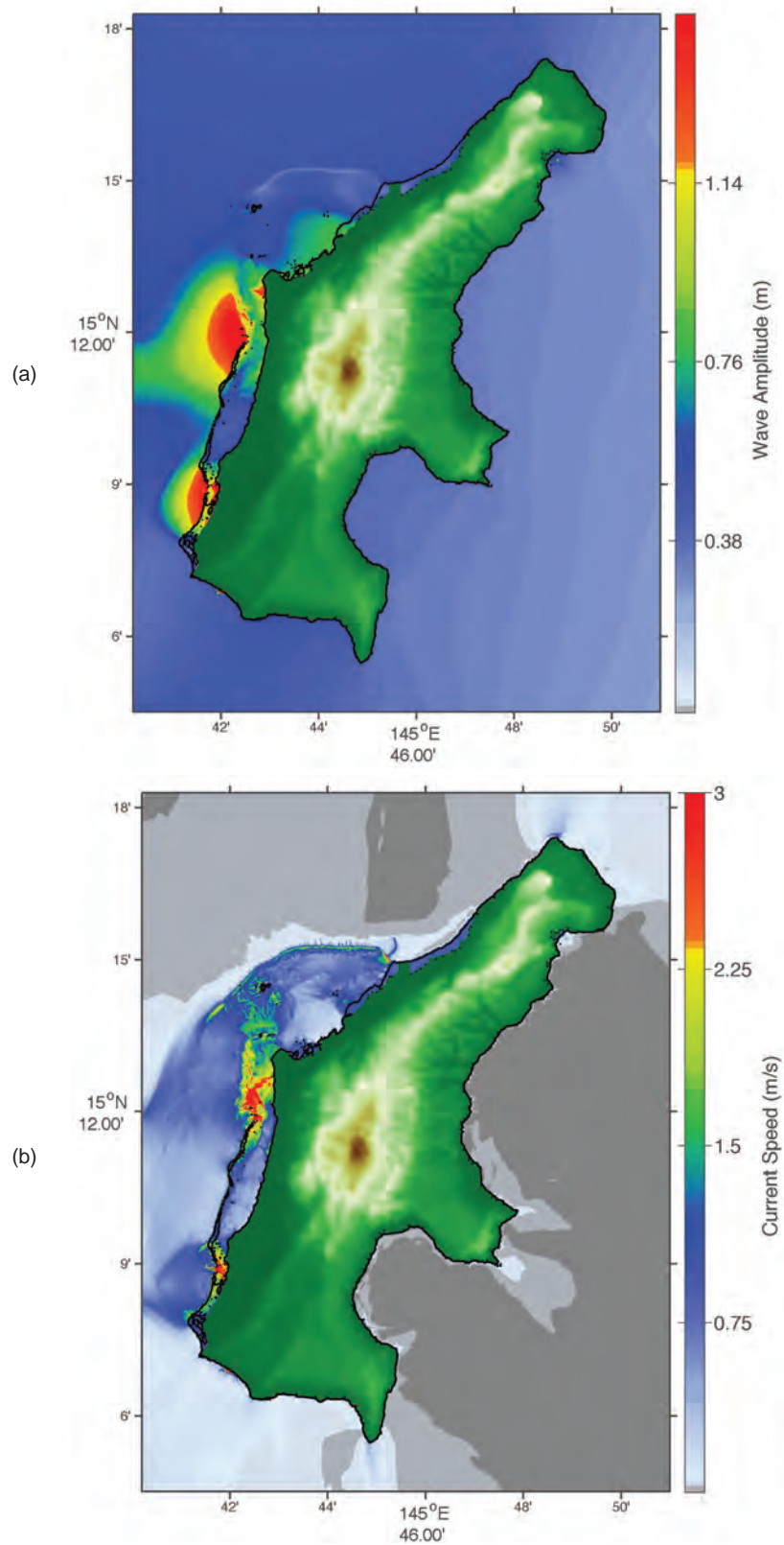
Figure B20: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the NGSZ 08 scenario.
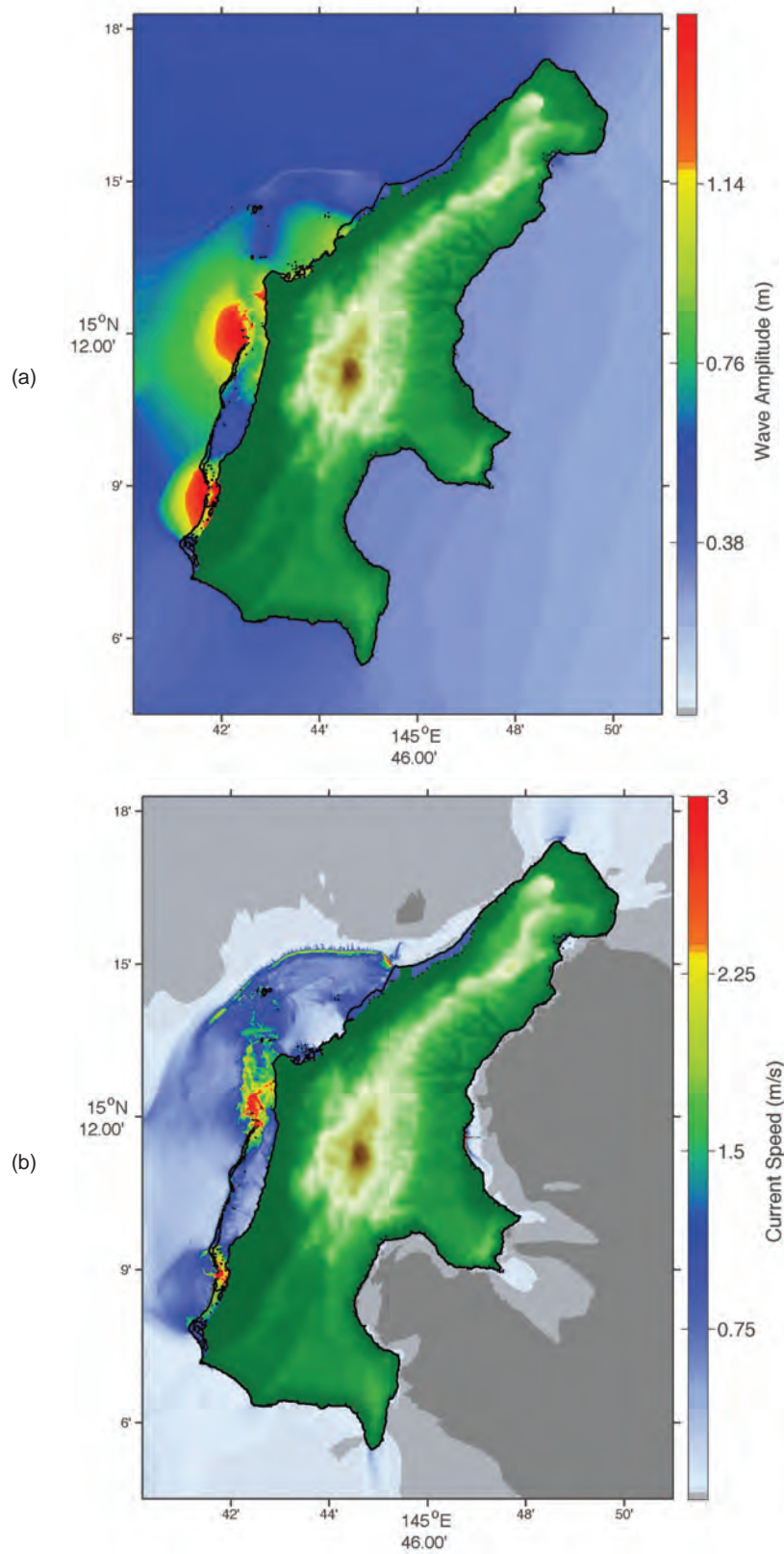
Figure B21: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the NGSZ 09 scenario.
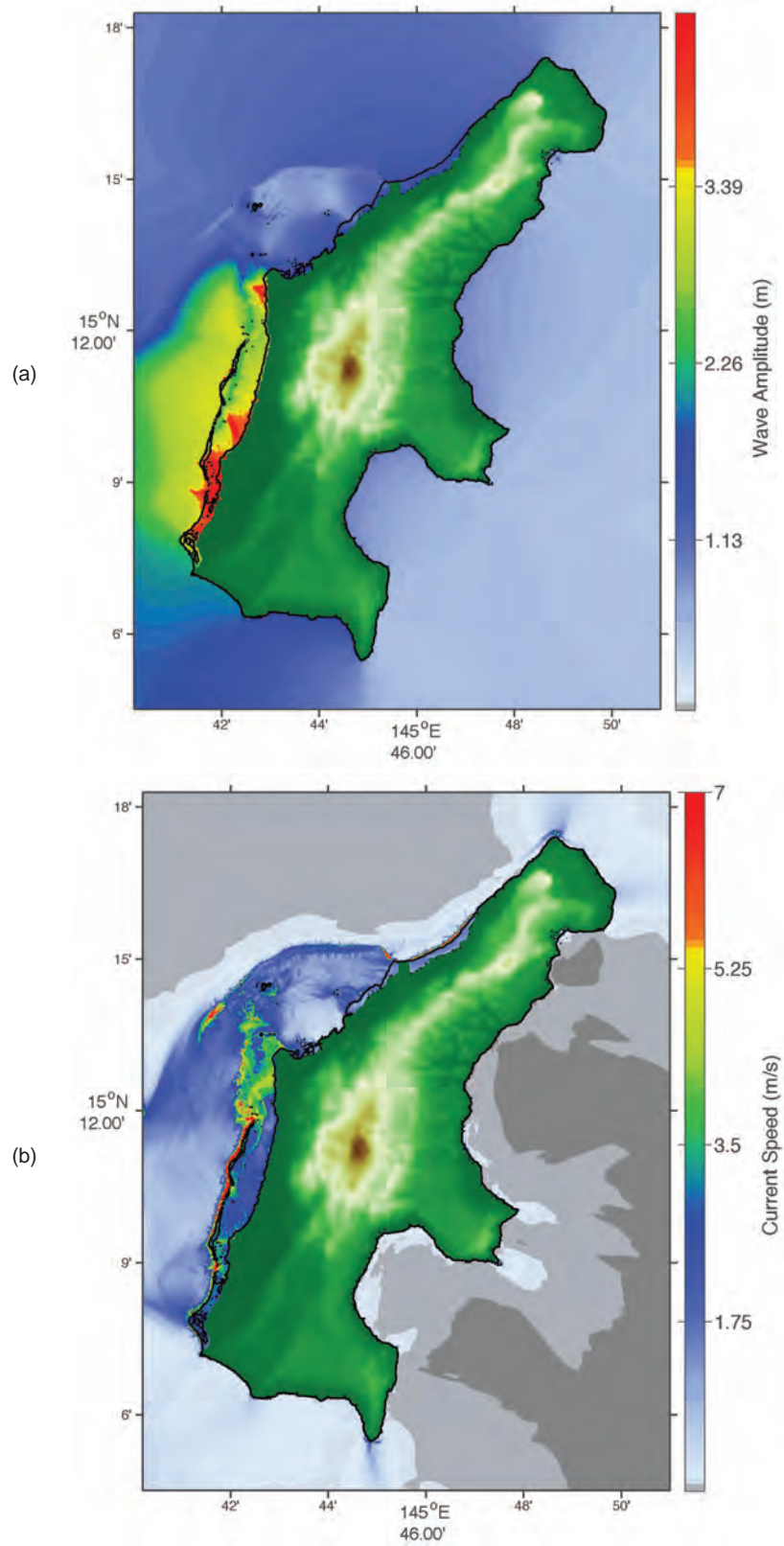
Figure B22: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the RNSZ 06 scenario.
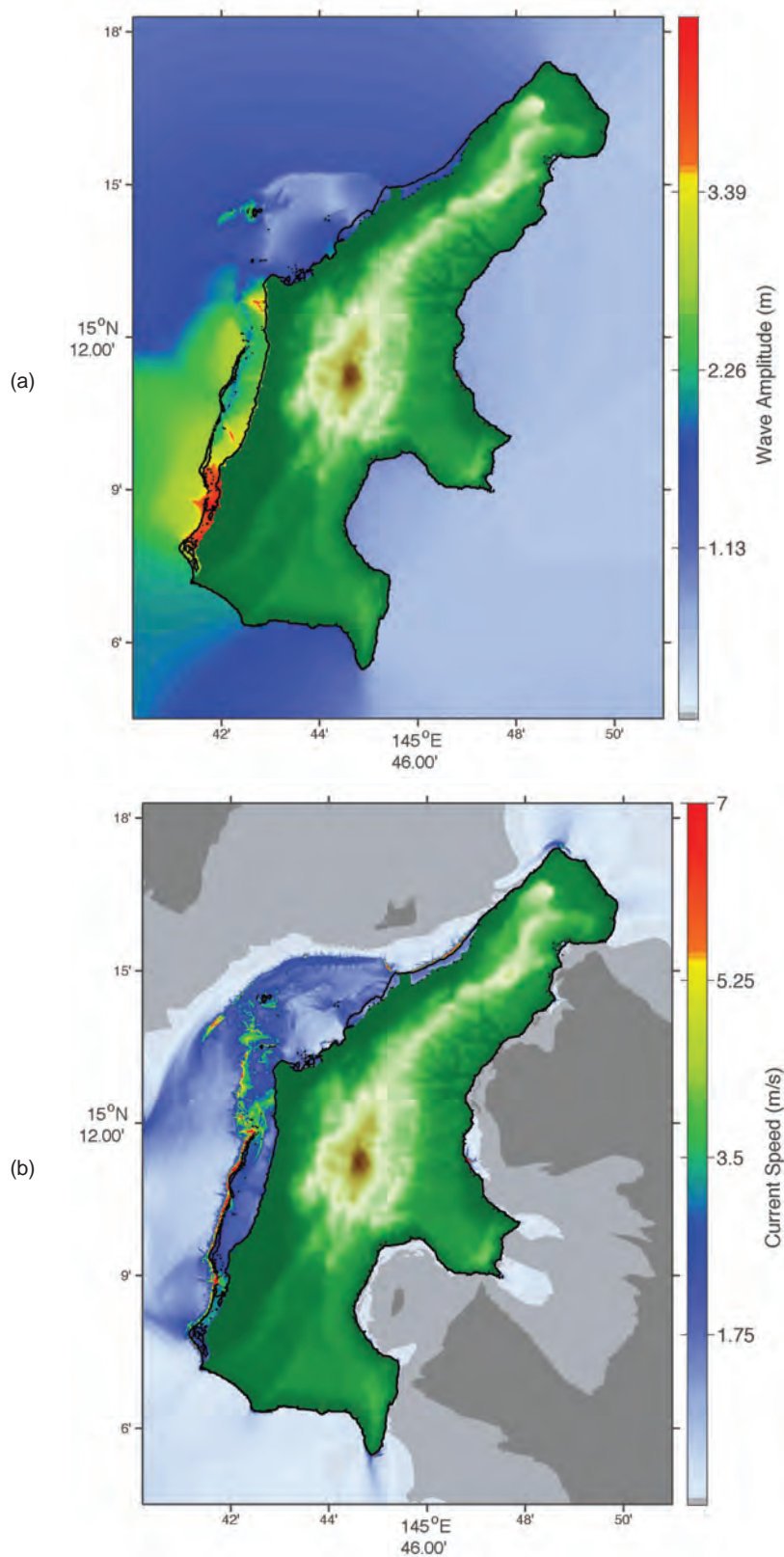
Figure B23: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the RNSZ 07 scenario.
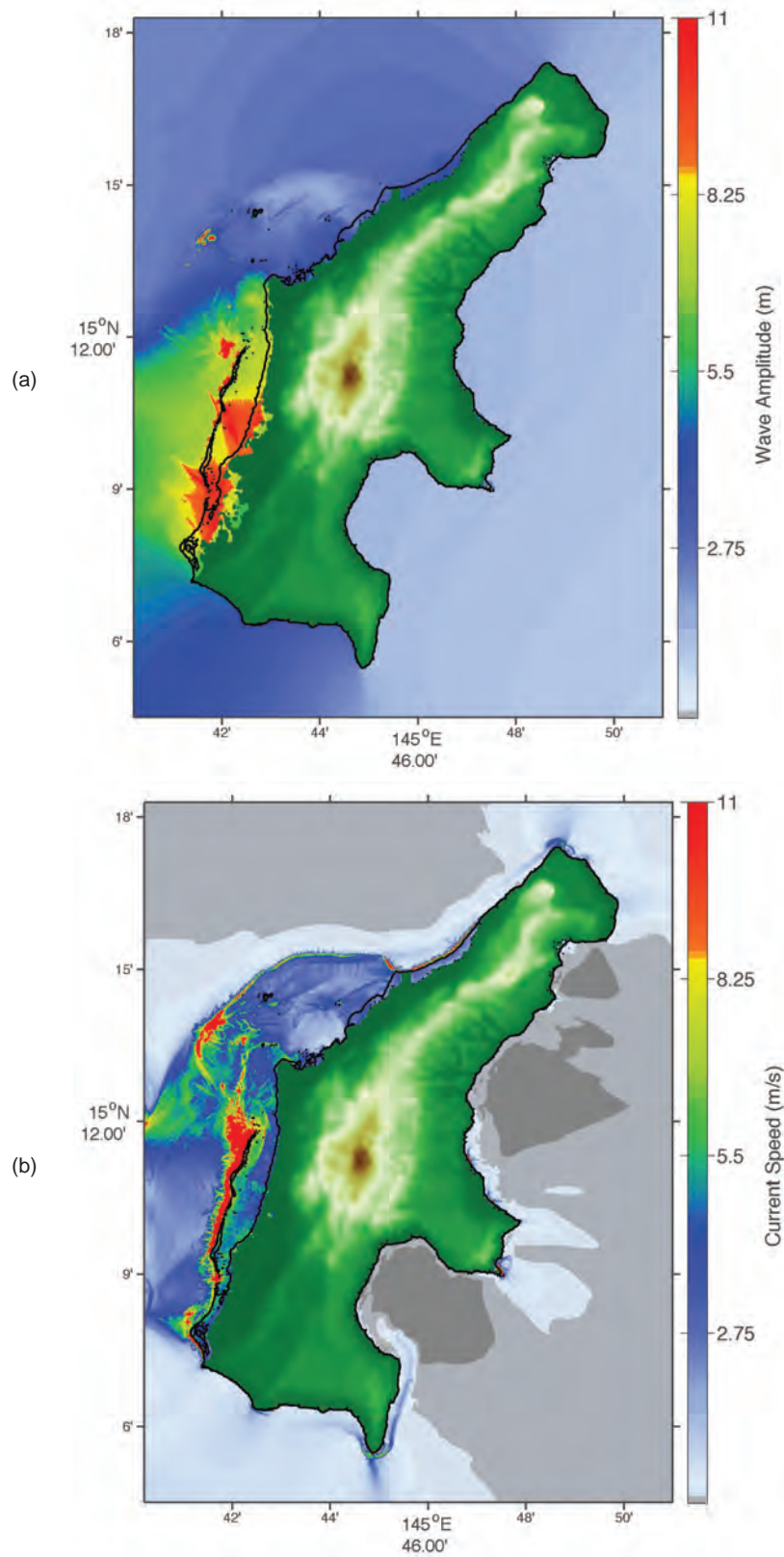
Figure B24: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the RNSZ 12 scenario.
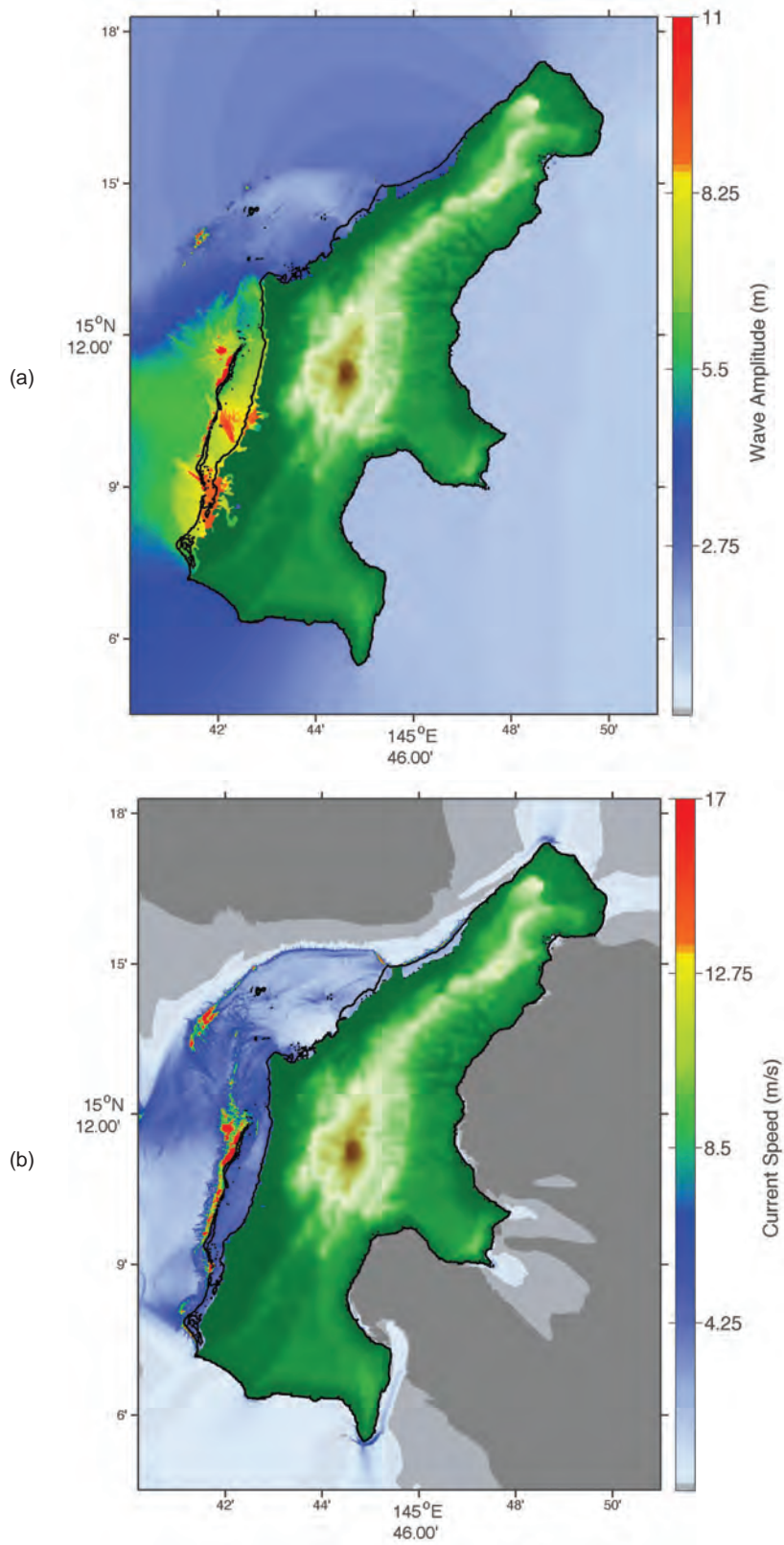
Figure B25: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the RNSZ 13 scenario.
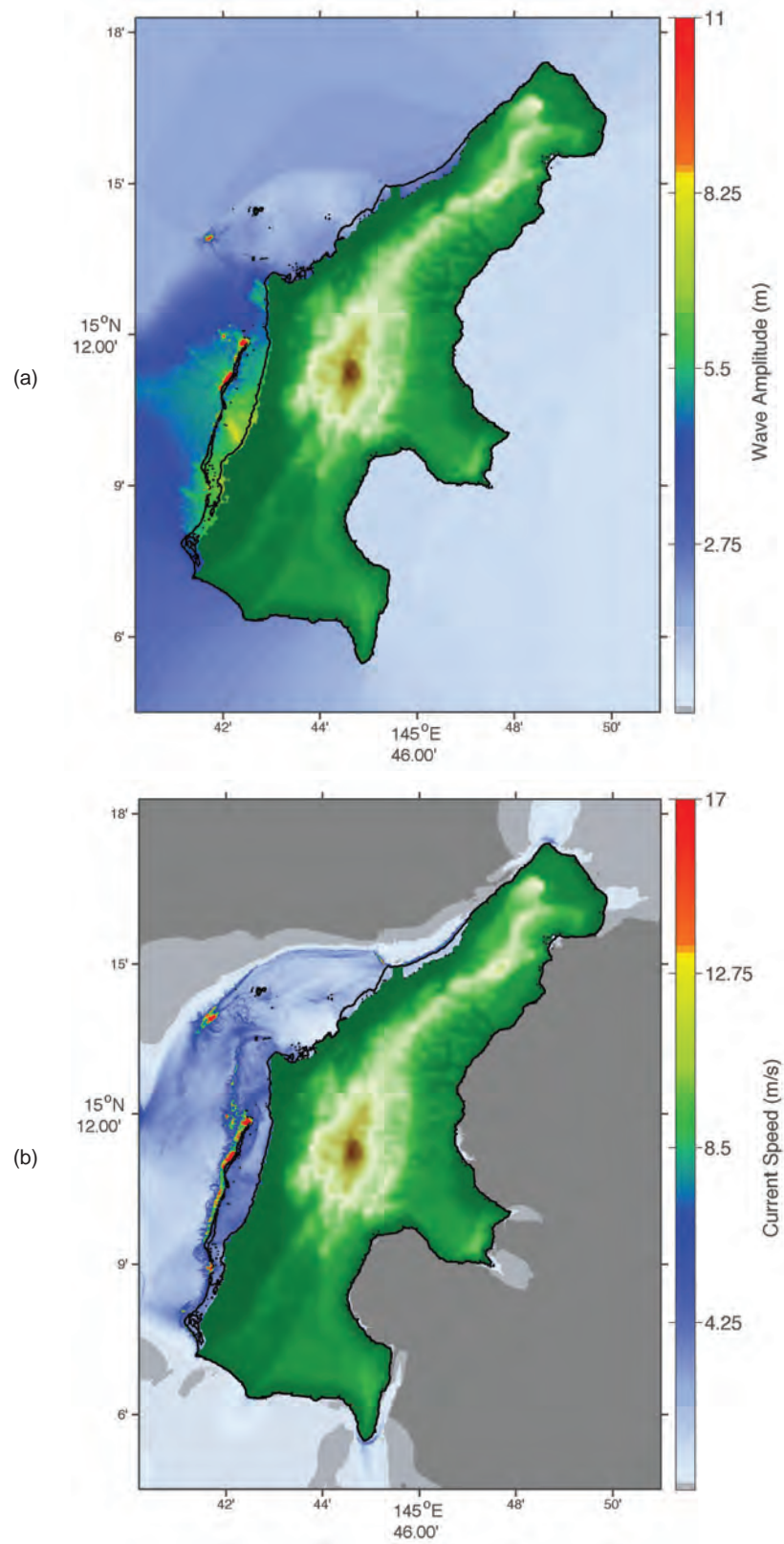
Figure B26: Maximum tsunami amplitudes (a) and currents (b) predicted for Saipan from the RNSZ 14 scenario.

Appendix C.   Tinian
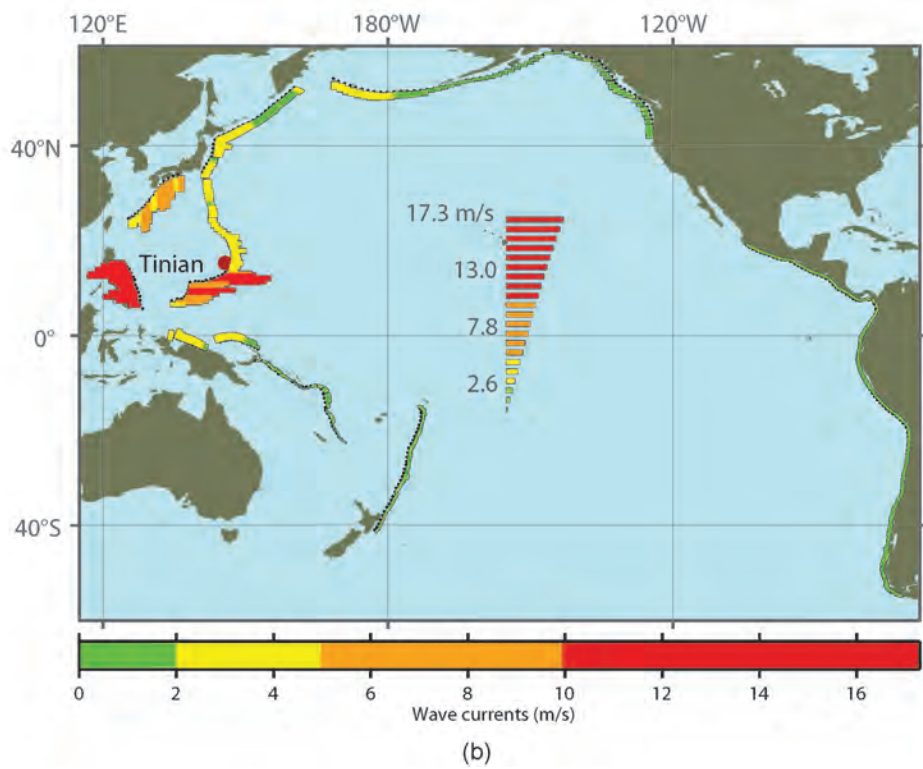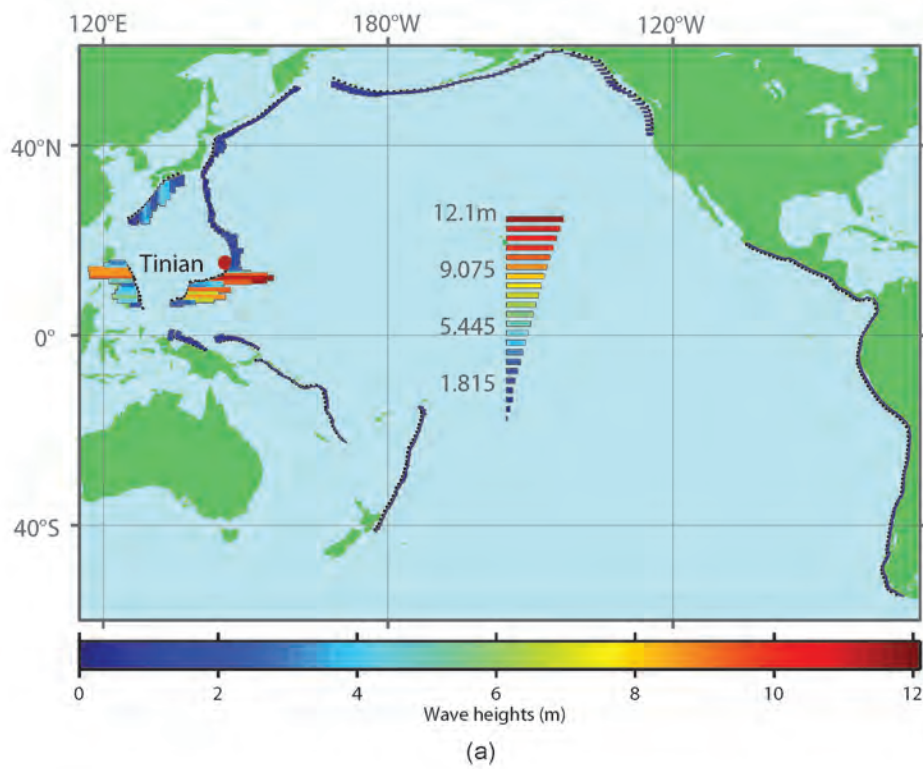
Figure C1: Computed maximum tsunami amplitude (a) and current speed (b) predicted to impact the island of Tinian from tsunamis triggered by synthetic M_w 9.0 earthquakes along subduction zones around the Pacific Basin. The optimized tsunami forecast model was used for all model runs.
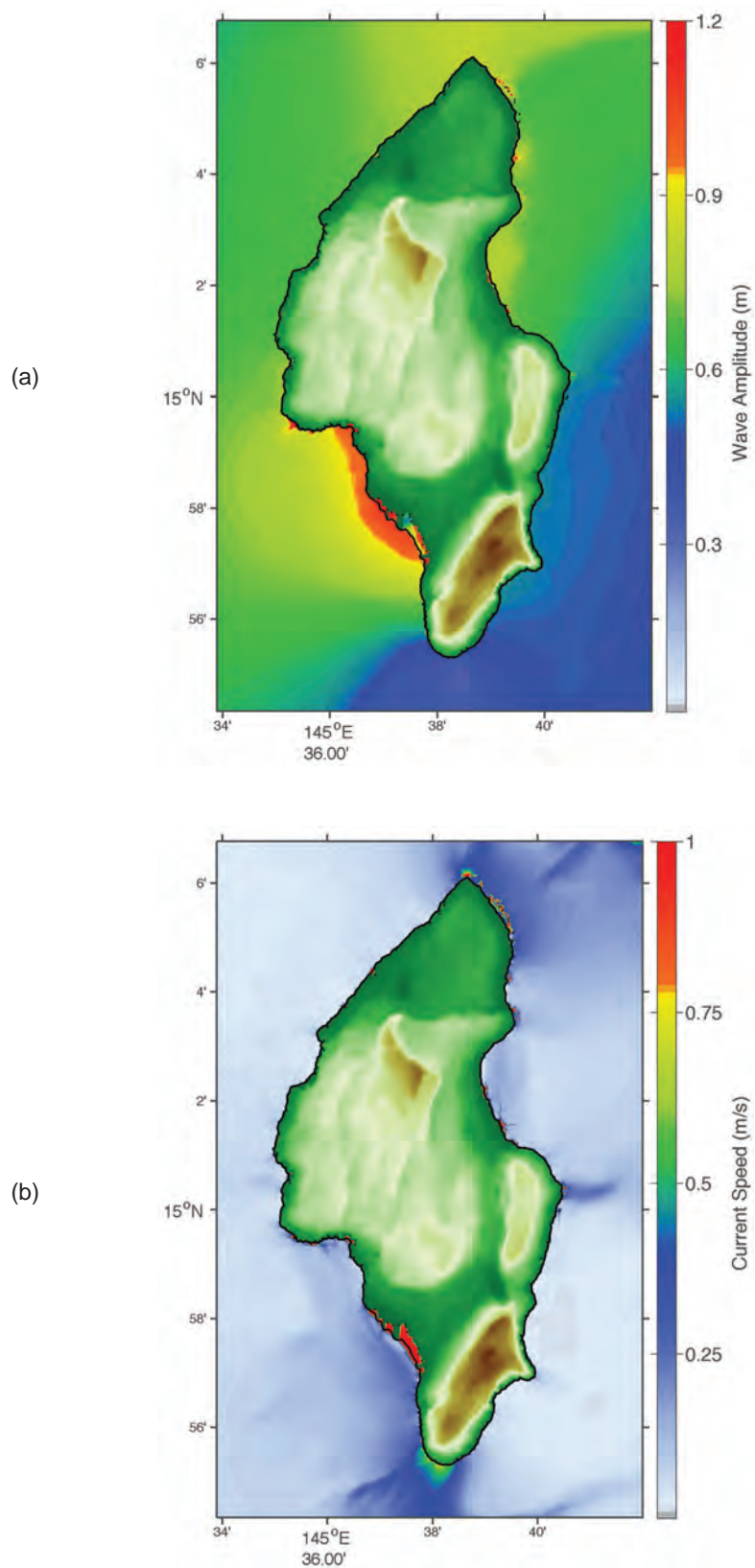
Figure C2: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the ACSZ 01 scenario.

(a)

(b)
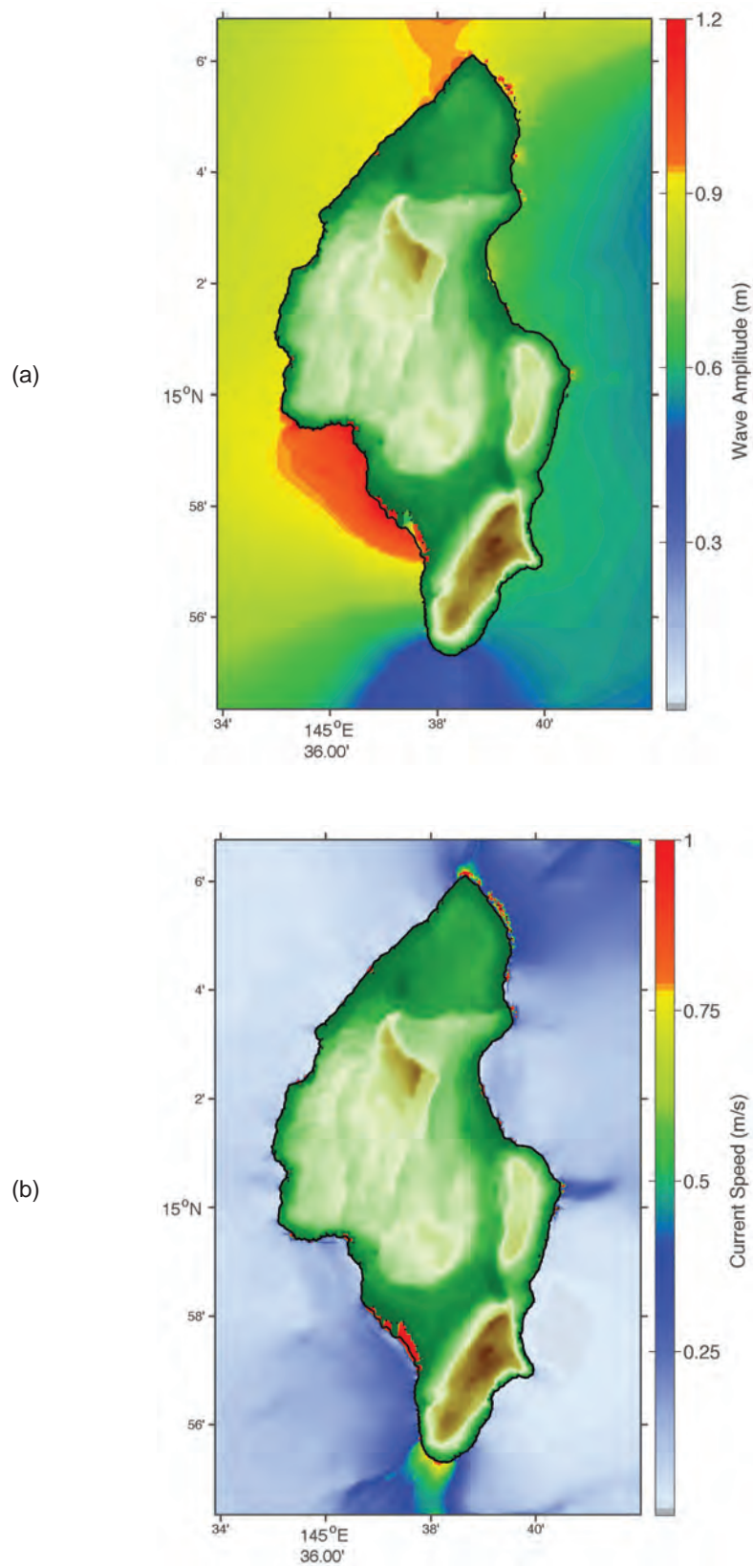
Figure C3: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the ACSZ 02 scenario.
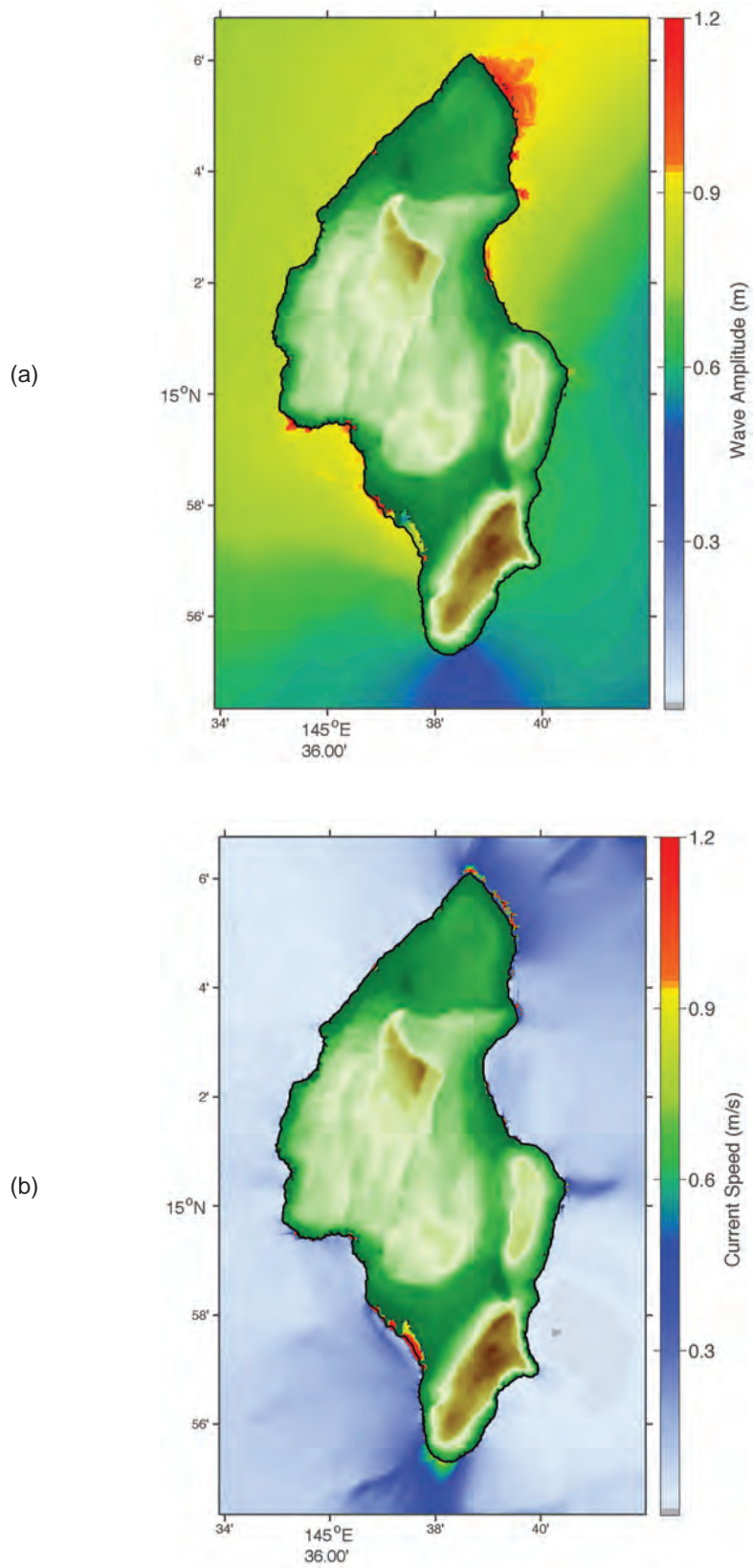
Figure C4: Maximum tsunami amplitudes (a) and currents
(b) predicted for Tinian from the ACSZ 03 scenario.
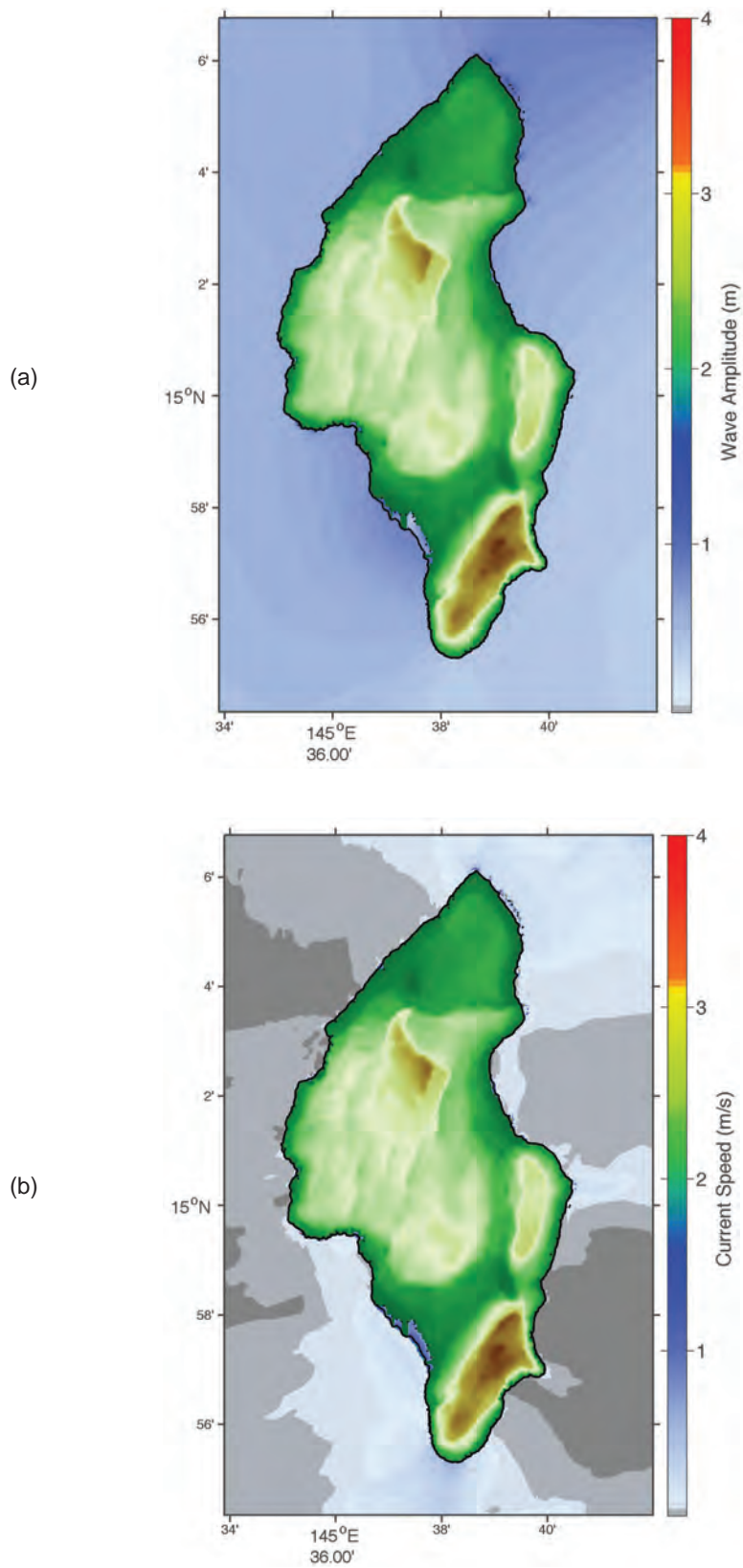
Figure C5: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the ACSZ 06 scenario.
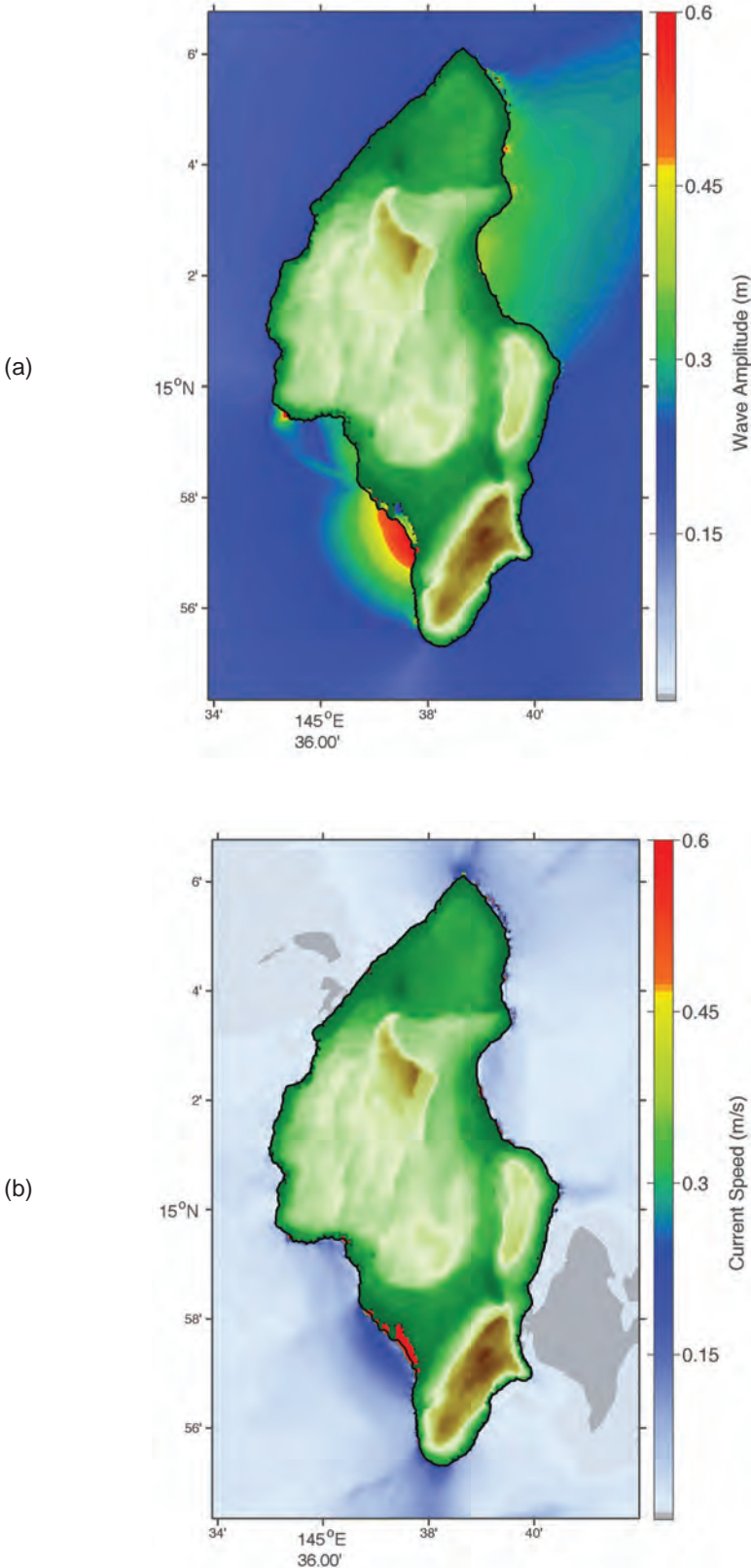
Figure C6: Maximum tsunami amplitudes (a) and currents
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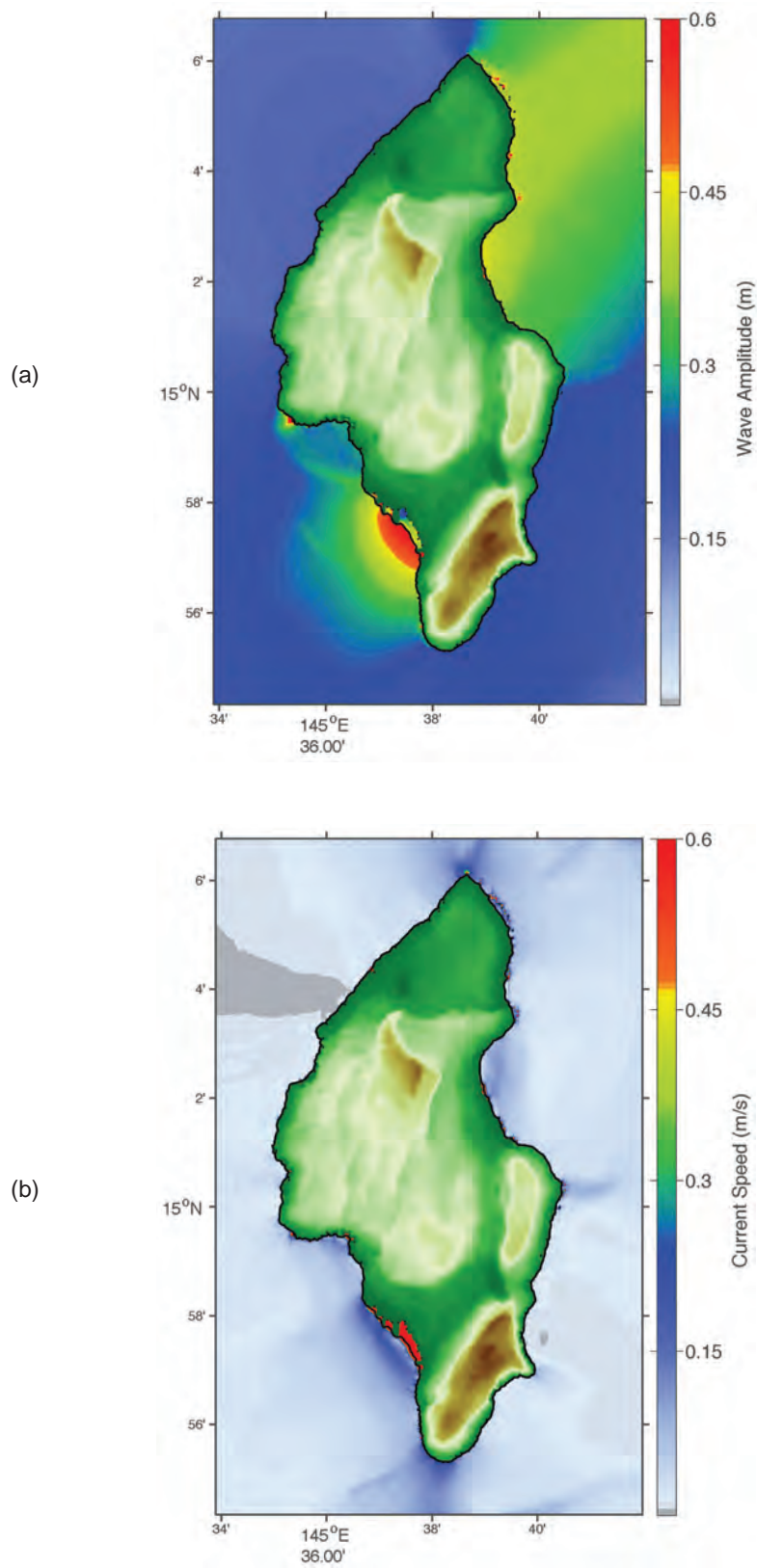
Figure C7: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the ACSZ 47 scenario.
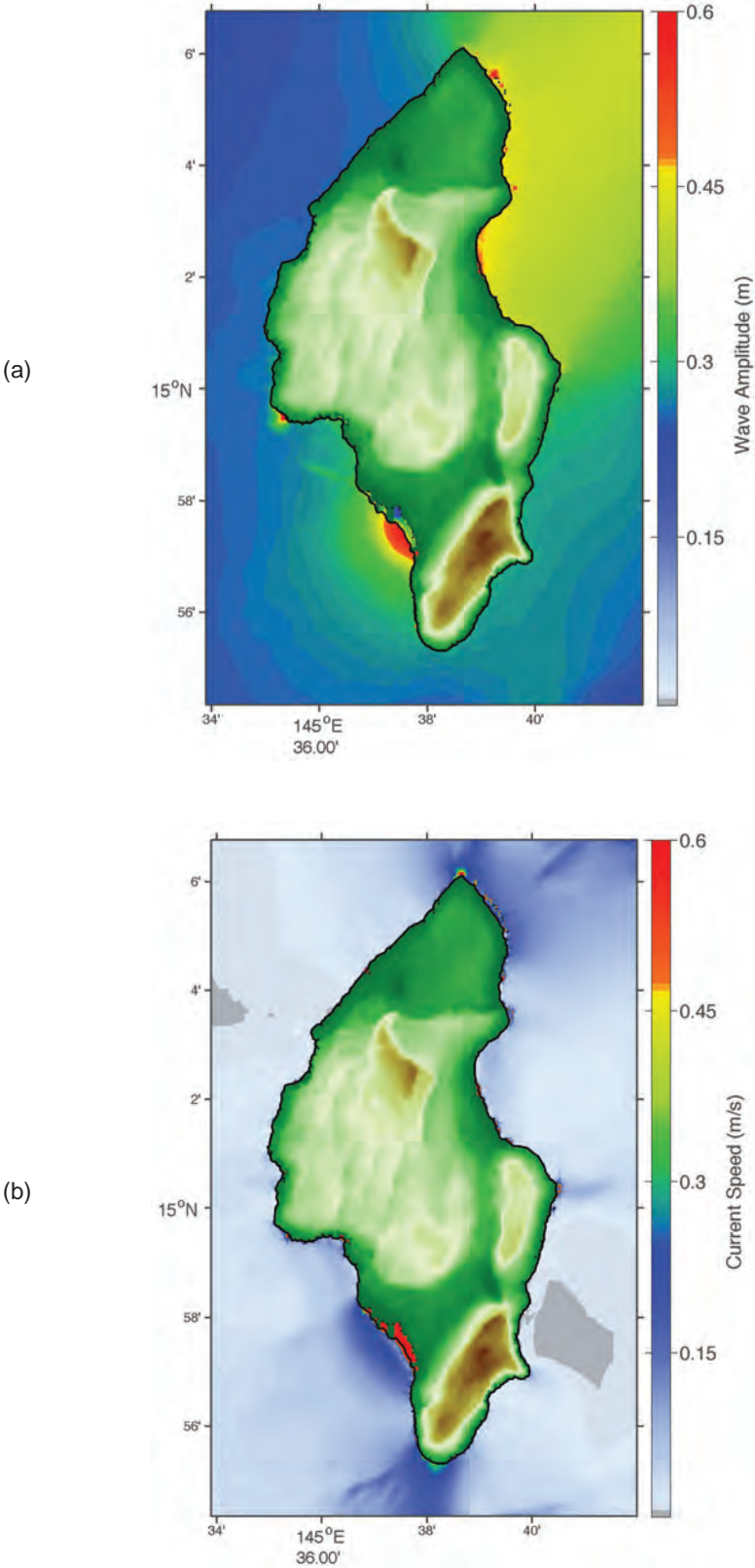
Figure C8: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the ACSZ 59 scenario.

(a)

(b)
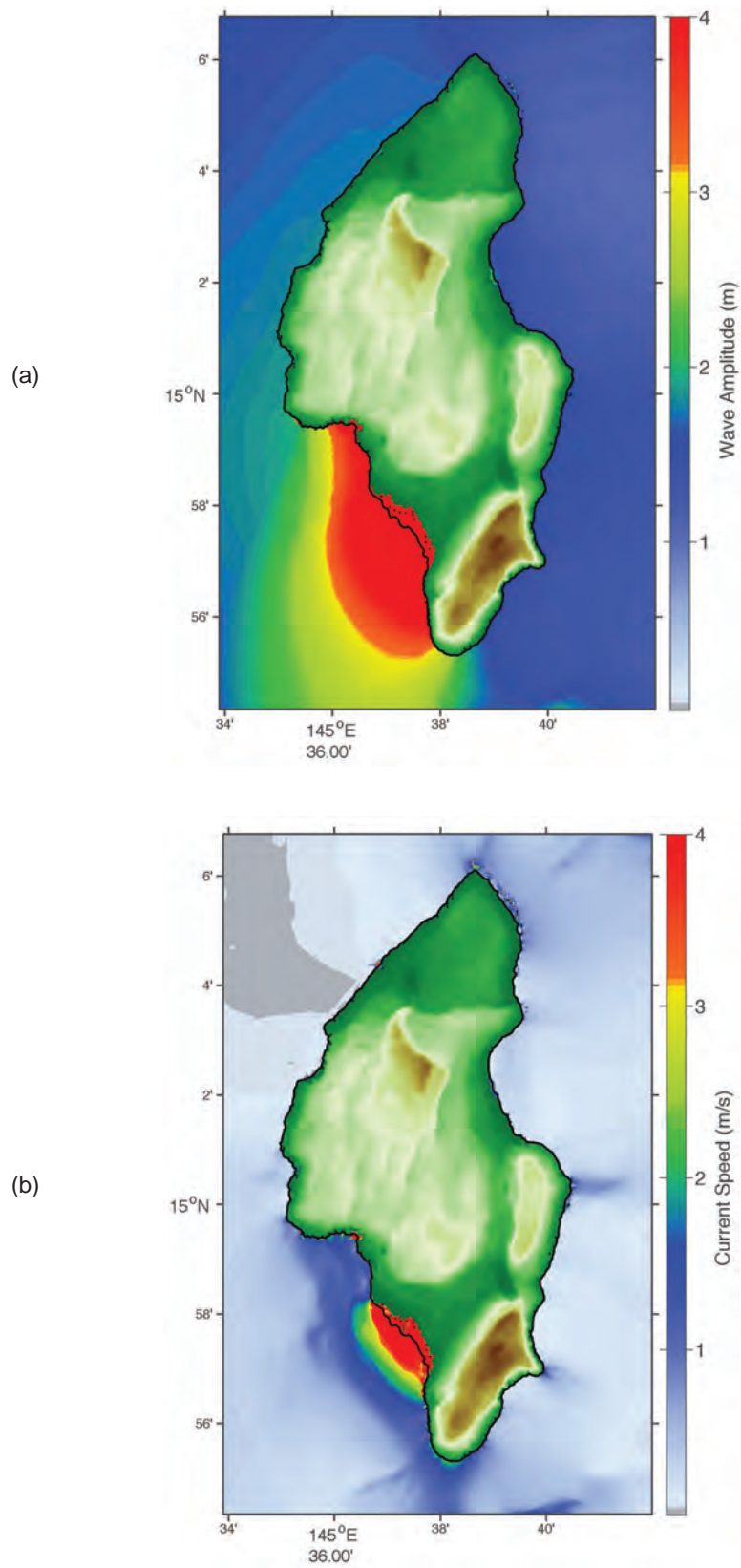
Figure C9: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the EPSZ 08 scenario.
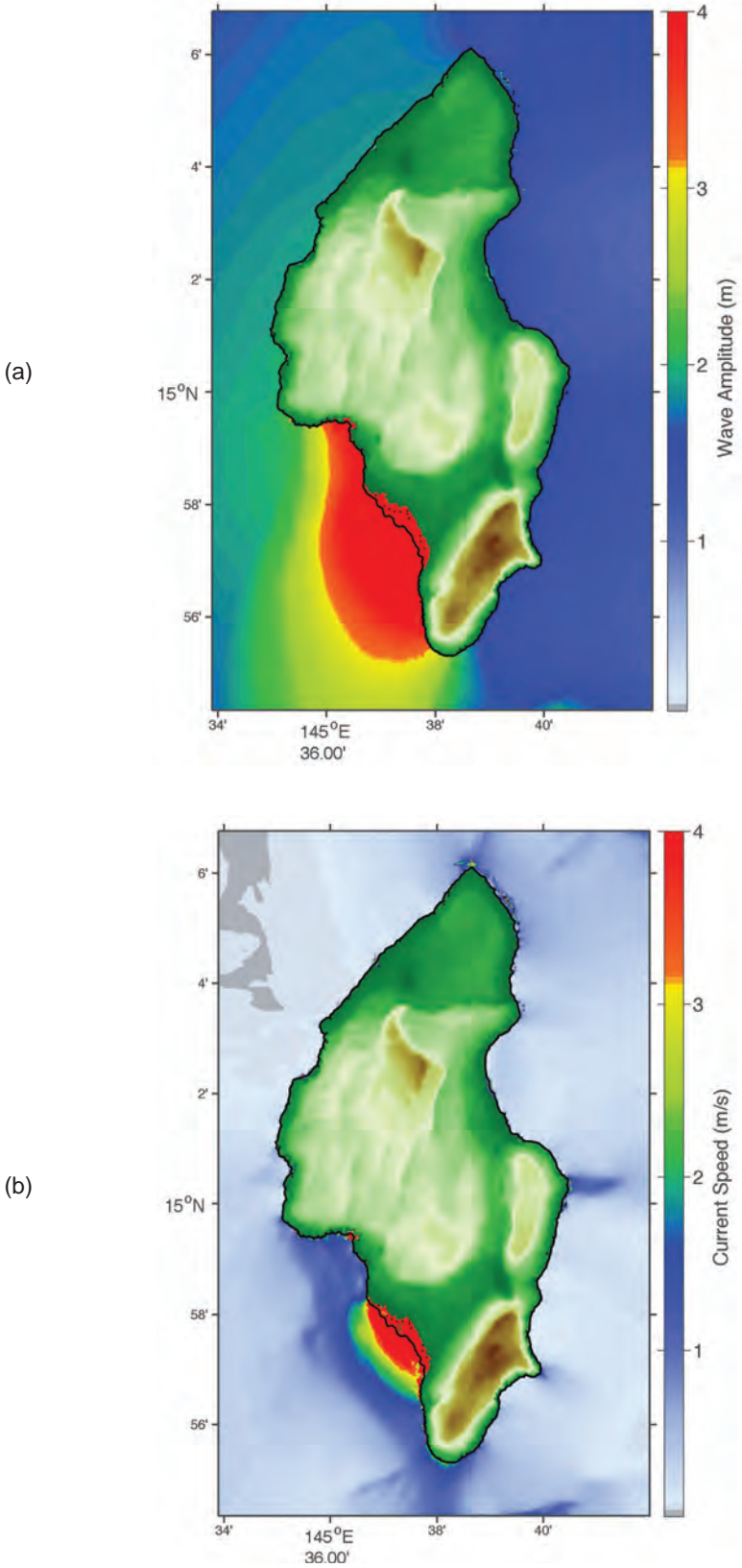
Figure C10: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the EPSZ 09 scenario.

(a)

(b)
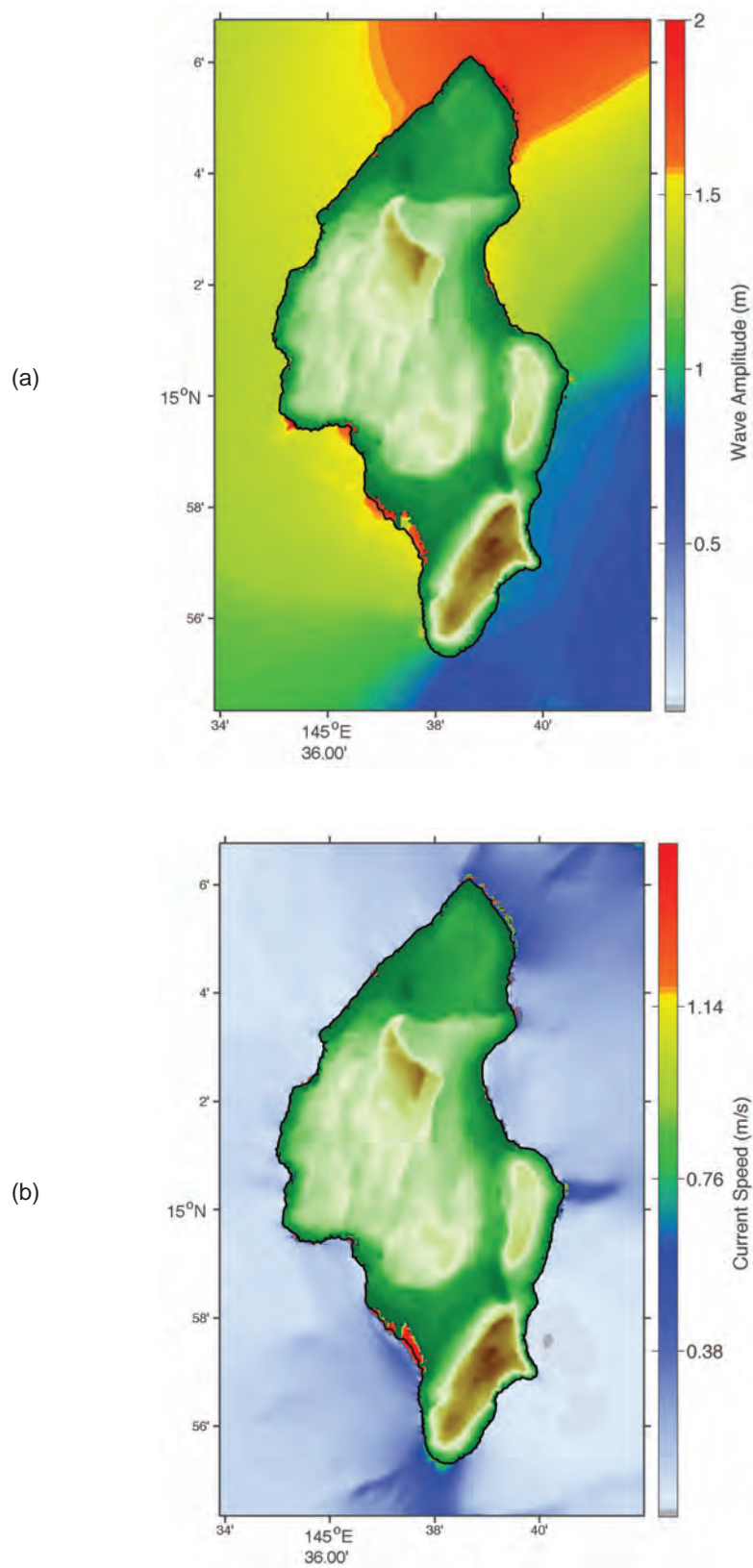
Figure C11: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the KISZ 20 scenario.
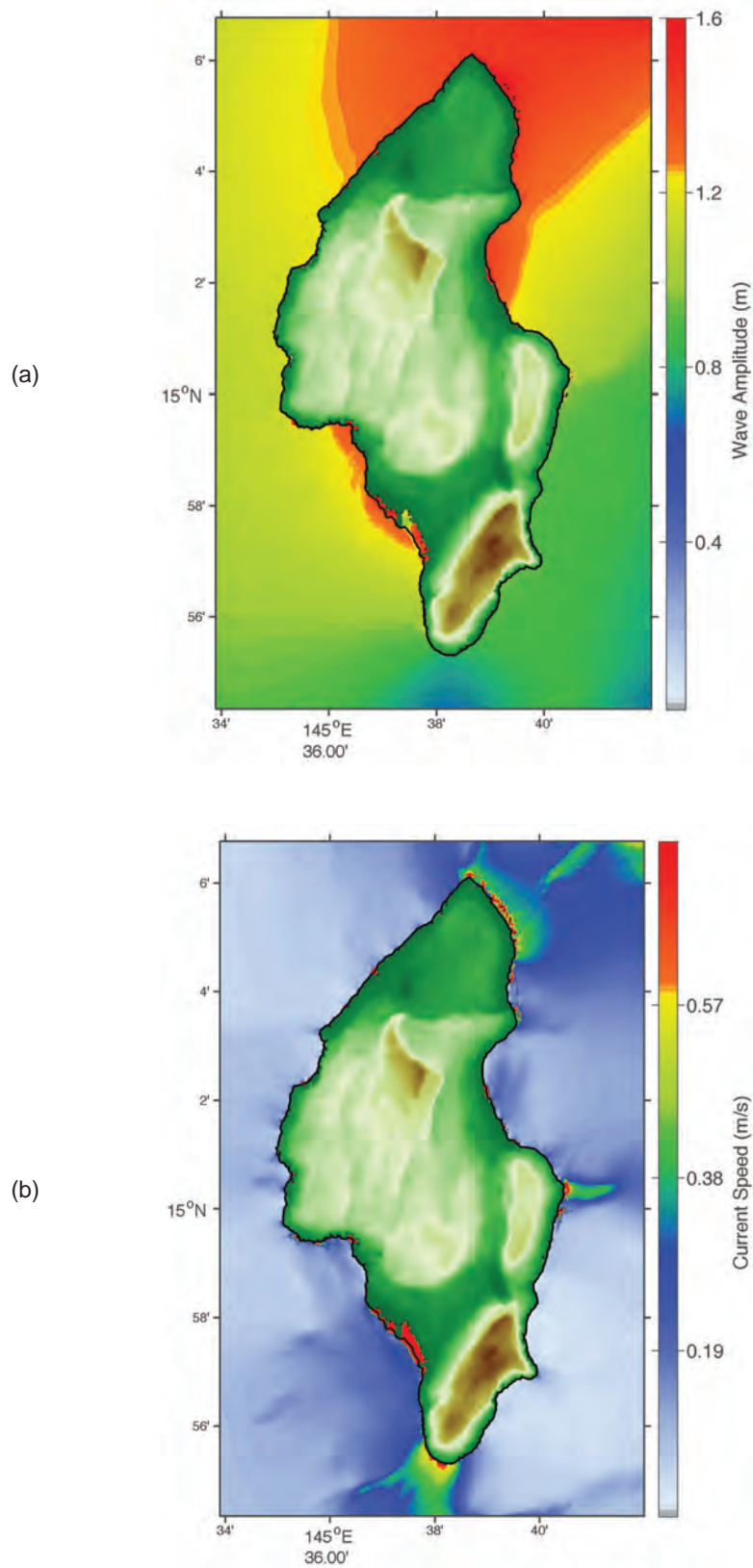
Figure C12: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the KISZ 21 scenario.

(a)

(b)
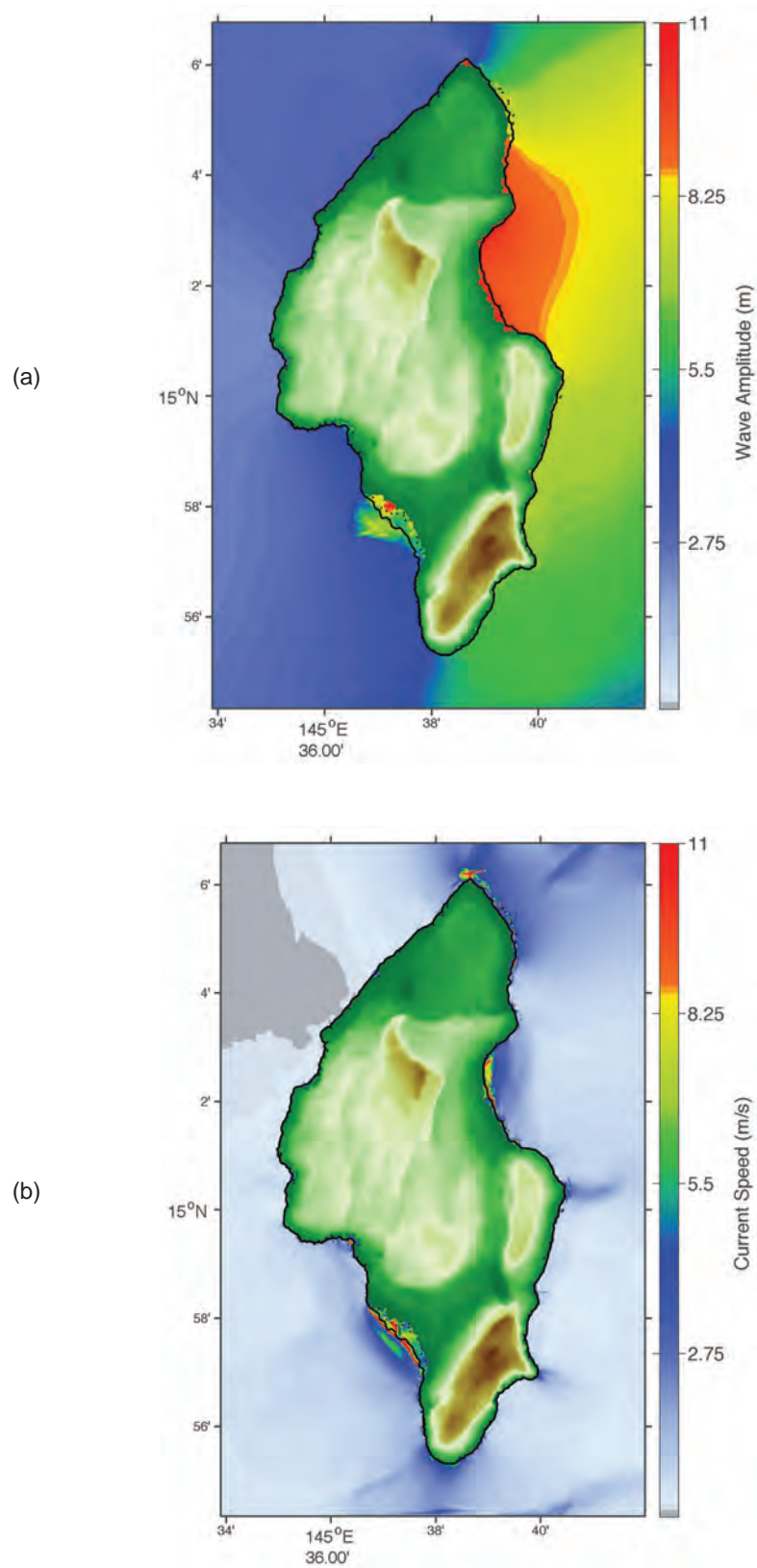
Figure C13: Maximum tsunami amplitudes (a) and currents
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(a)

(b)
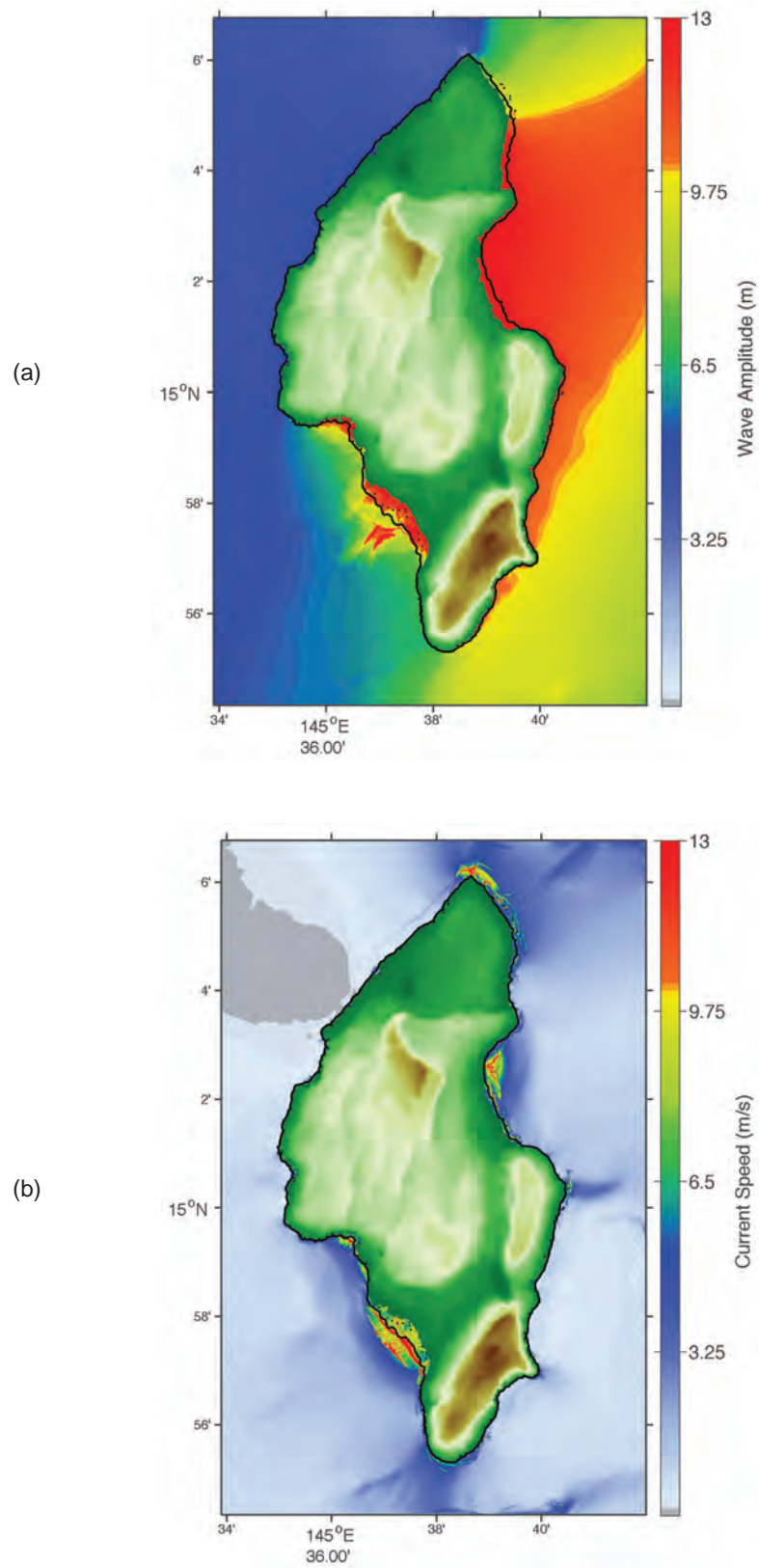
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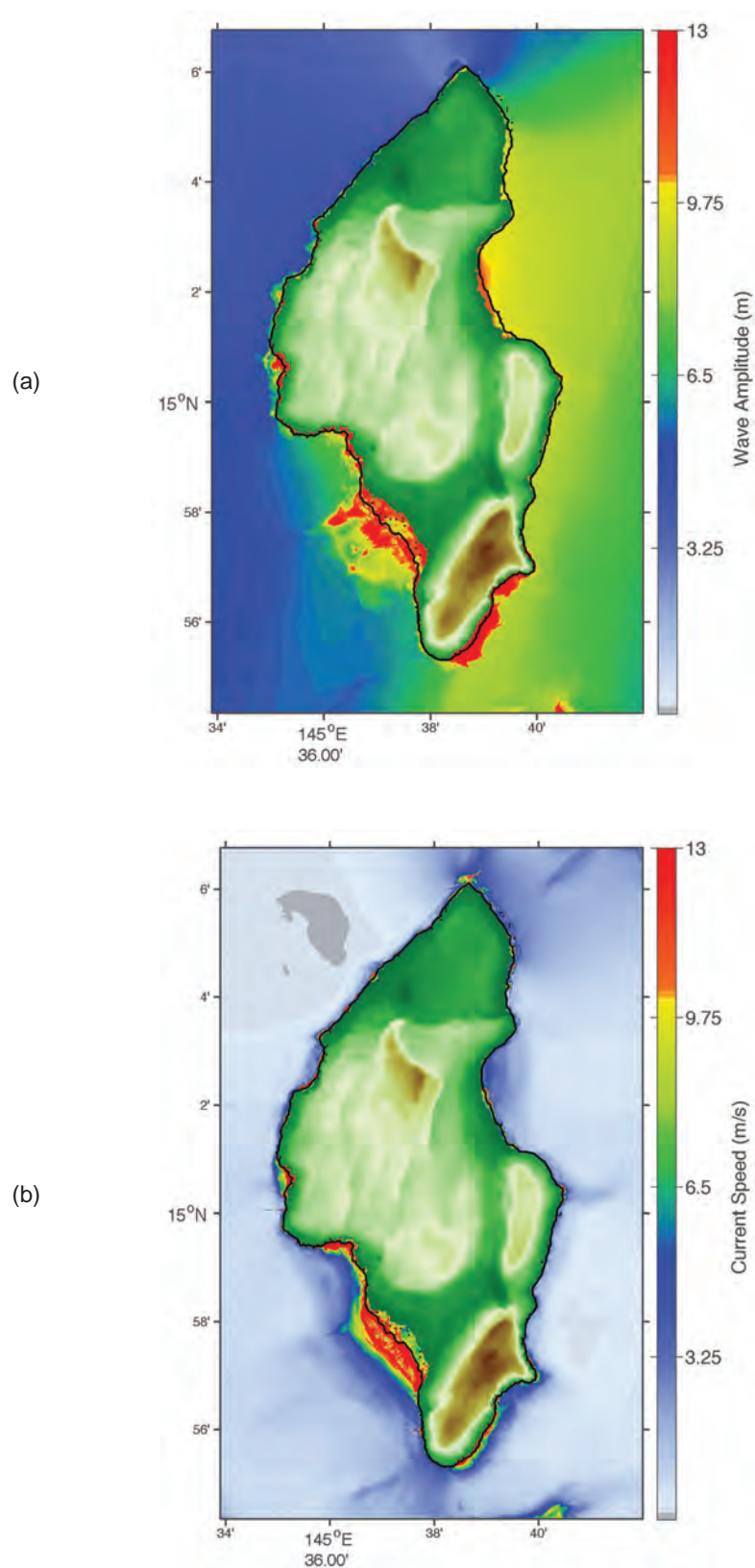
Figure C15: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the KISZ 55 scenario.
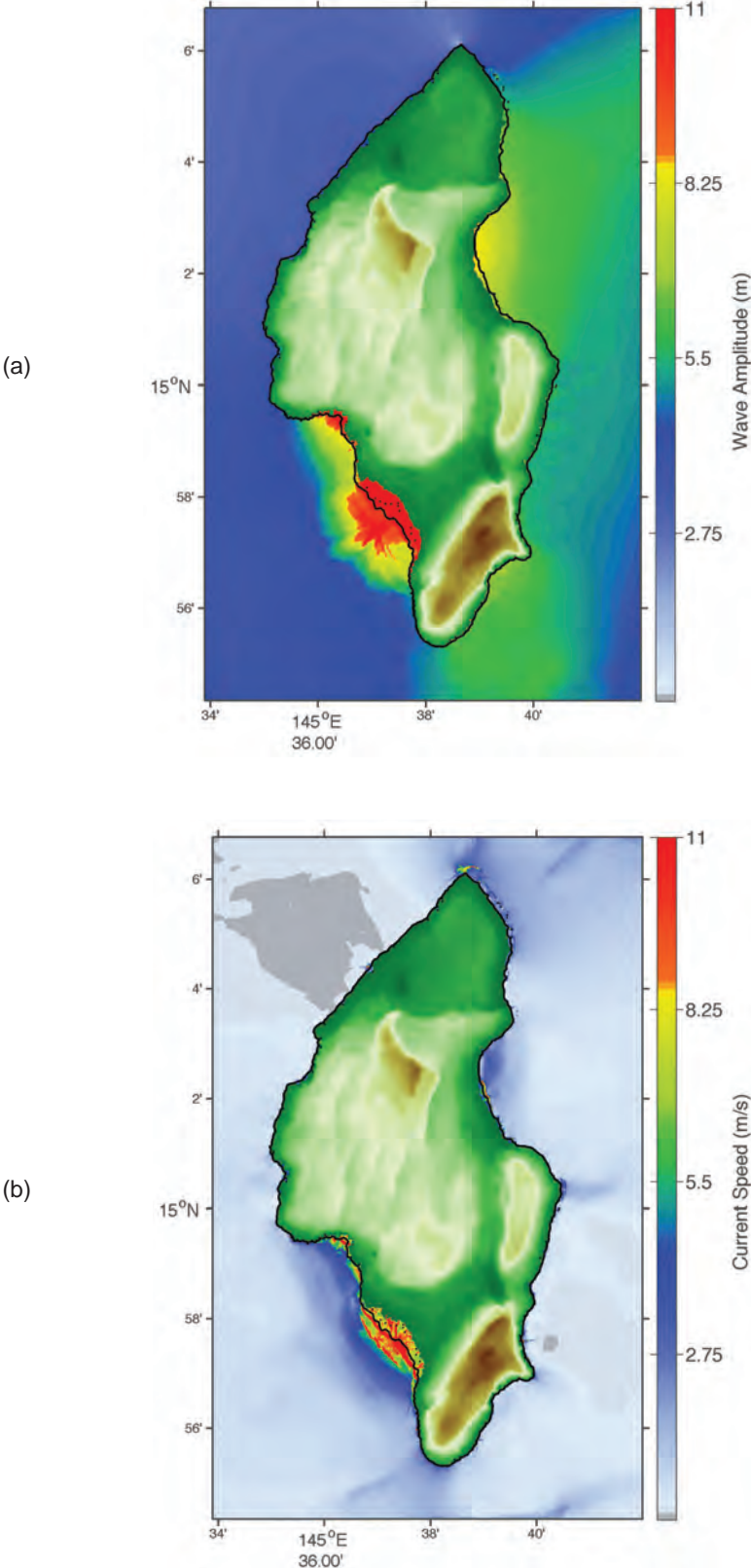
Figure C16: Maximum tsunami amplitudes (a) and currents
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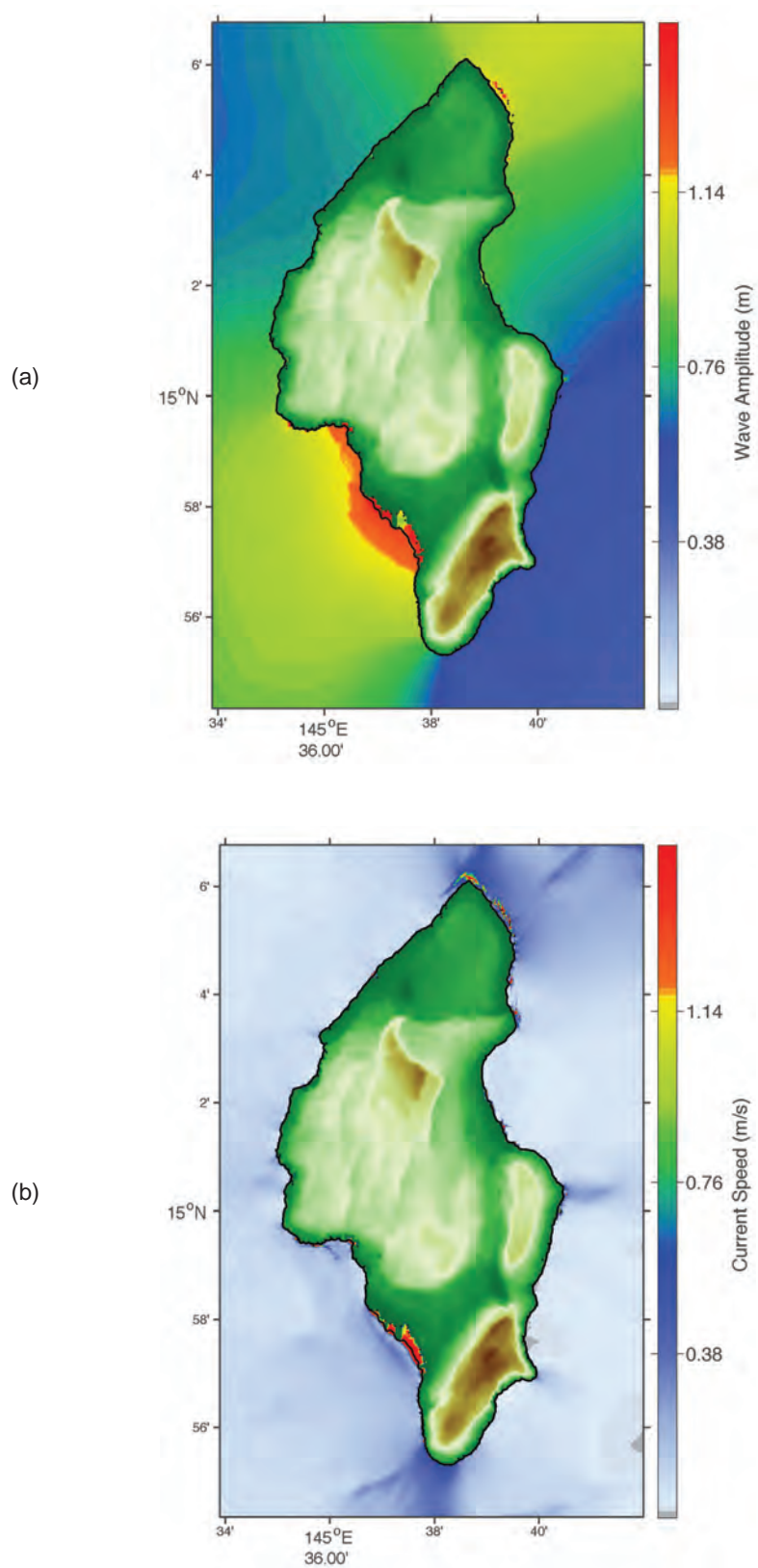
Figure C17: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the MOSZ 10 scenario.
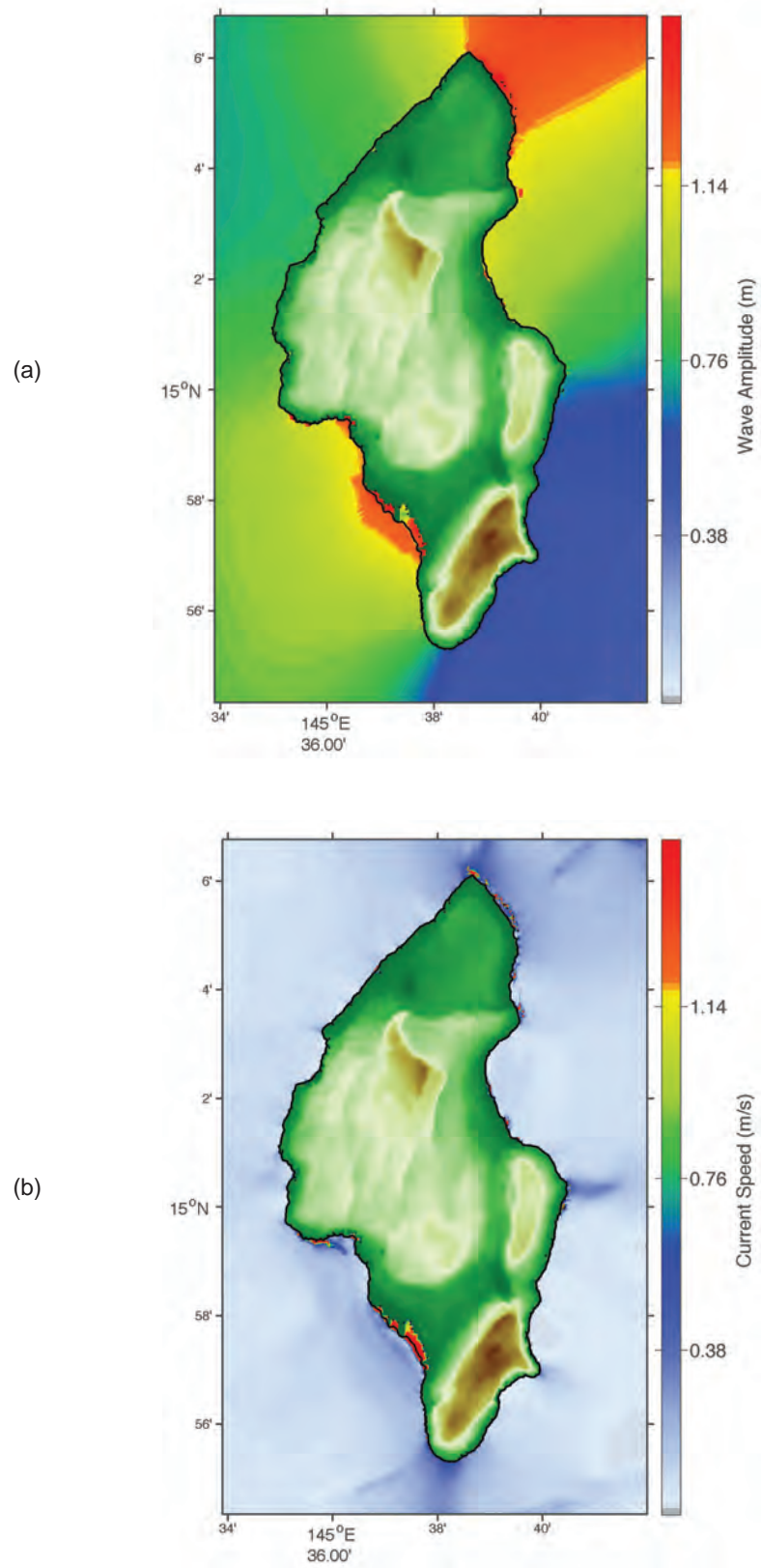
Figure C18: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the MOSZ 11 scenario.

(a)

(b)
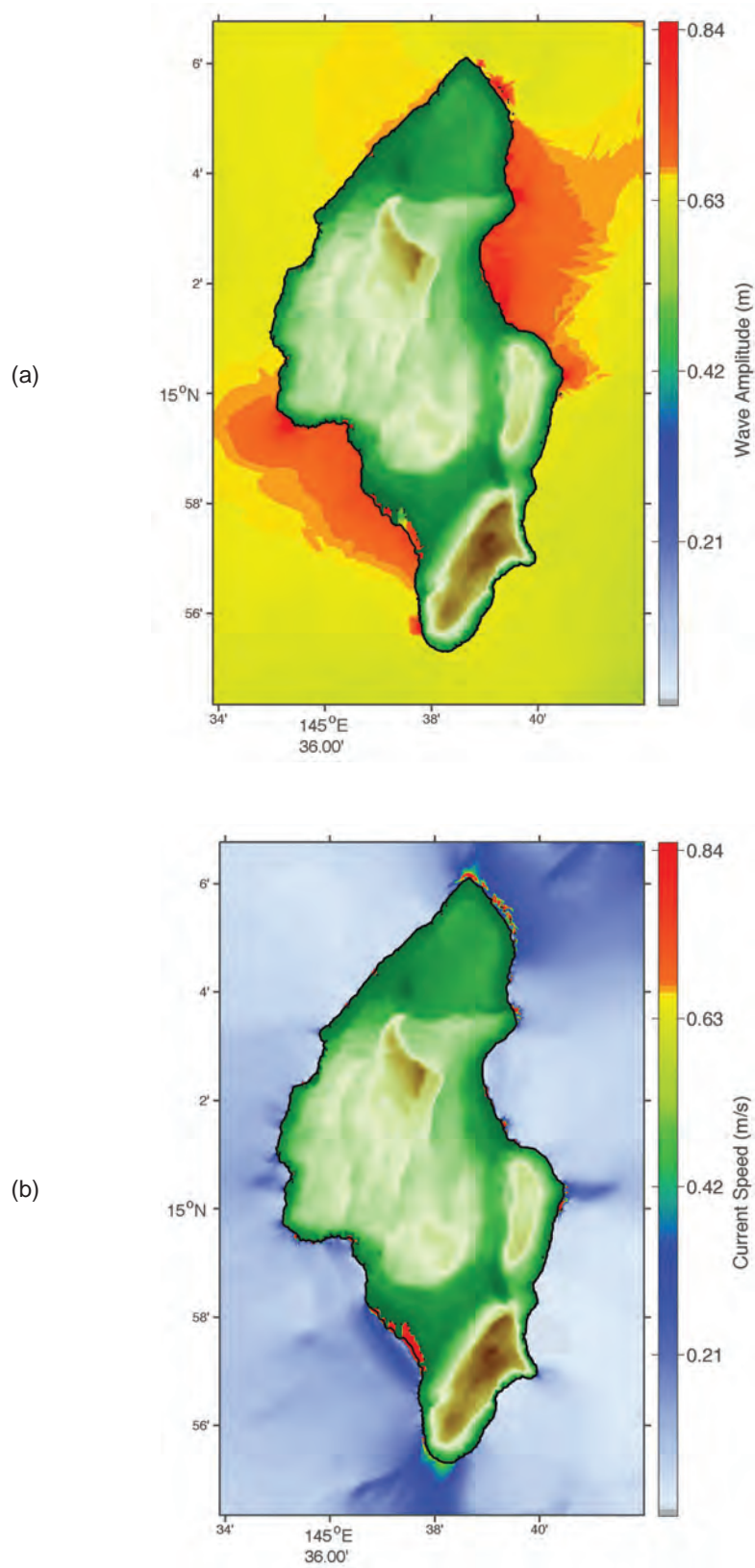
Figure C19: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the NGSZ 04 scenario.
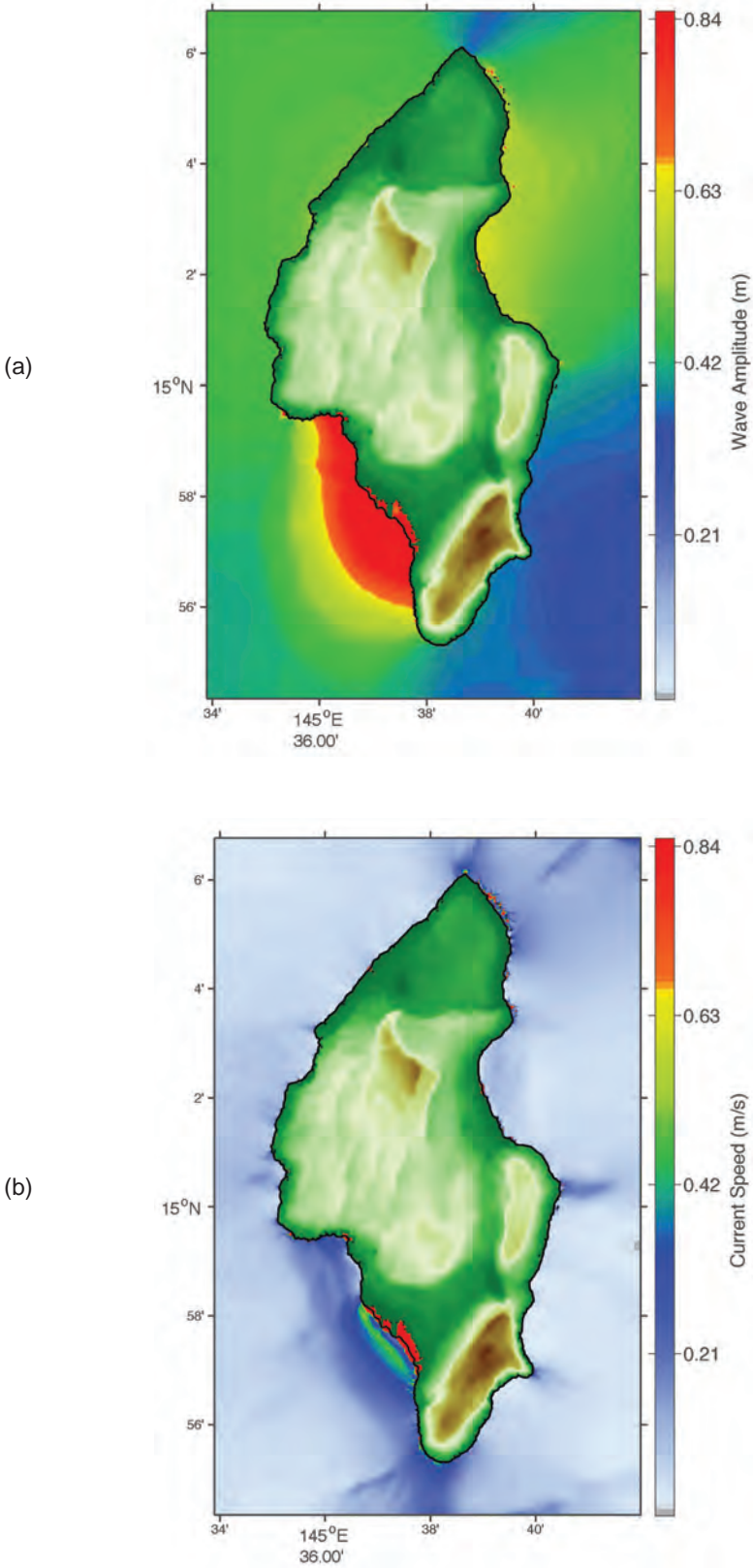
Figure C20: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the NGSZ 08 scenario.
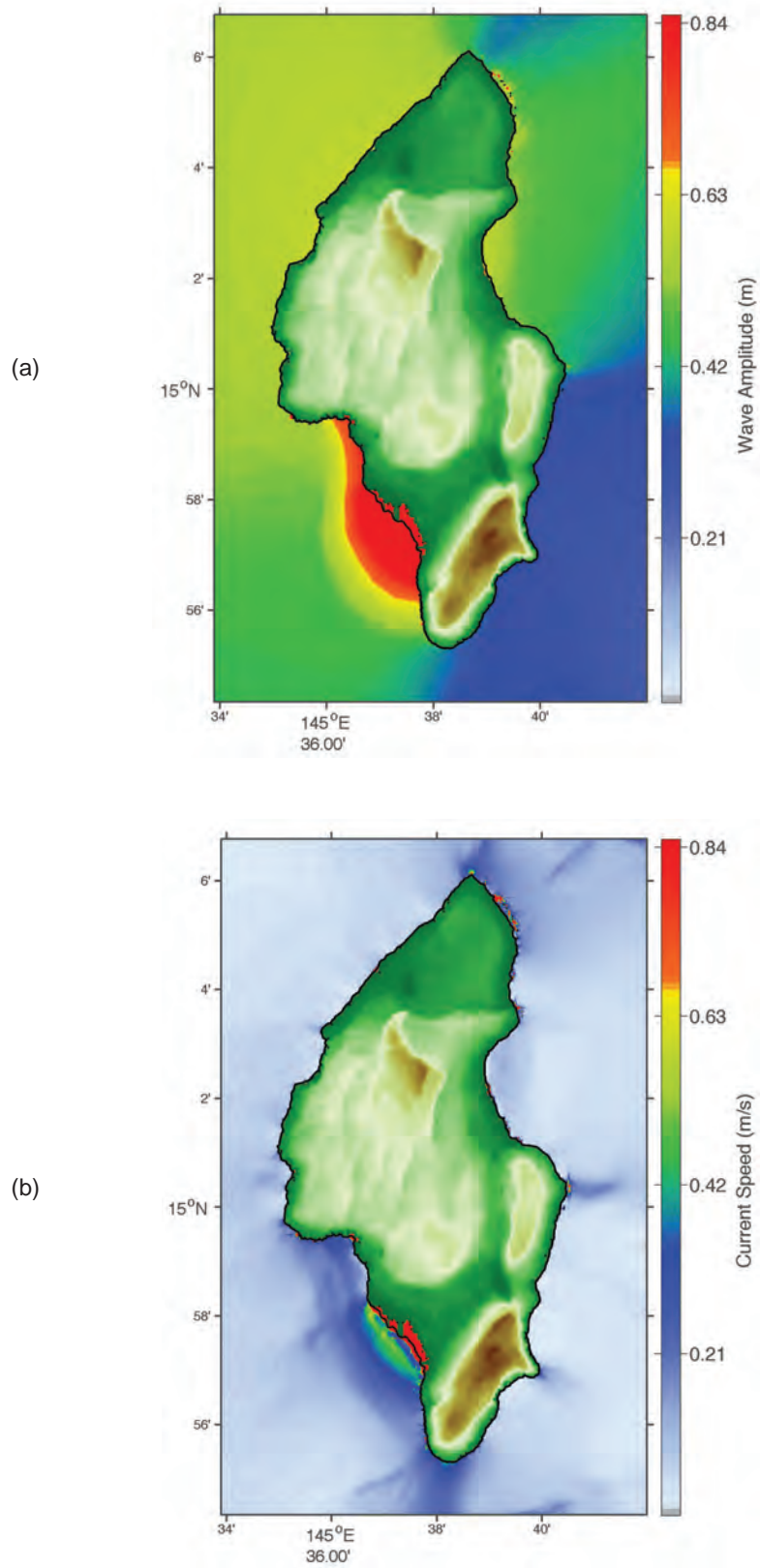
Figure C21: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the NGSZ 09 scenario.
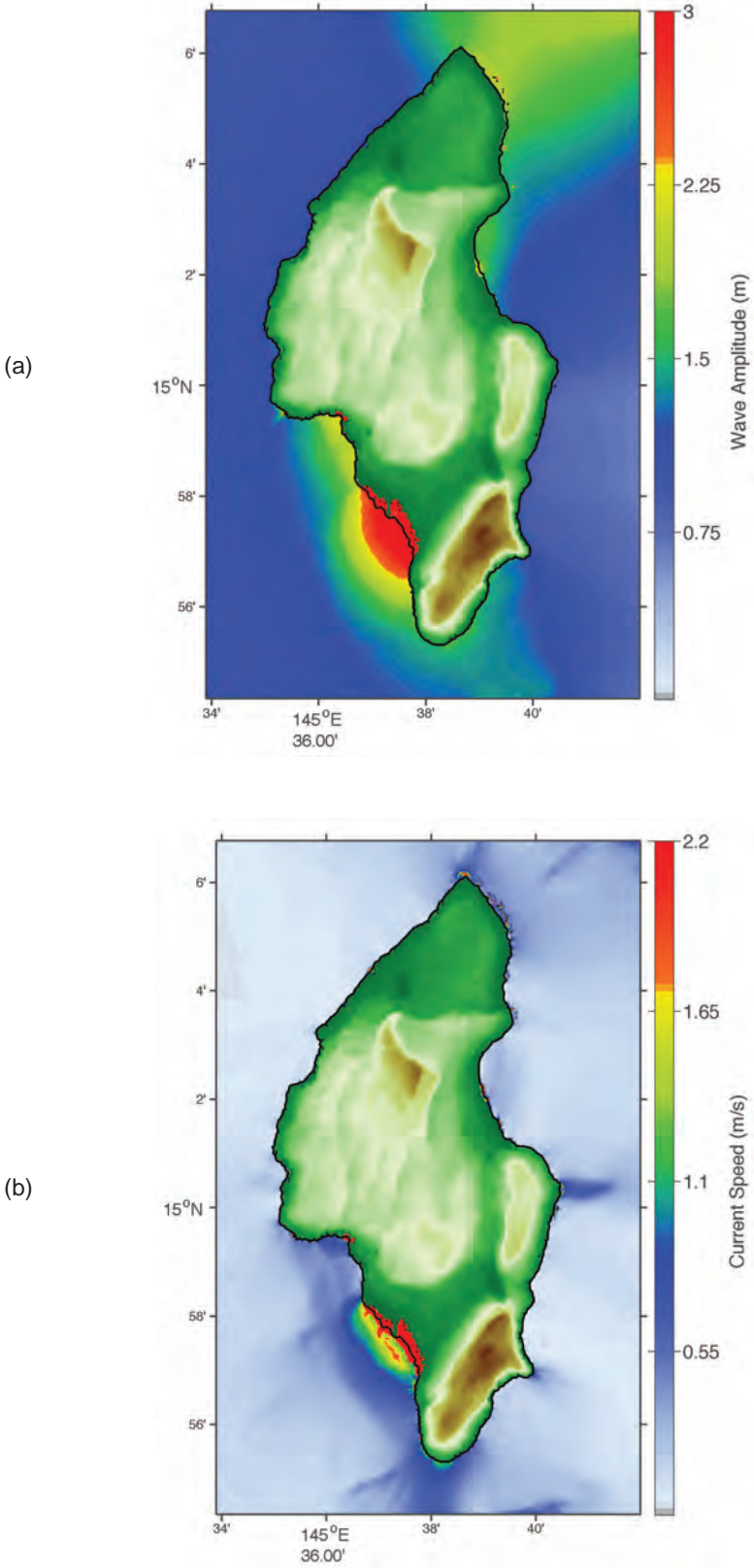
Figure C22: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the RNSZ 06 scenario.
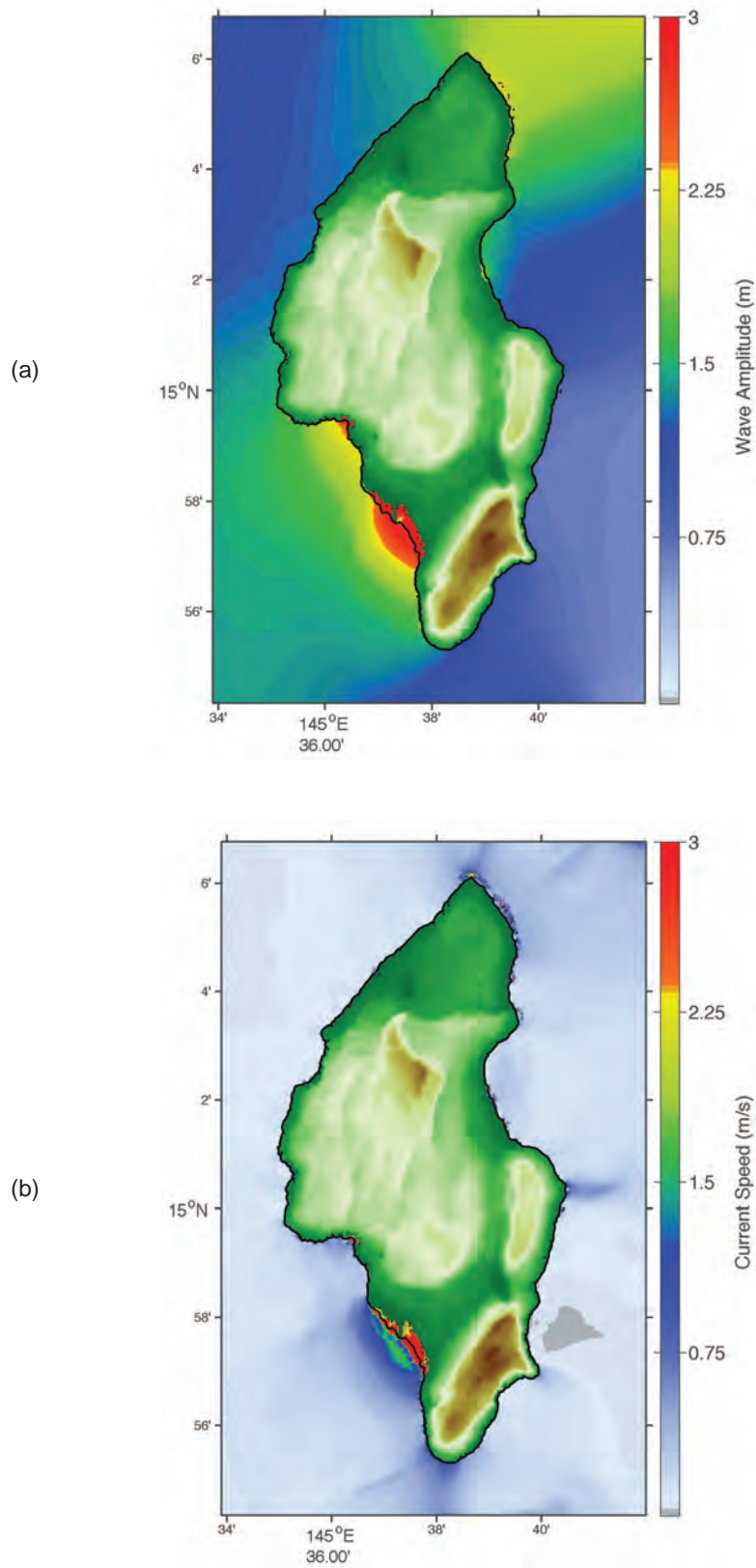
Figure C23: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the RNSZ 07 scenario.
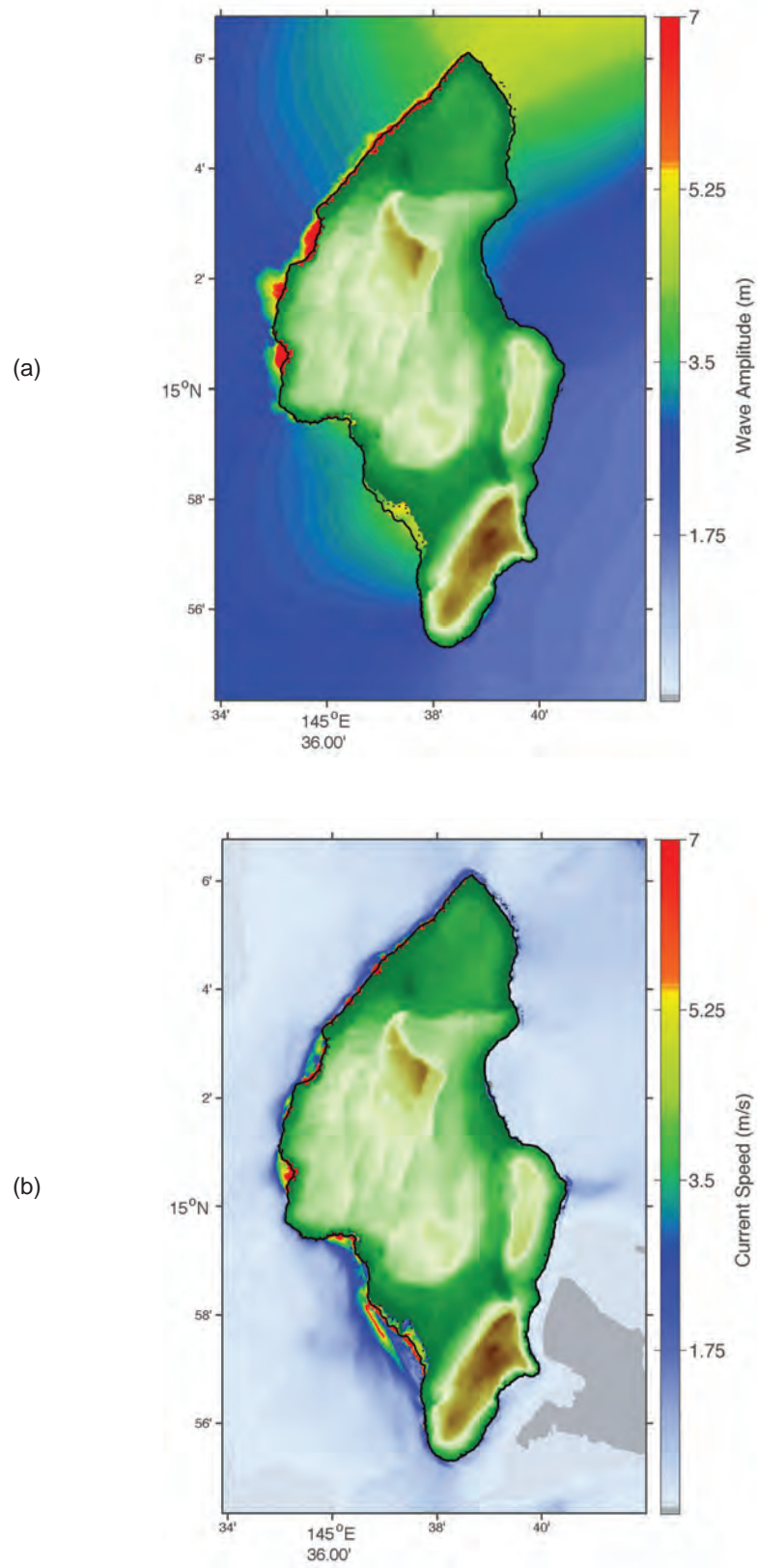
Figure C24: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the RNSZ 12 scenario.
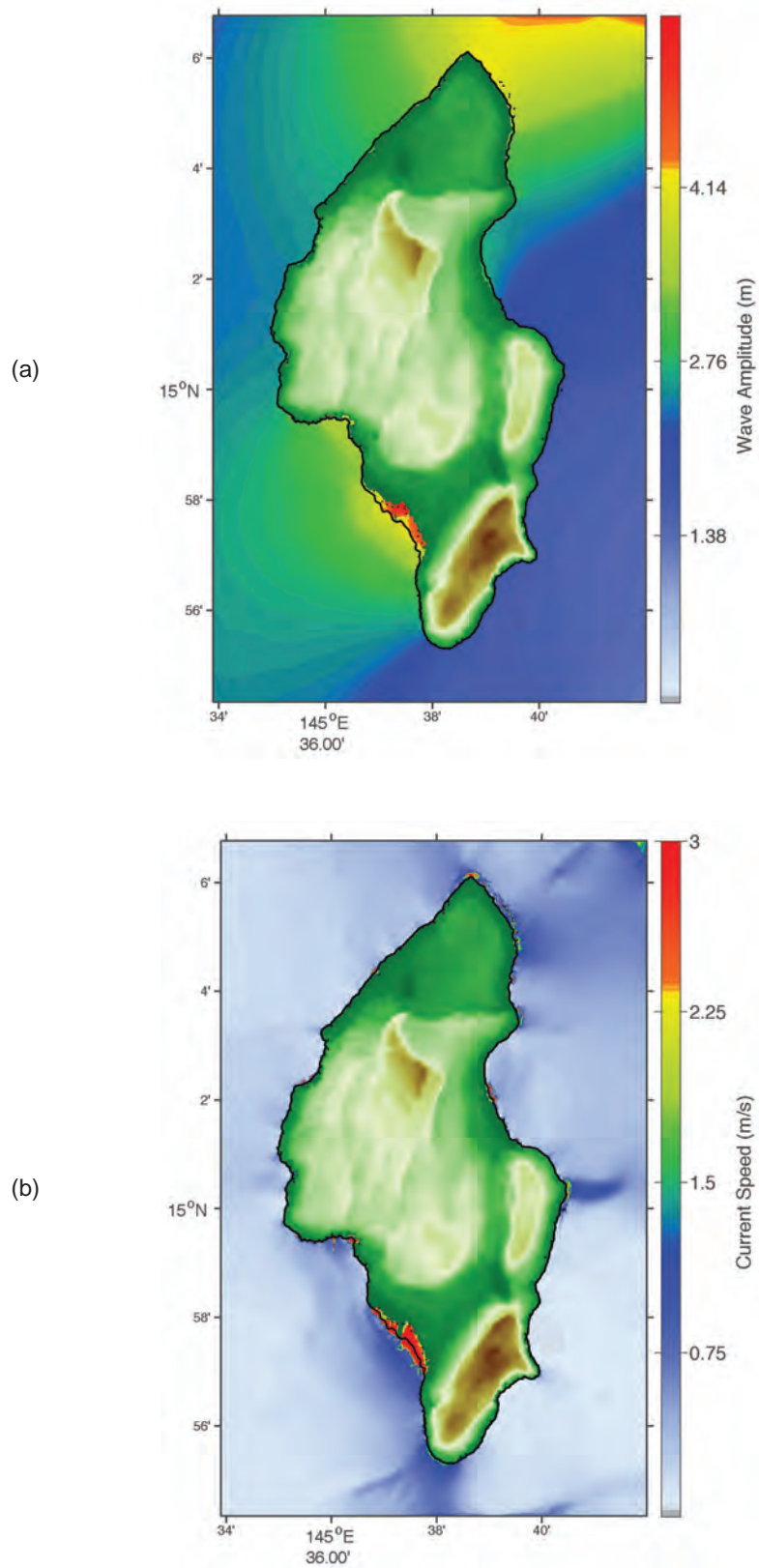
Figure C25: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the RNSZ 13 scenario.
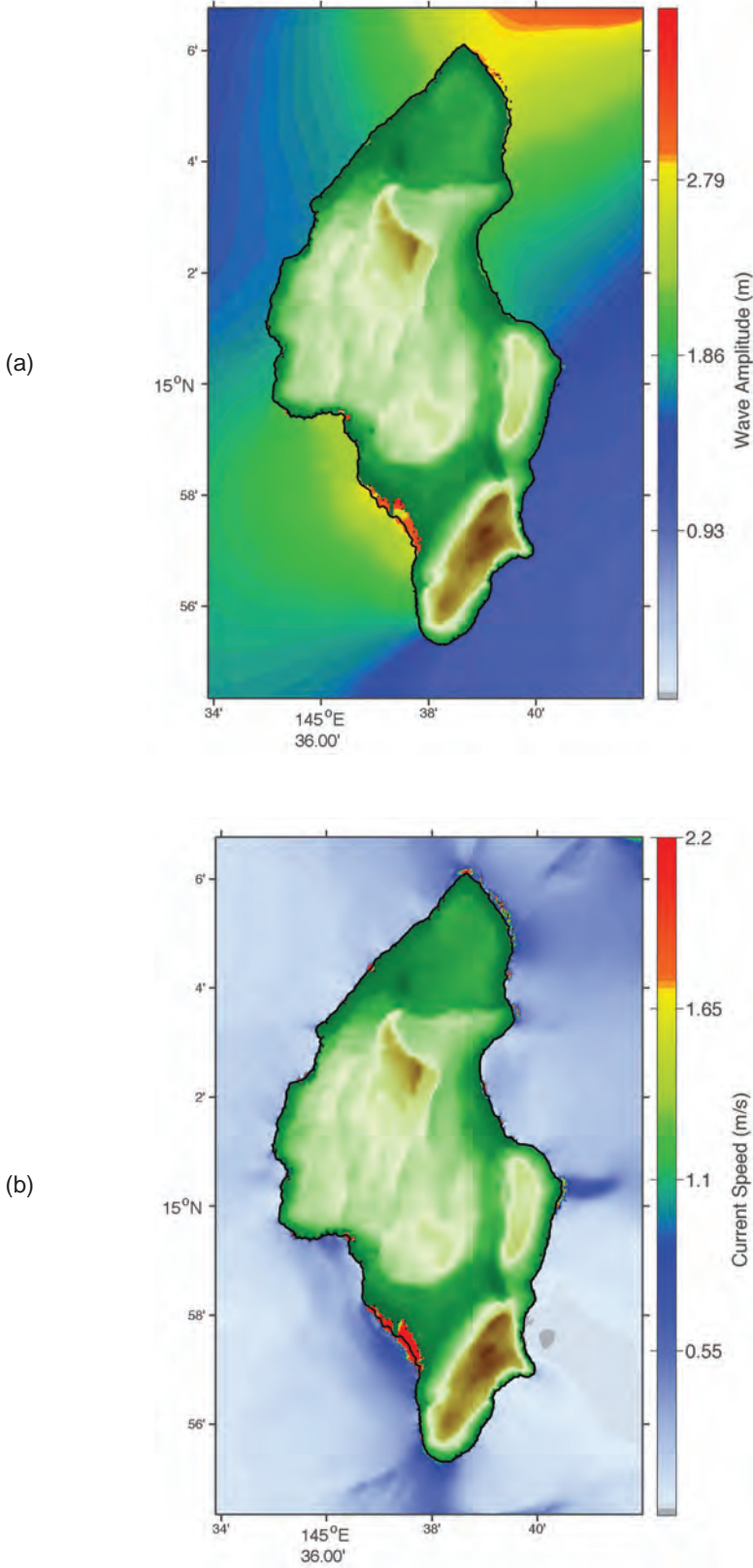
Figure C26: Maximum tsunami amplitudes (a) and currents (b) predicted for Tinian from the RNSZ 14 scenario.

Appendix D.   Rota
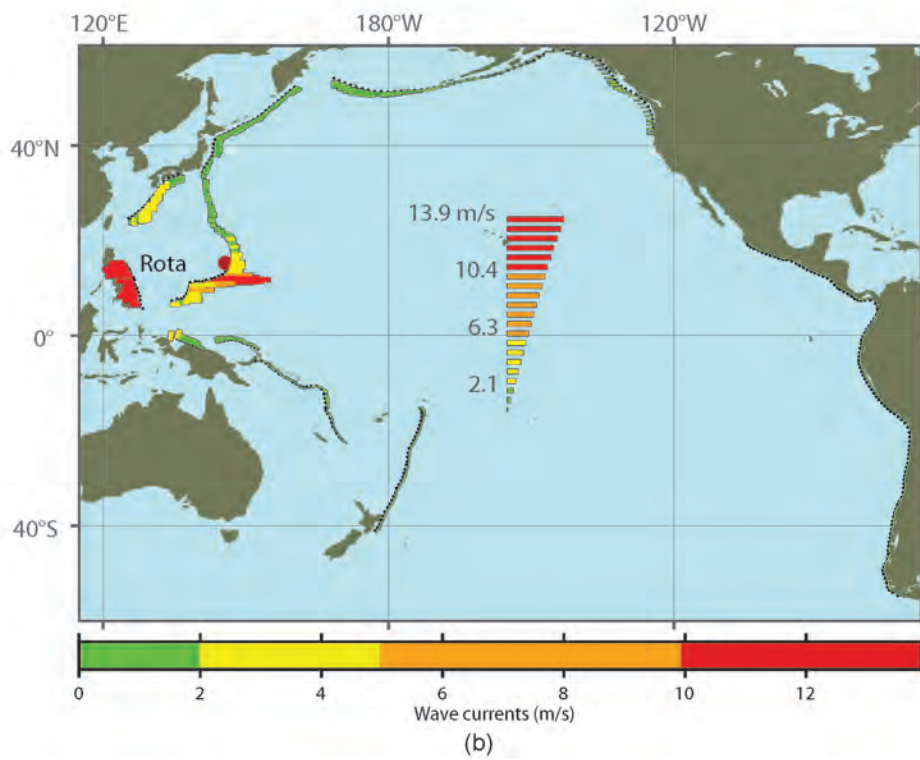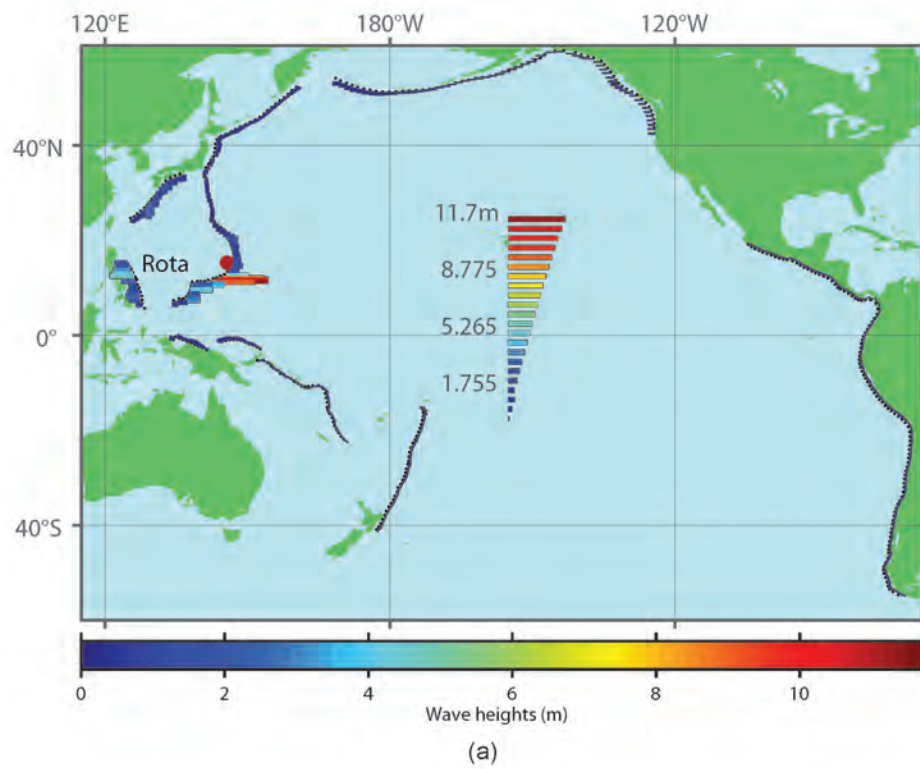
Figure D1: Computed maximum tsunami amplitude (a) and current speed (b) predicted to impact the island of Rota from tsunamis triggered by synthetic M_w 9.0 earthquakes along subduction zones around the Pacific Basin. The optimized tsunami forecast model was used for all model runs.
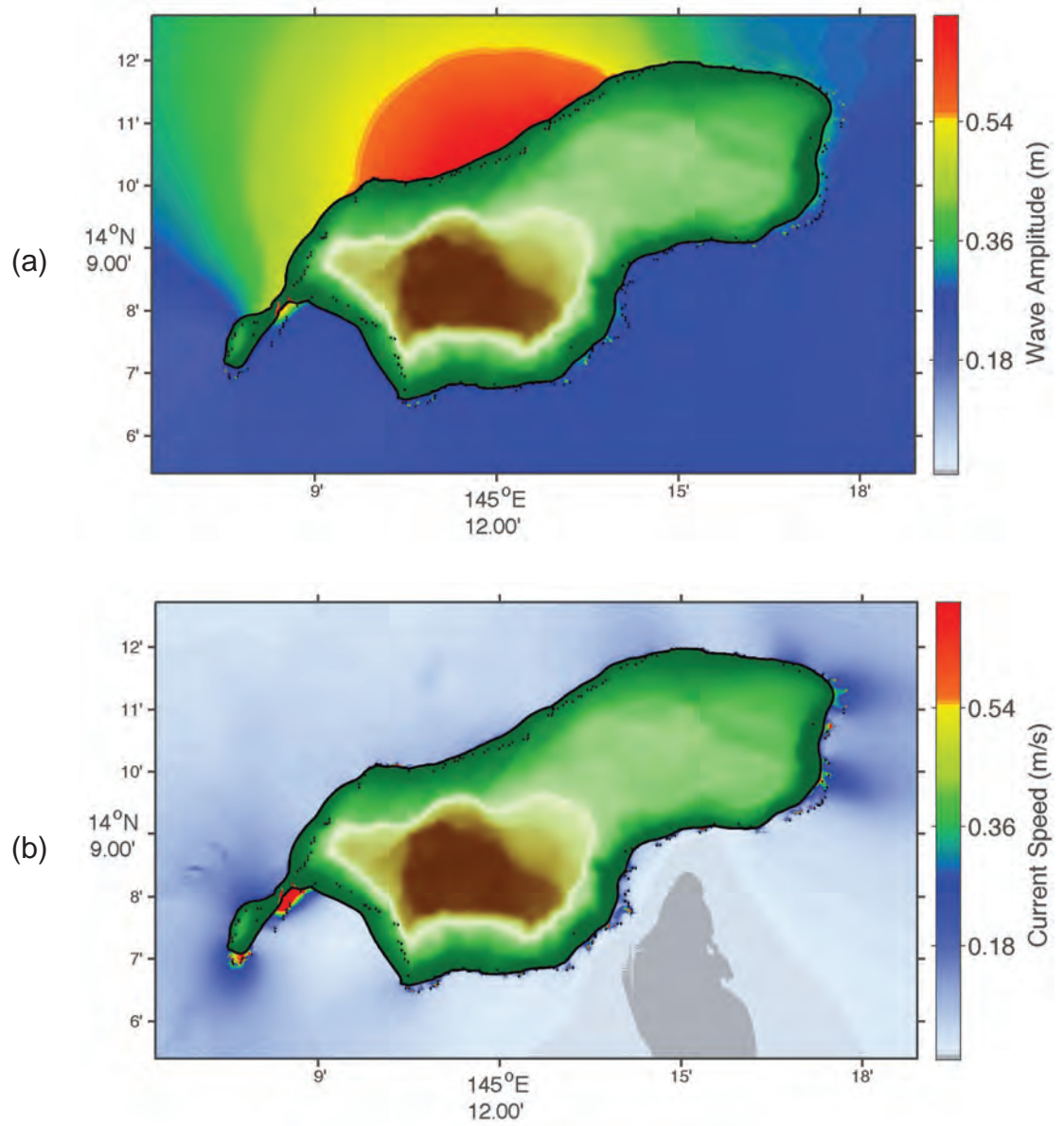
Figure D2: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 01 scenario.
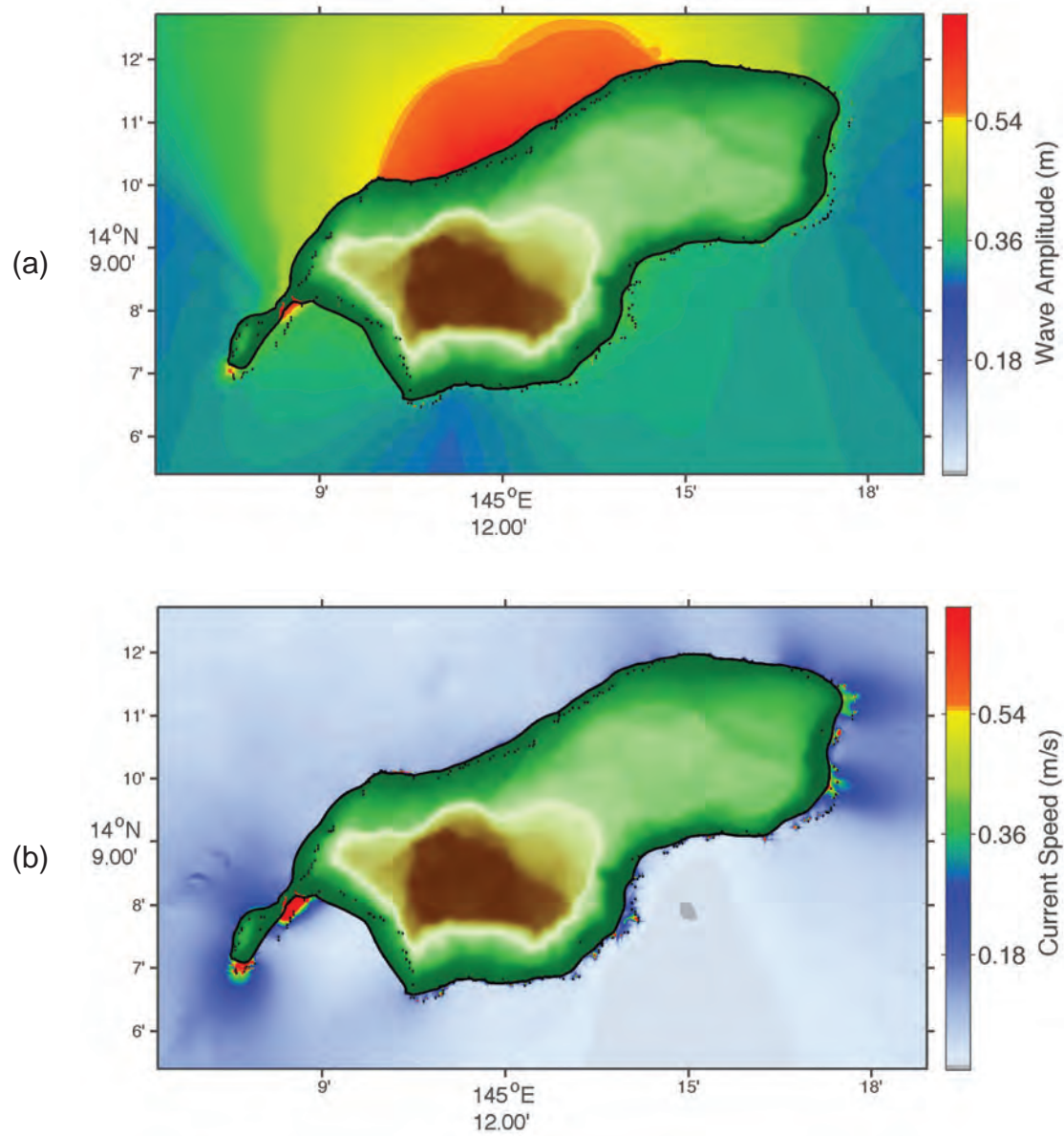
Figure D3: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 02 scenario.
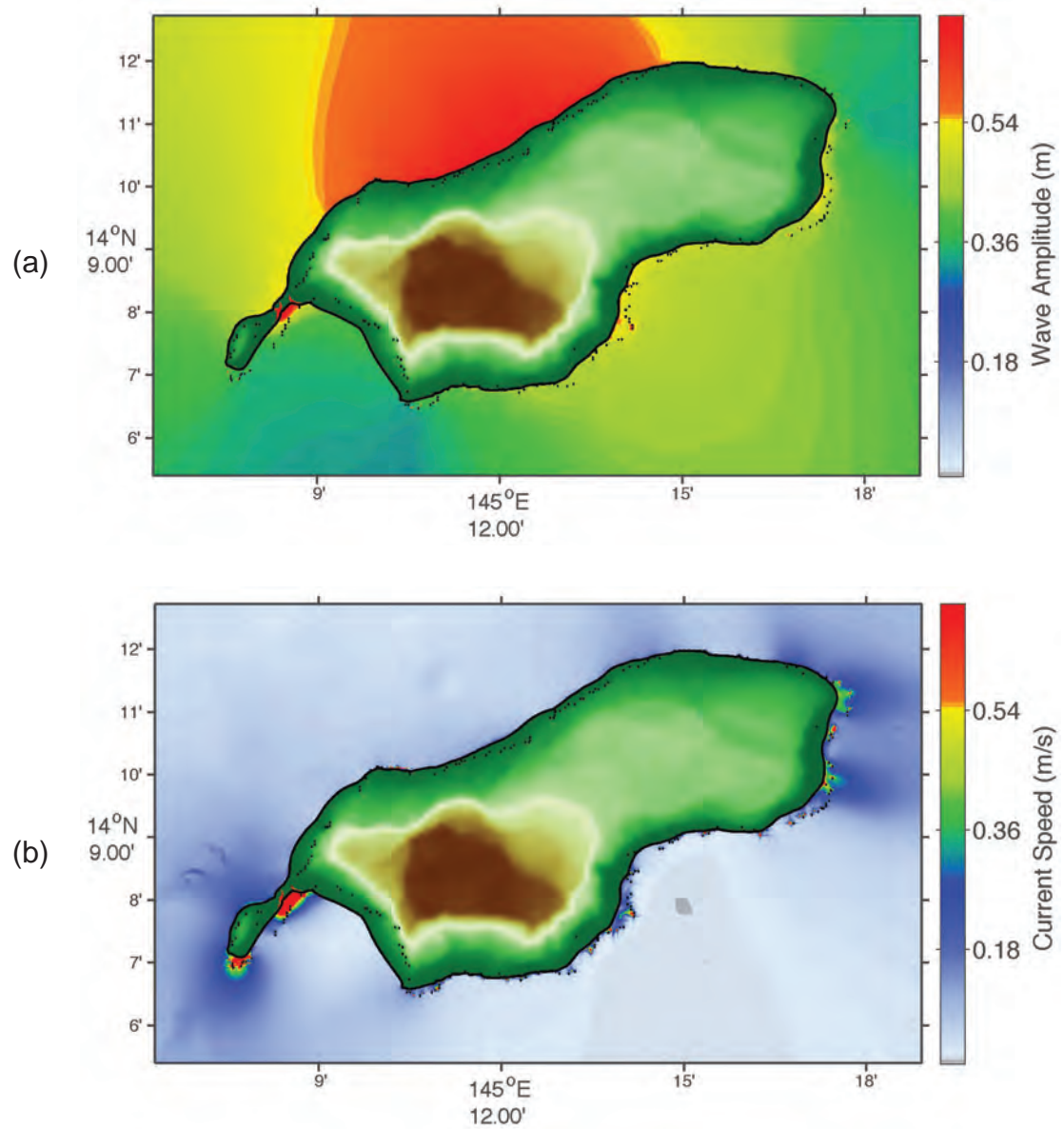
Figure D4: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 03 scenario.
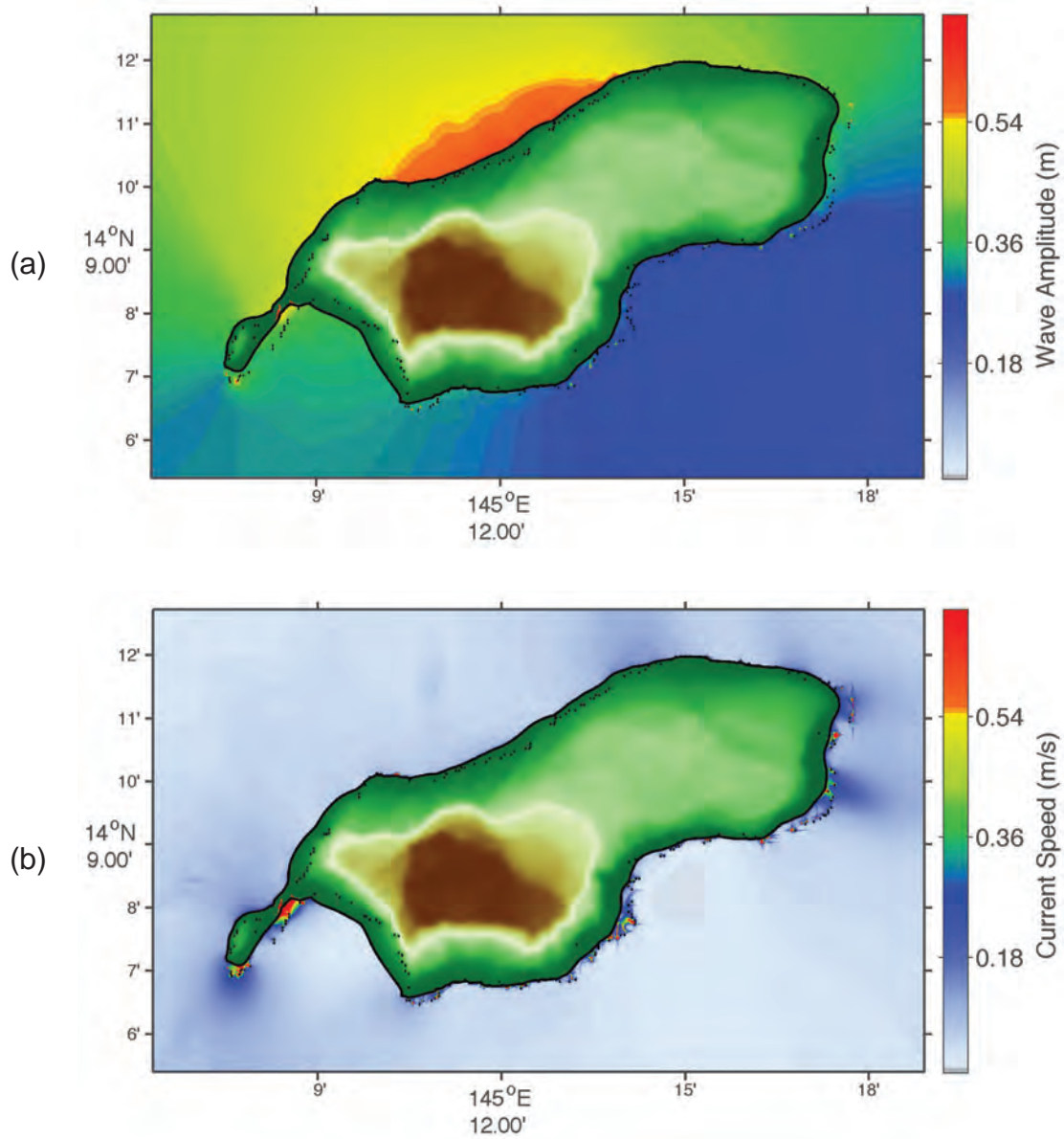
Figure D5: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 06 scenario.
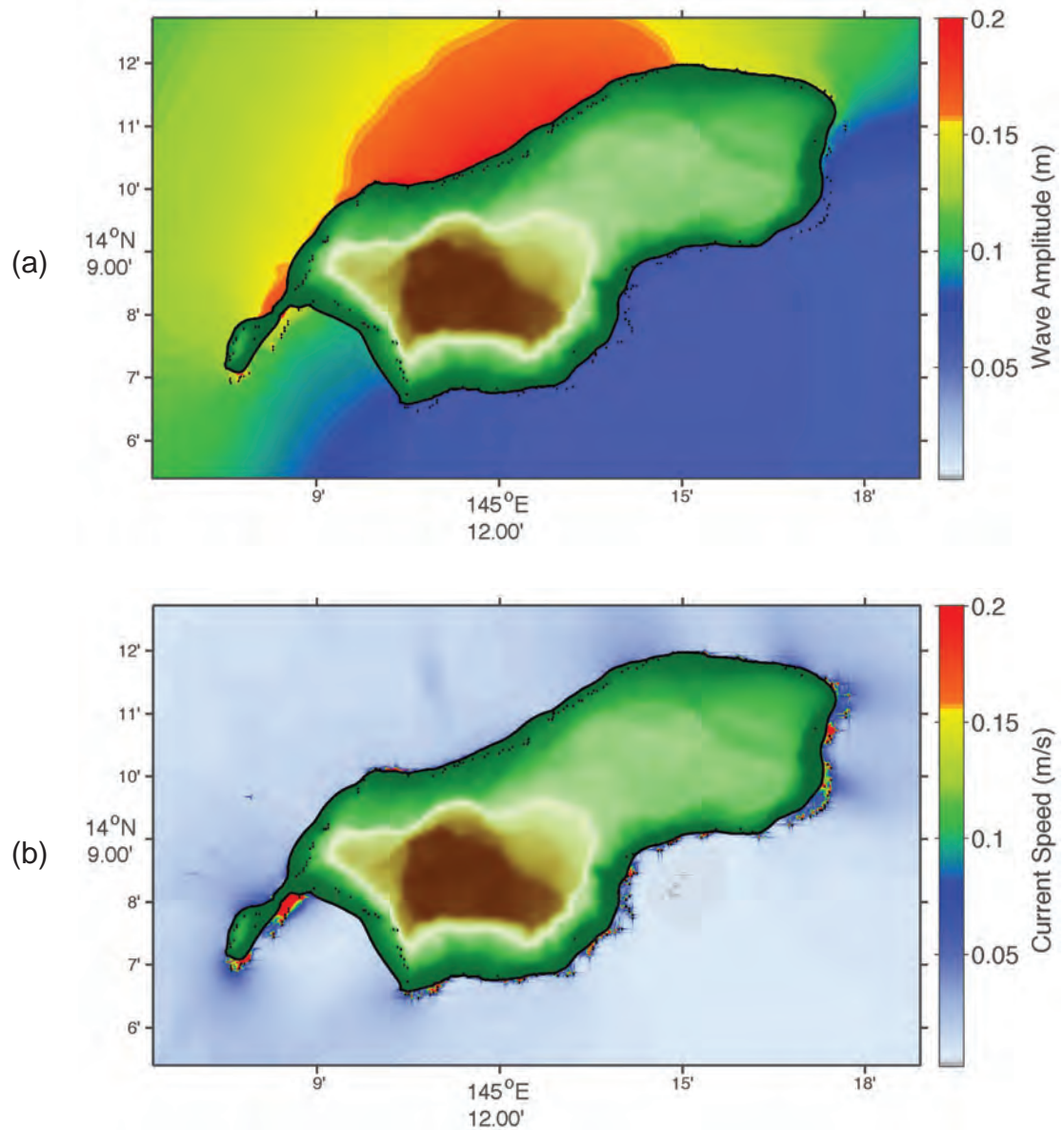
Figure D6: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 45 scenario.
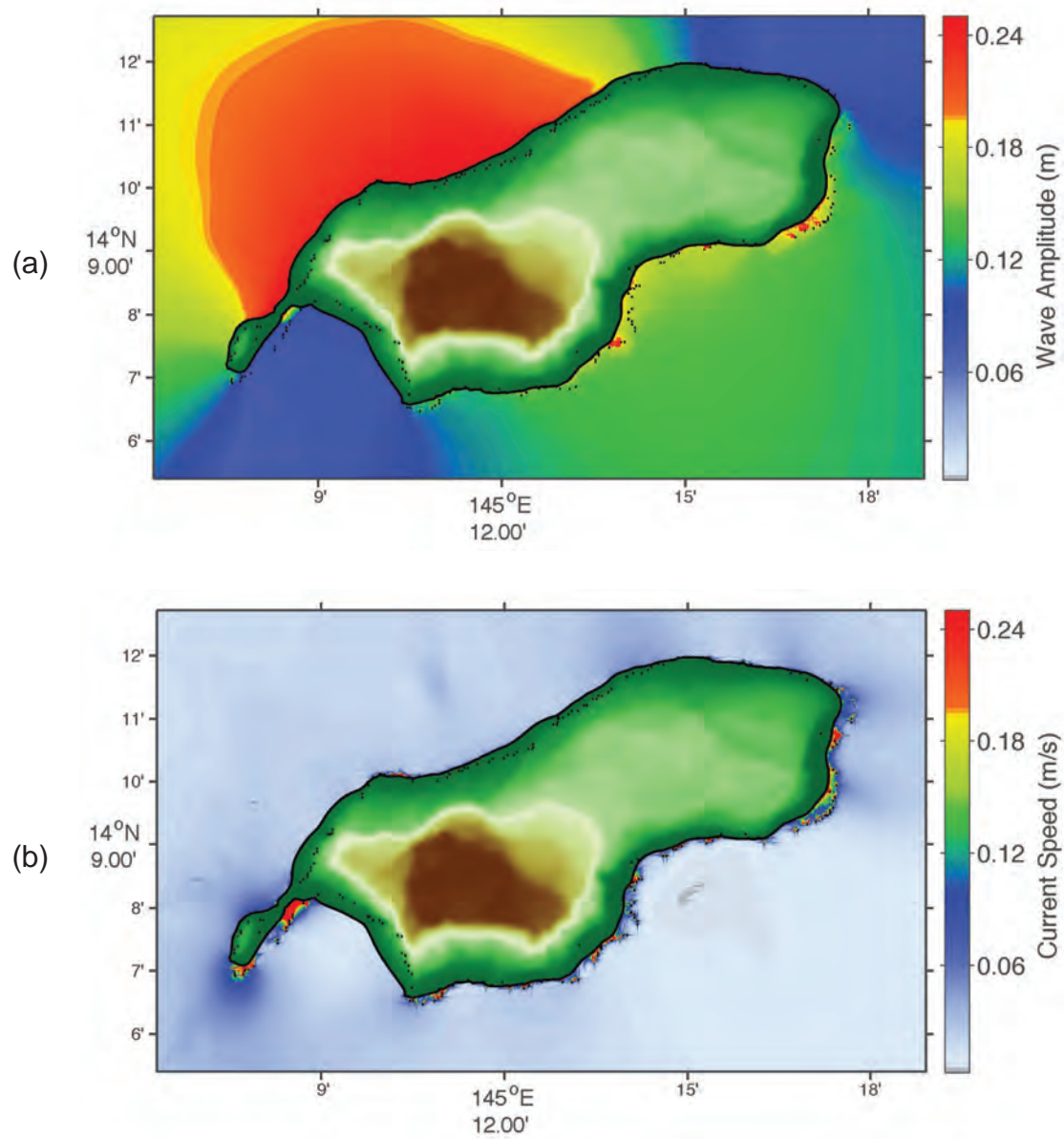
Figure D7: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 47 scenario.
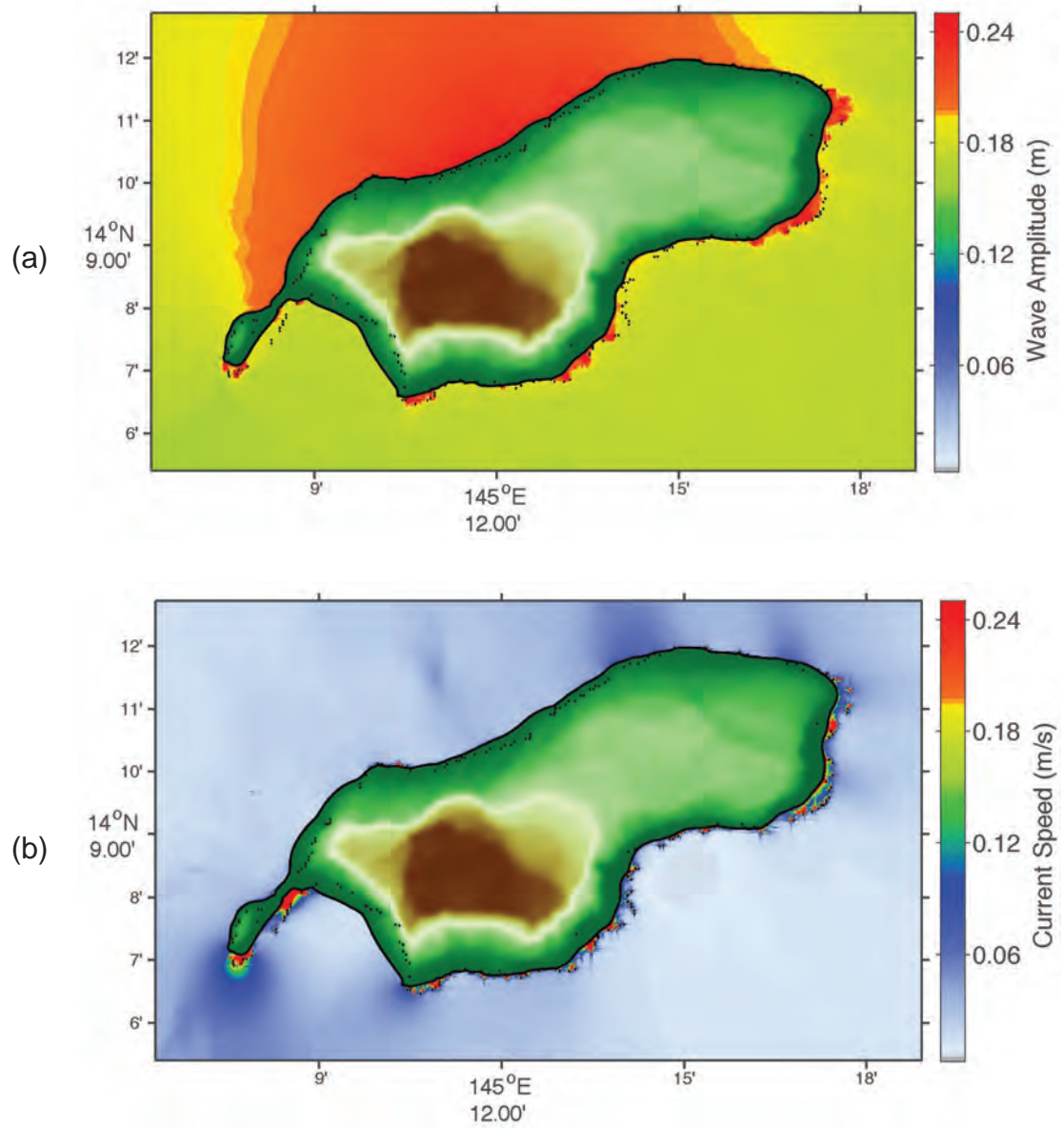
Figure D8: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the ACSZ 59 scenario.
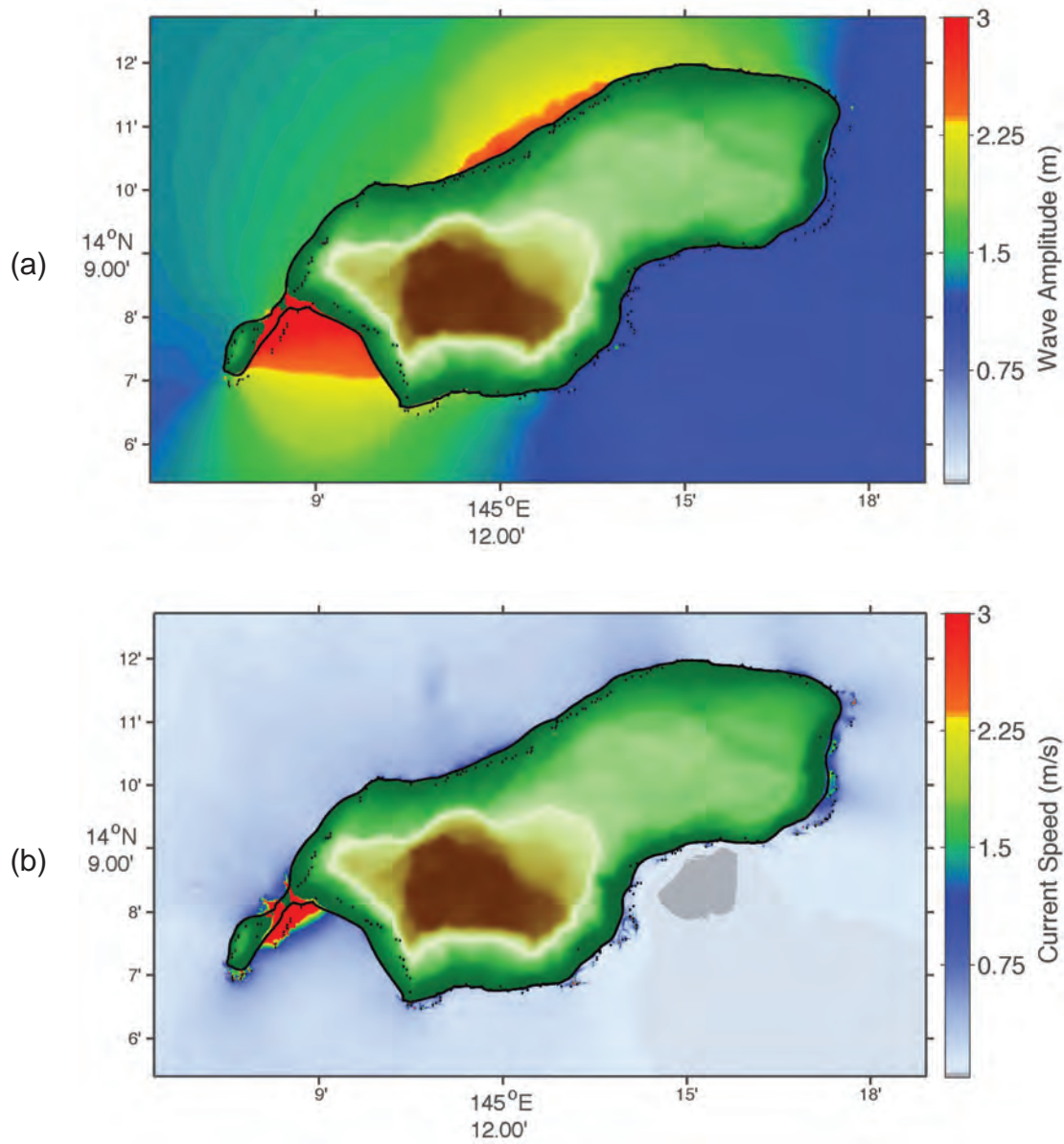
Figure D9: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the EPSZ 08 scenario.
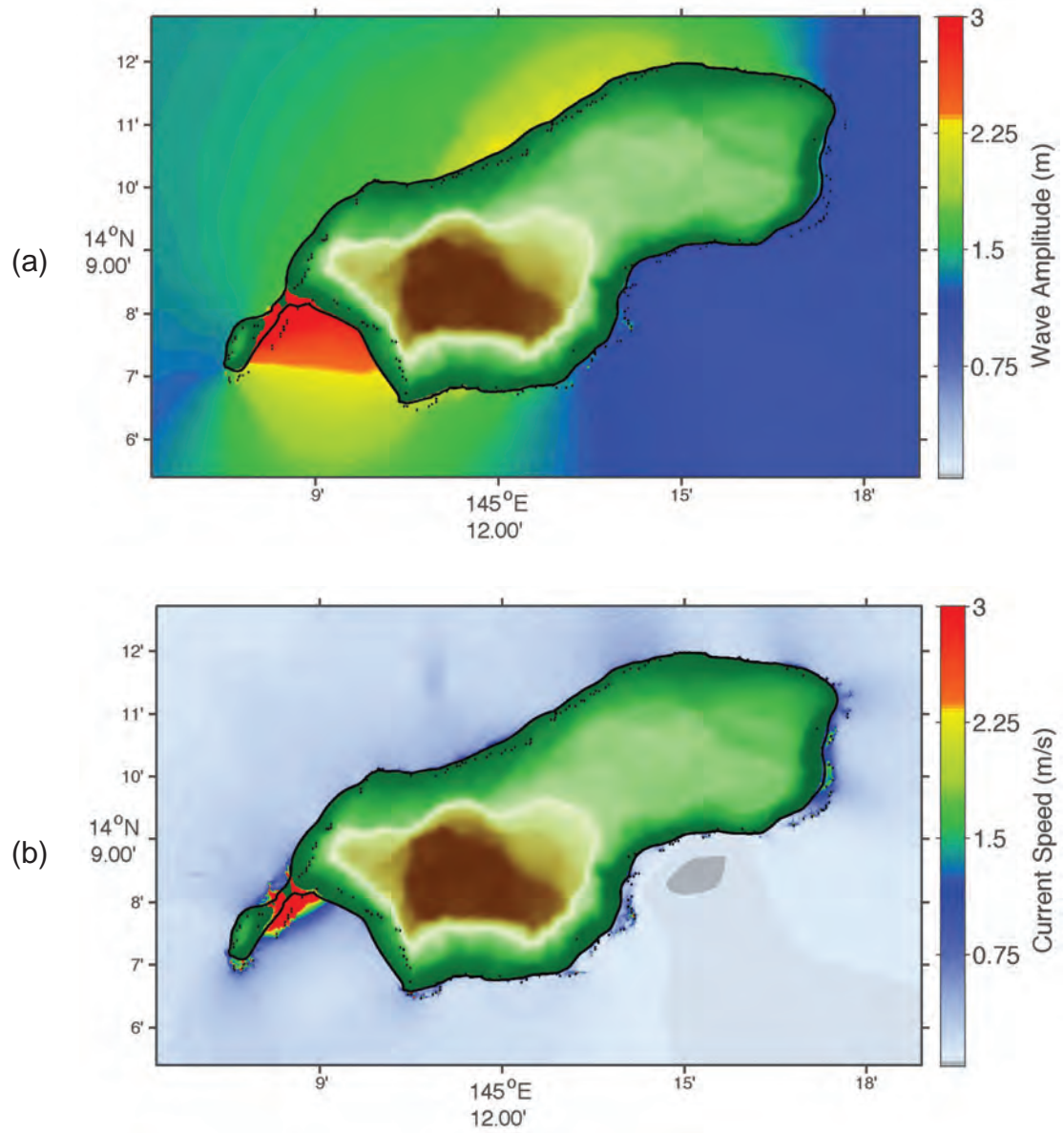
Figure D10: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the EPSZ 09 scenario.
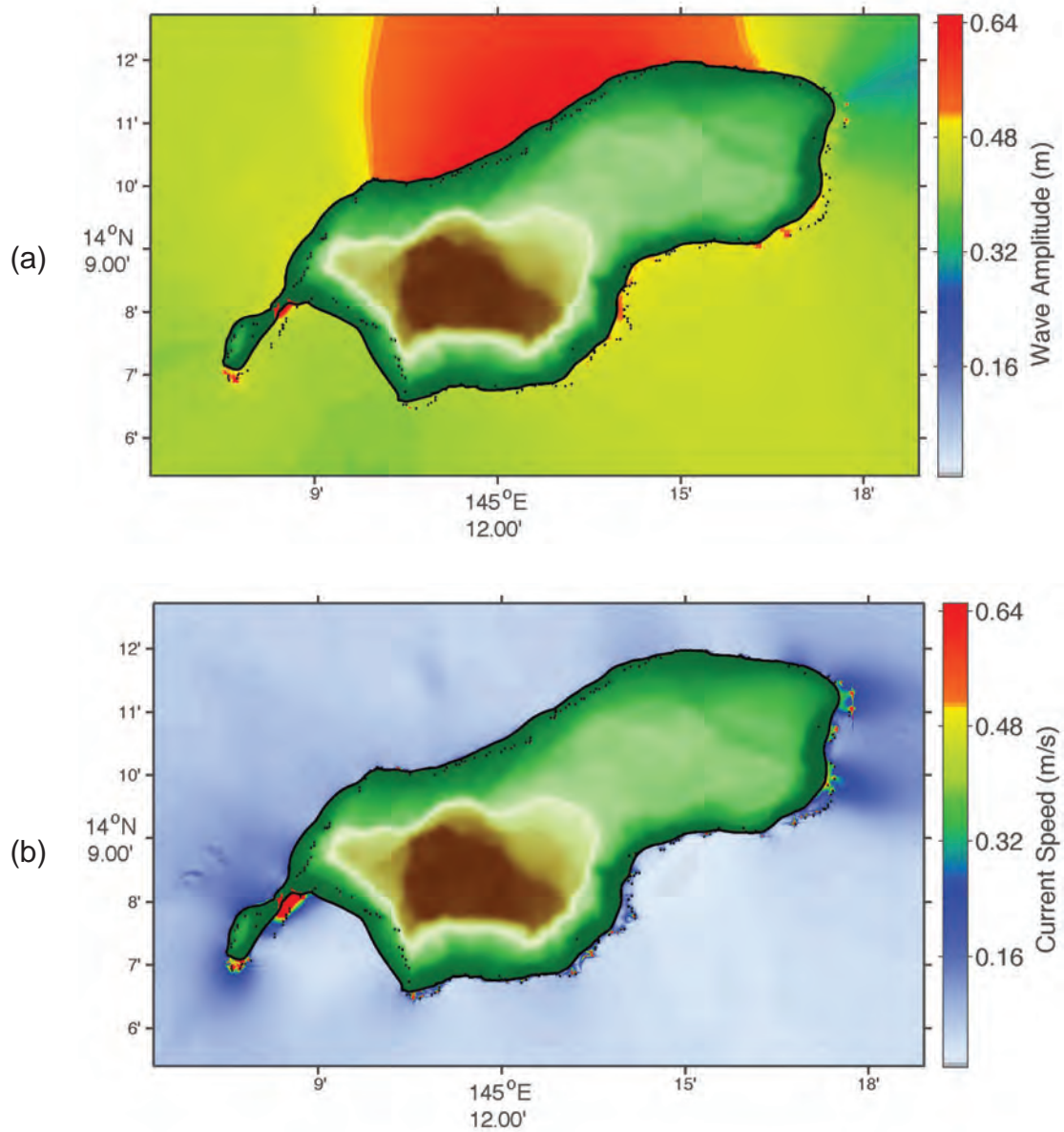
Figure D11: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 20 scenario.
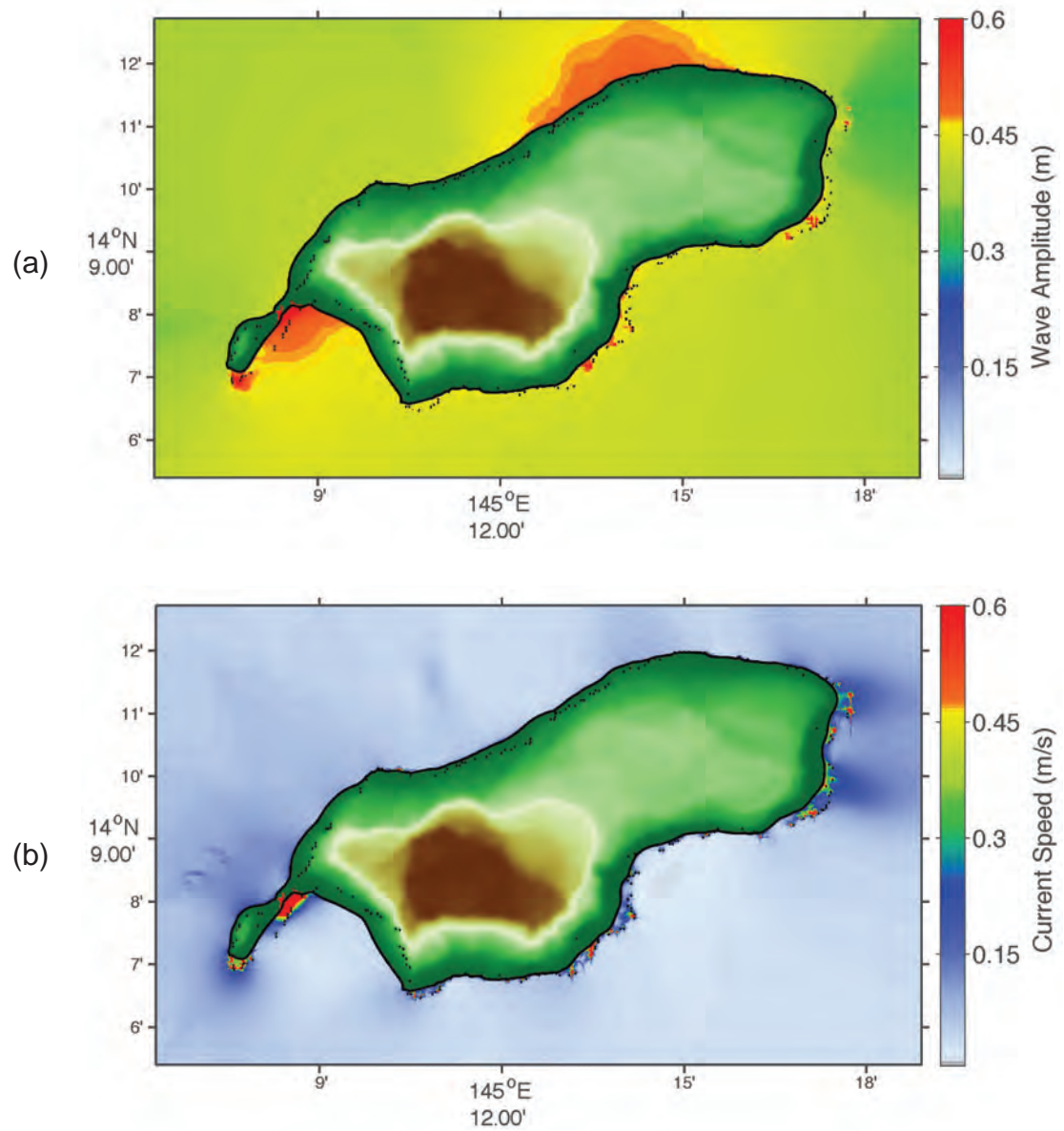
Figure D12: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 21 scenario.
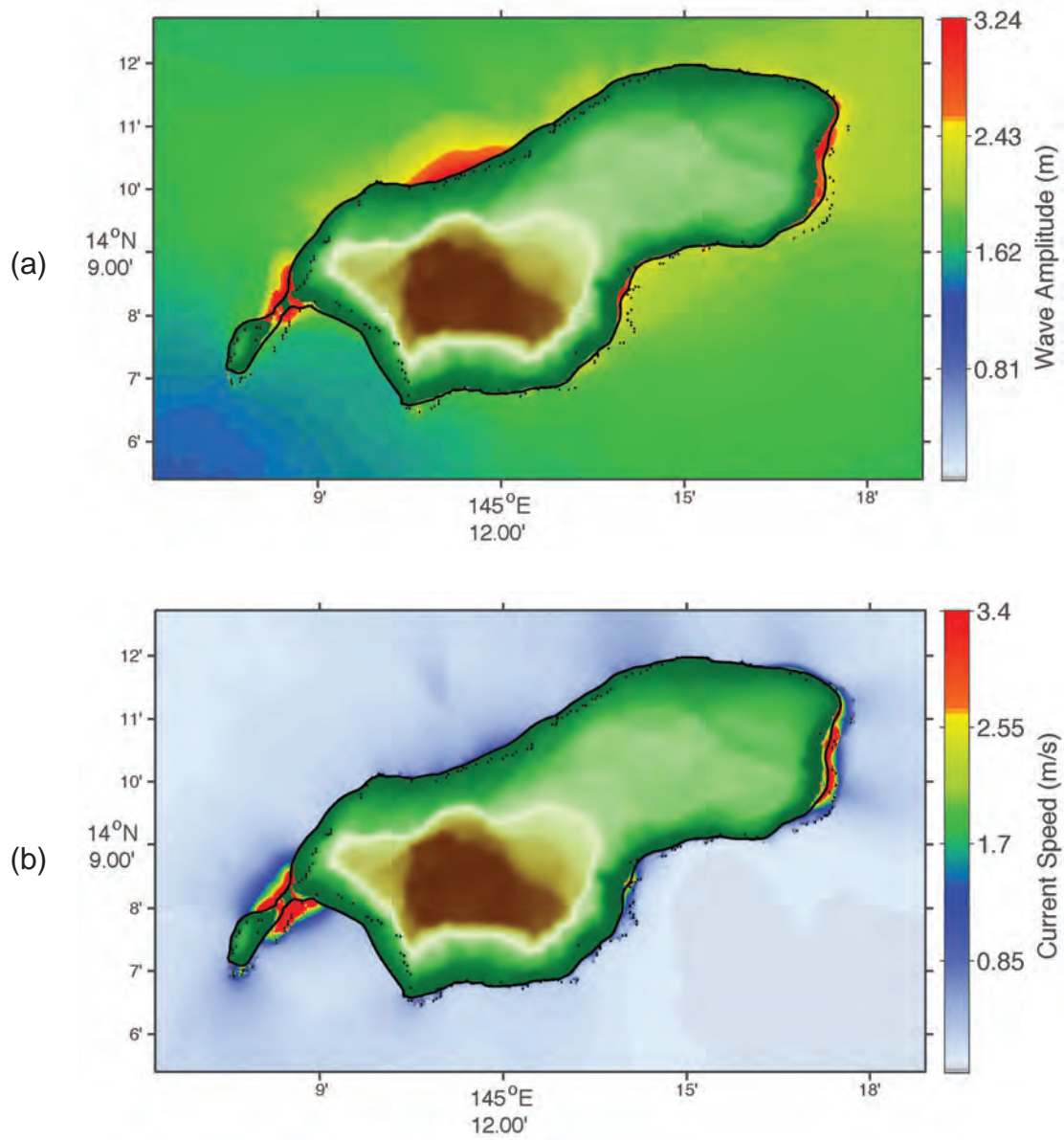
Figure D13: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 53 scenario.
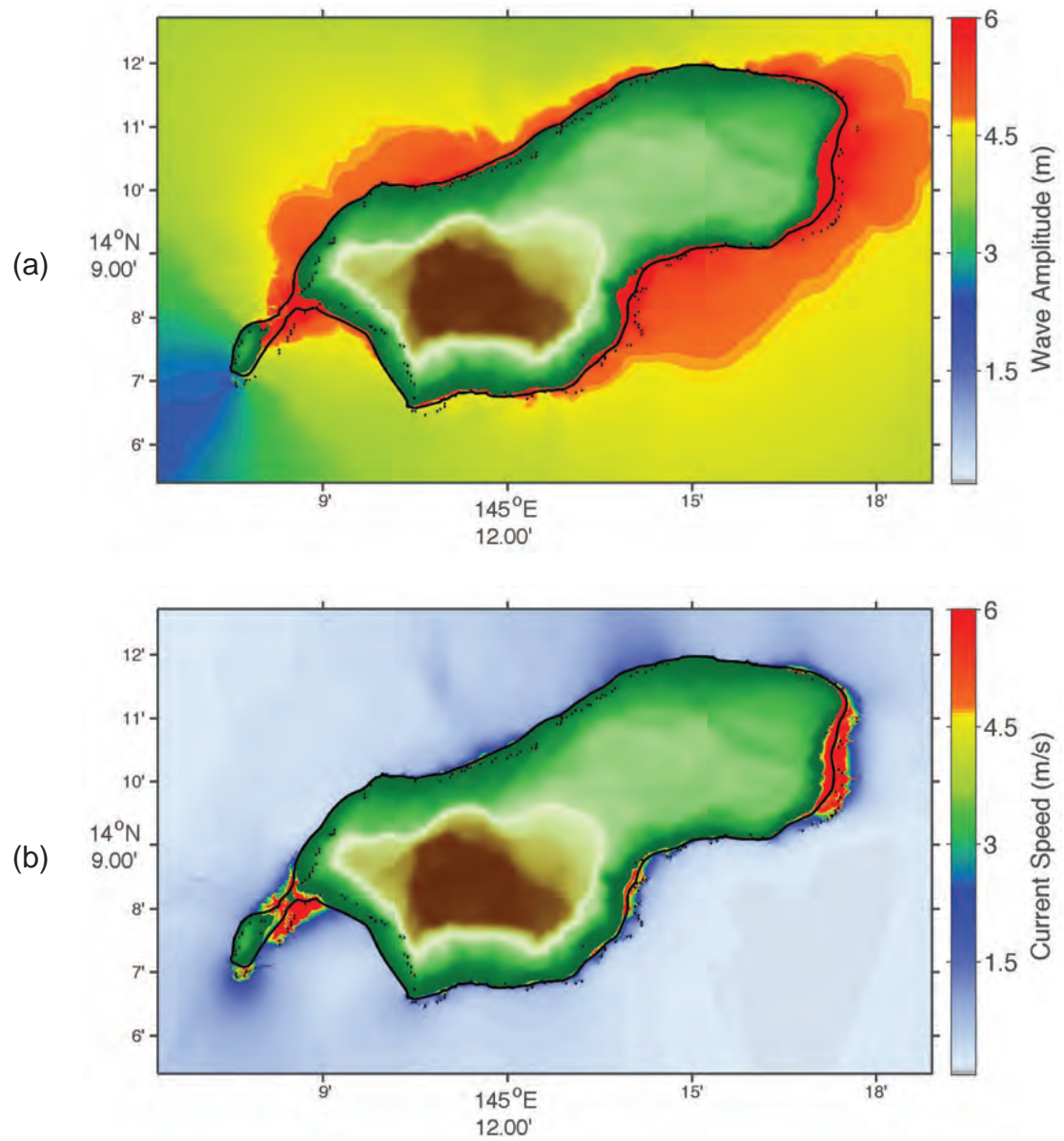
Figure D14: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 54 scenario.
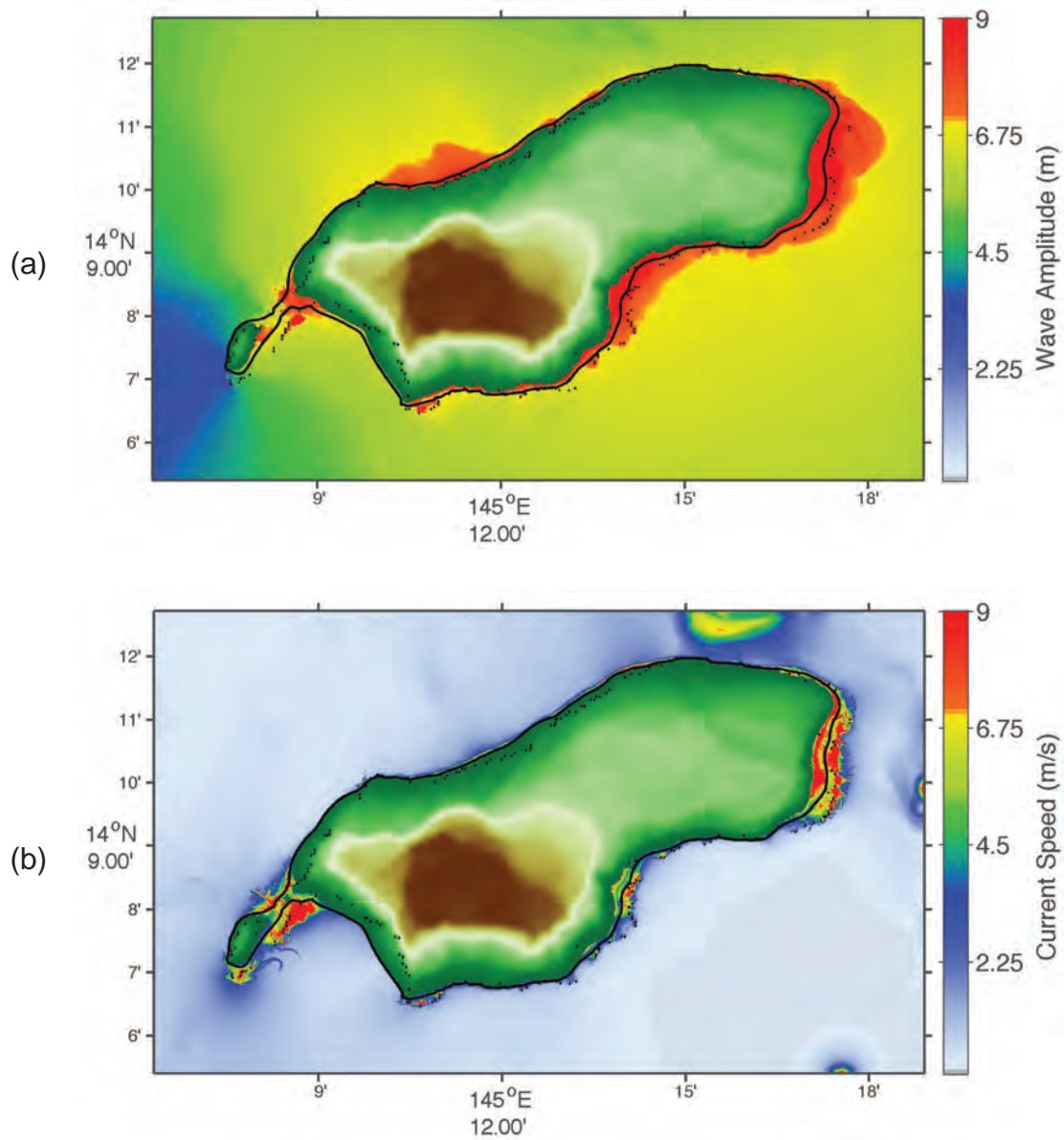
Figure D15: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 55 scenario.
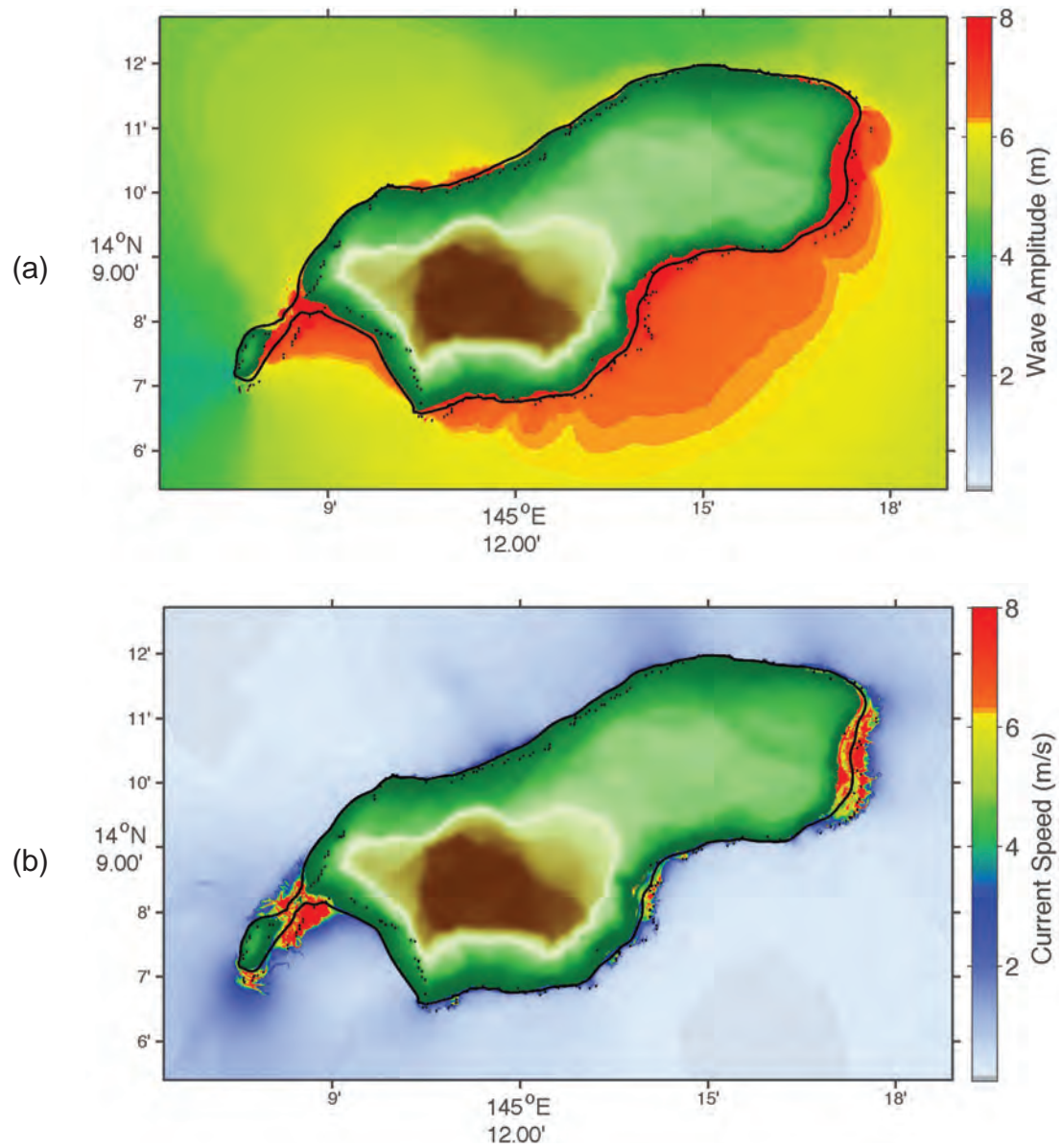
Figure D16: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the KISZ 56 scenario.
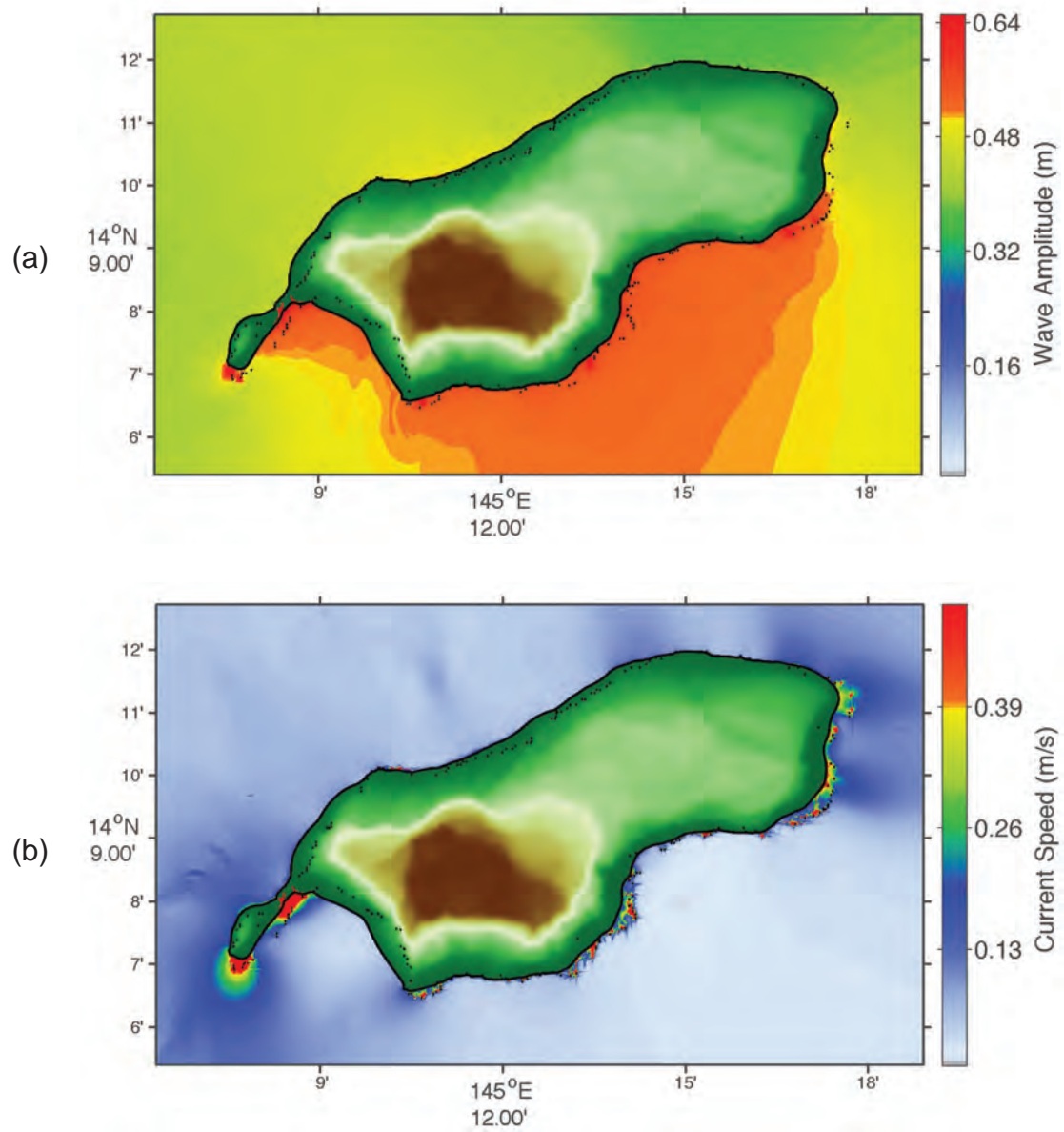
Figure D17: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the MOSZ 10 scenario.
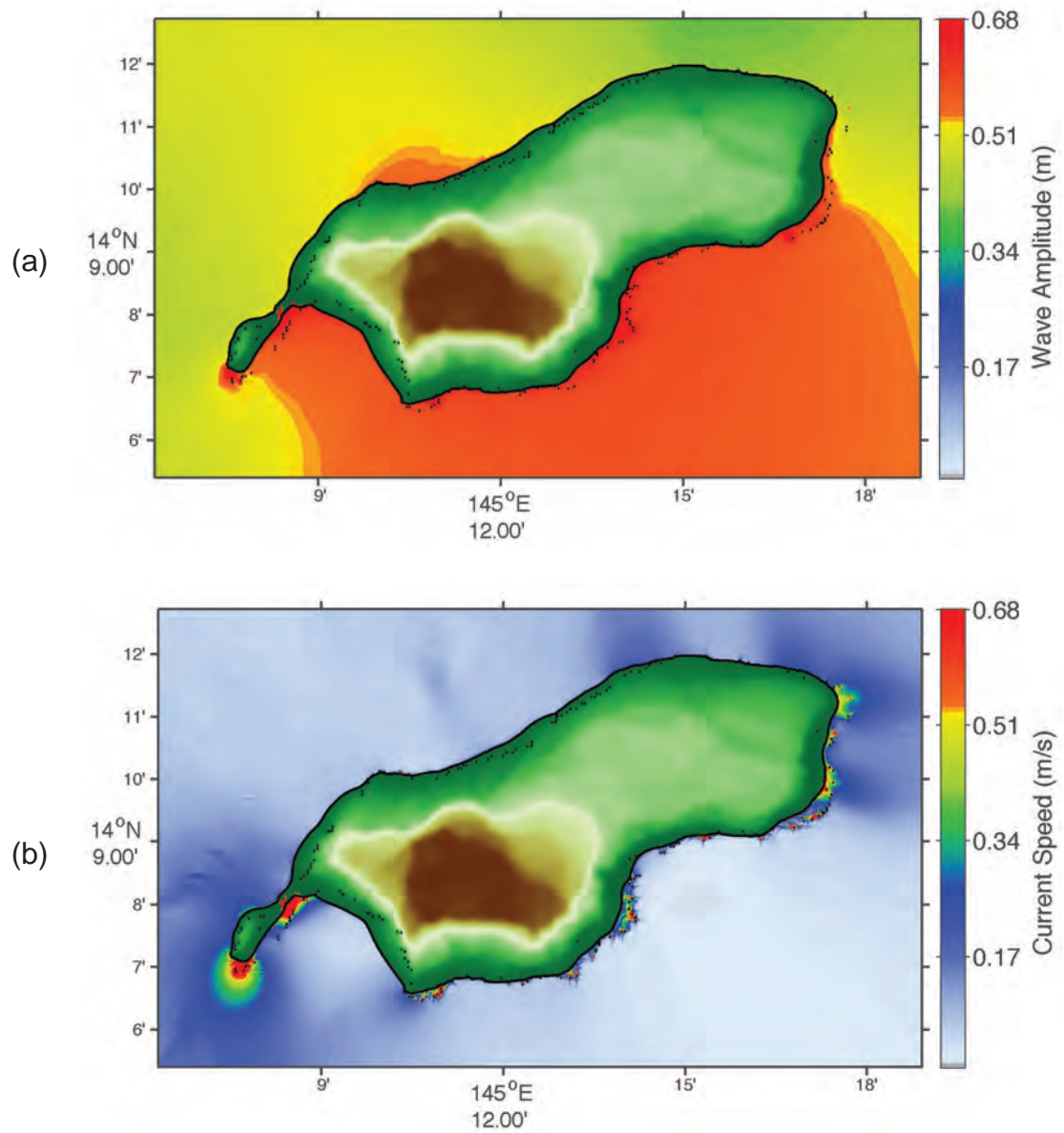
Figure D18: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the MOSZ 11 scenario.
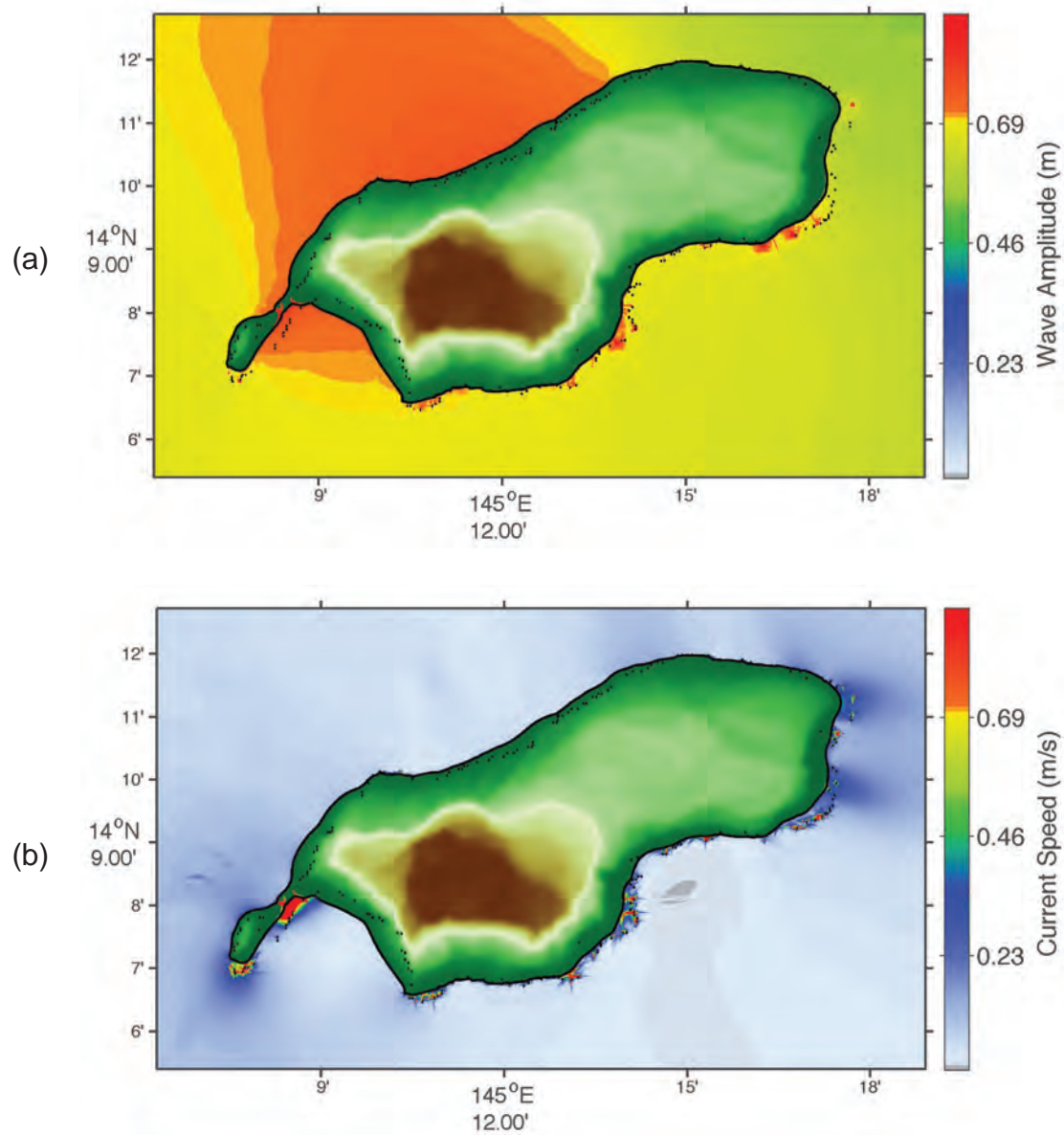
Figure D19: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the NGSZ 04 scenario.
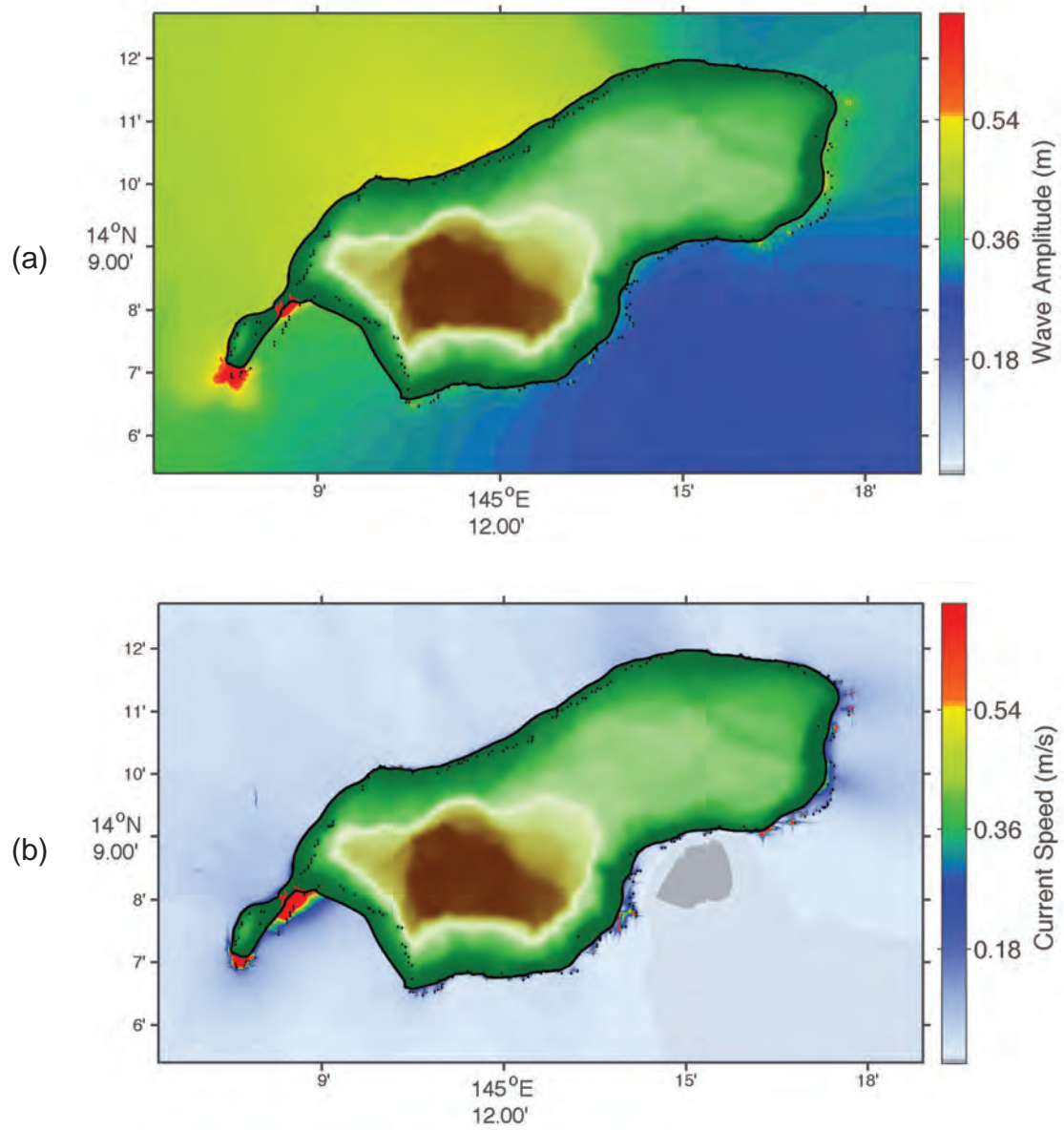
Figure D20: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the NGSZ 08 scenario.
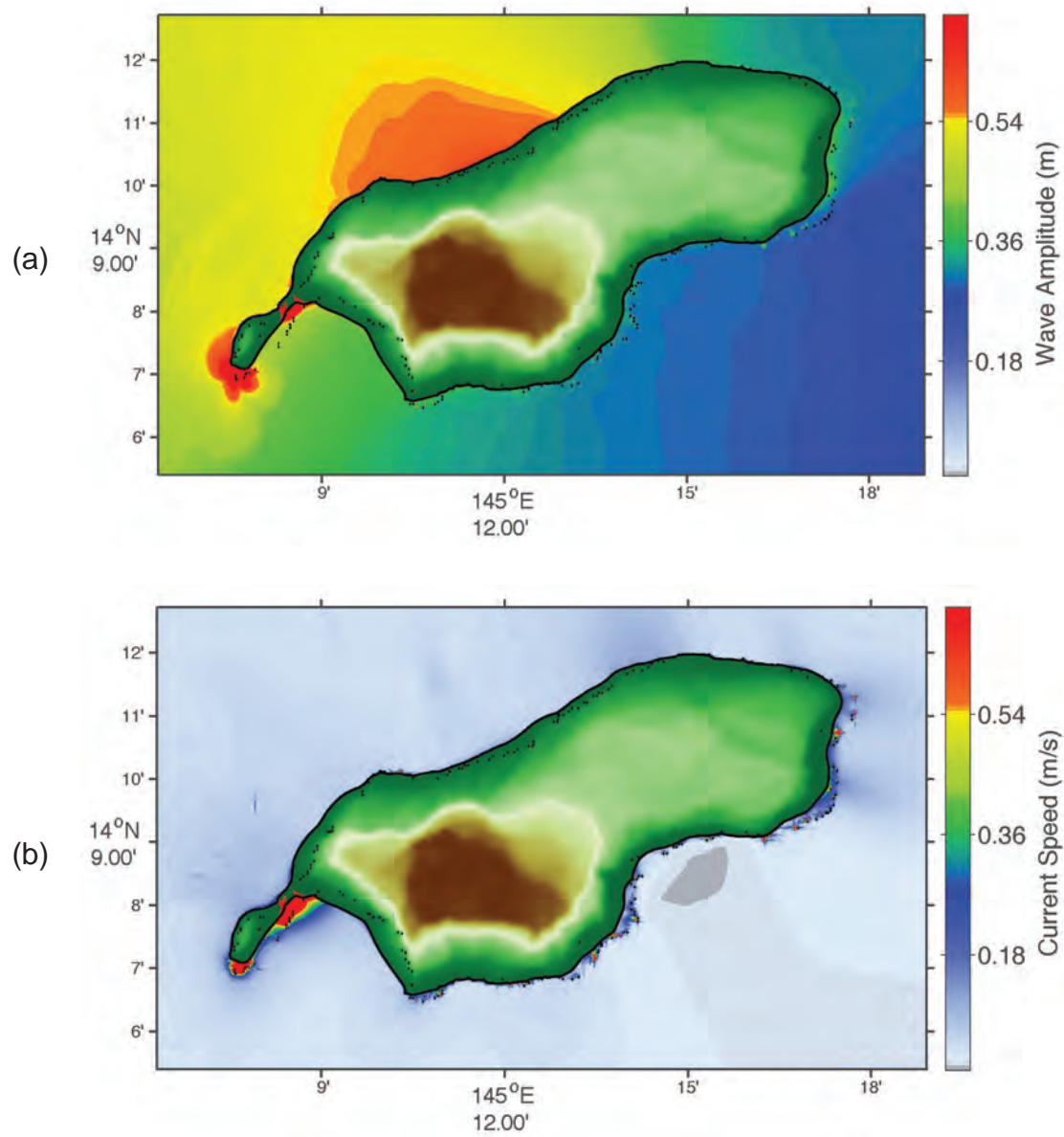
Figure D21: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the NGSZ 09 scenario.
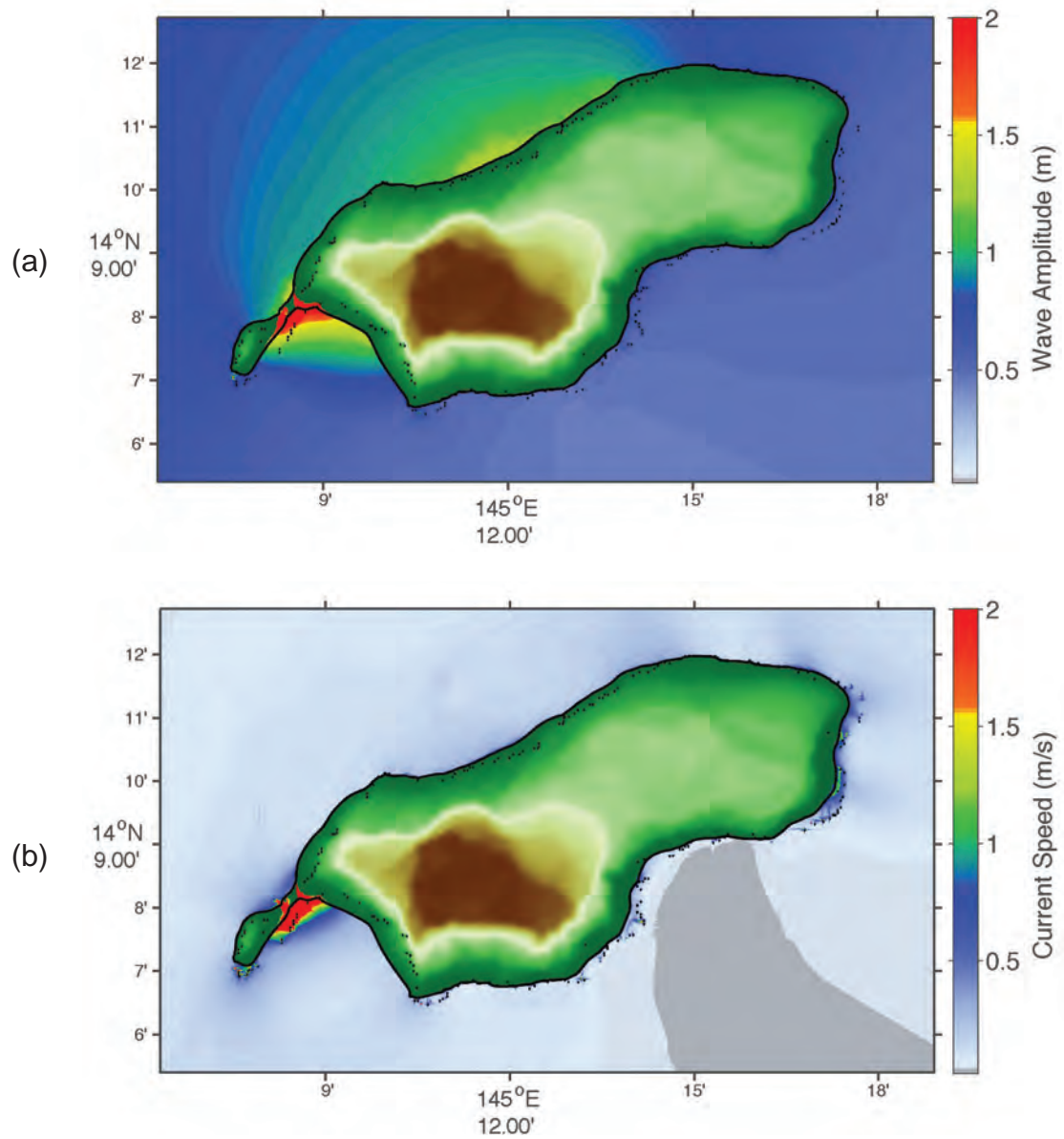
Figure D22: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the RNSZ 06 scenario.
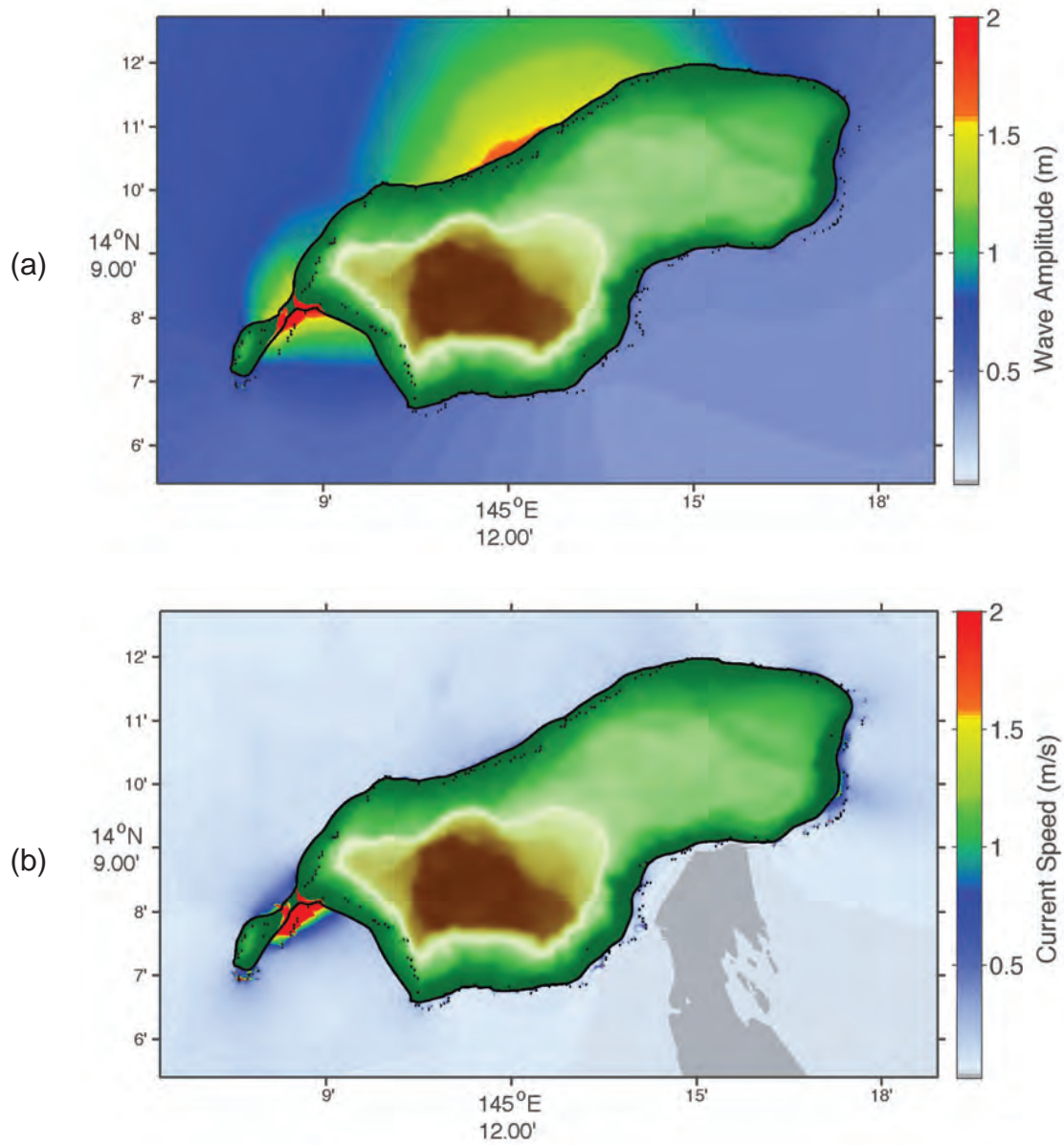
Figure D23: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the RNSZ 07 scenario.
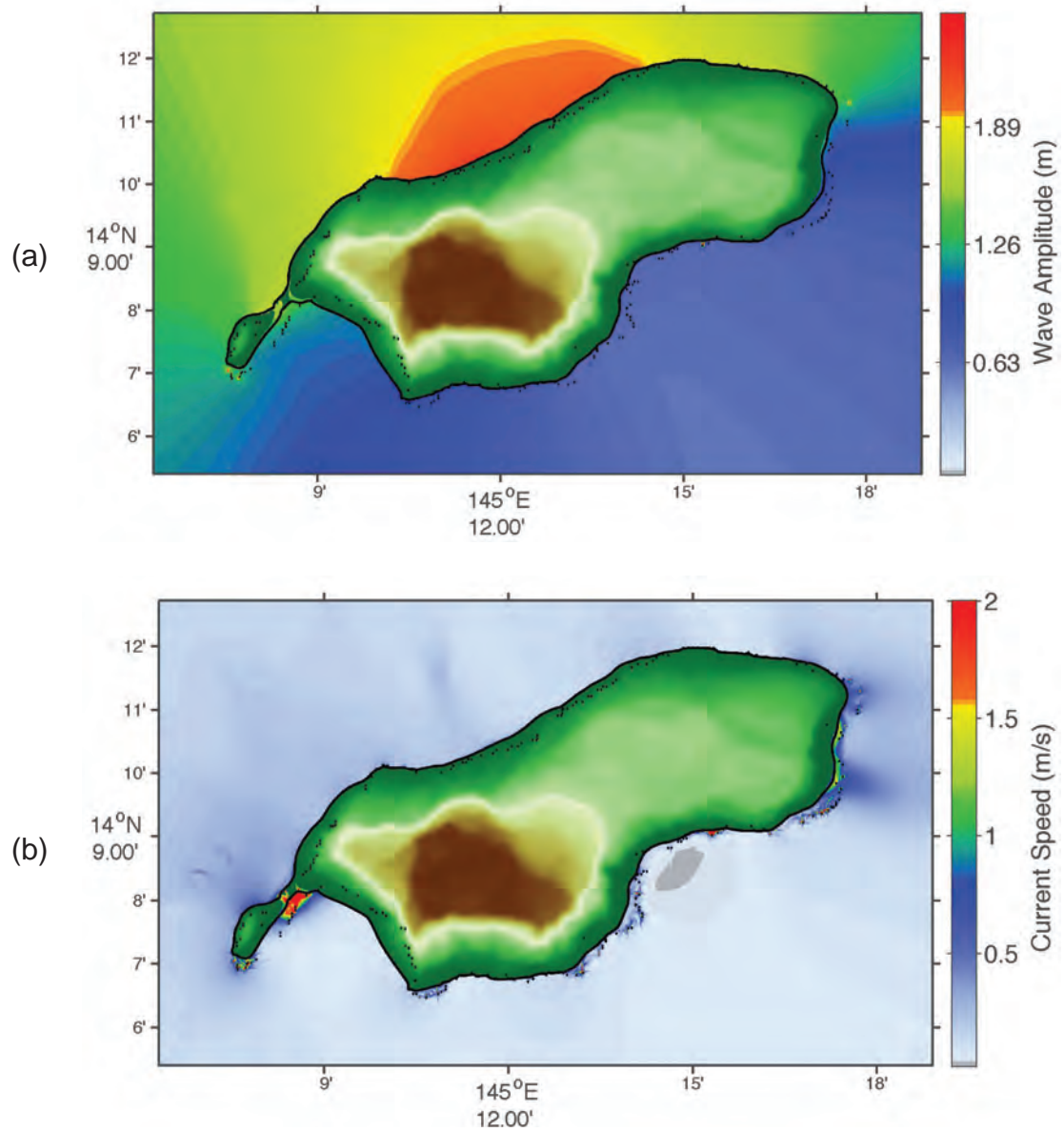
Figure D24: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the RNSZ 12 scenario.
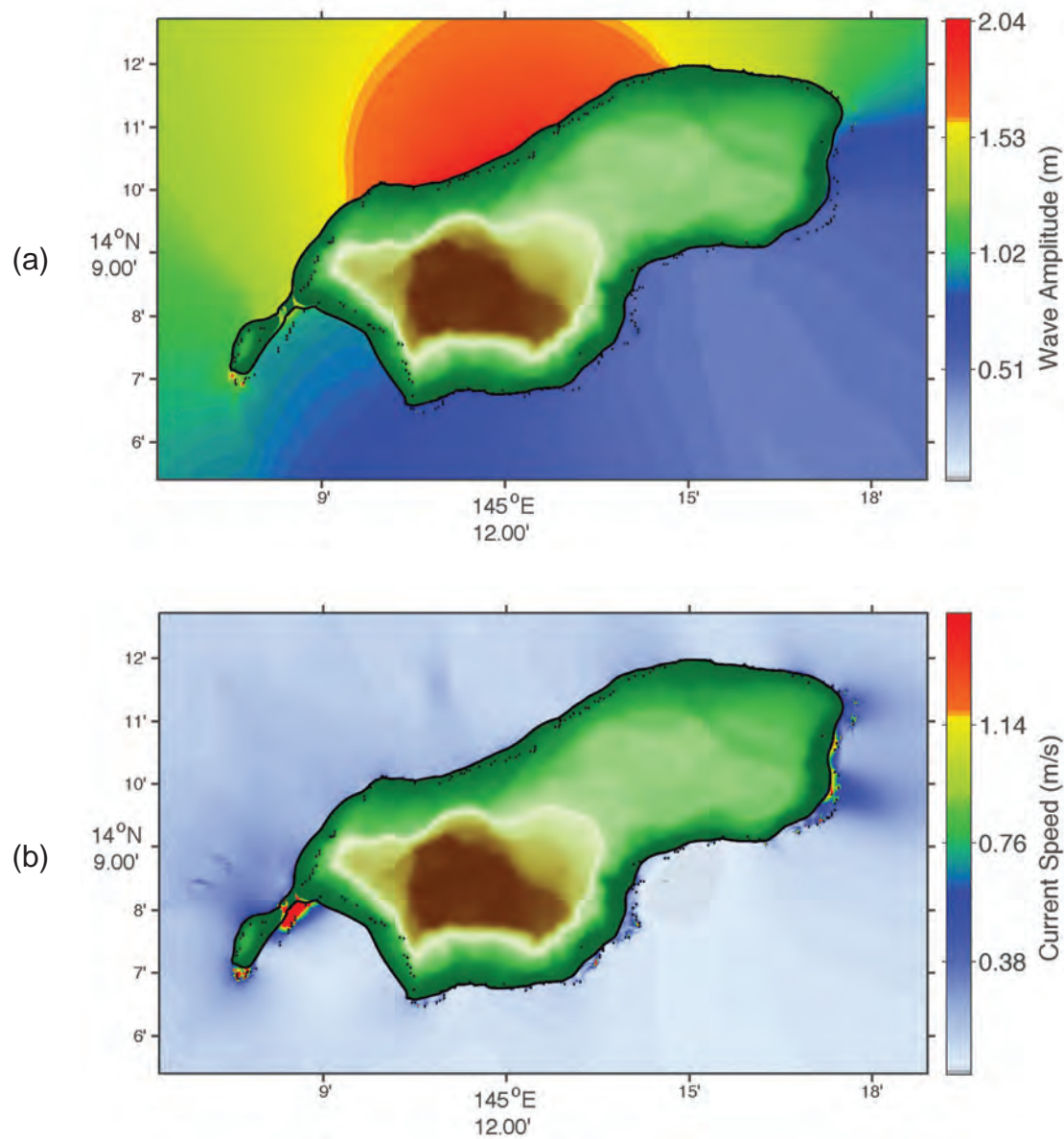
Figure D25: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the RNSZ 13 scenario.
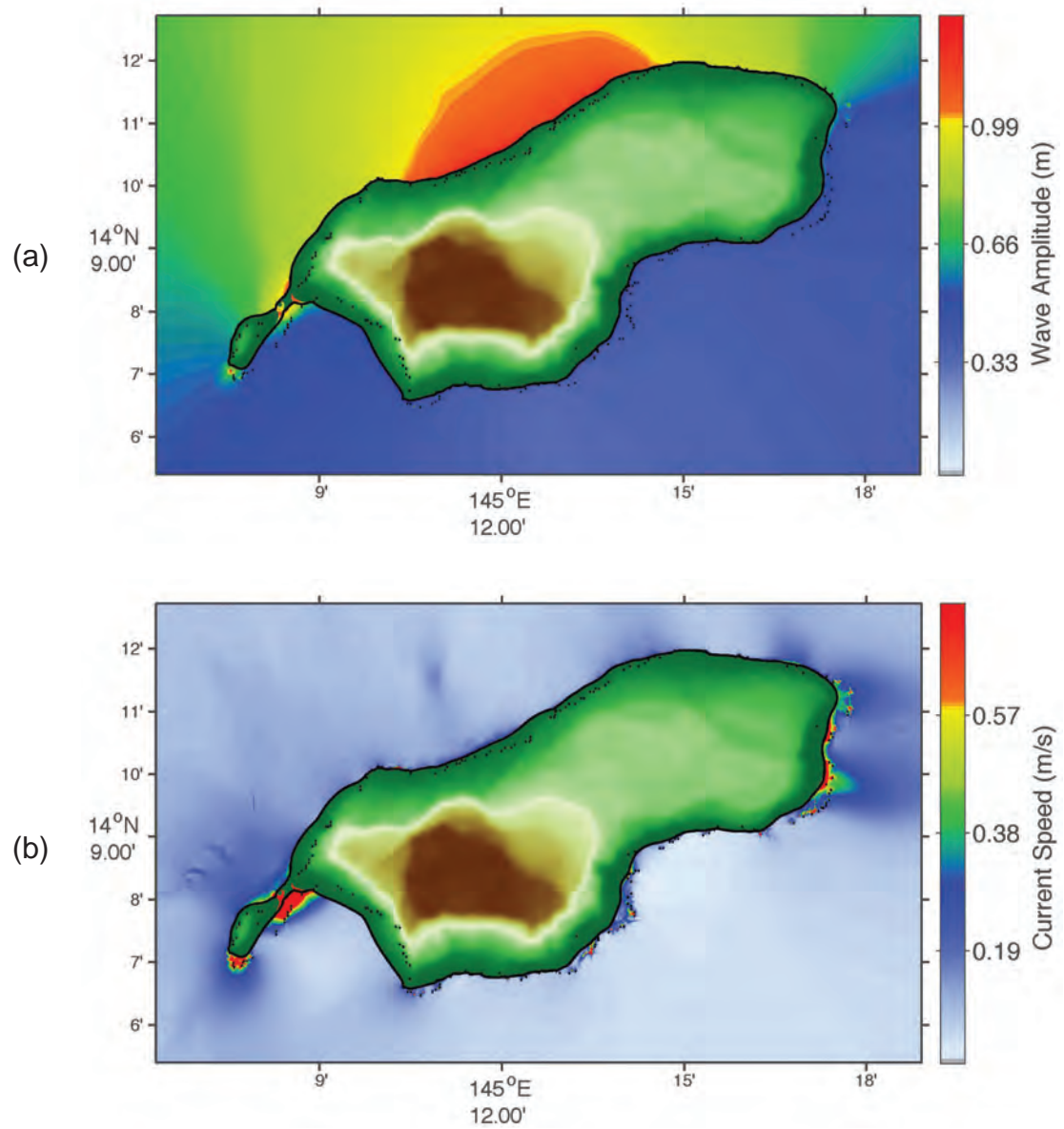
Figure D26: Maximum tsunami amplitudes (a) and currents (b) predicted for Rota from the RNSZ 14 scenario.

Appendix E.

Propagation Database Unit Sources
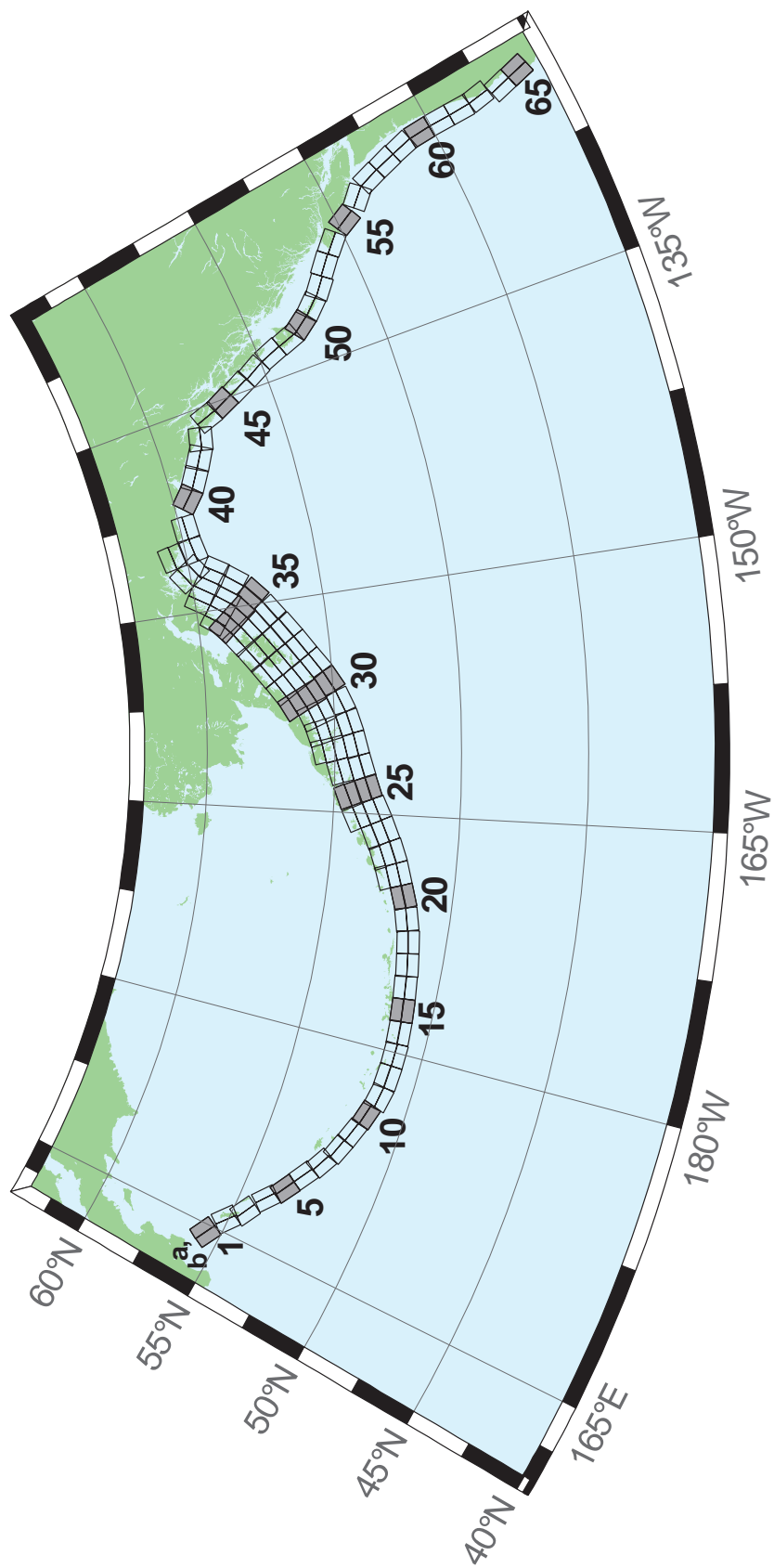
Figure E1: Aleutian–Alaska–Cascadia Subduction Zone unit sources.

Table E1: Earthquake parameters for Aleutian–Alaska–Cascadia Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
acsz-1a	Aleutian–Alaska–Cascadia	164.7994	55.9606	299	17	19.61
acsz-1b	Aleutian–Alaska–Cascadia	164.4310	55.5849	299	17	5
acsz-2a	Aleutian–Alaska–Cascadia	166.3418	55.4016	310.2	17	19.61
acsz-2b	Aleutian–Alaska–Cascadia	165.8578	55.0734	310.2	17	5
acsz-3a	Aleutian–Alaska–Cascadia	167.2939	54.8919	300.2	23.36	24.82
acsz-3b	Aleutian–Alaska–Cascadia	166.9362	54.5356	300.2	23.36	5
acsz-4a	Aleutian–Alaska–Cascadia	168.7131	54.2852	310.2	38.51	25.33
acsz-4b	Aleutian–Alaska–Cascadia	168.3269	54.0168	310.2	24	5
acsz-5a	Aleutian–Alaska–Cascadia	169.7447	53.7808	302.8	37.02	23.54
acsz-5b	Aleutian–Alaska–Cascadia	169.4185	53.4793	302.8	21.77	5
acsz-6a	Aleutian–Alaska–Cascadia	171.0144	53.3054	303.2	35.31	22.92
acsz-6b	Aleutian–Alaska–Cascadia	170.6813	52.9986	303.2	21	5
acsz-7a	Aleutian–Alaska–Cascadia	172.1500	52.8528	298.2	35.56	20.16
acsz-7b	Aleutian–Alaska–Cascadia	171.8665	52.5307	298.2	17.65	5
acsz-8a	Aleutian–Alaska–Cascadia	173.2726	52.4579	290.8	37.92	20.35
acsz-8b	Aleutian–Alaska–Cascadia	173.0681	52.1266	290.8	17.88	5
acsz-9a	Aleutian–Alaska–Cascadia	174.5866	52.1434	289	39.09	21.05
acsz-9b	Aleutian–Alaska–Cascadia	174.4027	51.8138	289	18.73	5
acsz-10a	Aleutian–Alaska–Cascadia	175.8784	51.8526	286.1	40.51	20.87
acsz-10b	Aleutian–Alaska–Cascadia	175.7265	51.5245	286.1	18.51	5
acsz-11a	Aleutian–Alaska–Cascadia	177.1140	51.6488	280	15	17.94
acsz-11b	Aleutian–Alaska–Cascadia	176.9937	51.2215	280	15	5
acsz-12a	Aleutian–Alaska–Cascadia	178.4500	51.5690	273	15	17.94
acsz-12b	Aleutian–Alaska–Cascadia	178.4130	51.1200	273	15	5
acsz-13a	Aleutian–Alaska–Cascadia	179.8550	51.5340	271	15	17.94
acsz-13b	Aleutian–Alaska–Cascadia	179.8420	51.0850	271	15	5
acsz-14a	Aleutian–Alaska–Cascadia	181.2340	51.5780	267	15	17.94
acsz-14b	Aleutian–Alaska–Cascadia	181.2720	51.1290	267	15	5
acsz-15a	Aleutian–Alaska–Cascadia	182.6380	51.6470	265	15	17.94
acsz-15b	Aleutian–Alaska–Cascadia	182.7000	51.2000	265	15	5
acsz-16a	Aleutian–Alaska–Cascadia	184.0550	51.7250	264	15	17.94
acsz-16b	Aleutian–Alaska–Cascadia	184.1280	51.2780	264	15	5
acsz-17a	Aleutian–Alaska–Cascadia	185.4560	51.8170	262	15	17.94
acsz-17b	Aleutian–Alaska–Cascadia	185.5560	51.3720	262	15	5
acsz-18a	Aleutian–Alaska–Cascadia	186.8680	51.9410	261	15	17.94
acsz-18b	Aleutian–Alaska–Cascadia	186.9810	51.4970	261	15	5
acsz-19a	Aleutian–Alaska–Cascadia	188.2430	52.1280	257	15	17.94
acsz-19b	Aleutian–Alaska–Cascadia	188.4060	51.6900	257	15	5

Table E1: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
acsz-20a	Aleutian–Alaska–Cascadia	189.5810	52.3550	251	15	17.94
acsz-20b	Aleutian–Alaska–Cascadia	189.8180	51.9300	251	15	5
acsz-21a	Aleutian–Alaska–Cascadia	190.9570	52.6470	251	15	17.94
acsz-21b	Aleutian–Alaska–Cascadia	191.1960	52.2220	251	15	5
acsz-21z	Aleutian–Alaska–Cascadia	190.7399	53.0443	250.8	15	30.88
acsz-22a	Aleutian–Alaska–Cascadia	192.2940	52.9430	247	15	17.94
acsz-22b	Aleutian–Alaska–Cascadia	192.5820	52.5300	247	15	5
acsz-22z	Aleutian–Alaska–Cascadia	192.0074	53.3347	247.8	15	30.88
acsz-23a	Aleutian–Alaska–Cascadia	193.6270	53.3070	245	15	17.94
acsz-23b	Aleutian–Alaska–Cascadia	193.9410	52.9000	245	15	5
acsz-23z	Aleutian–Alaska–Cascadia	193.2991	53.6768	244.6	15	30.88
acsz-24a	Aleutian–Alaska–Cascadia	194.9740	53.6870	245	15	17.94
acsz-24b	Aleutian–Alaska–Cascadia	195.2910	53.2800	245	15	5
acsz-24y	Aleutian–Alaska–Cascadia	194.3645	54.4604	244.4	15	43.82
acsz-24z	Aleutian–Alaska–Cascadia	194.6793	54.0674	244.6	15	30.88
acsz-25a	Aleutian–Alaska–Cascadia	196.4340	54.0760	250	15	17.94
acsz-25b	Aleutian–Alaska–Cascadia	196.6930	53.6543	250	15	5
acsz-25y	Aleutian–Alaska–Cascadia	195.9009	54.8572	247.9	15	43.82
acsz-25z	Aleutian–Alaska–Cascadia	196.1761	54.4536	248.1	15	30.88
acsz-26a	Aleutian–Alaska–Cascadia	197.8970	54.3600	253	15	17.94
acsz-26b	Aleutian–Alaska–Cascadia	198.1200	53.9300	253	15	5
acsz-26y	Aleutian–Alaska–Cascadia	197.5498	55.1934	253.1	15	43.82
acsz-26z	Aleutian–Alaska–Cascadia	197.7620	54.7770	253.3	15	30.88
acsz-27a	Aleutian–Alaska–Cascadia	199.4340	54.5960	256	15	17.94
acsz-27b	Aleutian–Alaska–Cascadia	199.6200	54.1600	256	15	5
acsz-27x	Aleutian–Alaska–Cascadia	198.9736	55.8631	256.5	15	56.24
acsz-27y	Aleutian–Alaska–Cascadia	199.1454	55.4401	256.6	15	43.82
acsz-27z	Aleutian–Alaska–Cascadia	199.3135	55.0170	256.8	15	30.88
acsz-28a	Aleutian–Alaska–Cascadia	200.8820	54.8300	253	15	17.94
acsz-28b	Aleutian–Alaska–Cascadia	201.1080	54.4000	253	15	5
acsz-28x	Aleutian–Alaska–Cascadia	200.1929	56.0559	252.5	15	56.24
acsz-28y	Aleutian–Alaska–Cascadia	200.4167	55.6406	252.7	15	43.82
acsz-28z	Aleutian–Alaska–Cascadia	200.6360	55.2249	252.9	15	30.88
acsz-29a	Aleutian–Alaska–Cascadia	202.2610	55.1330	247	15	17.94
acsz-29b	Aleutian–Alaska–Cascadia	202.5650	54.7200	247	15	5
acsz-29x	Aleutian–Alaska–Cascadia	201.2606	56.2861	245.7	15	56.24
acsz-29y	Aleutian–Alaska–Cascadia	201.5733	55.8888	246	15	43.82
acsz-29z	Aleutian–Alaska–Cascadia	201.8797	55.4908	246.2	15	30.88

Table E1: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
acsz-30a	Aleutian–Alaska–Cascadia	203.6040	55.5090	240	15	17.94
acsz-30b	Aleutian–Alaska–Cascadia	203.9970	55.1200	240	15	5
acsz-30w	Aleutian–Alaska–Cascadia	201.9901	56.9855	239.5	15	69.12
acsz-30x	Aleutian–Alaska–Cascadia	202.3851	56.6094	239.8	15	56.24
acsz-30y	Aleutian–Alaska–Cascadia	202.7724	56.2320	240.2	15	43.82
acsz-30z	Aleutian–Alaska–Cascadia	203.1521	55.8534	240.5	15	30.88
acsz-31a	Aleutian–Alaska–Cascadia	204.8950	55.9700	236	15	17.94
acsz-31b	Aleutian–Alaska–Cascadia	205.3400	55.5980	236	15	5
acsz-31w	Aleutian–Alaska–Cascadia	203.0825	57.3740	234.5	15	69.12
acsz-31x	Aleutian–Alaska–Cascadia	203.5408	57.0182	234.9	15	56.24
acsz-31y	Aleutian–Alaska–Cascadia	203.9904	56.6607	235.3	15	43.82
acsz-31z	Aleutian–Alaska–Cascadia	204.4315	56.3016	235.7	15	30.88
acsz-32a	Aleutian–Alaska–Cascadia	206.2080	56.4730	236	15	17.94
acsz-32b	Aleutian–Alaska–Cascadia	206.6580	56.1000	236	15	5
acsz-32w	Aleutian–Alaska–Cascadia	204.4129	57.8908	234.3	15	69.12
acsz-32x	Aleutian–Alaska–Cascadia	204.8802	57.5358	234.7	15	56.24
acsz-32y	Aleutian–Alaska–Cascadia	205.3385	57.1792	235.1	15	43.82
acsz-32z	Aleutian–Alaska–Cascadia	205.7880	56.8210	235.5	15	30.88
acsz-33a	Aleutian–Alaska–Cascadia	207.5370	56.9750	236	15	17.94
acsz-33b	Aleutian–Alaska–Cascadia	207.9930	56.6030	236	15	5
acsz-33w	Aleutian–Alaska–Cascadia	205.7126	58.3917	234.2	15	69.12
acsz-33x	Aleutian–Alaska–Cascadia	206.1873	58.0371	234.6	15	56.24
acsz-33y	Aleutian–Alaska–Cascadia	206.6527	57.6808	235	15	43.82
acsz-33z	Aleutian–Alaska–Cascadia	207.1091	57.3227	235.4	15	30.88
acsz-34a	Aleutian–Alaska–Cascadia	208.9371	57.5124	236	15	17.94
acsz-34b	Aleutian–Alaska–Cascadia	209.4000	57.1400	236	15	5
acsz-34w	Aleutian–Alaska–Cascadia	206.9772	58.8804	233.5	15	69.12
acsz-34x	Aleutian–Alaska–Cascadia	207.4677	58.5291	233.9	15	56.24
acsz-34y	Aleutian–Alaska–Cascadia	207.9485	58.1760	234.3	15	43.82
acsz-34z	Aleutian–Alaska–Cascadia	208.4198	57.8213	234.7	15	30.88
acsz-35a	Aleutian–Alaska–Cascadia	210.2597	58.0441	230	15	17.94
acsz-35b	Aleutian–Alaska–Cascadia	210.8000	57.7000	230	15	5
acsz-35w	Aleutian–Alaska–Cascadia	208.0204	59.3199	228.8	15	69.12
acsz-35x	Aleutian–Alaska–Cascadia	208.5715	58.9906	229.3	15	56.24
acsz-35y	Aleutian–Alaska–Cascadia	209.1122	58.6590	229.7	15	43.82
acsz-35z	Aleutian–Alaska–Cascadia	209.6425	58.3252	230.2	15	30.88
acsz-36a	Aleutian–Alaska–Cascadia	211.3249	58.6565	218	15	17.94
acsz-36b	Aleutian–Alaska–Cascadia	212.0000	58.3800	218	15	5

Table E1: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
acsz-36w	Aleutian–Alaska–Cascadia	208.5003	59.5894	215.6	15	69.12
acsz-36x	Aleutian–Alaska–Cascadia	209.1909	59.3342	216.2	15	56.24
acsz-36y	Aleutian–Alaska–Cascadia	209.8711	59.0753	216.8	15	43.82
acsz-36z	Aleutian–Alaska–Cascadia	210.5412	58.8129	217.3	15	30.88
acsz-37a	Aleutian–Alaska–Cascadia	212.2505	59.2720	213.7	15	17.94
acsz-37b	Aleutian–Alaska–Cascadia	212.9519	59.0312	213.7	15	5
acsz-37x	Aleutian–Alaska–Cascadia	210.1726	60.0644	213	15	56.24
acsz-37y	Aleutian–Alaska–Cascadia	210.8955	59.8251	213.7	15	43.82
acsz-37z	Aleutian–Alaska–Cascadia	211.6079	59.5820	214.3	15	30.88
acsz-38a	Aleutian–Alaska–Cascadia	214.6555	60.1351	260.1	0	15
acsz-38b	Aleutian–Alaska–Cascadia	214.8088	59.6927	260.1	0	15
acsz-38y	Aleutian–Alaska–Cascadia	214.3737	60.9838	259	0	15
acsz-38z	Aleutian–Alaska–Cascadia	214.5362	60.5429	259	0	15
acsz-39a	Aleutian–Alaska–Cascadia	216.5607	60.2480	267	0	15
acsz-39b	Aleutian–Alaska–Cascadia	216.6068	59.7994	267	0	15
acsz-40a	Aleutian–Alaska–Cascadia	219.3069	59.7574	310.9	0	15
acsz-40b	Aleutian–Alaska–Cascadia	218.7288	59.4180	310.9	0	15
acsz-41a	Aleutian–Alaska–Cascadia	220.4832	59.3390	300.7	0	15
acsz-41b	Aleutian–Alaska–Cascadia	220.0382	58.9529	300.7	0	15
acsz-42a	Aleutian–Alaska–Cascadia	221.8835	58.9310	298.9	0	15
acsz-42b	Aleutian–Alaska–Cascadia	221.4671	58.5379	298.9	0	15
acsz-43a	Aleutian–Alaska–Cascadia	222.9711	58.6934	282.3	0	15
acsz-43b	Aleutian–Alaska–Cascadia	222.7887	58.2546	282.3	0	15
acsz-44a	Aleutian–Alaska–Cascadia	224.9379	57.9054	340.9	12	11.09
acsz-44b	Aleutian–Alaska–Cascadia	224.1596	57.7617	340.9	7	5
acsz-45a	Aleutian–Alaska–Cascadia	225.4994	57.1634	334.1	12	11.09
acsz-45b	Aleutian–Alaska–Cascadia	224.7740	56.9718	334.1	7	5
acsz-46a	Aleutian–Alaska–Cascadia	226.1459	56.3552	334.1	12	11.09
acsz-46b	Aleutian–Alaska–Cascadia	225.4358	56.1636	334.1	7	5
acsz-47a	Aleutian–Alaska–Cascadia	226.7731	55.5830	332.3	12	11.09
acsz-47b	Aleutian–Alaska–Cascadia	226.0887	55.3785	332.3	7	5
acsz-48a	Aleutian–Alaska–Cascadia	227.4799	54.6763	339.4	12	11.09
acsz-48b	Aleutian–Alaska–Cascadia	226.7713	54.5217	339.4	7	5
acsz-49a	Aleutian–Alaska–Cascadia	227.9482	53.8155	341.2	12	11.09
acsz-49b	Aleutian–Alaska–Cascadia	227.2462	53.6737	341.2	7	5
acsz-50a	Aleutian–Alaska–Cascadia	228.3970	53.2509	324.5	12	11.09
acsz-50b	Aleutian–Alaska–Cascadia	227.8027	52.9958	324.5	7	5
acsz-51a	Aleutian–Alaska–Cascadia	229.1844	52.6297	318.4	12	11.09

Table E1: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
acsz-51b	Aleutian–Alaska–Cascadia	228.6470	52.3378	318.4	7	5
acsz-52a	Aleutian–Alaska–Cascadia	230.0306	52.0768	310.9	12	11.09
acsz-52b	Aleutian–Alaska–Cascadia	229.5665	51.7445	310.9	7	5
acsz-53a	Aleutian–Alaska–Cascadia	231.1735	51.5258	310.9	12	11.09
acsz-53b	Aleutian–Alaska–Cascadia	230.7150	51.1935	310.9	7	5
acsz-54a	Aleutian–Alaska–Cascadia	232.2453	50.8809	314.1	12	11.09
acsz-54b	Aleutian–Alaska–Cascadia	231.7639	50.5655	314.1	7	5
acsz-55a	Aleutian–Alaska–Cascadia	233.3066	49.9032	333.7	12	11.09
acsz-55b	Aleutian–Alaska–Cascadia	232.6975	49.7086	333.7	7	5
acsz-56a	Aleutian–Alaska–Cascadia	234.0588	49.1702	315	11	12.82
acsz-56b	Aleutian–Alaska–Cascadia	233.5849	48.8584	315	9	5
acsz-57a	Aleutian–Alaska–Cascadia	234.9041	48.2596	341	11	12.82
acsz-57b	Aleutian–Alaska–Cascadia	234.2797	48.1161	341	9	5
acsz-58a	Aleutian–Alaska–Cascadia	235.3021	47.3812	344	11	12.82
acsz-58b	Aleutian–Alaska–Cascadia	234.6776	47.2597	344	9	5
acsz-59a	Aleutian–Alaska–Cascadia	235.6432	46.5082	345	11	12.82
acsz-59b	Aleutian–Alaska–Cascadia	235.0257	46.3941	345	9	5
acsz-60a	Aleutian–Alaska–Cascadia	235.8640	45.5429	356	11	12.82
acsz-60b	Aleutian–Alaska–Cascadia	235.2363	45.5121	356	9	5
acsz-61a	Aleutian–Alaska–Cascadia	235.9106	44.6227	359	11	12.82
acsz-61b	Aleutian–Alaska–Cascadia	235.2913	44.6150	359	9	5
acsz-62a	Aleutian–Alaska–Cascadia	235.9229	43.7245	359	11	12.82
acsz-62b	Aleutian–Alaska–Cascadia	235.3130	43.7168	359	9	5
acsz-63a	Aleutian–Alaska–Cascadia	236.0220	42.9020	350	11	12.82
acsz-63b	Aleutian–Alaska–Cascadia	235.4300	42.8254	350	9	5
acsz-64a	Aleutian–Alaska–Cascadia	235.9638	41.9818	345	11	12.82
acsz-64b	Aleutian–Alaska–Cascadia	235.3919	41.8677	345	9	5
acsz-65a	Aleutian–Alaska–Cascadia	236.2643	41.1141	345	11	12.82
acsz-65b	Aleutian–Alaska–Cascadia	235.7000	41.0000	345	9	5
acsz-238a	Aleutian–Alaska–Cascadia	213.2878	59.8406	236.8	15	17.94
acsz-238y	Aleutian–Alaska–Cascadia	212.3424	60.5664	236.8	15	43.82
acsz-238z	Aleutian–Alaska–Cascadia	212.8119	60.2035	236.8	15	30.88
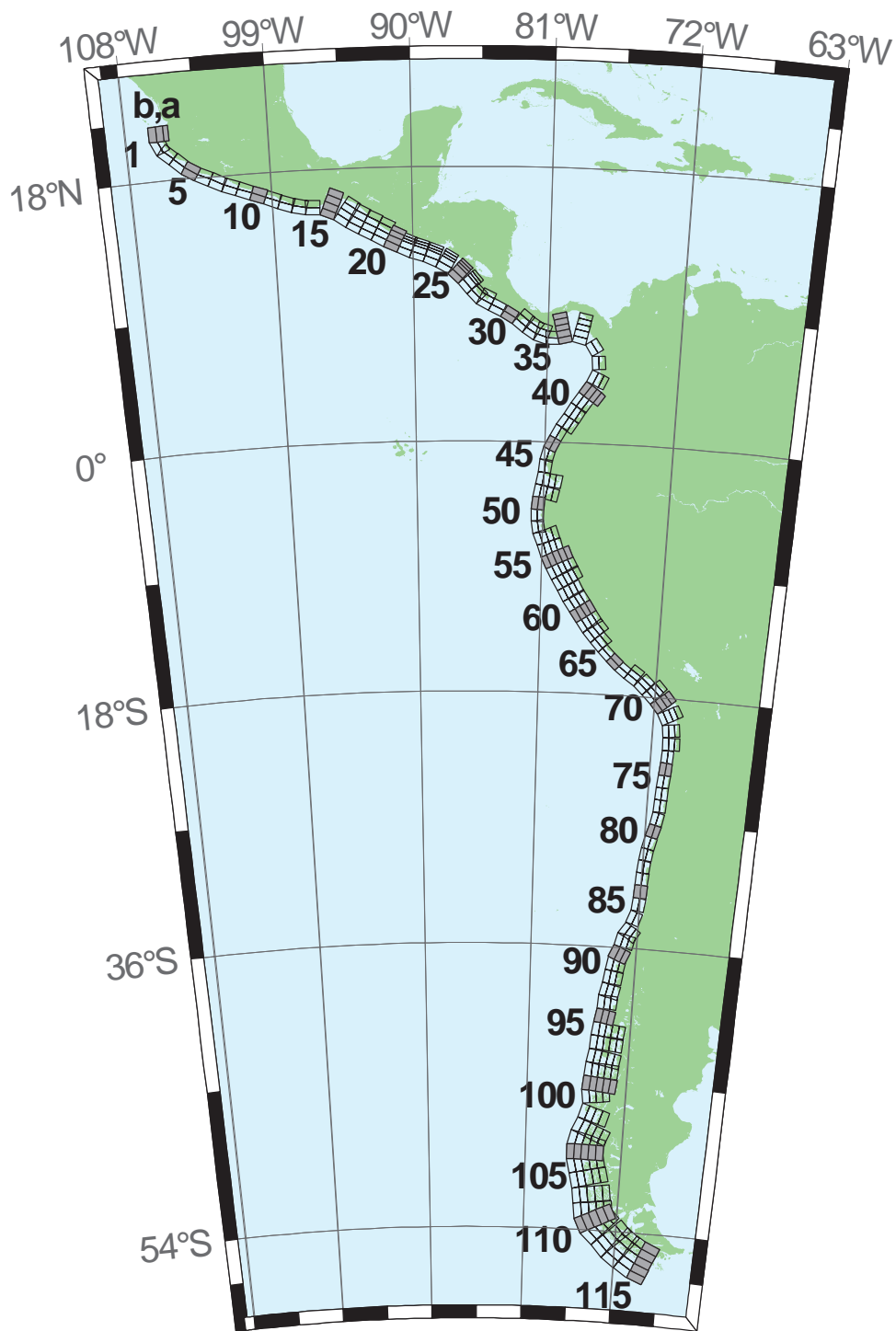
Figure E2: Central and South America Subduction Zone unit sources.

Table E2: Earthquake parameters for Central and South America Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-1a	Central and South America	254.4573	20.8170	359	19	15.4
cssz-1b	Central and South America	254.0035	20.8094	359	12	5
cssz-1z	Central and South America	254.7664	20.8222	359	50	31.67
cssz-2a	Central and South America	254.5765	20.2806	336.8	19	15.4
cssz-2b	Central and South America	254.1607	20.1130	336.8	12	5
cssz-3a	Central and South America	254.8789	19.8923	310.6	18.31	15.27
cssz-3b	Central and South America	254.5841	19.5685	310.6	11.85	5
cssz-4a	Central and South America	255.6167	19.2649	313.4	17.62	15.12
cssz-4b	Central and South America	255.3056	18.9537	313.4	11.68	5
cssz-5a	Central and South America	256.2240	18.8148	302.7	16.92	15
cssz-5b	Central and South America	255.9790	18.4532	302.7	11.54	5
cssz-6a	Central and South America	256.9425	18.4383	295.1	16.23	14.87
cssz-6b	Central and South America	256.7495	18.0479	295.1	11.38	5
cssz-7a	Central and South America	257.8137	18.0339	296.9	15.54	14.74
cssz-7b	Central and South America	257.6079	17.6480	296.9	11.23	5
cssz-8a	Central and South America	258.5779	17.7151	290.4	14.85	14.61
cssz-8b	Central and South America	258.4191	17.3082	290.4	11.08	5
cssz-9a	Central and South America	259.4578	17.4024	290.5	14.15	14.47
cssz-9b	Central and South America	259.2983	16.9944	290.5	10.92	5
cssz-10a	Central and South America	260.3385	17.0861	290.8	13.46	14.34
cssz-10b	Central and South America	260.1768	16.6776	290.8	10.77	5
cssz-11a	Central and South America	261.2255	16.7554	291.8	12.77	14.21
cssz-11b	Central and South America	261.0556	16.3487	291.8	10.62	5
cssz-12a	Central and South America	262.0561	16.4603	288.9	12.08	14.08
cssz-12b	Central and South America	261.9082	16.0447	288.9	10.46	5
cssz-13a	Central and South America	262.8638	16.2381	283.2	11.38	13.95
cssz-13b	Central and South America	262.7593	15.8094	283.2	10.31	5
cssz-14a	Central and South America	263.6066	16.1435	272.1	10.69	13.81
cssz-14b	Central and South America	263.5901	15.7024	272.1	10.15	5
cssz-15a	Central and South America	264.8259	15.8829	293	10	13.68
cssz-15b	Central and South America	264.6462	15.4758	293	10	5
cssz-15y	Central and South America	265.1865	16.6971	293	10	31.05
cssz-15z	Central and South America	265.0060	16.2900	293	10	22.36
cssz-16a	Central and South America	265.7928	15.3507	304.9	15	15.82
cssz-16b	Central and South America	265.5353	14.9951	304.9	12.5	5
cssz-16y	Central and South America	266.3092	16.0619	304.9	15	41.7
cssz-16z	Central and South America	266.0508	15.7063	304.9	15	28.76
cssz-17a	Central and South America	266.4947	14.9019	299.5	20	17.94
cssz-17b	Central and South America	266.2797	14.5346	299.5	15	5
cssz-17y	Central and South America	266.9259	15.6365	299.5	20	52.14

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-17z	Central and South America	266.7101	15.2692	299.5	20	35.04
cssz-18a	Central and South America	267.2827	14.4768	298	21.5	17.94
cssz-18b	Central and South America	267.0802	14.1078	298	15	5
cssz-18y	Central and South America	267.6888	15.2148	298	21.5	54.59
cssz-18z	Central and South America	267.4856	14.8458	298	21.5	36.27
cssz-19a	Central and South America	268.0919	14.0560	297.6	23	17.94
cssz-19b	Central and South America	267.8943	13.6897	297.6	15	5
cssz-19y	Central and South America	268.4880	14.7886	297.6	23	57.01
cssz-19z	Central and South America	268.2898	14.4223	297.6	23	37.48
cssz-20a	Central and South America	268.8929	13.6558	296.2	24	17.94
cssz-20b	Central and South America	268.7064	13.2877	296.2	15	5
cssz-20y	Central and South America	269.1796	14.2206	296.2	45.5	73.94
cssz-20z	Central and South America	269.0362	13.9382	296.2	45.5	38.28
cssz-21a	Central and South America	269.6797	13.3031	292.6	25	17.94
cssz-21b	Central and South America	269.5187	12.9274	292.6	15	5
cssz-21x	Central and South America	269.8797	13.7690	292.6	68	131.8
cssz-21y	Central and South America	269.8130	13.6137	292.6	68	85.43
cssz-21z	Central and South America	269.7463	13.4584	292.6	68	39.07
cssz-22a	Central and South America	270.4823	13.0079	288.6	25	17.94
cssz-22b	Central and South America	270.3492	12.6221	288.6	15	5
cssz-22x	Central and South America	270.6476	13.4864	288.6	68	131.8
cssz-22y	Central and South America	270.5925	13.3269	288.6	68	85.43
cssz-22z	Central and South America	270.5374	13.1674	288.6	68	39.07
cssz-23a	Central and South America	271.3961	12.6734	292.4	25	17.94
cssz-23b	Central and South America	271.2369	12.2972	292.4	15	5
cssz-23x	Central and South America	271.5938	13.1399	292.4	68	131.8
cssz-23y	Central and South America	271.5279	12.9844	292.4	68	85.43
cssz-23z	Central and South America	271.4620	12.8289	292.4	68	39.07
cssz-24a	Central and South America	272.3203	12.2251	300.2	25	17.94
cssz-24b	Central and South America	272.1107	11.8734	300.2	15	5
cssz-24x	Central and South America	272.5917	12.6799	300.2	67	131.1
cssz-24y	Central and South America	272.5012	12.5283	300.2	67	85.1
cssz-24z	Central and South America	272.4107	12.3767	300.2	67	39.07
cssz-25a	Central and South America	273.2075	11.5684	313.8	25	17.94
cssz-25b	Central and South America	272.9200	11.2746	313.8	15	5
cssz-25x	Central and South America	273.5950	11.9641	313.8	66	130.4
cssz-25y	Central and South America	273.4658	11.8322	313.8	66	84.75
cssz-25z	Central and South America	273.3366	11.7003	313.8	66	39.07
cssz-26a	Central and South America	273.8943	10.8402	320.4	25	17.94

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-26b	Central and South America	273.5750	10.5808	320.4	15	5
cssz-26x	Central and South America	274.3246	11.1894	320.4	66	130.4
cssz-26y	Central and South America	274.1811	11.0730	320.4	66	84.75
cssz-26z	Central and South America	274.0377	10.9566	320.4	66	39.07
cssz-27a	Central and South America	274.4569	10.2177	316.1	25	17.94
cssz-27b	Central and South America	274.1590	9.9354	316.1	15	5
cssz-27z	Central and South America	274.5907	10.3444	316.1	66	39.07
cssz-28a	Central and South America	274.9586	9.8695	297.1	22	14.54
cssz-28b	Central and South America	274.7661	9.4988	297.1	11	5
cssz-28z	Central and South America	275.1118	10.1643	297.1	42.5	33.27
cssz-29a	Central and South America	275.7686	9.4789	296.6	19	11.09
cssz-29b	Central and South America	275.5759	9.0992	296.6	7	5
cssz-30a	Central and South America	276.6346	8.9973	302.2	19	9.36
cssz-30b	Central and South America	276.4053	8.6381	302.2	5	5
cssz-31a	Central and South America	277.4554	8.4152	309.1	19	7.62
cssz-31b	Central and South America	277.1851	8.0854	309.1	3	5
cssz-31z	Central and South America	277.7260	8.7450	309.1	19	23.9
cssz-32a	Central and South America	278.1112	7.9425	303	18.67	8.49
cssz-32b	Central and South America	277.8775	7.5855	303	4	5
cssz-32z	Central and South America	278.3407	8.2927	303	21.67	24.49
cssz-33a	Central and South America	278.7082	7.6620	287.6	18.33	10.23
cssz-33b	Central and South America	278.5785	7.2555	287.6	6	5
cssz-33z	Central and South America	278.8328	8.0522	287.6	24.33	25.95
cssz-34a	Central and South America	279.3184	7.5592	269.5	18	17.94
cssz-34b	Central and South America	279.3223	7.1320	269.5	15	5
cssz-35a	Central and South America	280.0039	7.6543	255.9	17.67	14.54
cssz-35b	Central and South America	280.1090	7.2392	255.9	11	5
cssz-35x	Central and South America	279.7156	8.7898	255.9	29.67	79.22
cssz-35y	Central and South America	279.8118	8.4113	255.9	29.67	54.47
cssz-35z	Central and South America	279.9079	8.0328	255.9	29.67	29.72
cssz-36a	Central and South America	281.2882	7.6778	282.5	17.33	11.09
cssz-36b	Central and South America	281.1948	7.2592	282.5	7	5
cssz-36x	Central and South America	281.5368	8.7896	282.5	32.33	79.47
cssz-36y	Central and South America	281.4539	8.4190	282.5	32.33	52.73
cssz-36z	Central and South America	281.3710	8.0484	282.5	32.33	25.99
cssz-37a	Central and South America	282.5252	6.8289	326.9	17	10.23
cssz-37b	Central and South America	282.1629	6.5944	326.9	6	5
cssz-38a	Central and South America	282.9469	5.5973	355.4	17	10.23
cssz-38b	Central and South America	282.5167	5.5626	355.4	6	5

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-39a	Central and South America	282.7236	4.3108	24.13	17	10.23
cssz-39b	Central and South America	282.3305	4.4864	24.13	6	5
cssz-39z	Central and South America	283.0603	4.1604	24.13	35	24.85
cssz-40a	Central and South America	282.1940	3.3863	35.28	17	10.23
cssz-40b	Central and South America	281.8427	3.6344	35.28	6	5
cssz-40y	Central and South America	282.7956	2.9613	35.28	35	53.52
cssz-40z	Central and South America	282.4948	3.1738	35.28	35	24.85
cssz-41a	Central and South America	281.6890	2.6611	34.27	17	10.23
cssz-41b	Central and South America	281.3336	2.9030	34.27	6	5
cssz-41z	Central and South America	281.9933	2.4539	34.27	35	24.85
cssz-42a	Central and South America	281.2266	1.9444	31.29	17	10.23
cssz-42b	Central and South America	280.8593	2.1675	31.29	6	5
cssz-42z	Central and South America	281.5411	1.7533	31.29	35	24.85
cssz-43a	Central and South America	280.7297	1.1593	33.3	17	10.23
cssz-43b	Central and South America	280.3706	1.3951	33.3	6	5
cssz-43z	Central and South America	281.0373	0.9573	33.3	35	24.85
cssz-44a	Central and South America	280.3018	0.4491	28.8	17	10.23
cssz-44b	Central and South America	279.9254	0.6560	28.8	6	5
cssz-45a	Central and South America	279.9083	-0.3259	26.91	10	8.49
cssz-45b	Central and South America	279.5139	-0.1257	26.91	4	5
cssz-46a	Central and South America	279.6461	-0.9975	15.76	10	8.49
cssz-46b	Central and South America	279.2203	-0.8774	15.76	4	5
cssz-47a	Central and South America	279.4972	-1.7407	6.9	10	8.49
cssz-47b	Central and South America	279.0579	-1.6876	6.9	4	5
cssz-48a	Central and South America	279.3695	-2.6622	8.96	10	8.49
cssz-48b	Central and South America	278.9321	-2.5933	8.96	4	5
cssz-48y	Central and South America	280.2444	-2.8000	8.96	10	25.85
cssz-48z	Central and South America	279.8070	-2.7311	8.96	10	17.17
cssz-49a	Central and South America	279.1852	-3.6070	13.15	10	8.49
cssz-49b	Central and South America	278.7536	-3.5064	13.15	4	5
cssz-49y	Central and South America	280.0486	-3.8082	13.15	10	25.85
cssz-49z	Central and South America	279.6169	-3.7076	13.15	10	17.17
cssz-50a	Central and South America	279.0652	-4.3635	4.78	10.33	9.64
cssz-50b	Central and South America	278.6235	-4.3267	4.78	5.33	5
cssz-51a	Central and South America	279.0349	-5.1773	359.4	10.67	10.81
cssz-51b	Central and South America	278.5915	-5.1817	359.4	6.67	5
cssz-52a	Central and South America	279.1047	-5.9196	349.8	11	11.96
cssz-52b	Central and South America	278.6685	-5.9981	349.8	8	5
cssz-53a	Central and South America	279.3044	-6.6242	339.2	10.25	11.74

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-53b	Central and South America	278.8884	-6.7811	339.2	7.75	5
cssz-53y	Central and South America	280.1024	-6.3232	339.2	19.25	37.12
cssz-53z	Central and South America	279.7035	-6.4737	339.2	19.25	20.64
cssz-54a	Central and South America	279.6256	-7.4907	340.8	9.5	11.53
cssz-54b	Central and South America	279.2036	-7.6365	340.8	7.5	5
cssz-54y	Central and South America	280.4267	-7.2137	340.8	20.5	37.29
cssz-54z	Central and South America	280.0262	-7.3522	340.8	20.5	19.78
cssz-55a	Central and South America	279.9348	-8.2452	335.4	8.75	11.74
cssz-55b	Central and South America	279.5269	-8.4301	335.4	7.75	5
cssz-55x	Central and South America	281.0837	-7.7238	335.4	21.75	56.4
cssz-55y	Central and South America	280.7009	-7.8976	335.4	21.75	37.88
cssz-55z	Central and South America	280.3180	-8.0714	335.4	21.75	19.35
cssz-56a	Central and South America	280.3172	-8.9958	331.6	8	11.09
cssz-56b	Central and South America	279.9209	-9.2072	331.6	7	5
cssz-56x	Central and South America	281.4212	-8.4063	331.6	23	57.13
cssz-56y	Central and South America	281.0534	-8.6028	331.6	23	37.59
cssz-56z	Central and South America	280.6854	-8.7993	331.6	23	18.05
cssz-57a	Central and South America	280.7492	-9.7356	328.7	8.6	10.75
cssz-57b	Central and South America	280.3640	-9.9663	328.7	6.6	5
cssz-57x	Central and South America	281.8205	-9.0933	328.7	23.4	57.94
cssz-57y	Central and South America	281.4636	-9.3074	328.7	23.4	38.08
cssz-57z	Central and South America	281.1065	-9.5215	328.7	23.4	18.22
cssz-58a	Central and South America	281.2275	-10.5350	330.5	9.2	10.4
cssz-58b	Central and South America	280.8348	-10.7532	330.5	6.2	5
cssz-58y	Central and South America	281.9548	-10.1306	330.5	23.8	38.57
cssz-58z	Central and South America	281.5913	-10.3328	330.5	23.8	18.39
cssz-59a	Central and South America	281.6735	-11.2430	326.2	9.8	10.05
cssz-59b	Central and South America	281.2982	-11.4890	326.2	5.8	5
cssz-59y	Central and South America	282.3675	-10.7876	326.2	24.2	39.06
cssz-59z	Central and South America	282.0206	-11.0153	326.2	24.2	18.56
cssz-60a	Central and South America	282.1864	-11.9946	326.5	10.4	9.71
cssz-60b	Central and South America	281.8096	-12.2384	326.5	5.4	5
cssz-60y	Central and South America	282.8821	-11.5438	326.5	24.6	39.55
cssz-60z	Central and South America	282.5344	-11.7692	326.5	24.6	18.73
cssz-61a	Central and South America	282.6944	-12.7263	325.5	11	9.36
cssz-61b	Central and South America	282.3218	-12.9762	325.5	5	5
cssz-61y	Central and South America	283.3814	-12.2649	325.5	25	40.03
cssz-61z	Central and South America	283.0381	-12.4956	325.5	25	18.9
cssz-62a	Central and South America	283.1980	-13.3556	319	11	9.79

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-62b	Central and South America	282.8560	-13.6451	319	5.5	5
cssz-62y	Central and South America	283.8178	-12.8300	319	27	42.03
cssz-62z	Central and South America	283.5081	-13.0928	319	27	19.33
cssz-63a	Central and South America	283.8032	-14.0147	317.9	11	10.23
cssz-63b	Central and South America	283.4661	-14.3106	317.9	6	5
cssz-63z	Central and South America	284.1032	-13.7511	317.9	29	19.77
cssz-64a	Central and South America	284.4144	-14.6482	315.7	13	11.96
cssz-64b	Central and South America	284.0905	-14.9540	315.7	8	5
cssz-65a	Central and South America	285.0493	-15.2554	313.2	15	13.68
cssz-65b	Central and South America	284.7411	-15.5715	313.2	10	5
cssz-66a	Central and South America	285.6954	-15.7816	307.7	14.5	13.68
cssz-66b	Central and South America	285.4190	-16.1258	307.7	10	5
cssz-67a	Central and South America	286.4127	-16.2781	304.3	14	13.68
cssz-67b	Central and South America	286.1566	-16.6381	304.3	10	5
cssz-67z	Central and South America	286.6552	-15.9365	304.3	23	25.78
cssz-68a	Central and South America	287.2481	-16.9016	311.8	14	13.68
cssz-68b	Central and South America	286.9442	-17.2264	311.8	10	5
cssz-68z	Central and South America	287.5291	-16.6007	311.8	26	25.78
cssz-69a	Central and South America	287.9724	-17.5502	314.9	14	13.68
cssz-69b	Central and South America	287.6496	-17.8590	314.9	10	5
cssz-69y	Central and South America	288.5530	-16.9934	314.9	29	50.02
cssz-69z	Central and South America	288.2629	-17.2718	314.9	29	25.78
cssz-70a	Central and South America	288.6731	-18.2747	320.4	14	13.25
cssz-70b	Central and South America	288.3193	-18.5527	320.4	9.5	5
cssz-70y	Central and South America	289.3032	-17.7785	320.4	30	50.35
cssz-70z	Central and South America	288.9884	-18.0266	320.4	30	25.35
cssz-71a	Central and South America	289.3089	-19.1854	333.2	14	12.82
cssz-71b	Central and South America	288.8968	-19.3820	333.2	9	5
cssz-71y	Central and South America	290.0357	-18.8382	333.2	31	50.67
cssz-71z	Central and South America	289.6725	-19.0118	333.2	31	24.92
cssz-72a	Central and South America	289.6857	-20.3117	352.4	14	12.54
cssz-72b	Central and South America	289.2250	-20.3694	352.4	8.67	5
cssz-72z	Central and South America	290.0882	-20.2613	352.4	32	24.63
cssz-73a	Central and South America	289.7731	-21.3061	358.9	14	12.24
cssz-73b	Central and South America	289.3053	-21.3142	358.9	8.33	5
cssz-73z	Central and South America	290.1768	-21.2991	358.9	33	24.34
cssz-74a	Central and South America	289.7610	-22.2671	3.06	14	11.96
cssz-74b	Central and South America	289.2909	-22.2438	3.06	8	5

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-75a	Central and South America	289.6982	-23.1903	4.83	14.09	11.96
cssz-75b	Central and South America	289.2261	-23.1536	4.83	8	5
cssz-76a	Central and South America	289.6237	-24.0831	4.67	14.18	11.96
cssz-76b	Central and South America	289.1484	-24.0476	4.67	8	5
cssz-77a	Central and South America	289.5538	-24.9729	4.3	14.27	11.96
cssz-77b	Central and South America	289.0750	-24.9403	4.3	8	5
cssz-78a	Central and South America	289.4904	-25.8621	3.86	14.36	11.96
cssz-78b	Central and South America	289.0081	-25.8328	3.86	8	5
cssz-79a	Central and South America	289.3491	-26.8644	11.34	14.45	11.96
cssz-79b	Central and South America	288.8712	-26.7789	11.34	8	5
cssz-80a	Central and South America	289.1231	-27.7826	14.16	14.54	11.96
cssz-80b	Central and South America	288.6469	-27.6762	14.16	8	5
cssz-81a	Central and South America	288.8943	-28.6409	13.19	14.63	11.96
cssz-81b	Central and South America	288.4124	-28.5417	13.19	8	5
cssz-82a	Central and South America	288.7113	-29.4680	9.68	14.72	11.96
cssz-82b	Central and South America	288.2196	-29.3950	9.68	8	5
cssz-83a	Central and South America	288.5944	-30.2923	5.36	14.81	11.96
cssz-83b	Central and South America	288.0938	-30.2517	5.36	8	5
cssz-84a	Central and South America	288.5223	-31.1639	3.8	14.9	11.96
cssz-84b	Central and South America	288.0163	-31.1351	3.8	8	5
cssz-85a	Central and South America	288.4748	-32.0416	2.55	15	11.96
cssz-85b	Central and South America	287.9635	-32.0223	2.55	8	5
cssz-86a	Central and South America	288.3901	-33.0041	7.01	15	11.96
cssz-86b	Central and South America	287.8768	-32.9512	7.01	8	5
cssz-87a	Central and South America	288.1050	-34.0583	19.4	15	11.96
cssz-87b	Central and South America	287.6115	-33.9142	19.4	8	5
cssz-88a	Central and South America	287.5309	-35.0437	32.81	15	11.96
cssz-88b	Central and South America	287.0862	-34.8086	32.81	8	5
cssz-88z	Central and South America	287.9308	-35.2545	32.81	30	24.9
cssz-89a	Central and South America	287.2380	-35.5993	14.52	16.67	11.96
cssz-89b	Central and South America	286.7261	-35.4914	14.52	8	5
cssz-89z	Central and South America	287.7014	-35.6968	14.52	30	26.3
cssz-90a	Central and South America	286.8442	-36.5645	22.64	18.33	11.96
cssz-90b	Central and South America	286.3548	-36.4004	22.64	8	5
cssz-90z	Central and South America	287.2916	-36.7142	22.64	30	27.68
cssz-91a	Central and South America	286.5925	-37.2488	10.9	20	11.96
cssz-91b	Central and South America	286.0721	-37.1690	10.9	8	5
cssz-91z	Central and South America	287.0726	-37.3224	10.9	30	29.06

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-92a	Central and South America	286.4254	-38.0945	8.23	20	11.96
cssz-92b	Central and South America	285.8948	-38.0341	8.23	8	5
cssz-92z	Central and South America	286.9303	-38.1520	8.23	26.67	29.06
cssz-93a	Central and South America	286.2047	-39.0535	13.46	20	11.96
cssz-93b	Central and South America	285.6765	-38.9553	13.46	8	5
cssz-93z	Central and South America	286.7216	-39.1495	13.46	23.33	29.06
cssz-94a	Central and South America	286.0772	-39.7883	3.4	20	11.96
cssz-94b	Central and South America	285.5290	-39.7633	3.4	8	5
cssz-94z	Central and South America	286.6255	-39.8133	3.4	20	29.06
cssz-95a	Central and South America	285.9426	-40.7760	9.84	20	11.96
cssz-95b	Central and South America	285.3937	-40.7039	9.84	8	5
cssz-95z	Central and South America	286.4921	-40.8481	9.84	20	29.06
cssz-96a	Central and South America	285.7839	-41.6303	7.6	20	11.96
cssz-96b	Central and South America	285.2245	-41.5745	7.6	8	5
cssz-96x	Central and South America	287.4652	-41.7977	7.6	20	63.26
cssz-96y	Central and South America	286.9043	-41.7419	7.6	20	46.16
cssz-96z	Central and South America	286.3439	-41.6861	7.6	20	29.06
cssz-97a	Central and South America	285.6695	-42.4882	5.3	20	11.96
cssz-97b	Central and South America	285.0998	-42.4492	5.3	8	5
cssz-97x	Central and South America	287.3809	-42.6052	5.3	20	63.26
cssz-97y	Central and South America	286.8101	-42.5662	5.3	20	46.16
cssz-97z	Central and South America	286.2396	-42.5272	5.3	20	29.06
cssz-98a	Central and South America	285.5035	-43.4553	10.53	20	11.96
cssz-98b	Central and South America	284.9322	-43.3782	10.53	8	5
cssz-98x	Central and South America	287.2218	-43.6866	10.53	20	63.26
cssz-98y	Central and South America	286.6483	-43.6095	10.53	20	46.16
cssz-98z	Central and South America	286.0755	-43.5324	10.53	20	29.06
cssz-99a	Central and South America	285.3700	-44.2595	4.86	20	11.96
cssz-99b	Central and South America	284.7830	-44.2237	4.86	8	5
cssz-99x	Central and South America	287.1332	-44.3669	4.86	20	63.26
cssz-99y	Central and South America	286.5451	-44.3311	4.86	20	46.16
cssz-99z	Central and South America	285.9574	-44.2953	4.86	20	29.06
cssz-100a	Central and South America	285.2713	-45.1664	5.68	20	11.96
cssz-100b	Central and South America	284.6758	-45.1246	5.68	8	5
cssz-100x	Central and South America	287.0603	-45.2918	5.68	20	63.26
cssz-100y	Central and South America	286.4635	-45.2500	5.68	20	46.16
cssz-100z	Central and South America	285.8672	-45.2082	5.68	20	29.06
cssz-101a	Central and South America	285.3080	-45.8607	352.6	20	9.36

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-101b	Central and South America	284.7067	-45.9152	352.6	5	5
cssz-101y	Central and South America	286.5089	-45.7517	352.6	20	43.56
cssz-101z	Central and South America	285.9088	-45.8062	352.6	20	26.46
cssz-102a	Central and South America	285.2028	-47.1185	17.72	5	9.36
cssz-102b	Central and South America	284.5772	-46.9823	17.72	5	5
cssz-102y	Central and South America	286.4588	-47.3909	17.72	5	18.07
cssz-102z	Central and South America	285.8300	-47.2547	17.72	5	13.72
cssz-103a	Central and South America	284.7075	-48.0396	23.37	7.5	11.53
cssz-103b	Central and South America	284.0972	-47.8630	23.37	7.5	5
cssz-103x	Central and South America	286.5511	-48.5694	23.37	7.5	31.11
cssz-103y	Central and South America	285.9344	-48.3928	23.37	7.5	24.58
cssz-103z	Central and South America	285.3199	-48.2162	23.37	7.5	18.05
cssz-104a	Central and South America	284.3440	-48.7597	14.87	10	13.68
cssz-104b	Central and South America	283.6962	-48.6462	14.87	10	5
cssz-104x	Central and South America	286.2962	-49.1002	14.87	10	39.73
cssz-104y	Central and South America	285.6440	-48.9867	14.87	10	31.05
cssz-104z	Central and South America	284.9933	-48.8732	14.87	10	22.36
cssz-105a	Central and South America	284.2312	-49.4198	0.25	9.67	13.4
cssz-105b	Central and South America	283.5518	-49.4179	0.25	9.67	5
cssz-105x	Central and South America	286.2718	-49.4255	0.25	9.67	38.59
cssz-105y	Central and South America	285.5908	-49.4236	0.25	9.67	30.2
cssz-105z	Central and South America	284.9114	-49.4217	0.25	9.67	21.8
cssz-106a	Central and South America	284.3730	-50.1117	347.5	9.25	13.04
cssz-106b	Central and South America	283.6974	-50.2077	347.5	9.25	5
cssz-106x	Central and South America	286.3916	-49.8238	347.5	9.25	37.15
cssz-106y	Central and South America	285.7201	-49.9198	347.5	9.25	29.11
cssz-106z	Central and South America	285.0472	-50.0157	347.5	9.25	21.07
cssz-107a	Central and South America	284.7130	-50.9714	346.5	9	12.82
cssz-107b	Central and South America	284.0273	-51.0751	346.5	9	5
cssz-107x	Central and South America	286.7611	-50.6603	346.5	9	36.29
cssz-107y	Central and South America	286.0799	-50.7640	346.5	9	28.47
cssz-107z	Central and South America	285.3972	-50.8677	346.5	9	20.64
cssz-108a	Central and South America	285.0378	-51.9370	352	8.67	12.54
cssz-108b	Central and South America	284.3241	-51.9987	352	8.67	5
cssz-108x	Central and South America	287.1729	-51.7519	352	8.67	35.15
cssz-108y	Central and South America	286.4622	-51.8136	352	8.67	27.61
cssz-108z	Central and South America	285.7505	-51.8753	352	8.67	20.07
cssz-109a	Central and South America	285.2635	-52.8439	353.1	8.33	12.24
cssz-109b	Central and South America	284.5326	-52.8974	353.1	8.33	5

Table E2: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
cssz-109x	Central and South America	287.4508	-52.6834	353.1	8.33	33.97
cssz-109y	Central and South America	286.7226	-52.7369	353.1	8.33	26.73
cssz-109z	Central and South America	285.9935	-52.7904	353.1	8.33	19.49
cssz-110a	Central and South America	285.5705	-53.4139	334.2	8	11.96
cssz-110b	Central and South America	284.8972	-53.6076	334.2	8	5
cssz-110x	Central and South America	287.5724	-52.8328	334.2	8	32.83
cssz-110y	Central and South America	286.9081	-53.0265	334.2	8	25.88
cssz-110z	Central and South America	286.2408	-53.2202	334.2	8	18.92
cssz-111a	Central and South America	286.1627	-53.8749	313.8	8	11.96
cssz-111b	Central and South America	285.6382	-54.1958	313.8	8	5
cssz-111x	Central and South America	287.7124	-52.9122	313.8	8	32.83
cssz-111y	Central and South America	287.1997	-53.2331	313.8	8	25.88
cssz-111z	Central and South America	286.6832	-53.5540	313.8	8	18.92
cssz-112a	Central and South America	287.3287	-54.5394	316.4	8	11.96
cssz-112b	Central and South America	286.7715	-54.8462	316.4	8	5
cssz-112x	Central and South America	288.9756	-53.6190	316.4	8	32.83
cssz-112y	Central and South America	288.4307	-53.9258	316.4	8	25.88
cssz-112z	Central and South America	287.8817	-54.2326	316.4	8	18.92
cssz-113a	Central and South America	288.3409	-55.0480	307.6	8	11.96
cssz-113b	Central and South America	287.8647	-55.4002	307.6	8	5
cssz-113x	Central and South America	289.7450	-53.9914	307.6	8	32.83
cssz-113y	Central and South America	289.2810	-54.3436	307.6	8	25.88
cssz-113z	Central and South America	288.8130	-54.6958	307.6	8	18.92
cssz-114a	Central and South America	289.5342	-55.5026	301.5	8	11.96
cssz-114b	Central and South America	289.1221	-55.8819	301.5	8	5
cssz-114x	Central and South America	290.7472	-54.3647	301.5	8	32.83
cssz-114y	Central and South America	290.3467	-54.7440	301.5	8	25.88
cssz-114z	Central and South America	289.9424	-55.1233	301.5	8	18.92
cssz-115a	Central and South America	290.7682	-55.8485	292.7	8	11.96
cssz-115b	Central and South America	290.4608	-56.2588	292.7	8	5
cssz-115x	Central and South America	291.6714	-54.6176	292.7	8	32.83
cssz-115y	Central and South America	291.3734	-55.0279	292.7	8	25.88
cssz-115z	Central and South America	291.0724	-55.4382	292.7	8	18.92
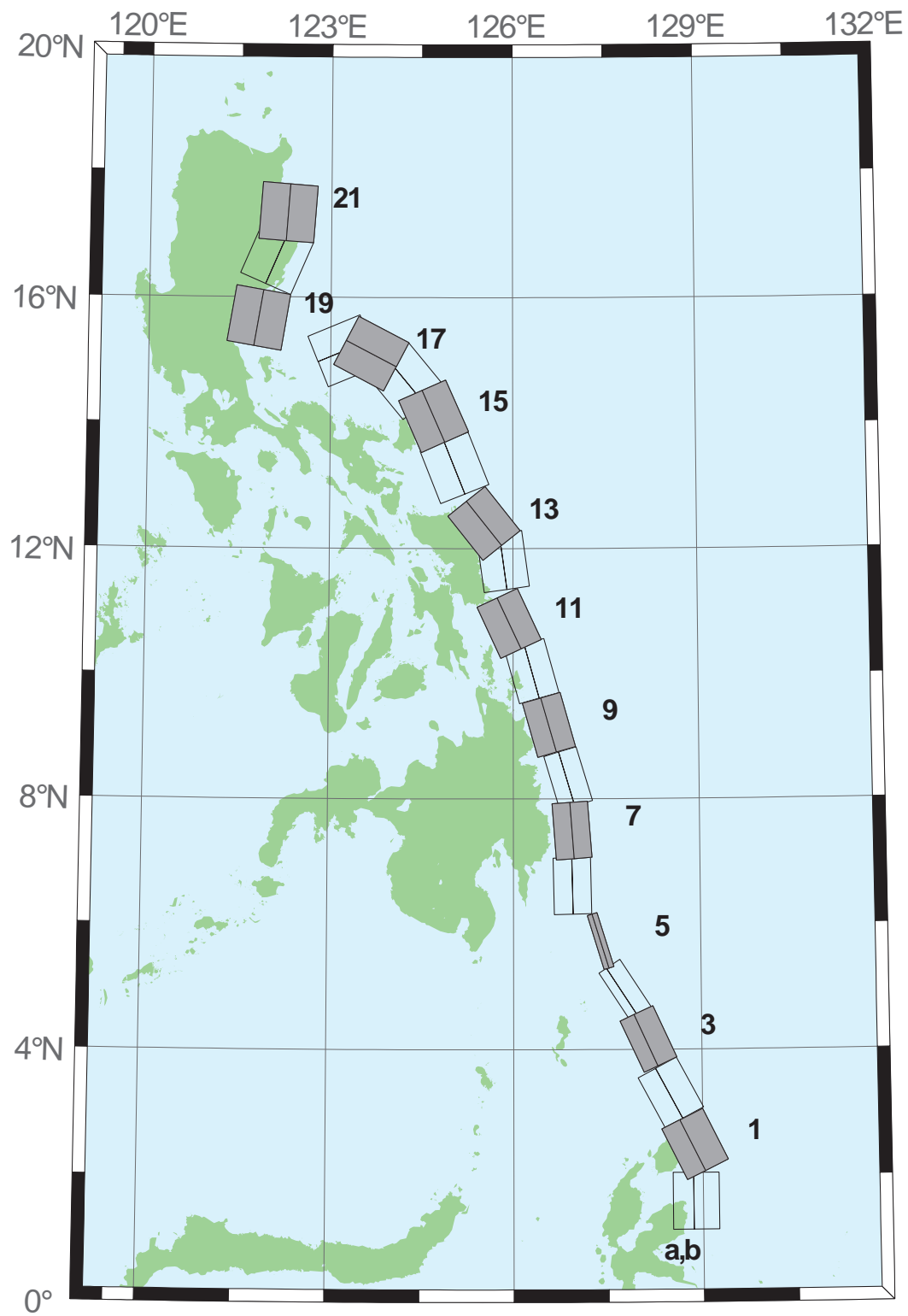
Figure E3: Eastern Philippines Subduction Zone unit sources.

Table E3: Earthquake parameters for Eastern Philippines Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
epsz-0a	Eastern Philippines	128.5264	1.5930	180	44	26.92
epsz-0b	Eastern Philippines	128.8496	1.5930	180	26	5
epsz-1a	Eastern Philippines	128.5521	2.3289	153.6	44.2	27.62
epsz-1b	Eastern Philippines	128.8408	2.4720	153.6	26.9	5
epsz-2a	Eastern Philippines	128.1943	3.1508	151.9	45.9	32.44
epsz-2b	Eastern Philippines	128.4706	3.2979	151.9	32.8	5.35
epsz-3a	Eastern Philippines	127.8899	4.0428	155.2	57.3	40.22
epsz-3b	Eastern Philippines	128.1108	4.1445	155.2	42.7	6.31
epsz-4a	Eastern Philippines	127.6120	4.8371	146.8	71.4	48.25
epsz-4b	Eastern Philippines	127.7324	4.9155	146.8	54.8	7.39
epsz-5a	Eastern Philippines	127.3173	5.7040	162.9	79.9	57.4
epsz-5b	Eastern Philippines	127.3930	5.7272	162.9	79.4	8.25
epsz-6a	Eastern Philippines	126.6488	6.6027	178.9	48.6	45.09
epsz-6b	Eastern Philippines	126.9478	6.6085	178.9	48.6	7.58
epsz-7a	Eastern Philippines	126.6578	7.4711	175.8	50.7	45.52
epsz-7b	Eastern Philippines	126.9439	7.4921	175.8	50.7	6.83
epsz-8a	Eastern Philippines	126.6227	8.2456	163.3	56.7	45.6
epsz-8b	Eastern Philippines	126.8614	8.3164	163.3	48.9	7.92
epsz-9a	Eastern Philippines	126.2751	9.0961	164.1	47	43.59
epsz-9b	Eastern Philippines	126.5735	9.1801	164.1	44.9	8.3
epsz-10a	Eastern Philippines	125.9798	9.9559	164.5	43.1	42.25
epsz-10b	Eastern Philippines	126.3007	10.0438	164.5	43.1	8.09
epsz-11a	Eastern Philippines	125.6079	10.6557	155	37.8	38.29
epsz-11b	Eastern Philippines	125.9353	10.8059	155	37.8	7.64
epsz-12a	Eastern Philippines	125.4697	11.7452	172.1	36	37.01
epsz-12b	Eastern Philippines	125.8374	11.7949	172.1	36	7.62
epsz-13a	Eastern Philippines	125.2238	12.1670	141.5	32.4	33.87
epsz-13b	Eastern Philippines	125.5278	12.4029	141.5	32.4	7.08
epsz-14a	Eastern Philippines	124.6476	13.1365	158.2	23	25.92
epsz-14b	Eastern Philippines	125.0421	13.2898	158.2	23	6.38
epsz-15a	Eastern Philippines	124.3107	13.9453	156.1	24.1	26.51
epsz-15b	Eastern Philippines	124.6973	14.1113	156.1	24.1	6.09
epsz-16a	Eastern Philippines	123.8998	14.4025	140.3	19.5	21.69
epsz-16b	Eastern Philippines	124.2366	14.6728	140.3	19.5	5
epsz-17a	Eastern Philippines	123.4604	14.7222	117.6	15.3	18.19
epsz-17b	Eastern Philippines	123.6682	15.1062	117.6	15.3	5
epsz-18a	Eastern Philippines	123.3946	14.7462	67.4	15	17.94
epsz-18b	Eastern Philippines	123.2219	15.1467	67.4	15	5
epsz-19a	Eastern Philippines	121.3638	15.7400	189.6	15	17.94
epsz-19b	Eastern Philippines	121.8082	15.6674	189.6	15	5
epsz-20a	Eastern Philippines	121.6833	16.7930	203.3	15	17.94
epsz-20b	Eastern Philippines	122.0994	16.6216	203.3	15	5
epsz-21a	Eastern Philippines	121.8279	17.3742	184.2	15	17.94
epsz-21b	Eastern Philippines	122.2814	17.3425	184.2	15	5
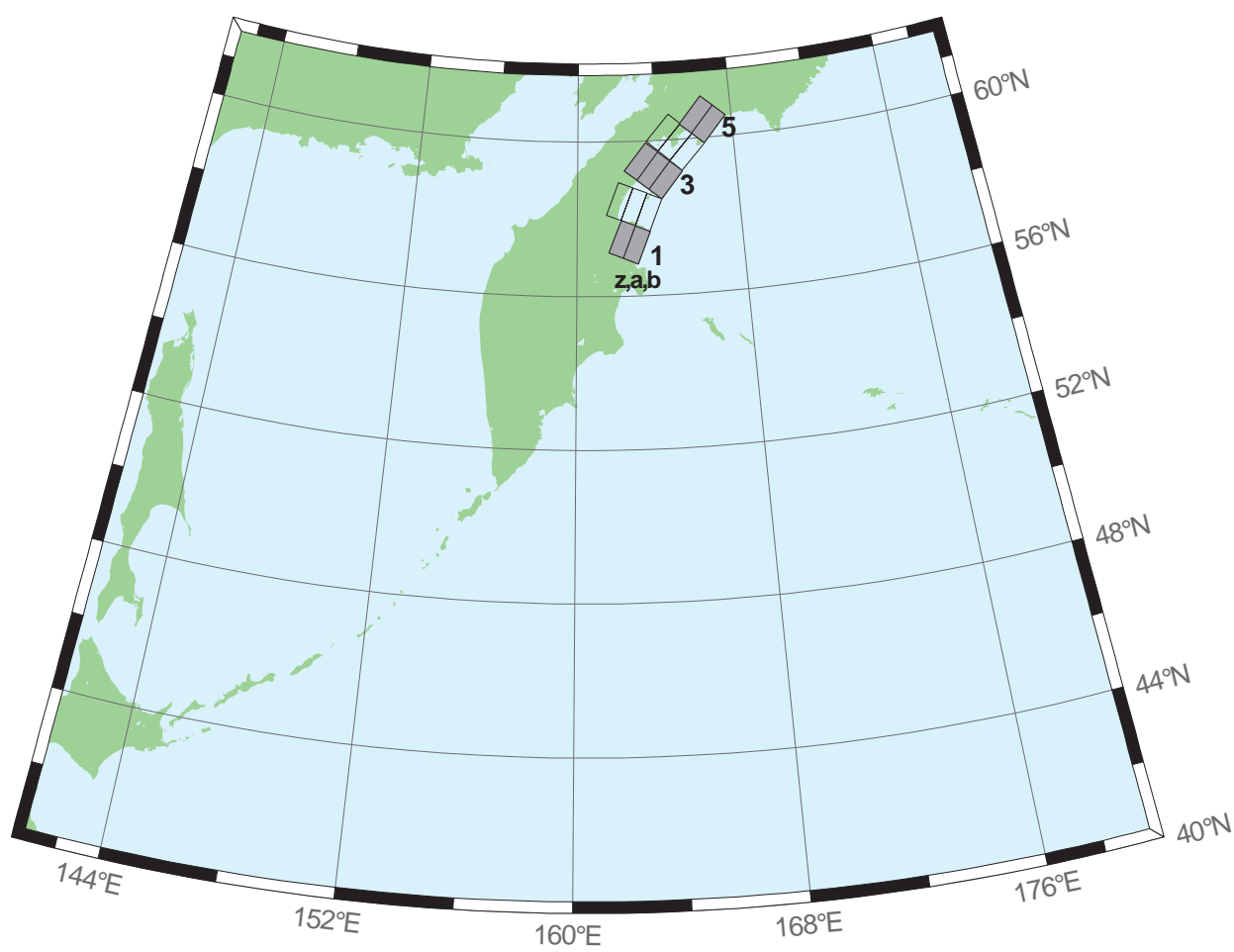
Figure E4: Kamchatka–Bering Subduction Zone unit sources.

Table E4: Earthquake parameters for Kamchatka–Bering Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kbsz-1a	Kamchatka-Bering	161.8374	57.5485	201.5	29	26.13
kbsz-1b	Kamchatka-Bering	162.5162	57.4030	202.1	25	5
kbsz-2a	Kamchatka-Bering	162.4410	58.3816	201.7	29	26.13
kbsz-2b	Kamchatka-Bering	163.1344	58.2343	202.3	25	5
kbsz-2z	Kamchatka-Bering	161.7418	58.5249	201.1	29	50.37
kbsz-3a	Kamchatka-Bering	163.5174	59.3493	218.9	29	26.13
kbsz-3b	Kamchatka-Bering	164.1109	59.1001	219.4	25	5
kbsz-3z	Kamchatka-Bering	162.9150	59.5958	218.4	29	50.37
kbsz-4a	Kamchatka-Bering	164.7070	60.0632	222.2	29	26.13
kbsz-4b	Kamchatka-Bering	165.2833	59.7968	222.7	25	5
kbsz-4z	Kamchatka-Bering	164.1212	60.3270	221.7	29	50.37
kbsz-5a	Kamchatka-Bering	165.8652	60.7261	220.5	29	26.13
kbsz-5b	Kamchatka-Bering	166.4692	60.4683	221	25	5
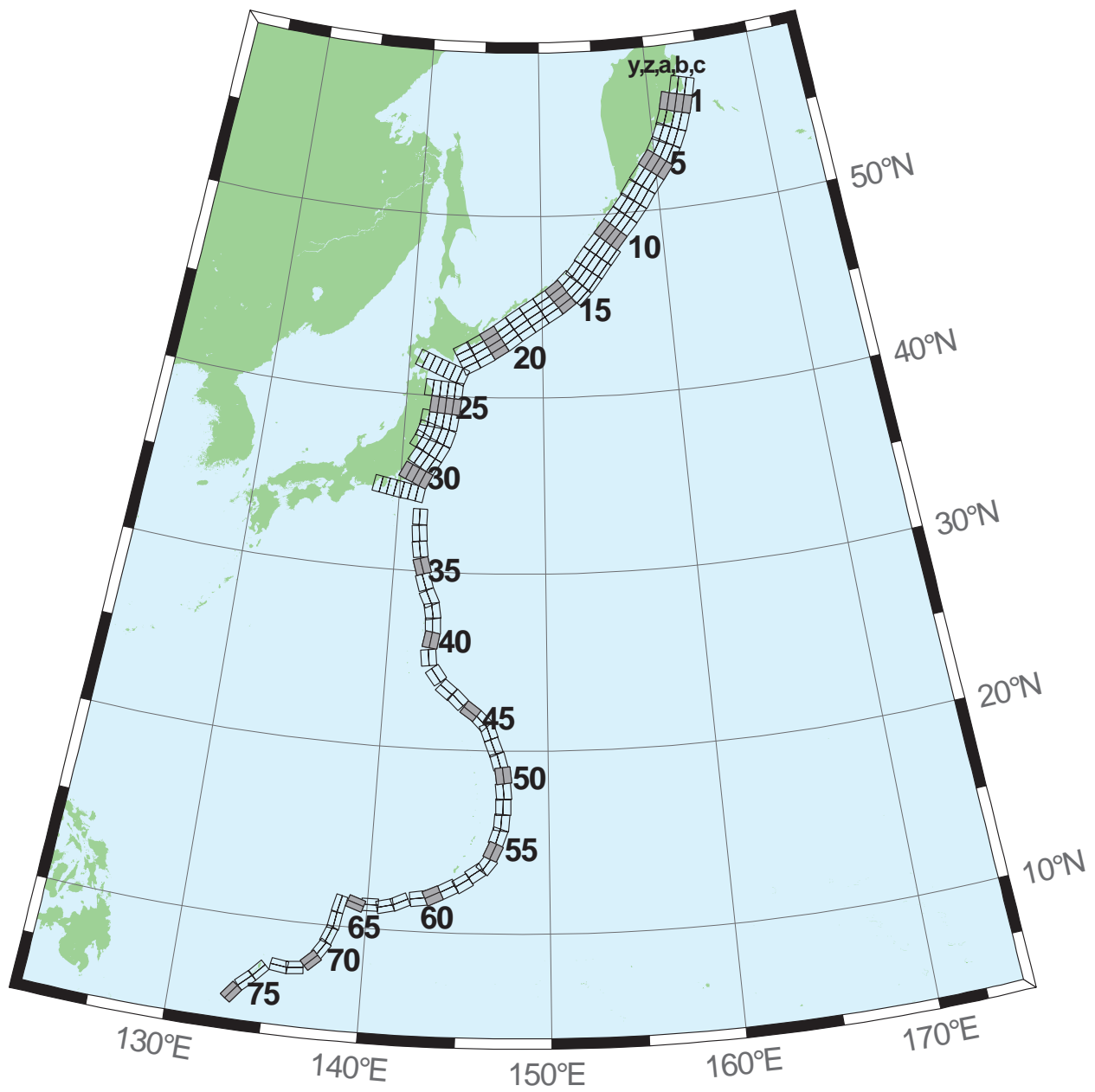
Figure E5: Kamchatka–Kuril–Japan–Izu–Mariana–Yap Subduction Zone unit sources.

Table E5: Earthquake parameters for Kamchatka-Kuril-Japan-Izu-Mariana-Yap Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-0a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	162.8200	56.3667	194.4	29	26.13
kisz-0b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	163.5057	56.2677	195	25	5
kisz-0z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	162.1309	56.4618	193.8	29	50.37
kisz-1a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	162.4318	55.5017	195	29	26.13
kisz-1b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	163.1000	55.4000	195	25	5
kisz-1y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.0884	55.7050	195	29	74.61
kisz-1z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.7610	55.6033	195	29	50.37
kisz-2a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.9883	54.6784	200	29	26.13
kisz-2b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	162.6247	54.5440	200	25	5
kisz-2y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.7072	54.9471	200	29	74.61
kisz-2z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.3488	54.8127	200	29	50.37
kisz-3a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.4385	53.8714	204	29	26.13
kisz-3b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	162.0449	53.7116	204	25	5
kisz-3y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.2164	54.1910	204	29	74.61
kisz-3z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.8286	54.0312	204	29	50.37
kisz-4a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.7926	53.1087	210	29	26.13
kisz-4b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	161.3568	52.9123	210	25	5
kisz-4y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	159.6539	53.5015	210	29	74.61
kisz-4z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.2246	53.3051	210	29	50.37
kisz-5a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.0211	52.4113	218	29	26.13
kisz-5b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	160.5258	52.1694	218	25	5
kisz-5y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	159.0005	52.8950	218	29	74.61
kisz-5z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	159.5122	52.6531	218	29	50.37
kisz-6a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	159.1272	51.7034	218	29	26.13
kisz-6b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	159.6241	51.4615	218	25	5
kisz-6y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	158.1228	52.1871	218	29	74.61
kisz-6z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	158.6263	51.9452	218	29	50.37
kisz-7a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	158.2625	50.9549	214	29	26.13
kisz-7b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	158.7771	50.7352	214	25	5
kisz-7y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	157.2236	51.3942	214	29	74.61
kisz-7z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	157.7443	51.1745	214	29	50.37
kisz-8a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	157.4712	50.2459	218	31	27.7
kisz-8b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	157.9433	50.0089	218	27	5
kisz-8y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.5176	50.7199	218	31	79.2
kisz-8z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.9956	50.4829	218	31	53.45
kisz-9a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.6114	49.5583	220	31	27.7
kisz-9b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	157.0638	49.3109	220	27	5
kisz-9y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	155.6974	50.0533	220	31	79.2
kisz-9z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.1556	49.8058	220	31	53.45

Table E5: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-10a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	155.7294	48.8804	221	31	27.7
kisz-10b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.1690	48.6278	221	27	5
kisz-10y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	154.8413	49.3856	221	31	79.2
kisz-10z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	155.2865	49.1330	221	31	53.45
kisz-11a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	154.8489	48.1821	219	31	27.7
kisz-11b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	155.2955	47.9398	219	27	5
kisz-11y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.9472	48.6667	219	31	79.2
kisz-11z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	154.3991	48.4244	219	31	53.45
kisz-11c	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	156.0358	47.5374	39	57.89	4.602
kisz-12a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.9994	47.4729	217	31	27.7
kisz-12b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	154.4701	47.2320	217	27	5
kisz-12y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.0856	47.9363	217	31	79.2
kisz-12z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.5435	47.7046	217	31	53.45
kisz-12c	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	155.2208	46.8473	37	57.89	4.602
kisz-13a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.2239	46.7564	218	31	27.7
kisz-13b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.6648	46.5194	218	27	5
kisz-13y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	152.3343	47.2304	218	31	79.2
kisz-13z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	152.7801	46.9934	218	31	53.45
kisz-13c	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	154.3957	46.1257	38	57.89	4.602
kisz-14a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	152.3657	46.1514	225	23	24.54
kisz-14b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	152.7855	45.8591	225	23	5
kisz-14y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	151.5172	46.7362	225	23	63.62
kisz-14z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	151.9426	46.4438	225	23	44.08
kisz-14c	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	153.4468	45.3976	45	57.89	4.602
kisz-15a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	151.4663	45.5963	233	25	23.73
kisz-15b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	151.8144	45.2712	233	22	5
kisz-15y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	150.7619	46.2465	233	25	65.99
kisz-15z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	151.1151	45.9214	233	25	44.86
kisz-16a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	150.4572	45.0977	237	25	23.73
kisz-16b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	150.7694	44.7563	237	22	5
kisz-16y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	149.8253	45.7804	237	25	65.99
kisz-16z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	150.1422	45.4390	237	25	44.86
kisz-17a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	149.3989	44.6084	237	25	23.73
kisz-17b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	149.7085	44.2670	237	22	5
kisz-17y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	148.7723	45.2912	237	25	65.99
kisz-17z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	149.0865	44.9498	237	25	44.86
kisz-18a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	148.3454	44.0982	235	25	23.73
kisz-18b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	148.6687	43.7647	235	22	5
kisz-18y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.6915	44.7651	235	25	65.99

Table E5: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-18z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	148.0194	44.4316	235	25	44.86
kisz-19a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.3262	43.5619	233	25	23.73
kisz-19b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.6625	43.2368	233	22	5
kisz-19y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.6463	44.2121	233	25	65.99
kisz-19z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.9872	43.8870	233	25	44.86
kisz-20a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.3513	43.0633	237	25	23.73
kisz-20b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.6531	42.7219	237	22	5
kisz-20y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.7410	43.7461	237	25	65.99
kisz-20z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.0470	43.4047	237	25	44.86
kisz-21a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.3331	42.5948	239	25	23.73
kisz-21b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.6163	42.2459	239	22	5
kisz-21y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.7603	43.2927	239	25	65.99
kisz-21z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.0475	42.9438	239	25	44.86
kisz-22a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.3041	42.1631	242	25	23.73
kisz-22b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.5605	41.8037	242	22	5
kisz-22y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.7854	42.8819	242	25	65.99
kisz-22z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.0455	42.5225	242	25	44.86
kisz-23a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.2863	41.3335	202	21	21.28
kisz-23b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.8028	41.1764	202	19	5
kisz-23v	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.6816	42.1189	202	21	110.9
kisz-23w	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.2050	41.9618	202	21	92.95
kisz-23x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.7273	41.8047	202	21	75.04
kisz-23y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.2482	41.6476	202	21	57.12
kisz-23z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7679	41.4905	202	21	39.2
kisz-24a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.9795	40.3490	185	21	21.28
kisz-24b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.5273	40.3125	185	19	5
kisz-24x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.3339	40.4587	185	21	75.04
kisz-24y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.8827	40.4221	185	21	57.12
kisz-24z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.4312	40.3856	185	21	39.2
kisz-25a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.8839	39.4541	185	21	21.28
kisz-25b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.4246	39.4176	185	19	5
kisz-25y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.8012	39.5272	185	21	57.12
kisz-25z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.3426	39.4907	185	21	39.2
kisz-26a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7622	38.5837	188	21	21.28
kisz-26b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.2930	38.5254	188	19	5
kisz-26x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.1667	38.7588	188	21	75.04
kisz-26y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.6990	38.7004	188	21	57.12
kisz-26z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.2308	38.6421	188	21	39.2
kisz-27a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.5320	37.7830	198	21	21.28

Table E5: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-27b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.0357	37.6534	198	19	5
kisz-27x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.0142	38.1717	198	21	75.04
kisz-27y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.5210	38.0421	198	21	57.12
kisz-27z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.0269	37.9126	198	21	39.2
kisz-28a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.1315	37.0265	208	21	21.28
kisz-28b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.5941	36.8297	208	19	5
kisz-28x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.7348	37.6171	208	21	75.04
kisz-28y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.2016	37.4202	208	21	57.12
kisz-28z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.6671	37.2234	208	21	39.2
kisz-29a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.5970	36.2640	211	21	21.28
kisz-29b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.0416	36.0481	211	19	5
kisz-29y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.7029	36.6960	211	21	57.12
kisz-29z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.1506	36.4800	211	21	39.2
kisz-30a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.0553	35.4332	205	21	21.28
kisz-30b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.5207	35.2560	205	19	5
kisz-30y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.1204	35.7876	205	21	57.12
kisz-30z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.5883	35.6104	205	21	39.2
kisz-31a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.6956	34.4789	190	22	22.1
kisz-31b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.1927	34.4066	190	20	5
kisz-31v	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.2025	34.8405	190	22	115.8
kisz-31w	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.7021	34.7682	190	22	97.02
kisz-31x	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	139.2012	34.6958	190	22	78.29
kisz-31y	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	139.6997	34.6235	190	22	59.56
kisz-31z	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.1979	34.5512	190	22	40.83
kisz-32a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.0551	33.0921	180	32	23.48
kisz-32b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.5098	33.0921	180	21.69	5
kisz-33a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.0924	32.1047	173.8	27.65	20.67
kisz-33b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.5596	32.1473	173.8	18.27	5
kisz-34a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.1869	31.1851	172.1	25	18.26
kisz-34b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.6585	31.2408	172.1	15.38	5
kisz-35a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.4154	30.1707	163	25	17.12
kisz-35b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.8662	30.2899	163	14.03	5
kisz-36a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.6261	29.2740	161.7	25.73	18.71
kisz-36b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.0670	29.4012	161.7	15.91	5
kisz-37a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.0120	28.3322	154.7	20	14.54
kisz-37b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.4463	28.5124	154.7	11	5
kisz-38a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.2254	27.6946	170.3	20	14.54
kisz-38b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.6955	27.7659	170.3	11	5
kisz-39a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.3085	26.9127	177.2	24.23	17.42

Table E5: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-39b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7674	26.9325	177.2	14.38	5
kisz-40a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.2673	26.1923	189.4	26.49	22.26
kisz-40b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7090	26.1264	189.4	20.2	5
kisz-41a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.1595	25.0729	173.7	22.07	19.08
kisz-41b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.6165	25.1184	173.7	16.36	5
kisz-42a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7641	23.8947	143.5	21.54	18.4
kisz-42b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.1321	24.1432	143.5	15.54	5
kisz-43a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.5281	23.0423	129.2	23.02	18.77
kisz-43b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.8128	23.3626	129.2	15.99	5
kisz-44a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.2230	22.5240	134.6	28.24	18.56
kisz-44b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.5246	22.8056	134.6	15.74	5
kisz-45a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.0895	21.8866	125.8	36.73	22.79
kisz-45b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.3171	22.1785	125.8	20.84	5
kisz-46a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.6972	21.3783	135.9	30.75	20.63
kisz-46b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.9954	21.6469	135.9	18.22	5
kisz-47a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.0406	20.9341	160.1	29.87	19.62
kisz-47b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.4330	21.0669	160.1	17	5
kisz-48a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.3836	20.0690	158	32.75	19.68
kisz-48b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.7567	20.2108	158	17.07	5
kisz-49a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.6689	19.3123	164.5	25.07	21.41
kisz-49b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.0846	19.4212	164.5	19.16	5
kisz-50a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.9297	18.5663	172.1	22	22.1
kisz-50b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.3650	18.6238	172.1	20	5
kisz-51a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.9495	17.7148	175.1	22.06	22.04
kisz-51b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.3850	17.7503	175.1	19.93	5
kisz-52a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.9447	16.8869	180	25.51	18.61
kisz-52b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.3683	16.8869	180	15.79	5
kisz-53a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.8626	16.0669	185.2	27.39	18.41
kisz-53b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.2758	16.0309	185.2	15.56	5
kisz-54a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.7068	15.3883	199.1	28.12	20.91
kisz-54b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	147.0949	15.2590	199.1	18.56	5
kisz-55a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.4717	14.6025	204.3	29.6	26.27
kisz-55b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.8391	14.4415	204.3	25.18	5
kisz-56a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.1678	13.9485	217.4	32.04	26.79
kisz-56b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	146.4789	13.7170	217.4	25.84	5
kisz-57a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.6515	13.5576	235.8	37	24.54
kisz-57b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.8586	13.2609	235.8	23	5
kisz-58a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.9648	12.9990	237.8	37.72	24.54
kisz-58b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	145.1589	12.6984	237.8	23	5

Table E5: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
kisz-59a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.1799	12.6914	242.9	34.33	22.31
kisz-59b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	144.3531	12.3613	242.9	20.25	5
kisz-60a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.3687	12.3280	244.9	30.9	20.62
kisz-60b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	143.5355	11.9788	244.9	18.2	5
kisz-61a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7051	12.1507	261.8	35.41	25.51
kisz-61b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	142.7582	11.7883	261.8	24.22	5
kisz-62a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.6301	11.8447	245.7	39.86	34.35
kisz-62b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	141.7750	11.5305	245.7	35.94	5
kisz-63a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.8923	11.5740	256.2	42	38.46
kisz-63b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.9735	11.2498	256.2	42	5
kisz-64a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.1387	11.6028	269.6	42.48	38.77
kisz-64b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	140.1410	11.2716	269.6	42.48	5
kisz-65a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	139.4595	11.5883	288.7	44.16	39.83
kisz-65b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	139.3541	11.2831	288.7	44.16	5
kisz-66a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.1823	11.2648	193.1	45	40.36
kisz-66b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.4977	11.1929	193.1	45	5
kisz-67a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.9923	10.3398	189.8	45	40.36
kisz-67b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.3104	10.2856	189.8	45	5
kisz-68a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.7607	9.6136	201.7	45	40.36
kisz-68b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	138.0599	9.4963	201.7	45	5
kisz-69a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.4537	8.8996	213.5	45	40.36
kisz-69b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.7215	8.7241	213.5	45	5
kisz-70a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.0191	8.2872	226.5	45	40.36
kisz-70b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	137.2400	8.0569	226.5	45	5
kisz-71a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	136.3863	7.9078	263.9	45	40.36
kisz-71b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	136.4202	7.5920	263.9	45	5
kisz-72a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	135.6310	7.9130	276.9	45	40.36
kisz-72b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	135.5926	7.5977	276.9	45	5
kisz-73a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	134.3296	7.4541	224	45	40.36
kisz-73b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	134.5600	7.2335	224	45	5
kisz-74a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	133.7125	6.8621	228.1	45	40.36
kisz-74b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	133.9263	6.6258	228.1	45	5
kisz-75a	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	133.0224	6.1221	217.7	45	40.36
kisz-75b	Kamchatka-Kuril-Japan-Izu-Mariana-Yap	133.2751	5.9280	217.7	45	5
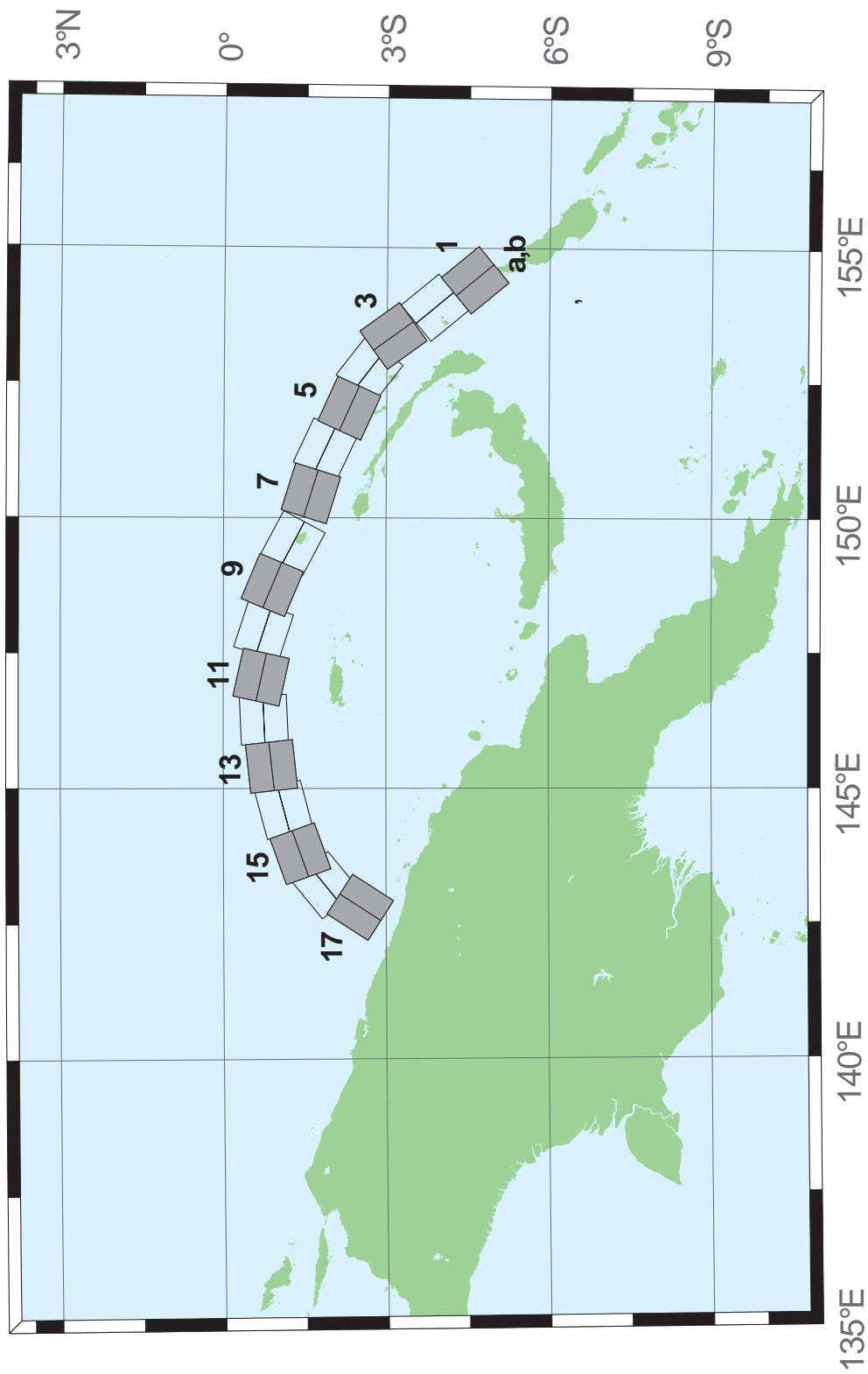
Figure E6: Manus–Oceanic Convergent Boundary Subduction Zone unit sources.

Table E6: Earthquake parameters for Manus–Oceanic Convergent Boundary Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
mosz-1a	Manus-Oceanic Convergent Boundary	154.0737	-4.8960	140.2	15	15.88
mosz-1b	Manus-Oceanic Convergent Boundary	154.4082	-4.6185	140.2	15	2.94
mosz-2a	Manus-Oceanic Convergent Boundary	153.5589	-4.1575	140.2	15	15.91
mosz-2b	Manus-Oceanic Convergent Boundary	153.8931	-3.8800	140.2	15	2.97
mosz-3a	Manus-Oceanic Convergent Boundary	153.0151	-3.3716	143.9	15	16.64
mosz-3b	Manus-Oceanic Convergent Boundary	153.3662	-3.1160	143.9	15	3.7
mosz-4a	Manus-Oceanic Convergent Boundary	152.4667	-3.0241	127.7	15	17.32
mosz-4b	Manus-Oceanic Convergent Boundary	152.7321	-2.6806	127.7	15	4.38
mosz-5a	Manus-Oceanic Convergent Boundary	151.8447	-2.7066	114.3	15	17.57
mosz-5b	Manus-Oceanic Convergent Boundary	152.0235	-2.3112	114.3	15	4.63
mosz-6a	Manus-Oceanic Convergent Boundary	151.0679	-2.2550	115	15	17.66
mosz-6b	Manus-Oceanic Convergent Boundary	151.2513	-1.8618	115	15	4.72
mosz-7a	Manus-Oceanic Convergent Boundary	150.3210	-2.0236	107.2	15	17.73
mosz-7b	Manus-Oceanic Convergent Boundary	150.4493	-1.6092	107.2	15	4.79
mosz-8a	Manus-Oceanic Convergent Boundary	149.3226	-1.6666	117.8	15	17.83
mosz-8b	Manus-Oceanic Convergent Boundary	149.5251	-1.2829	117.8	15	4.89
mosz-9a	Manus-Oceanic Convergent Boundary	148.5865	-1.3017	112.7	15	17.84
mosz-9b	Manus-Oceanic Convergent Boundary	148.7540	-0.9015	112.7	15	4.9
mosz-10a	Manus-Oceanic Convergent Boundary	147.7760	-1.1560	108	15	17.78
mosz-10b	Manus-Oceanic Convergent Boundary	147.9102	-0.7434	108	15	4.84
mosz-11a	Manus-Oceanic Convergent Boundary	146.9596	-1.1226	102.5	15	17.54
mosz-11b	Manus-Oceanic Convergent Boundary	147.0531	-0.6990	102.5	15	4.6
mosz-12a	Manus-Oceanic Convergent Boundary	146.2858	-1.1820	87.48	15	17.29
mosz-12b	Manus-Oceanic Convergent Boundary	146.2667	-0.7486	87.48	15	4.35
mosz-13a	Manus-Oceanic Convergent Boundary	145.4540	-1.3214	83.75	15	17.34
mosz-13b	Manus-Oceanic Convergent Boundary	145.4068	-0.8901	83.75	15	4.4
mosz-14a	Manus-Oceanic Convergent Boundary	144.7151	-1.5346	75.09	15	17.21
mosz-14b	Manus-Oceanic Convergent Boundary	144.6035	-1.1154	75.09	15	4.27
mosz-15a	Manus-Oceanic Convergent Boundary	143.9394	-1.8278	70.43	15	16.52
mosz-15b	Manus-Oceanic Convergent Boundary	143.7940	-1.4190	70.43	15	3.58
mosz-16a	Manus-Oceanic Convergent Boundary	143.4850	-2.2118	50.79	15	15.86
mosz-16b	Manus-Oceanic Convergent Boundary	143.2106	-1.8756	50.79	15	2.92
mosz-17a	Manus-Oceanic Convergent Boundary	143.1655	-2.7580	33	15	16.64
mosz-17b	Manus-Oceanic Convergent Boundary	142.8013	-2.5217	33	15	3.7
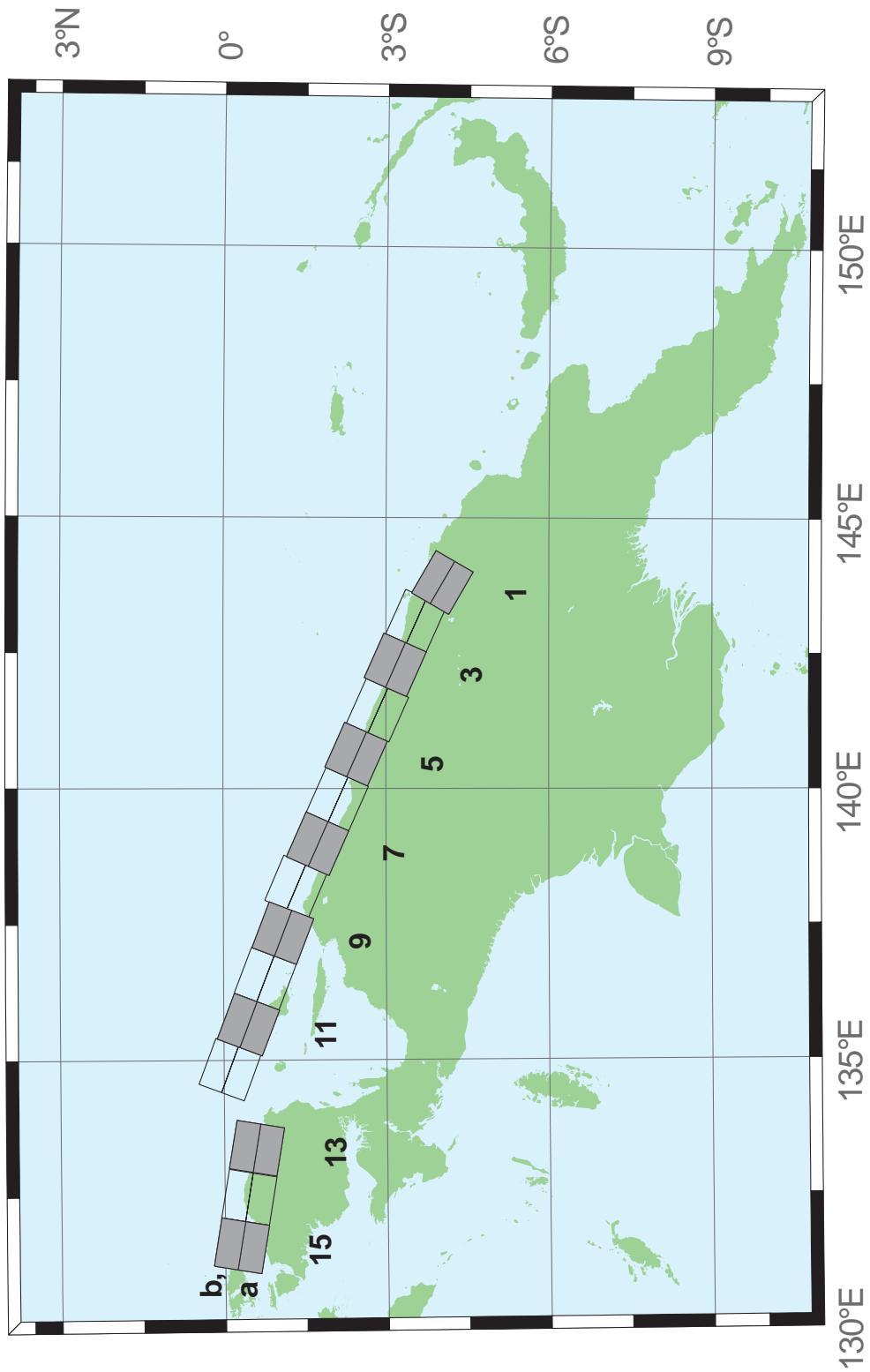
Figure E7: New Guinea Subduction Zone unit sources.

Table E7: Earthquake parameters for New Guinea Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
ngsz-1a	New Guinea	143.6063	-4.3804	120	29	25.64
ngsz-1b	New Guinea	143.8032	-4.0402	120	29	1.4
ngsz-2a	New Guinea	142.9310	-3.9263	114	27.63	20.1
ngsz-2b	New Guinea	143.0932	-3.5628	114	21.72	1.6
ngsz-3a	New Guinea	142.1076	-3.5632	114	20.06	18.73
ngsz-3b	New Guinea	142.2795	-3.1778	114	15.94	5
ngsz-4a	New Guinea	141.2681	-3.2376	114	21	17.76
ngsz-4b	New Guinea	141.4389	-2.8545	114	14.79	5
ngsz-5a	New Guinea	140.4592	-2.8429	114	21.26	16.14
ngsz-5b	New Guinea	140.6296	-2.4605	114	12.87	5
ngsz-6a	New Guinea	139.6288	-2.4960	114	22.72	15.4
ngsz-6b	New Guinea	139.7974	-2.1175	114	12	5
ngsz-7a	New Guinea	138.8074	-2.1312	114	21.39	15.4
ngsz-7b	New Guinea	138.9776	-1.7491	114	12	5
ngsz-8a	New Guinea	138.0185	-1.7353	113.1	18.79	15.14
ngsz-8b	New Guinea	138.1853	-1.3441	113.1	11.7	5
ngsz-9a	New Guinea	137.1805	-1.5037	111	15.24	13.23
ngsz-9b	New Guinea	137.3358	-1.0991	111	9.47	5
ngsz-10a	New Guinea	136.3418	-1.1774	111	13.51	11.09
ngsz-10b	New Guinea	136.4983	-0.7697	111	7	5
ngsz-11a	New Guinea	135.4984	-0.8641	111	11.38	12.49
ngsz-11b	New Guinea	135.6562	-0.4530	111	8.62	5
ngsz-12a	New Guinea	134.6759	-0.5216	110.5	10	13.68
ngsz-12b	New Guinea	134.8307	-0.1072	110.5	10	5
ngsz-13a	New Guinea	133.3065	-1.0298	99.5	10	13.68
ngsz-13b	New Guinea	133.3795	-0.5935	99.5	10	5
ngsz-14a	New Guinea	132.4048	-0.8816	99.5	10	13.68
ngsz-14b	New Guinea	132.4778	-0.4453	99.5	10	5
ngsz-15a	New Guinea	131.5141	-0.7353	99.5	10	13.68
ngsz-15b	New Guinea	131.5871	-0.2990	99.5	10	5
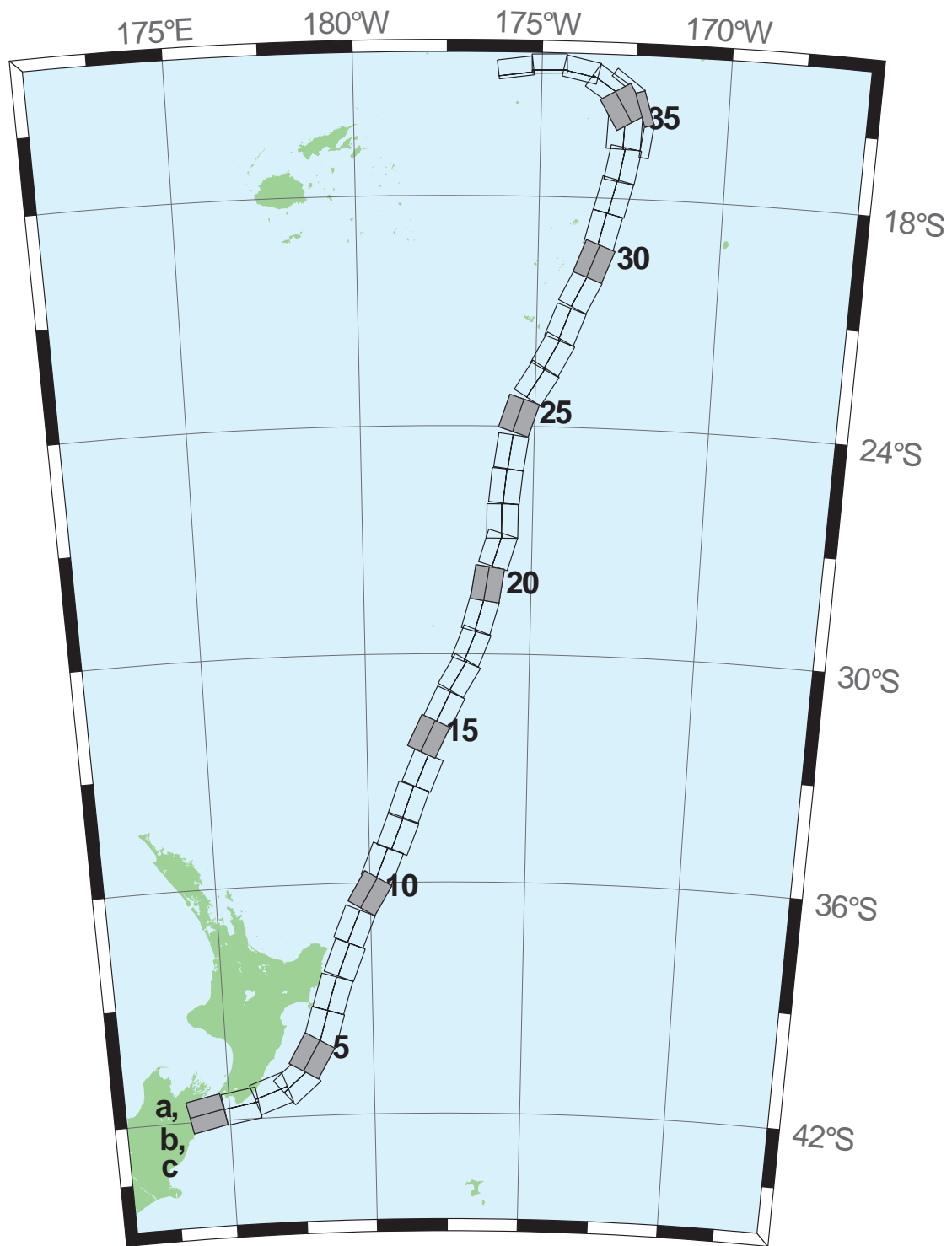
Figure E8: New Zealand–Kermadec–Tonga Subduction Zone unit sources.

Table E8: Earthquake parameters for New Zealand–Kermadec–Tonga Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
ntsz-1a	New Zealand–Kermadec–Tonga	174.0985	-41.3951	258.6	24	25.34
ntsz-1b	New Zealand–Kermadec–Tonga	174.2076	-41.7973	258.6	24	5
ntsz-2a	New Zealand–Kermadec–Tonga	175.3289	-41.2592	260.6	29.38	23.17
ntsz-2b	New Zealand–Kermadec–Tonga	175.4142	-41.6454	260.6	21.31	5
ntsz-3a	New Zealand–Kermadec–Tonga	176.2855	-40.9950	250.7	29.54	21.74
ntsz-3b	New Zealand–Kermadec–Tonga	176.4580	-41.3637	250.7	19.56	5
ntsz-4a	New Zealand–Kermadec–Tonga	177.0023	-40.7679	229.4	24.43	18.87
ntsz-4b	New Zealand–Kermadec–Tonga	177.3552	-41.0785	229.4	16.1	5
ntsz-5a	New Zealand–Kermadec–Tonga	177.4114	-40.2396	210	18.8	19.29
ntsz-5b	New Zealand–Kermadec–Tonga	177.8951	-40.4525	210	16.61	5
ntsz-6a	New Zealand–Kermadec–Tonga	177.8036	-39.6085	196.7	18.17	15.8
ntsz-6b	New Zealand–Kermadec–Tonga	178.3352	-39.7310	196.7	12.48	5
ntsz-7a	New Zealand–Kermadec–Tonga	178.1676	-38.7480	197	28.1	17.85
ntsz-7b	New Zealand–Kermadec–Tonga	178.6541	-38.8640	197	14.89	5
ntsz-8a	New Zealand–Kermadec–Tonga	178.6263	-37.8501	201.4	31.47	18.78
ntsz-8b	New Zealand–Kermadec–Tonga	179.0788	-37.9899	201.4	16	5
ntsz-9a	New Zealand–Kermadec–Tonga	178.9833	-36.9770	202.2	29.58	20.02
ntsz-9b	New Zealand–Kermadec–Tonga	179.4369	-37.1245	202.2	17.48	5
ntsz-10a	New Zealand–Kermadec–Tonga	179.5534	-36.0655	210.6	32.1	20.72
ntsz-10b	New Zealand–Kermadec–Tonga	179.9595	-36.2593	210.6	18.32	5
ntsz-11a	New Zealand–Kermadec–Tonga	179.9267	-35.3538	201.7	25	16.09
ntsz-11b	New Zealand–Kermadec–Tonga	180.3915	-35.5040	201.7	12.81	5
ntsz-12a	New Zealand–Kermadec–Tonga	180.4433	-34.5759	201.2	25	15.46
ntsz-12b	New Zealand–Kermadec–Tonga	180.9051	-34.7230	201.2	12.08	5
ntsz-13a	New Zealand–Kermadec–Tonga	180.7990	-33.7707	199.8	25.87	19.06
ntsz-13b	New Zealand–Kermadec–Tonga	181.2573	-33.9073	199.8	16.33	5
ntsz-14a	New Zealand–Kermadec–Tonga	181.2828	-32.9288	202.4	31.28	22.73
ntsz-14b	New Zealand–Kermadec–Tonga	181.7063	-33.0751	202.4	20.77	5
ntsz-15a	New Zealand–Kermadec–Tonga	181.4918	-32.0035	205.4	32.33	22.64
ntsz-15b	New Zealand–Kermadec–Tonga	181.8967	-32.1665	205.4	20.66	5
ntsz-16a	New Zealand–Kermadec–Tonga	181.9781	-31.2535	205.5	34.29	23.59
ntsz-16b	New Zealand–Kermadec–Tonga	182.3706	-31.4131	205.5	21.83	5
ntsz-17a	New Zealand–Kermadec–Tonga	182.4819	-30.3859	210.3	37.6	25.58
ntsz-17b	New Zealand–Kermadec–Tonga	182.8387	-30.5655	210.3	24.3	5
ntsz-18a	New Zealand–Kermadec–Tonga	182.8176	-29.6545	201.6	37.65	26.13
ntsz-18b	New Zealand–Kermadec–Tonga	183.1985	-29.7856	201.6	25	5
ntsz-19a	New Zealand–Kermadec–Tonga	183.0622	-28.8739	195.7	34.41	26.13
ntsz-19b	New Zealand–Kermadec–Tonga	183.4700	-28.9742	195.7	25	5
ntsz-20a	New Zealand–Kermadec–Tonga	183.2724	-28.0967	188.8	38	26.13
ntsz-20b	New Zealand–Kermadec–Tonga	183.6691	-28.1508	188.8	25	5

Table E8: (continued)

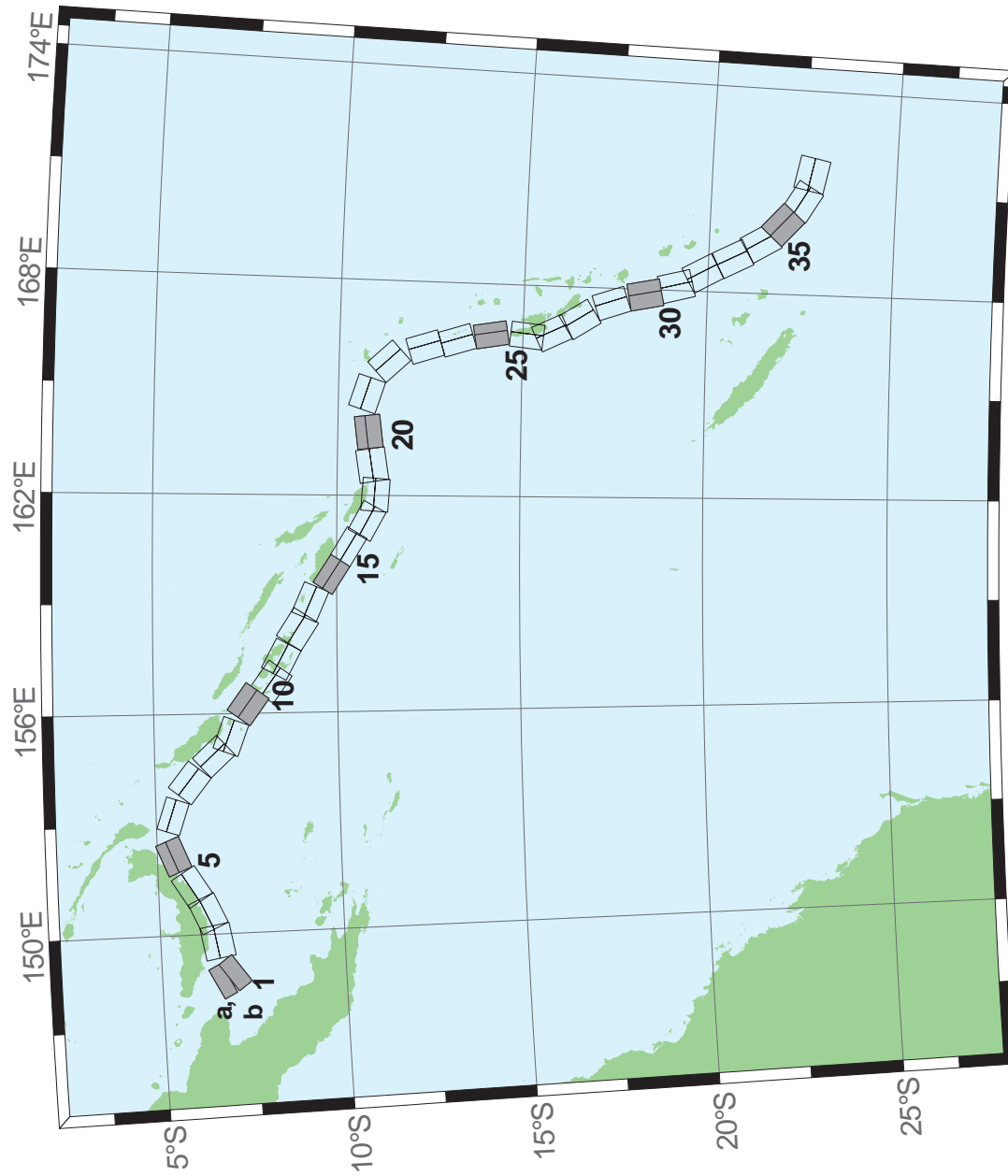| Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
ntsz-21a	New Zealand–Kermadec–Tonga	183.5747	-27.1402	197.1	32.29	24.83
ntsz-21b	New Zealand–Kermadec–Tonga	183.9829	-27.2518	197.1	23.37	5
ntsz-22a	New Zealand–Kermadec–Tonga	183.6608	-26.4975	180	29.56	18.63
ntsz-22b	New Zealand–Kermadec–Tonga	184.0974	-26.4975	180	15.82	5
ntsz-23a	New Zealand–Kermadec–Tonga	183.7599	-25.5371	185.8	32.42	20.56
ntsz-23b	New Zealand–Kermadec–Tonga	184.1781	-25.5752	185.8	18.13	5
ntsz-24a	New Zealand–Kermadec–Tonga	183.9139	-24.6201	188.2	33.31	23.73
ntsz-24b	New Zealand–Kermadec–Tonga	184.3228	-24.6734	188.2	22	5
ntsz-25a	New Zealand–Kermadec–Tonga	184.1266	-23.5922	198.5	29.34	19.64
ntsz-25b	New Zealand–Kermadec–Tonga	184.5322	-23.7163	198.5	17.03	5
ntsz-26a	New Zealand–Kermadec–Tonga	184.6613	-22.6460	211.7	30.26	19.43
ntsz-26b	New Zealand–Kermadec–Tonga	185.0196	-22.8497	211.7	16.78	5
ntsz-27a	New Zealand–Kermadec–Tonga	185.0879	-21.9139	207.9	31.73	20.67
ntsz-27b	New Zealand–Kermadec–Tonga	185.4522	-22.0928	207.9	18.27	5
ntsz-28a	New Zealand–Kermadec–Tonga	185.4037	-21.1758	200.5	32.44	21.76
ntsz-28b	New Zealand–Kermadec–Tonga	185.7849	-21.3084	200.5	19.58	5
ntsz-29a	New Zealand–Kermadec–Tonga	185.8087	-20.2629	206.4	32.47	20.4
ntsz-29b	New Zealand–Kermadec–Tonga	186.1710	-20.4312	206.4	17.94	5
ntsz-30a	New Zealand–Kermadec–Tonga	186.1499	-19.5087	200.9	32.98	22.46
ntsz-30b	New Zealand–Kermadec–Tonga	186.5236	-19.6432	200.9	20.44	5
ntsz-31a	New Zealand–Kermadec–Tonga	186.3538	-18.7332	193.9	34.41	21.19
ntsz-31b	New Zealand–Kermadec–Tonga	186.7339	-18.8221	193.9	18.89	5
ntsz-32a	New Zealand–Kermadec–Tonga	186.5949	-17.8587	194.1	30	19.12
ntsz-32b	New Zealand–Kermadec–Tonga	186.9914	-17.9536	194.1	16.4	5
ntsz-33a	New Zealand–Kermadec–Tonga	186.8172	-17.0581	190	33.15	23.34
ntsz-33b	New Zealand–Kermadec–Tonga	187.2047	-17.1237	190	21.52	5
ntsz-34a	New Zealand–Kermadec–Tonga	186.7814	-16.2598	182.1	15	13.41
ntsz-34b	New Zealand–Kermadec–Tonga	187.2330	-16.2759	182.1	9.68	5
ntsz-34c	New Zealand–Kermadec–Tonga	187.9697	-16.4956	7.62	57.06	6.571
ntsz-35a	New Zealand–Kermadec–Tonga	186.8000	-15.8563	149.8	15	12.17
ntsz-35b	New Zealand–Kermadec–Tonga	187.1896	-15.6384	149.8	8.24	5
ntsz-35c	New Zealand–Kermadec–Tonga	187.8776	-15.6325	342.4	57.06	6.571
ntsz-36a	New Zealand–Kermadec–Tonga	186.5406	-15.3862	123.9	40.44	36.72
ntsz-36b	New Zealand–Kermadec–Tonga	186.7381	-15.1025	123.9	39.38	5
ntsz-36c	New Zealand–Kermadec–Tonga	187.3791	-14.9234	307	57.06	6.571
ntsz-37a	New Zealand–Kermadec–Tonga	185.9883	-14.9861	102	68.94	30.99
ntsz-37b	New Zealand–Kermadec–Tonga	186.0229	-14.8282	102	31.32	5
ntsz-38a	New Zealand–Kermadec–Tonga	185.2067	-14.8259	88.4	80	26.13
ntsz-38b	New Zealand–Kermadec–Tonga	185.2044	-14.7479	88.4	25	5
ntsz-39a	New Zealand–Kermadec–Tonga	184.3412	-14.9409	82.55	80	26.13
ntsz-39b	New Zealand–Kermadec–Tonga	184.3307	-14.8636	82.55	25	5

Figure E9: New Britain–Solomons–Vanuatu Subduction Zone unit sources.

Table E9: Earthquake parameters for New Britain–Solomons–Vanuatu Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
nvsz-1a	New Britain–Solomons–Vanuatu	148.6217	-6.4616	243.2	32.34	15.69
nvsz-1b	New Britain–Solomons–Vanuatu	148.7943	-6.8002	234.2	12.34	5
nvsz-2a	New Britain–Solomons–Vanuatu	149.7218	-6.1459	260.1	35.1	16.36
nvsz-2b	New Britain–Solomons–Vanuatu	149.7856	-6.5079	260.1	13.13	5
nvsz-3a	New Britain–Solomons–Vanuatu	150.4075	-5.9659	245.7	42.35	18.59
nvsz-3b	New Britain–Solomons–Vanuatu	150.5450	-6.2684	245.7	15.77	5
nvsz-4a	New Britain–Solomons–Vanuatu	151.1095	-5.5820	238.2	42.41	23.63
nvsz-4b	New Britain–Solomons–Vanuatu	151.2851	-5.8639	238.2	21.88	5
nvsz-5a	New Britain–Solomons–Vanuatu	152.0205	-5.1305	247.7	49.22	32.39
nvsz-5b	New Britain–Solomons–Vanuatu	152.1322	-5.4020	247.7	33.22	5
nvsz-6a	New Britain–Solomons–Vanuatu	153.3450	-5.1558	288.6	53.53	33.59
nvsz-6b	New Britain–Solomons–Vanuatu	153.2595	-5.4089	288.6	34.87	5
nvsz-7a	New Britain–Solomons–Vanuatu	154.3814	-5.6308	308.3	39.72	19.18
nvsz-7b	New Britain–Solomons–Vanuatu	154.1658	-5.9017	308.3	16.48	5
nvsz-8a	New Britain–Solomons–Vanuatu	155.1097	-6.3511	317.2	45.33	22.92
nvsz-8b	New Britain–Solomons–Vanuatu	154.8764	-6.5656	317.2	21	5
nvsz-9a	New Britain–Solomons–Vanuatu	155.5027	-6.7430	290.5	48.75	22.92
nvsz-9b	New Britain–Solomons–Vanuatu	155.3981	-7.0204	290.5	21	5
nvsz-10a	New Britain–Solomons–Vanuatu	156.4742	-7.2515	305.9	36.88	27.62
nvsz-10b	New Britain–Solomons–Vanuatu	156.2619	-7.5427	305.9	26.9	5
nvsz-11a	New Britain–Solomons–Vanuatu	157.0830	-7.8830	305.4	32.97	29.72
nvsz-11b	New Britain–Solomons–Vanuatu	156.8627	-8.1903	305.4	29.63	5
nvsz-12a	New Britain–Solomons–Vanuatu	157.6537	-8.1483	297.9	37.53	28.57
nvsz-12b	New Britain–Solomons–Vanuatu	157.4850	-8.4630	297.9	28.13	5
nvsz-13a	New Britain–Solomons–Vanuatu	158.5089	-8.5953	302.7	33.62	23.02
nvsz-13b	New Britain–Solomons–Vanuatu	158.3042	-8.9099	302.7	21.12	5
nvsz-14a	New Britain–Solomons–Vanuatu	159.1872	-8.9516	293.3	38.44	34.06
nvsz-14b	New Britain–Solomons–Vanuatu	159.0461	-9.2747	293.3	35.54	5
nvsz-15a	New Britain–Solomons–Vanuatu	159.9736	-9.5993	302.8	46.69	41.38
nvsz-15b	New Britain–Solomons–Vanuatu	159.8044	-9.8584	302.8	46.69	5
nvsz-16a	New Britain–Solomons–Vanuatu	160.7343	-10.0574	301	46.05	41
nvsz-16b	New Britain–Solomons–Vanuatu	160.5712	-10.3246	301	46.05	5
nvsz-17a	New Britain–Solomons–Vanuatu	161.4562	-10.5241	298.4	40.12	37.22
nvsz-17b	New Britain–Solomons–Vanuatu	161.2900	-10.8263	298.4	40.12	5
nvsz-18a	New Britain–Solomons–Vanuatu	162.0467	-10.6823	274.1	40.33	29.03
nvsz-18b	New Britain–Solomons–Vanuatu	162.0219	-11.0238	274.1	28.72	5
nvsz-19a	New Britain–Solomons–Vanuatu	162.7818	-10.5645	261.3	34.25	24.14
nvsz-19b	New Britain–Solomons–Vanuatu	162.8392	-10.9315	261.3	22.51	5
nvsz-20a	New Britain–Solomons–Vanuatu	163.7222	-10.5014	262.9	50.35	26.3

Table E9: (continued)

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
nvsz-20b	New Britain–Solomons–Vanuatu	163.7581	-10.7858	262.9	25.22	5
nvsz-21a	New Britain–Solomons–Vanuatu	164.9445	-10.4183	287.9	40.31	23.3
nvsz-21b	New Britain–Solomons–Vanuatu	164.8374	-10.7442	287.9	21.47	5
nvsz-22a	New Britain–Solomons–Vanuatu	166.0261	-11.1069	317.1	42.39	20.78
nvsz-22b	New Britain–Solomons–Vanuatu	165.7783	-11.3328	317.1	18.4	5
nvsz-23a	New Britain–Solomons–Vanuatu	166.5179	-12.2260	342.4	47.95	22.43
nvsz-23b	New Britain–Solomons–Vanuatu	166.2244	-12.3171	342.4	20.4	5
nvsz-24a	New Britain–Solomons–Vanuatu	166.7236	-13.1065	342.6	47.13	28.52
nvsz-24b	New Britain–Solomons–Vanuatu	166.4241	-13.1979	342.6	28.06	5
nvsz-25a	New Britain–Solomons–Vanuatu	166.8914	-14.0785	350.3	54.1	31.16
nvsz-25b	New Britain–Solomons–Vanuatu	166.6237	-14.1230	350.3	31.55	5
nvsz-26a	New Britain–Solomons–Vanuatu	166.9200	-15.1450	365.6	50.46	29.05
nvsz-26b	New Britain–Solomons–Vanuatu	166.6252	-15.1170	365.6	28.75	5
nvsz-27a	New Britain–Solomons–Vanuatu	167.0053	-15.6308	334.2	44.74	25.46
nvsz-27b	New Britain–Solomons–Vanuatu	166.7068	-15.7695	334.2	24.15	5
nvsz-28a	New Britain–Solomons–Vanuatu	167.4074	-16.3455	327.5	41.53	22.44
nvsz-28b	New Britain–Solomons–Vanuatu	167.1117	-16.5264	327.5	20.42	5
nvsz-29a	New Britain–Solomons–Vanuatu	167.9145	-17.2807	341.2	49.1	24.12
nvsz-29b	New Britain–Solomons–Vanuatu	167.6229	-17.3757	341.2	22.48	5
nvsz-30a	New Britain–Solomons–Vanuatu	168.2220	-18.2353	348.6	44.19	23.99
nvsz-30b	New Britain–Solomons–Vanuatu	167.8895	-18.2991	348.6	22.32	5
nvsz-31a	New Britain–Solomons–Vanuatu	168.5022	-19.0510	345.6	42.2	22.26
nvsz-31b	New Britain–Solomons–Vanuatu	168.1611	-19.1338	345.6	20.2	5
nvsz-32a	New Britain–Solomons–Vanuatu	168.8775	-19.6724	331.1	42.03	21.68
nvsz-32b	New Britain–Solomons–Vanuatu	168.5671	-19.8338	331.1	19.49	5
nvsz-33a	New Britain–Solomons–Vanuatu	169.3422	-20.4892	332.9	40.25	22.4
nvsz-33b	New Britain–Solomons–Vanuatu	169.0161	-20.6453	332.9	20.37	5
nvsz-34a	New Britain–Solomons–Vanuatu	169.8304	-21.2121	329.1	39	22.73
nvsz-34b	New Britain–Solomons–Vanuatu	169.5086	-21.3911	329.1	20.77	5
nvsz-35a	New Britain–Solomons–Vanuatu	170.3119	-21.6945	311.9	39	22.13
nvsz-35b	New Britain–Solomons–Vanuatu	170.0606	-21.9543	311.9	20.03	5
nvsz-36a	New Britain–Solomons–Vanuatu	170.9487	-22.1585	300.4	39.42	23.5
nvsz-36b	New Britain–Solomons–Vanuatu	170.7585	-22.4577	300.4	21.71	5
nvsz-37a	New Britain–Solomons–Vanuatu	171.6335	-22.3087	281.3	30	22.1
nvsz-37b	New Britain–Solomons–Vanuatu	171.5512	-22.6902	281.3	20	5
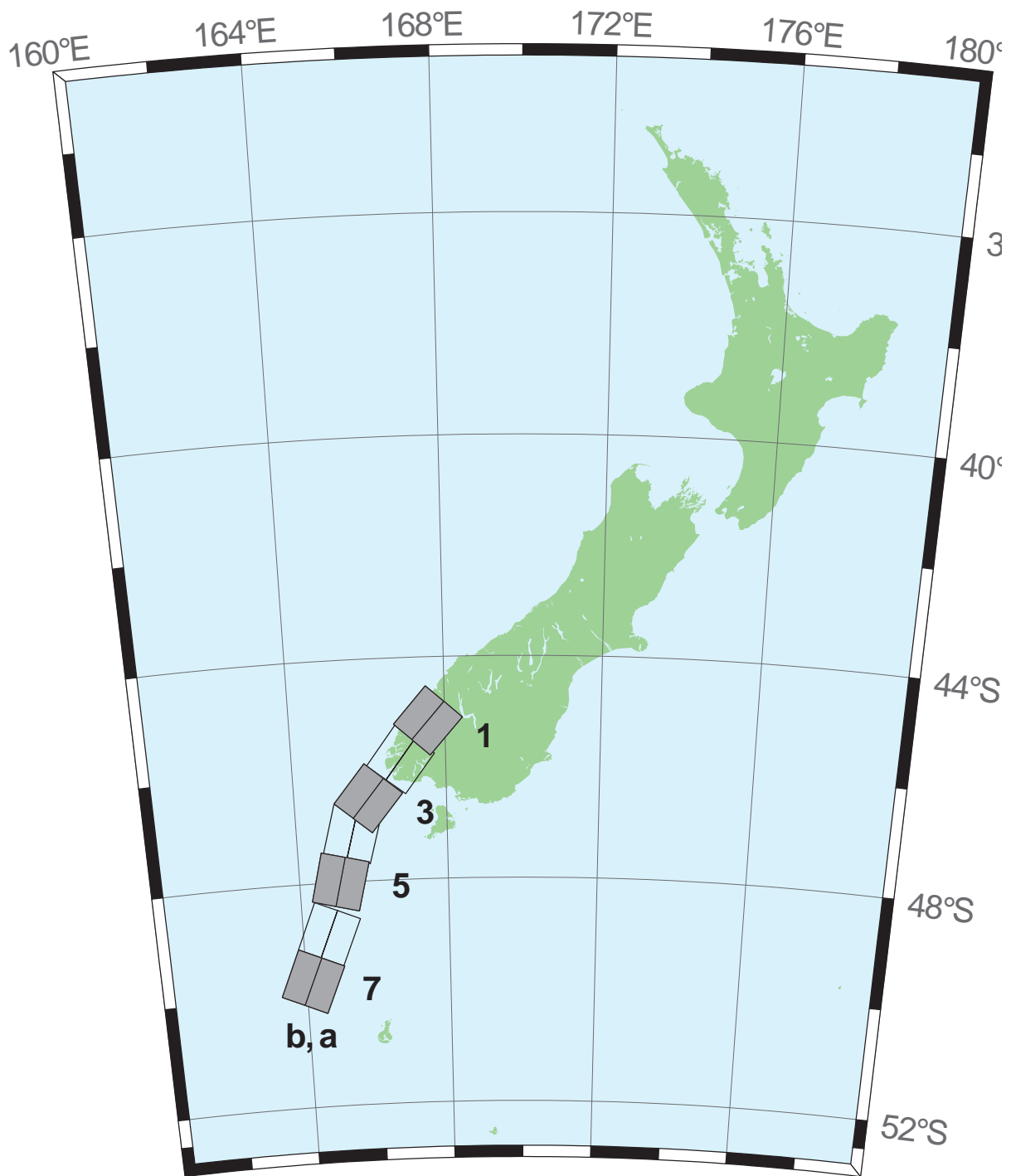
Figure E10: New Zealand–Puysegur Subduction Zone unit sources.

Table E10: Earthquake parameters for New Zealand–Puysegur Subduction Zone unit sources.

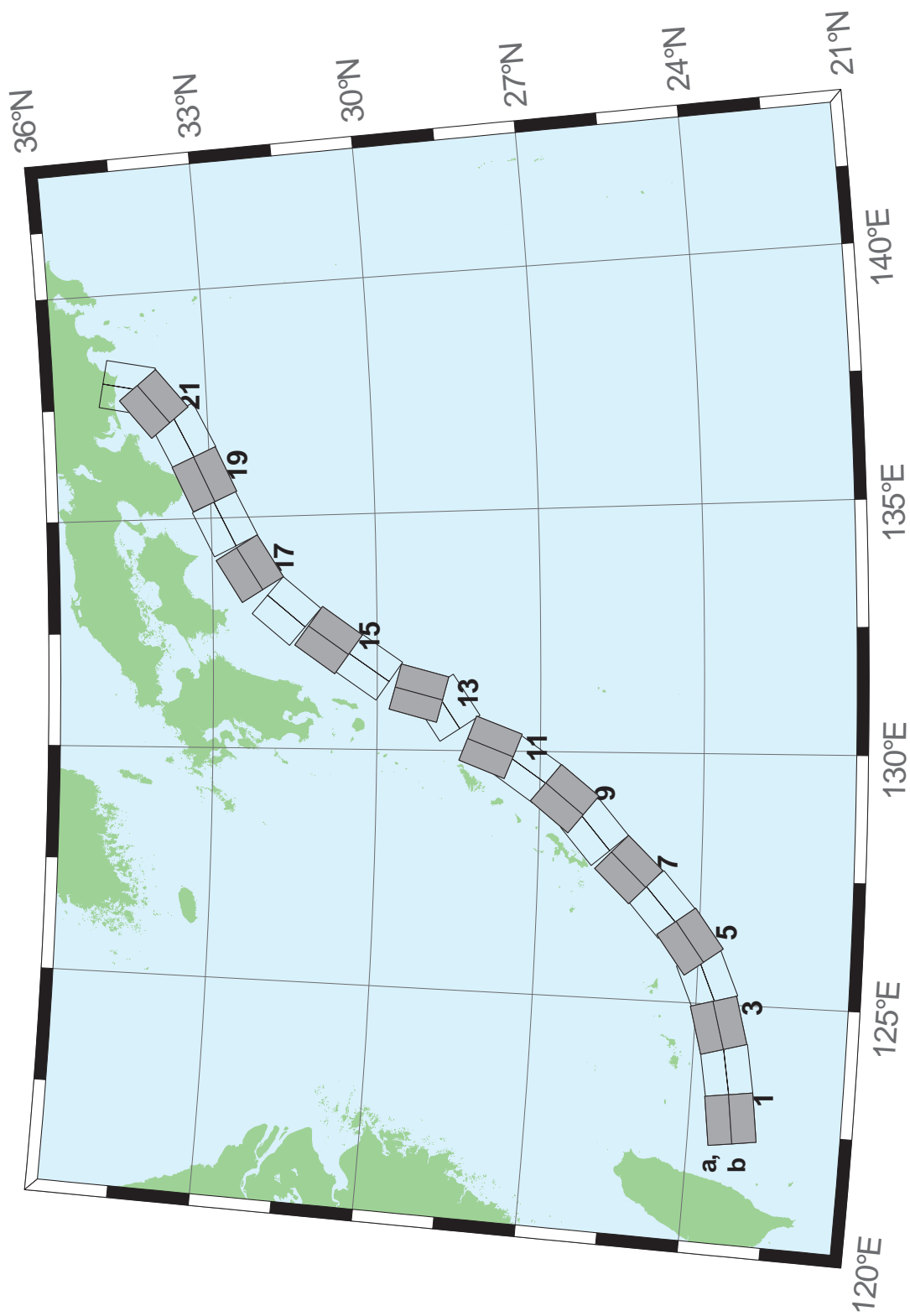| Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
nzsz-1a	New Zealand–Puysegur	168.0294	-45.4368	41.5	15	17.94
nzsz-1b	New Zealand–Puysegur	167.5675	-45.1493	41.5	15	5
nzsz-2a	New Zealand–Puysegur	167.3256	-46.0984	37.14	15	17.94
nzsz-2b	New Zealand–Puysegur	166.8280	-45.8365	37.14	15	5
nzsz-3a	New Zealand–Puysegur	166.4351	-46.7897	39.53	15	17.94
nzsz-3b	New Zealand–Puysegur	165.9476	-46.5136	39.53	15	5
nzsz-4a	New Zealand–Puysegur	166.0968	-47.2583	15.38	15	17.94
nzsz-4b	New Zealand–Puysegur	165.4810	-47.1432	15.38	15	5
nzsz-5a	New Zealand–Puysegur	165.7270	-48.0951	13.94	15	17.94
nzsz-5b	New Zealand–Puysegur	165.0971	-47.9906	13.94	15	5
nzsz-6a	New Zealand–Puysegur	165.3168	-49.0829	22.71	15	17.94
nzsz-6b	New Zealand–Puysegur	164.7067	-48.9154	22.71	15	5
nzsz-7a	New Zealand–Puysegur	164.8017	-49.9193	23.25	15	17.94
nzsz-7b	New Zealand–Puysegur	164.1836	-49.7480	23.25	15	5

Figure E11: Ryukyu–Kyushu–Nankai Subduction Zone unit sources.

Table E11: Earthquake parameters for Ryukyu–Kyushu–Nankai Subduction Zone unit sources.

Segment	Description	Longitude (°E)	Latitude (°N)	Strike (°)	Dip (°)	Depth (km)
rnsz-1a	Ryukyu–Kyushu–Nankai	122.6672	23.6696	262	14	11.88
rnsz-1b	Ryukyu–Kyushu–Nankai	122.7332	23.2380	262	10	3.2
rnsz-2a	Ryukyu–Kyushu–Nankai	123.5939	23.7929	259.9	18.11	12.28
rnsz-2b	Ryukyu–Kyushu–Nankai	123.6751	23.3725	259.9	10	3.6
rnsz-3a	Ryukyu–Kyushu–Nankai	124.4604	23.9777	254.6	19.27	14.65
rnsz-3b	Ryukyu–Kyushu–Nankai	124.5830	23.5689	254.6	12.18	4.1
rnsz-4a	Ryukyu–Kyushu–Nankai	125.2720	24.2102	246.8	18	20.38
rnsz-4b	Ryukyu–Kyushu–Nankai	125.4563	23.8177	246.8	16	6.6
rnsz-5a	Ryukyu–Kyushu–Nankai	125.9465	24.5085	233.6	18	20.21
rnsz-5b	Ryukyu–Kyushu–Nankai	126.2241	24.1645	233.6	16	6.43
rnsz-6a	Ryukyu–Kyushu–Nankai	126.6349	25.0402	228.7	17.16	19.55
rnsz-6b	Ryukyu–Kyushu–Nankai	126.9465	24.7176	228.7	15.16	6.47
rnsz-7a	Ryukyu–Kyushu–Nankai	127.2867	25.6343	224	15.85	17.98
rnsz-7b	Ryukyu–Kyushu–Nankai	127.6303	25.3339	224	13.56	6.26
rnsz-8a	Ryukyu–Kyushu–Nankai	128.0725	26.3146	229.7	14.55	14.31
rnsz-8b	Ryukyu–Kyushu–Nankai	128.3854	25.9831	229.7	9.64	5.94
rnsz-9a	Ryukyu–Kyushu–Nankai	128.6642	26.8177	219.2	15.4	12.62
rnsz-9b	Ryukyu–Kyushu–Nankai	129.0391	26.5438	219.2	8	5.66
rnsz-10a	Ryukyu–Kyushu–Nankai	129.2286	27.4879	215.2	17	12.55
rnsz-10b	Ryukyu–Kyushu–Nankai	129.6233	27.2402	215.2	8.16	5.45
rnsz-11a	Ryukyu–Kyushu–Nankai	129.6169	28.0741	201.3	17	12.91
rnsz-11b	Ryukyu–Kyushu–Nankai	130.0698	27.9181	201.3	8.8	5.26
rnsz-12a	Ryukyu–Kyushu–Nankai	130.6175	29.0900	236.7	16.42	13.05
rnsz-12b	Ryukyu–Kyushu–Nankai	130.8873	28.7299	236.7	9.57	4.74
rnsz-13a	Ryukyu–Kyushu–Nankai	130.7223	29.3465	195.2	20.25	15.89
rnsz-13b	Ryukyu–Kyushu–Nankai	131.1884	29.2362	195.2	12.98	4.66
rnsz-14a	Ryukyu–Kyushu–Nankai	131.3467	30.3899	215.1	22.16	19.73
rnsz-14b	Ryukyu–Kyushu–Nankai	131.7402	30.1507	215.1	17.48	4.71
rnsz-15a	Ryukyu–Kyushu–Nankai	131.9149	31.1450	216	15.11	16.12
rnsz-15b	Ryukyu–Kyushu–Nankai	132.3235	30.8899	216	13.46	4.48
rnsz-16a	Ryukyu–Kyushu–Nankai	132.5628	31.9468	220.9	10.81	10.88
rnsz-16b	Ryukyu–Kyushu–Nankai	132.9546	31.6579	220.9	7.19	4.62
rnsz-17a	Ryukyu–Kyushu–Nankai	133.6125	32.6956	239	10.14	12.01
rnsz-17b	Ryukyu–Kyushu–Nankai	133.8823	32.3168	239	8.41	4.7
rnsz-18a	Ryukyu–Kyushu–Nankai	134.6416	33.1488	244.7	10.99	14.21
rnsz-18b	Ryukyu–Kyushu–Nankai	134.8656	32.7502	244.5	10.97	4.7
rnsz-19a	Ryukyu–Kyushu–Nankai	135.6450	33.5008	246.5	14.49	14.72
rnsz-19b	Ryukyu–Kyushu–Nankai	135.8523	33.1021	246.5	11.87	4.44
rnsz-20a	Ryukyu–Kyushu–Nankai	136.5962	33.8506	244.8	15	14.38
rnsz-20b	Ryukyu–Kyushu–Nankai	136.8179	33.4581	244.8	12	3.98
rnsz-21a	Ryukyu–Kyushu–Nankai	137.2252	34.3094	231.9	15	15.4
rnsz-21b	Ryukyu–Kyushu–Nankai	137.5480	33.9680	231.9	12	5
rnsz-22a	Ryukyu–Kyushu–Nankai	137.4161	34.5249	192.3	15	15.4
rnsz-22b	Ryukyu–Kyushu–Nankai	137.9301	34.4327	192.3	12	5