A Tsunami Forecast Model for Eureka, California

Dylan Righi

Contents

Abstract

In support of the National Oceanic and Atmospheric Administration's tsunami forecast system, we have developed and tested a numerical tsunami model for the city of Eureka, California and the communities on Humboldt Bay. The Eureka tsunami forecast model employs the optimized version of the Method of Splitting Tsunami (MOST) numerical code and has been validated and tested using data from 13 historical tsunamis and a set of 43 synthetically generated mega events (forced by Mw 9.3 earthquakes). A high-resolution reference model, without limitations on computational run-times, has also been developed to provide comparison for the forecast model. Validation results show good agreement between the forecast and reference models, and also with sea level data available from the Eureka tide-gauge. The forecast model is shown to be stable under forcing from both large and small modeled tsunami events and will provide dependable warnings in the event of a tsunami that might threaten the people and resources of Eureka and surrounding communities.

1.0 Background and Objectives

The National Oceanic and Atmospheric Administration (NOAA) Center for Tsunami Research (NCTR) at the NOAA Pacific Marine Environmental Laboratory (PMEL) has developed a tsunami forecasting capability for operational use by NOAA's two Tsunami Warning Centers located in Hawaii and Alaska (Titov *et al.*, 2005). The system is designed to efficiently provide basin-wide warning of approaching tsunami waves accurately and quickly. The system, termed Short-term Inundation Forecast of Tsunamis (SIFT), combines real-time tsunami event data with numerical models to produce estimates of tsunami wave arrival times and amplitudes at a coastal community of interest. The SIFT system integrates several key components: deep-ocean observations of tsunamis in real time, a basin-wide pre-computed propagation database of water level and flow velocities based on potential seismic unit sources, an inversion algorithm to refine the tsunami source based on deep-ocean observations during an event, and high-resolution tsunami forecast models.

Eureka is in Humboldt County in Northern California, 270 miles north of San Francisco. The city is located on Humboldt Bay, a large deep-water bay home to both large industrial docks and numerous marinas serving fishing and recreational boats. A map of the area is shown in Figure 1. The population of Eureka is 26,157 (2008, California Statistical Abstract). Neighboring Arcata, located on the northern edge of Humboldt Bay, has a population of 17,417. The estimated total population living in communities bordering Humboldt Bay is 80,000.

The goal of this work is to provide a high quality forecast model that will enable emergency planners at the local, state and national levels to protect the people and resources of Eureka and surrounding communities on Humboldt Bay from the dangers of tsunami events.

2.0 Forecast Methodology

A high-resolution inundation model was used as the basis for development of a tsunami forecast model to operationally provide an estimate of wave arrival time, wave height, and inundation in Eureka and surrounding communities following tsunami generation. All tsunami forecast models are run in real time while a tsunami is propagating across the open ocean. The Eureka model was designed and tested to perform under stringent time constraints given that time is generally the single limiting factor in saving lives and property. The goal of this work is to maximize the length of time that residents of the area have to react to a tsunami threat by providing accurate information quickly to emergency managers and other officials responsible for the community and infrastructure.

The general tsunami forecast model, based on the Method of Splitting Tsunami (MOST), is used in the tsunami inundation and forecasting system to provide real-time tsunami forecasts at selected coastal communities. The model run-times are on the order of a few minutes, and employ high-resolution grids constructed by the National Geophysical Data Center. The Method of Splitting Tsunami (MOST) is a suite of numerical simulation codes capable of simulating three processes of tsunami evolution: earthquake, transoceanic propagation, and inundation of dry land. The MOST model has been extensively tested against a number of laboratory experiments and benchmarks (Synolakis *et al.*, 2008) and was successfully used for simulations of many historical tsunami events. The main objective of a forecast model is to provide an accurate, yet rapid, estimate of wave arrival time, wave height, and inundation in the minutes following a tsunami event. Titov and González (1997) describe the technical aspects of forecast model development, stability, testing, and robustness, and Tang *et al*. 2009 provide detailed forecast methodology.

A basin-wide database of pre-computed water elevations and flow velocities for unit sources covering worldwide subduction zones has been generated to expedite forecasts (Gica *et al.*, 2008). As the tsunami wave propagates across the ocean and successively reaches tsunameter observation sites, recorded sea level is ingested into the tsunami forecast application in near real-time and incorporated into an inversion algorithm to produce an improved estimate of the tsunami source. A linear combination of the pre-computed database is then performed based on this tsunami source, now reflecting the transfer of energy to the fluid body, to produce synthetic boundary conditions of water elevation and flow velocities to initiate the forecast model computation.

Accurate forecasting of the tsunami impact on a coastal community largely relies on the accuracies of bathymetry and topography and the numerical computation. The high spatial and temporal grid resolution necessary for modeling accuracy poses a challenge in the run-time requirement for real-time forecasts. Each forecast model consists of three nested grids with increasing spatial resolution in the finest grid, and temporal resolution for simulation of wave inundation onto dry land. The forecast model utilizes the most recent bathymetry and topography available to reproduce the correct wave dynamics during the inundation computation. Forecast models, including the Eureka model, are constructed for at-risk populous coastal communities in the Pacific and Atlantic Oceans. Previous and present development of forecast models in the Pacific (Titov *et al.*, 2005; Titov, 2009; Tang *et al.*, 2008; Wei *et al.*, 2008) have validated the accuracy and efficiency of each forecast model currently implemented in the real-time tsunami forecast system. Models are tested when the opportunity arises and are used for scientific research. Tang *et al*. 2009 provide forecast methodology details.

3.0 Model Development

The general methodology for modeling at-risk coastal communities is to develop a set of three nested grids, referred to as A, B, and C-grids, each of which becomes successively finer in resolution as they telescope into the population and economic center of the community of interest. The offshore area is covered by the largest and lowest resolution A-grid while the near-shore details are resolved within the finest scale C-grid to the point that tide gauge observations recorded during historical tsunamis are resolved within expected accuracy limits. The procedure is to begin development with large spatial extent merged bathymetric topographic grids at high resolution, and then optimize these grids by sub-sampling to coarsen the resolution and shrink the overall grid dimensions to achieve a 4 to 10 hr simulation of modeled tsunami waves within the required time period of 10 min of wall-clock time. The basis for these grids is a high-resolution digital elevation model constructed by the National Geophysical Data Center and NCTR using all available bathymetric, topographic, and shoreline data to reproduce the wave dynamics during the inundation computation for an at-risk community. For each community, data are compiled from a variety of sources to produce a digital elevation model referenced to Mean High Water in the vertical and to the World Geodetic System 1984 in the horizontal (http://ngdc.noaa.gov/mgg/inundation/tsunami/inundation.html). From these digital elevation models, a set of three high-resolution, "reference" elevation grids are constructed for development of a high-resolution reference model from which an 'optimized' model is constructed to run in an operationally specified period of time. The operationally developed model is referred to as the optimized tsunami forecast model or forecast model for brevity.

Development of an optimized tsunami forecast model for Eureka began with the spatial extent merged bathymetric/topographic grid provided by the National Geophysical Data Center (Carignan et al. 2010) shown in Figure 3. The author considers this to be an adequate representation of the local topography/bathymetry. As new digital elevation models become available, forecast models will be updated and report updates will be posted at http://nctr.pmel.noaa.gov/forecast_reports/. Grid dimension extension and additional information were updated as needed and appropriate. A significant portion of the modeled tsunami waves, typically 4 to 10 hr of modeled tsunami time, pass through the model domain without appreciable signal degradation. Table 1 provides specific details of both reference and tsunami forecast model grids, including extents and complete input parameter information for the model runs is provided in Appendix A.

3.1 Forecast Area

Eureka and the surrounding communities on Humboldt Bay are shown in the map presented in Figure 1. Humboldt Bay is about 13 miles long and consists of Arcata Bay to the north of Eureka, the South Bay, and the central Bay area. The bay entrance is south of Eureka and is protected by jetties, making the entrance easier for boats. Eureka is situated at the center of Humboldt Bay, on the hill overlooking the thinnest part of the bay's channels. Arcata is to the north, and other smaller unincorporated communities, such as Fairhaven, Manila, Indianola and King Salmon surround the bay. A channel from the bay entrance to north of Eureka is dredged to a depth of 35-40 feet to accommodate larger vessels docking at a number of shipping facilities on the central bay in and around Eureka. The aerial image in Figure 2 shows the bay entrance and looks north to Eureka and Arcata Bay beyond. There are three islands in the Bay, all just north of Eureka: Indian Island is the largest, Woodley Island is the second and the site for a marina, and Daby Island the smallest.

There are a number of sites in the area to consider when assessing tsunami threats. There are two small air-fields in the region: the Eureka Municipal Airport is located south of Fairhaven on the spit across from Eureka; and Murray Field is just to the northeast of Eureka in the Fay Slough area. A natural gas and electric power plant is sited opposite the bay's entrance and north of King Salmon. The main transportation artery in the region, Highway 101, borders Humboldt Bay from north to south, connecting Eureka and Arcata and the rest of California.

The Humboldt Bay National Wildlife Refuge is an important natural and tourist component of the Bay. The Refuge is mainly in the shallow and marshy South Bay, but also rings Arcata Bay. The mudflats and eelgrass beds here provide habitat for local and migratory birds, with estimates as high as 100,000 birds being present. The Bay is also important for spawning and feeding fish.

3.2 Historical Events and Data

NOAA's National Ocean Service operates a tide gauge sensor at North Spit in Humboldt Bay. The gauge is located on the dock at the Humboldt Bay Coast Guard Station, at 40.76633 N and 124.21725 W. The dock is near the bay entrance on the inshore side of spit, across the bay and south of Eureka. The tide gauge was established in August of 1977. The mean tidal range at the gauge location is 1.5 meters. An image of the tide gauge shack on the CG pier is shown in Figure 4, and the location of the tide gauge is shown in the maps in Figures 5 and 6, denoted by the red star. The water depth in the forecast model grid at the tide gauge location is 5.7 meters. There are historical accounts of tsunami run-up heights available from the National Geophysical and Data Center tsunami run-up database (http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=167&d=166), and we will use the data available for comparison with the model predictions.

Before comparing the tide gauge data to the model predicted wave heights it must be de-tided and smoothed. First, a running mean filter with a width of 1 hour is constructed and used to eliminate outlier points with greater than 6 standard deviations difference between the smoothed and original time series. Then the tidal and instrument noise are eliminated using a band-pass digital Fourier filter with cutoffs at the high and low frequency ends of 8 minutes and 3 hours. The resulting observed sea surface height changes due to historical tsunamis are used to compare and validate our modeled time-series predictions of those events.

3.3 Model Setup

The grids developed for the reference and forecast models were derived from the Pacific basin-wide 30 arc-second grid developed at NCTR and the 1/3 arc-second DEM developed by NGDC (Carignan et al. 2010)). The Eureka DEM is shown in Figure 3.

The grid extents and parameters of the forecast and reference model grids are detailed in Table 1. The forecast and reference grid sets were set up using matching boundaries. The A-grid covers the United States coast from central California in the south to central Oregon in the north, and out to the deep ocean to the west. The B-grid focuses on the region surrounding Humboldt Bay. It was designed to cover the bathymetry and topography of Point Mendocino to the south of Humboldt and Patrick's Point to the north. The highest resolution C-grid zooms in on Humboldt Bay itself, with its goal to describe the waves and water levels of the Bay and along the coastal spits. The developed reference and forecast model grids are shown in Figures 5 and 6, respectively.

4.0 Results and Discussion

The developed models are tested for accuracy and stability using a combination of historical and synthetic tsunami events. The goal is to compare the fast-running forecast model to the high-resolution reference model and check that we have not lost important details or dynamics in the sub-sampling process of developing the forecast model. When available, the results of both models are compared to data from the historical event under consideration. Also, to check that the forecast model is able to supply quality wave height estimates under strong forcing, a set of synthetic mega-tsunami events is used to test model stability. These events are 'synthetic' in the sense that they do not represent tsunamis that have happened, but can be viewed as possible worse case scenarios.

4.1 Model Validation

We use thirteen historical tsunamis to validate and test the Eureka forecast and reference models. The locations, magnitudes, and unit source combinations used to describe these events are described in Table 2. The events selected for testing range from smaller to larger originating earthquakes (7.7 to 9.2 M_W), and are from varied locations around the Pacific Rim. The majority of the events are more recent since we have higher quality descriptions of the earthquakes and can describe the tsunamigenic response more accurately. The locations and magnitudes of the thirteen historical events are plotted in Figure 7.

Results and comparisons from the forecast and reference models for the historical events are shown in Figure 8 - 20. In each figure the top two axes show the maximum amplitude for the forecast and reference models, respectively, and the lower axis shows the time series of wave amplitude from both models at the location of the Eureka tide gauge. Data from the tide gauge is also plotted on this axis when available for the event. Note that the color scale and axes limits change from figure to figure.

The first tsunami event used for validation is the 1946 Unimak 8.5 M_W earthquake. The forecast and reference model results are shown in Figure 8. Both models show similar wave heights offshore, with the main difference being the location of the wave cusps. Heights inside the harbor are also well matched except for the bay opposite the jetty entrance. The time-series of wave amplitude at the tide gauge shows that the forecast model predictions match the reference model well at that location.

The model responses to the 1960 Chilean tsunami are shown in Figure 9. Wave heights of almost a meter are predicted on the ocean side of the Humboldt Bay spits, while in the Bay the maximum height is less – about 0.75 meters. Both the forecast and reference models predict inundation in the South Bay and along the slough north of Eureka. The tide gauge time series shows that the forecast model is doing a good job of resolving the tsunami response.

The 1964 Alaskan earthquake, with a magnitude of 9.3 M_W, caused damage and deaths in Alaska, Oregon and California. In Figure 10 the predicted wave heights are shown and are seen to match well (note that the color scale has been allowed to wash out the ocean maxima so that the details inside the Bay are apparent). Inside the Bay, maxima are 2.6 and 2.7 meters for the forecast and reference models, respectively. Observations from the event of waterlines on docks and structures estimated maximum run-up of 2.1 meters (http://www.ngdc.noaa.gov/nndc/struts/form?t=101650&s=167&d=166). The models both predict inundation at many locations around the bay, including in Eureka itself. The time series at the tide gauge shows the models predicting similar waves, with magnitudes of 1.3 meters.

The next four events used for validation are all moderate events that did not have much impact on Eureka. The 1994 Kuril earthquake is predicted to cause offshore waves on the order of 20 centimeters (Figure 11), while inside the bay the highest values are approximately 14 centimeters. Both the maximum height maps and the tide-gauge time series match well. For both the 1996 Andreanof (Figure 12) and 2003 Rat Island (Figure 13) earthquakes we have real tide-gauge data but the resulting tsunami at Eureka is small enough that the wave height signal is not very easily separated from the noise level. For Andreanof, the predicted wave heights are less than 10 cms at all points in the C-grid, while for the Rat Island event there are no values greater than 7 cms. Figure 14 shows the predictions for the 2006 Tonga event and the forecast and reference models agree well, showing maxima of approximately 20 cms south of the jetty on the ocean side and no significant waves inside the harbor.

The Kuril events of 2006 and 2007 are shown in Figure 15 and 16, respectively. The 2006 tsunami led to a larger wave-height signal at Eureka, and this is reflected in the plots. The tide gauge data for the 2006 event is plotted in the lower panel of Figure 15 and the models predict values that are comparable in magnitude, if not exact wave timing. For both events the forecast model does well in reproducing the reference model wave-height prediction.

The Salomon tsunami of 2007 (Figure 17) is interesting because, although it results in a small tsunami with maximum wave heights of less than 10 cms, the wave heights inside the harbor are comparable to the ocean values. Both the forecast and reference models show ~8 cm heights in the Bay north of the entrance and east of Eureka itself.

The Chilean earthquake of 2010, which caused major destruction and over 500 deaths in Chile is shown in Figure 19. The forecast and reference models predict similar wave-height maxima, with waves of over 30 cms on the ocean side of the spits. Inside the harbor, the reference model shows higher wave-heights opposite the channel entrance. The tide-gauge at Eureka measured wave peaks between 10 and 20 centimeters. The forecast and reference models reproduce the time-series at the tide-gauge very well – predicting quality estimates of both amplitude and phase. It should be noted though, that the modeled time series are delayed by 11 minutes to give a better correlation. This temporal offset for this Chile 2010 event has been observed in testing at other sites and the cause is under investigation. Lastly, note that there is no significant inundation for this strong event.

The last event presented here for model validation is the 2011 Tohoku tsunami. The forecast and reference model maximum wave height maps show in Figure 20 show very good agreement inside Humboldt Bay (the color scale has been pushed to highlight the variation inside the bay). Minimal inundation is seen in South Bay and the northeast corner of Arcata, which are both low marshy areas. The time series plots in the low panel shows high correlation between the model predictions and the tide gauge data. The highest wave is seen to be the second one, arriving almost an hour after the first and peaking near 0.9 meters. For this event we have once again delayed the model predictions, here by 12 minutes, to provide a better timing match.

4.2 Model stability testing using synthetic scenarios

To further test the stability and robustness of the forecast model, we use a set of 21 synthetic tsunamis. These events are 'synthetic' in the sense that they do not represent actual historical earthquakes, but allow us the flexibility to stress-test our model using large forcing inputs from many different directions. Of these, 19 are Mw 9.3 events that each use a set of 20 unit sources, corresponding to a rupture area of 1000 km by 100 km, and are located all around the Pacific Basin and in each subduction zone. For comparison, the 2004 Indian Ocean tsunami that resulted in hundreds of thousands of deaths in Indonesia, and was detectable globally was the result of a Mw 9.1 earthquake. We also run tests using a medium Mw 7.5 and a micro-event, to ensure that the model triggers correctly for low energy events. Table 3 describes the synthetic events used and their unit source combinations and Figure 21 shows the locations of these events and their positions relative to Eureka. The resulting maximum wave amplitude maps and time series of wave amplitudes at the Eureka tide gauge location as predicted from the forecast model are shown in Figures 22 - 42. Once again, note that the color table mapping and plot limits vary from figure to figure.

The events originating from the Kamchatka-Yap-Mariana-Izu-Bonin (KISZ) sources (Figures 22 – 25) are predicted to force waves ranging from 1.2 to 1.9 meters in height at the Eureka tide gauge location. The largest of these originates from the KISZ32-41 (Figure 24) source set and is seen to cause flooding on the North Spit, on the northern edges of Arcata Bay, in South Bay and in the low farmland opposite the bay mouth. Inundation is also seen in the other KISZ events presented, but to lesser extents.

The Aleutian-Alaska-Cascadia subduction zone (ACSZ) events are shown in Figures 26 – 30. The largest response of all the synthetic events presented, as would be expected, is from the near-field ACSZ56-65 event (Figure 36) whose source is on the Juan de Fuca fault and is the closet event used for testing. The model predicts 10 meter waves on the beach and extensive inundation. Inundation is predicted to overwash both spits, and flood all the lower marsh and farmland areas, and more significantly, soe of the inhabatided regions or Eureka and Arcata. At the tide gauge inside the bay the waves peak near 5 meters. The other ACSZ events lead to 1 – 1.5 meter waves at the tide gauge and moderate flooding.

The Central and South America (CSZZ) events are seen in Figures 31 - 34, and all force waves of less than a meter, with minimal inundation observed. The CSSZ01-10 event (Figure 31) shows an interesting effect: the initial waves arrive 5 hours after the event and are less than 0.2 meters. But waves three times as large arrive from 16 to 24 hours after the event, suggesting the larger wave energy arriving at Eureka does not travel directly there, but is reflected from the south Pacific.

The remaining source zones events, originating in the southern and southwest Pacific Ocean, are predicted to cause minimal to moderate waves at Eureka. The strongest of these is the North New Guinea event (NGSZ03-12) shown in Figure 38, where 3 meter wave heights are seen at the coast and a maximum wave of almost 1.6 meters at the tide gauge location. Moderate inundation is predicted from this event in most of the lower, marshy areas.

Both the medium and micro synthetic events (Figures 41 and 42) show minimal and negligible response at Eureka. This result is still important in that it shows that the forecast model will correctly trigger and predict events with very low energy. Finally and most importantly, note that for all the synthetic events tested, the forecast model developed here for Eureka is stable under extreme forcing.

5.0 Summary and Conclusions

We have developed a set of optimized and reference tsunami forecast models for Eureka and Humboldt Bay. The models have been validated using historical tsunamis events and stress-tested using synthetic mega-tsunami events. For historical events where tide gauge data is available, the model predictions compared favorably at the tide gauge location. The grid developed for the forecast model has resolutions in longitude and latitude of 2.0 and 1.6 arc-seconds – corresponding to a grid spacing of ~47 meters. Four hours of model time can be run in under 10 minutes, providing fast wave height estimates. From the synthetic model testing it is seen that the tsunami event most threatening to the region would be a near-field earthquake on the Jan de Fuca fault, possibly leading to maximum waves of 10 meters, 5-6 meters on the bay and major inundation. Far-field events from the Kamchatka-Yap-Mariana-Izu-Bonin source zone and, to a lesser extent, the Southern Pacific zones can also lead to large waves and inundation at Eureka.

We are confident that the models developed here give quality predictions of wave height and water velocity in response to tsunami forcing. These models are part of NOAA's tsunami forecast and warning system and will be used to predict, in real-time, the potential threat of tsunami waves for the people and resources of the communities on Humboldt Bay.

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Tables

		Reference Model				Forecast Model			
Grid	Region	Coverage Lat. [ºN] Lon. [ºE]	Cell Size ["]	nx x ny	Time Step [sec]	Coverage Lat. [º N] Lon. [ºE]	Cell Size ["]	nx x ny	Time Step [sec]
A	US West Coast	38.5 – 44.0 233.2 – 236.8	36 x 36	361 x 551	2.7	38.5 – 44.0 233.2 – 236.8	144 x 72	236 x 251	8.0
B	Northern California	40.3 – 41.3 235.3 – 235.95	6 x 6	391 x 601	0.9	40.4 – 41.3 235.4 – 235.93	24 x 18	331 x 153	3.2
C	Humboldt Bay	40.67– 40.87 235.71 – 235.92	0.5 x 0.5	1513 x 1441	0.3	40.67– 40.87 235.71 – 235.92	2.0 x 1.6	367 x 178	1.6
Minimum offshore depth [m]			5				5		
Water depth for dry land [m]			0.1				0.1		
Friction coefficient [n^2]			0.0009				0.0009		
CPU time for 4-hr simulation			11.6 hr				9.8 min		

Computations were performed on a single Intel Xeon processor at 3.6 GHz, Dell PowerEdge 1850.

Table 1 MOST model setup of the reference and forecast models for Eureka, California.

Earthquake / Seismic				Model		
Event	USGS Date Time (UTC) Epicenter	CMT Date Time (UTC) Centroid	Magnitude Mw	Tsunami Magnitude [1]	Subduction Zone	Tsunami Source
1946 Unimak	01 Apr 12:28:56 52.75ºN 163.50ºW	01 Apr 12:28:56 53.32ºN 163.19ºW	[2]8.5	8.5	Aleutian-Alaska-Cascadia (ACSZ)	7.5 × b23 + 19.7 × b24 + 3.7 × b25
1960 Chile	22 May 19:11:14 [3]38.29ºS 73.05ºW	04 Nov 16:58:26.0 52.75ºN 159.50ºE	[4]9.5		Central-South America (CSSZ)	Kanamori and Ciper (1974)
1964 Alaska	28 Mar 03:36:00 [3]61.02ºN 147.65ºW	28 Mar 03:36:14 61.10ºN 147.50ºW	[3]9.2	9.0	Aleutian-Alaska-Cascadia (ACSZ)	a34 × 15.4 + a35 × 19.4 + z34 × 48.3 + b34 × 18.3 + b35 × 15.1
1994 East Kuril	04 Oct 13:22:58 43.73ºN 147.321ºE	04 Oct 13:23:28.5 43.60ºN 147.63ºE	[5]8.3	8.1	Kamchatka-Kuril-Japan-Izu-Mariana-Yap (KISZ)	9.0 × a20
1996 Andreanof	10 Jun 04:03:35 51.56ºN 175.39ºW	10 Jun 04:04:03.4 51.10ºN 177.410ºW	[5]7.9	7.8	Aleutian-Alaska-Cascadia (ACSZ)	2.40 × a15 + 0.80 × b16
2003 Rat Island	17 Nov 06:43:07 51.13ºN 178.74ºE	17 Nov 06:43:31.0 51.14ºN 177.86ºE	[5]7.7	7.8	Aleutian-Alaska-Cascadia (ACSZ)	[6]2.81 × b11
2006 Tonga	03 May 15:26:39 20.13ºS 174.161ºW	03 May 15:27:03.7 20.39ºS 173.47ºW	[5]8.0	8.0	New Zealand-Kermadec-Tonga (NTSZ)	6.6 × b29
2006 Kuril	15 Nov 11:14:16 46.607ºN 153.230ºE	15 Nov 11:15:08 46.71ºN 154.33ºE	[5]8.3	8.1	Kamchatka-Kuril-Japan-Izu-Mariana-Yap (KISZ)	[6]4 × a12 + 0.5 × b12 + 2 × a13 + 1.5 × b13
2007 Kuril	13 Jan 04:23:20 46.272ºN 154.455ºE	13 Jan 04:23:48.1 46.17ºN 154.80ºE	[5]8.1	7.9	Kamchatka-Kuril-Japan-Izu-Mariana-Yap (KISZ)	-3.64 × b13
2007 Solomon	01 Apr 20:39:56 8.481ºS 156.978ºE	01 Apr 20:40:38.9 7.76ºS 156.34ºE	[3]8.1	8.2	New Britain-Solomons-Vanuatu (NVSZ)	12.0 × b10
2009 Samoa	29 Sep 17:48:10 15.509ºS 172.034ºW	29 Sep 17:48:26.8 15.13ºS 171.97ºW	[5]8.1	8.1	New Zealand-Kermadec-Tonga (NTSZ)	[6]3.96 × a34 + 3.96 × b34
2010 Chile	27 Feb 06:34:14 35.909ºS 72.733ºW	27 Feb 06:35:15.4 35.95ºS 73.15ºW	[5]8.8	8.8	Central-South America (CSSZ)	[6]a88 × 17.24 + a90 × 8.82 + b88 × 11.86 + b89 × 18.39 + b90 × 16.75 + z88 × 20.78 + z90 × 7.06

[1] Preliminary source – derived from source and deep-ocean observations
[2] López and Okal (2006)
[3] United States Geological Survey (USGS)
[4] Kanamori and Ciper (1974)
[5] Centroid Moment Tensor
[6] Tsunami source was obtained in real time and applied to the forecast

Sce No.	Scenario Name	Source Zone	Tsunami Source	α (m)
Mega-tsunami scenario				
1	KISZ 1-10	Kamchatka-Yap-Mariana-Izu-Bonin	A1-A10, B1-B10	25
2	KISZ 22-31	Kamchatka-Yap-Mariana-Izu-Bonin	A22-A31, B22-B31	25
3	KISZ 32-41	Kamchatka-Yap-Mariana-Izu-Bonin	A32-A41, B32-B41	25
4	KISZ 56-65	Kamchatka-Yap-Mariana-Izu-Bonin	A56-65, B56-65	25
5	ACSZ 6-15	Aleutian-Alaska-Cascadia	A6-A15, B6-B15	25
6	ACSZ 16-25	Aleutian-Alaska-Cascadia	A16-A25, B16-B25	25
7	ACSZ 22-31	Aleutian-Alaska-Cascadia	A22-A31, B22-B31	25
8	ACSZ 50-59	Aleutian-Alaska-Cascadia	A50-A59, B50-B59	25
9	ACSZ 56-65	Aleutian-Alaska-Cascadia	A56-A65, B56-B65	25
10	CSSZ 1-10	Central and South America	A1-A10, B1-B10	25
11	CSSZ 37-46	Central and South America	A37-A46, B37-B46	25
12	CSSZ 89-98	Central and South America	A89-A98, B89-B98	25
13	CSSZ 102 – 111	Central and South America	A102-A111, B102-B111	25
14	NTSZ 30-39	New Zealand-Kermadec-Tonga	A30-A39, B30-B39	25
15	NVSZ 28-37	New Britain-Solomons-Vanuatu	A28-A37, B28-B37	25
16	MOSZ 1-10	ManusOCB	A1-A10, B1-B10	25
17	NGSZ 3-12	North New Guinea	A3-A12, B3-B12	25
18	EPSZ 6-15	East Philippines	A6-A15, B6-B15	25
19	RNSZ 12-21	Ryukus-Kyushu-Nankai	A12-A21, B12-B21	25
Mw 7.5 Tsunami scenario				
20	NTSZ B36	New Zealand-Kermadec-Tonga	B36	1

Micro-tsunami scenario

21	ACSZ B6	Aleutian-Alaska-Cascadia	B6	0.05

Table 3 Unit source combinations used to generate synthetic mega-tsunami scenarios for robustness and stability testing of the Eureka forecast model.

Figures

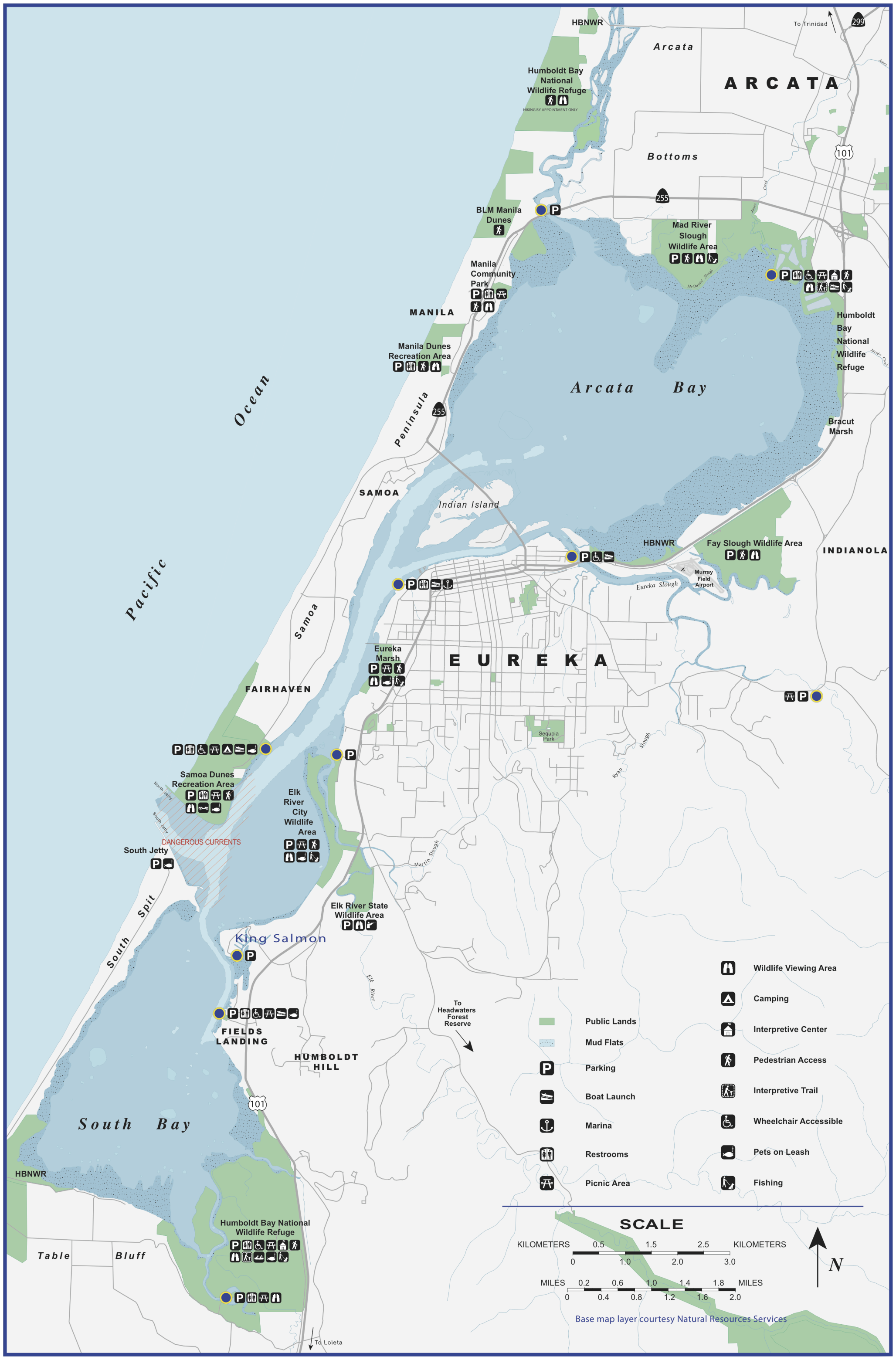


Figure 1 Map of the Eureka area. *(Courtesy of the North Coast Sea Kayakers Assoc.)*

Figure 2 An aerial photo of Eureka and Humboldt Bay. Arcata Bay is in the upper left corner and the north part of South Bay is to the right. Eureka is in the upper left quadrant of the photo. The smaller community of King Salmon is in the center-right, opposite of the bay entrance.

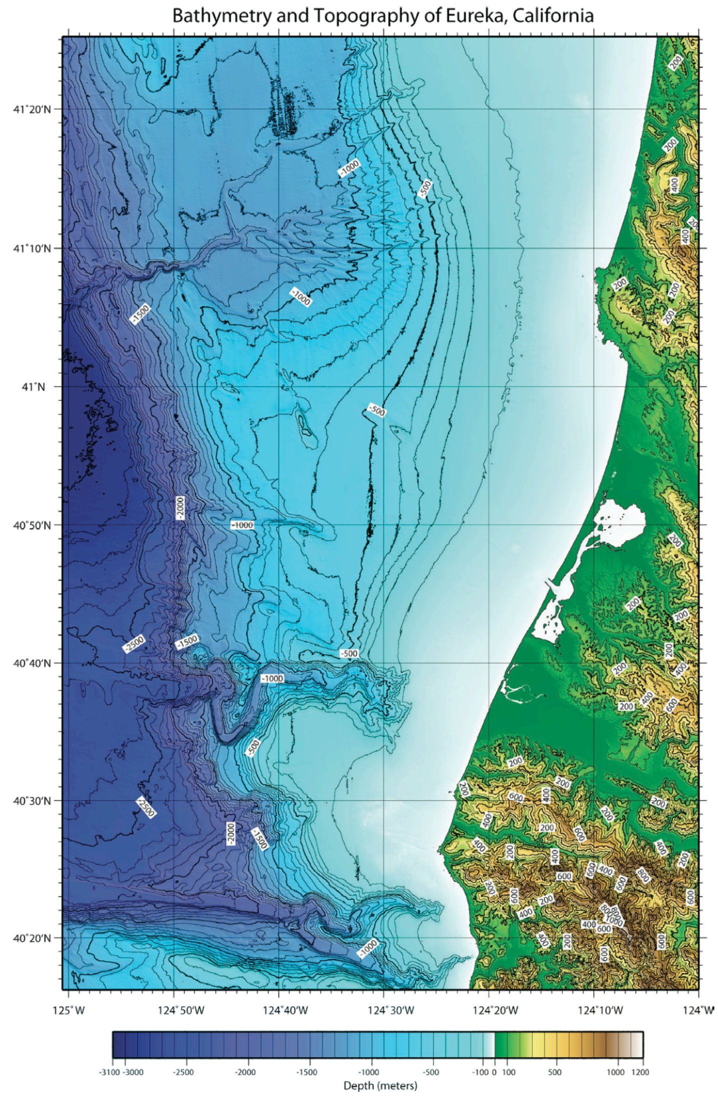


Figure 3 Shaded-relief image of the Eureka DEM. Bathymetric and topographic contour intervals are 100 meters. (Courtesy of NGDC)

Figure 4 Image of the Eureka tide gauge shack, on the pier at the Humboldt Bay Coast Guard Station.

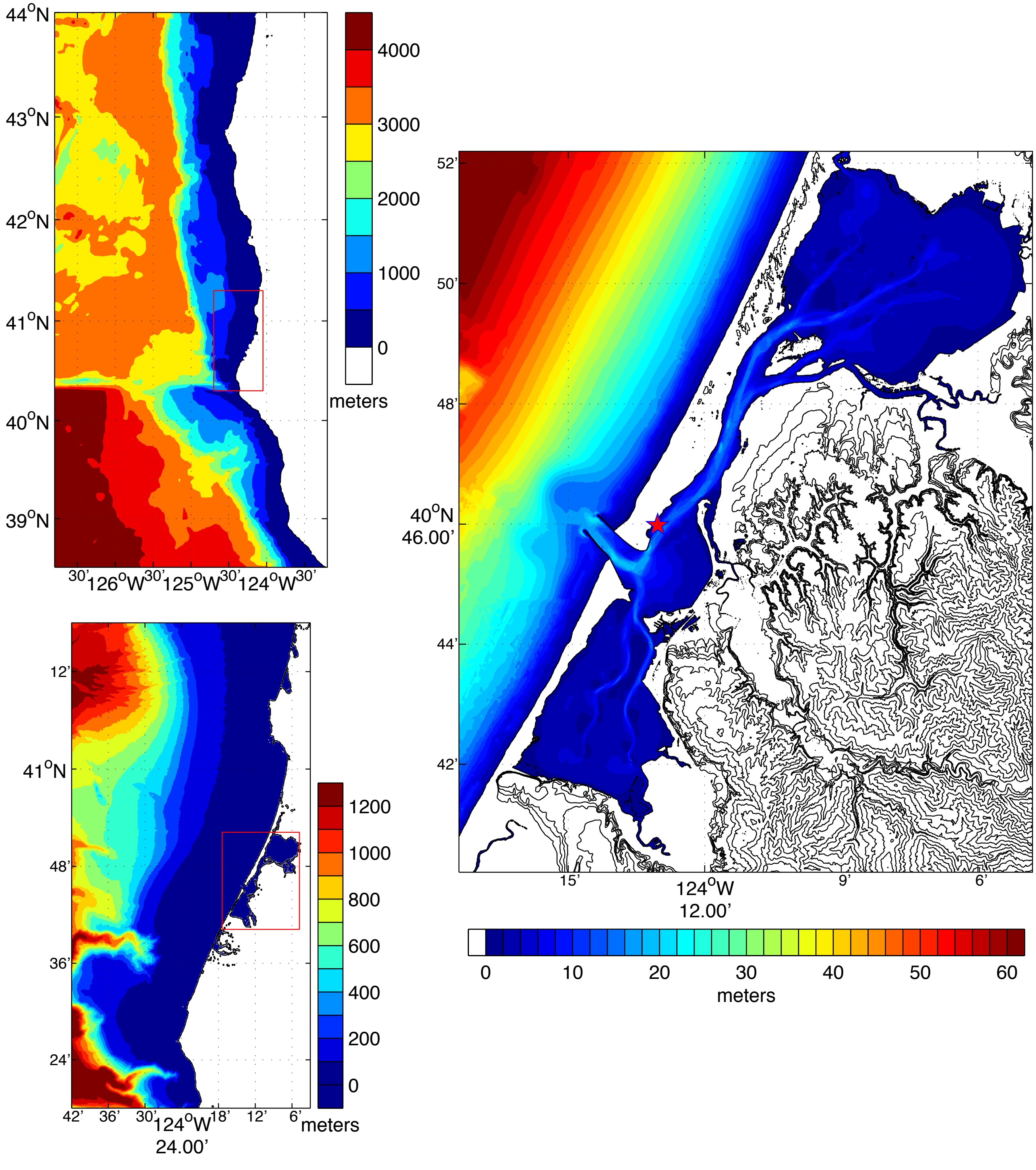


Figure 5 Bathymetry (meters) for the reference inundation model grids. The A grid is shown in the top left panel, the B grid in the bottom left panel, and the C grid in the right panel. The topography of the C grid is shown using contours with 10 meter intervals from 0 to 40 and then 40 meters intervals for higher values. The red boxes in the A and B plots show the position of the nested B and C grids, respectively. The red star shows the location of the Eureka tide gauge installation.

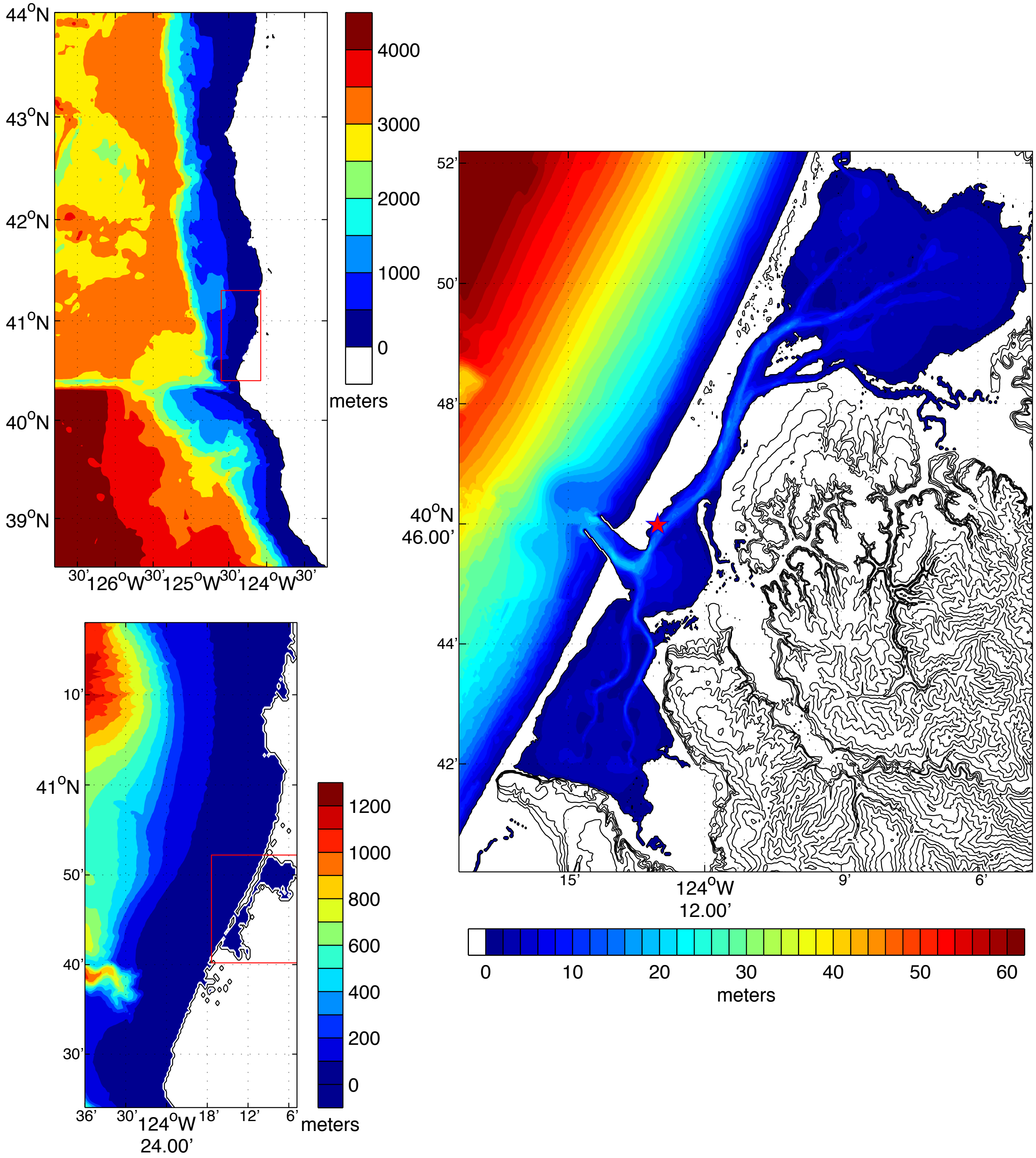


Figure 6 Bathymetry (meters) for the forecast inundation model grids. The A grid is shown in the top left panel, the B grid in the bottom left panel, and the C grid in the right panel. The topography of the C grid is shown using contours with 10 meter intervals from 0 to 40 and then 40 meters intervals for higher values. The red boxes in the A and B plots show the position of the nested B and C grids, respectively. The red star shows the location of the Eureka tide gauge installation.

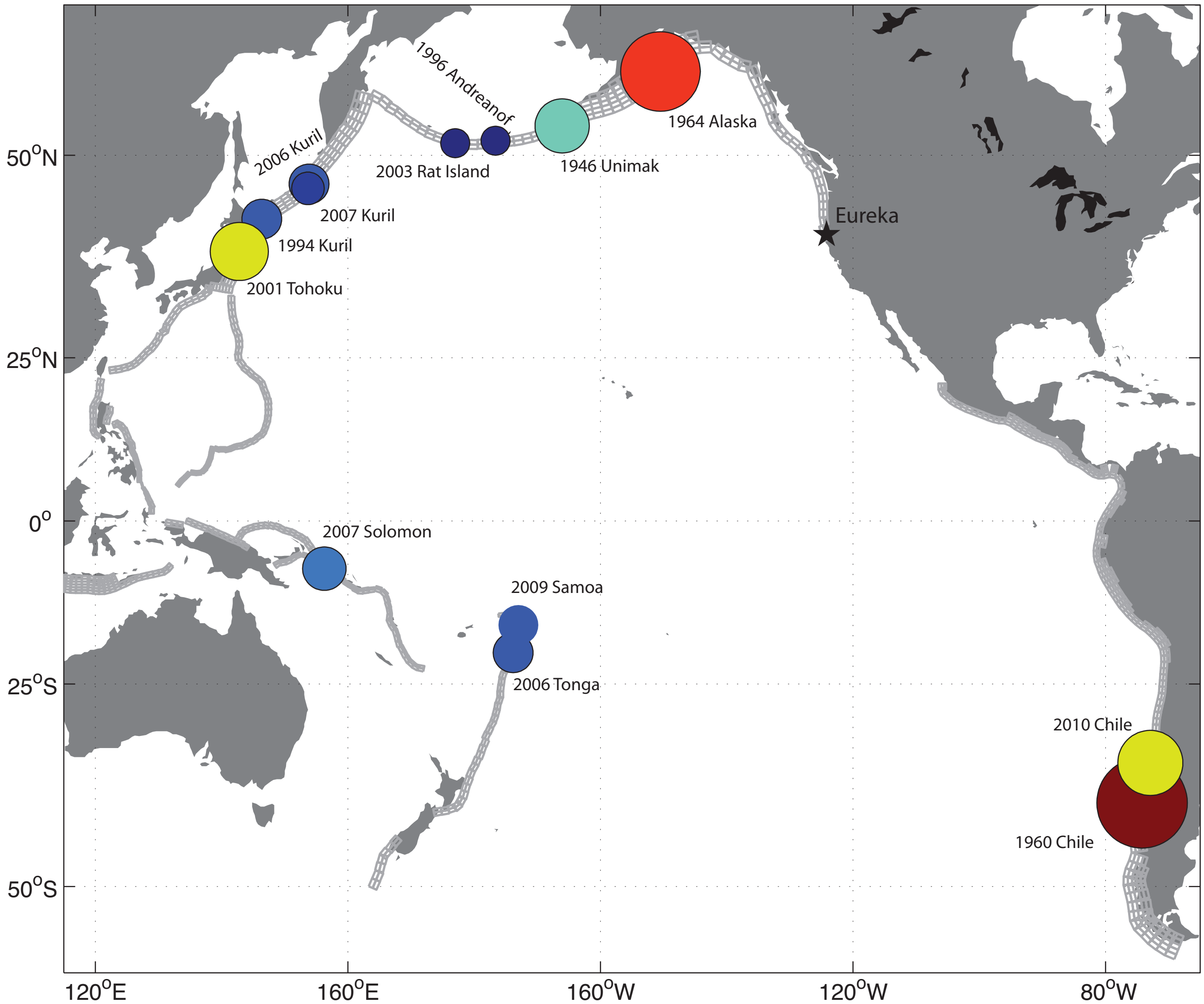


Figure 7 Map of the Pacific Ocean Basin showing the locations and magnitudes of the 12 historical events used to test and validate the Eureka model. Relative earthquake magnitude is shown by the varying sizes and colors of the filled circles. The largest magnitude earthquake used in model validation was the 1964 Alaska Mw 9.2 earthquake. The star denotes Eureka's location.

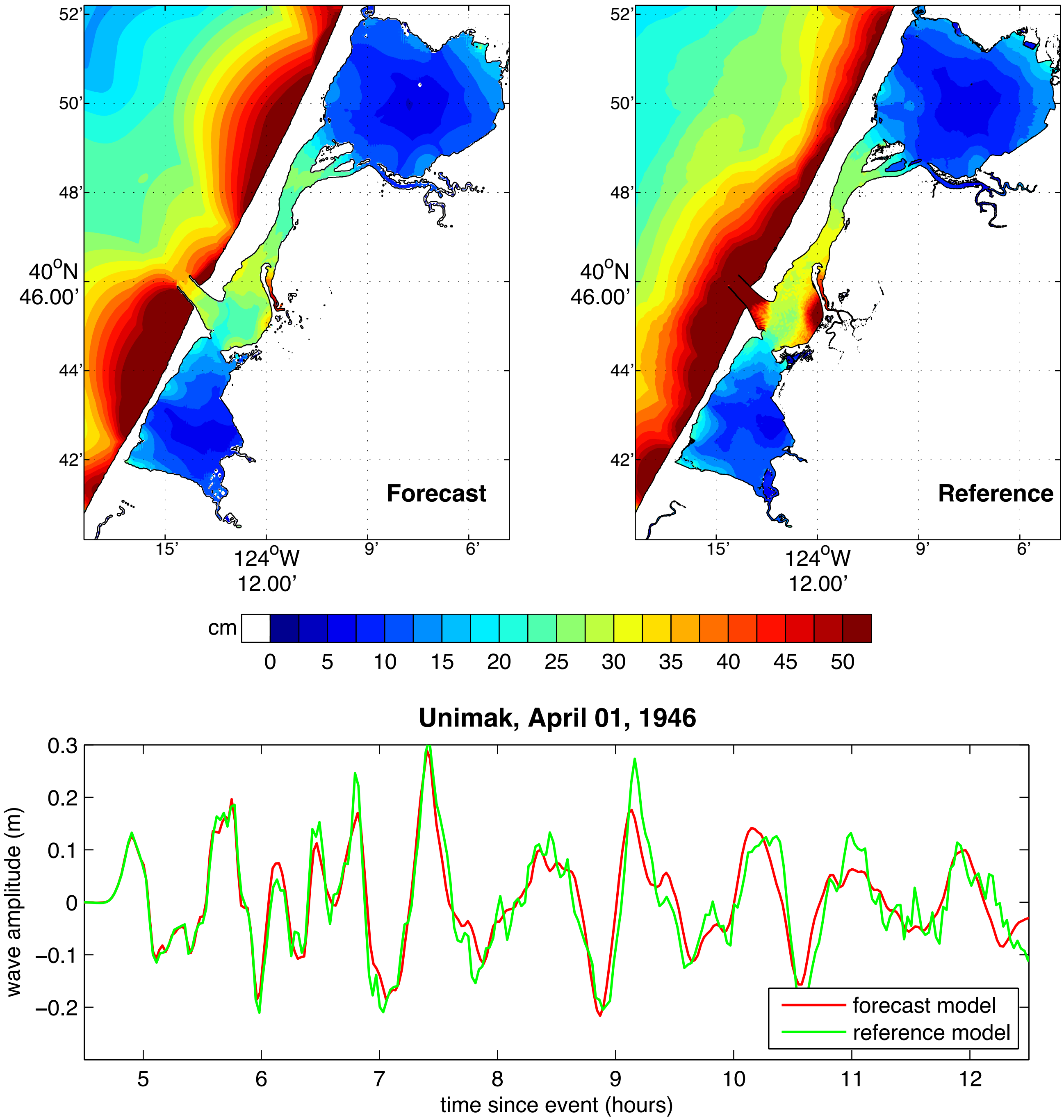


Figure 8 Model results for the 1946 Unimak Mw 8.5 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

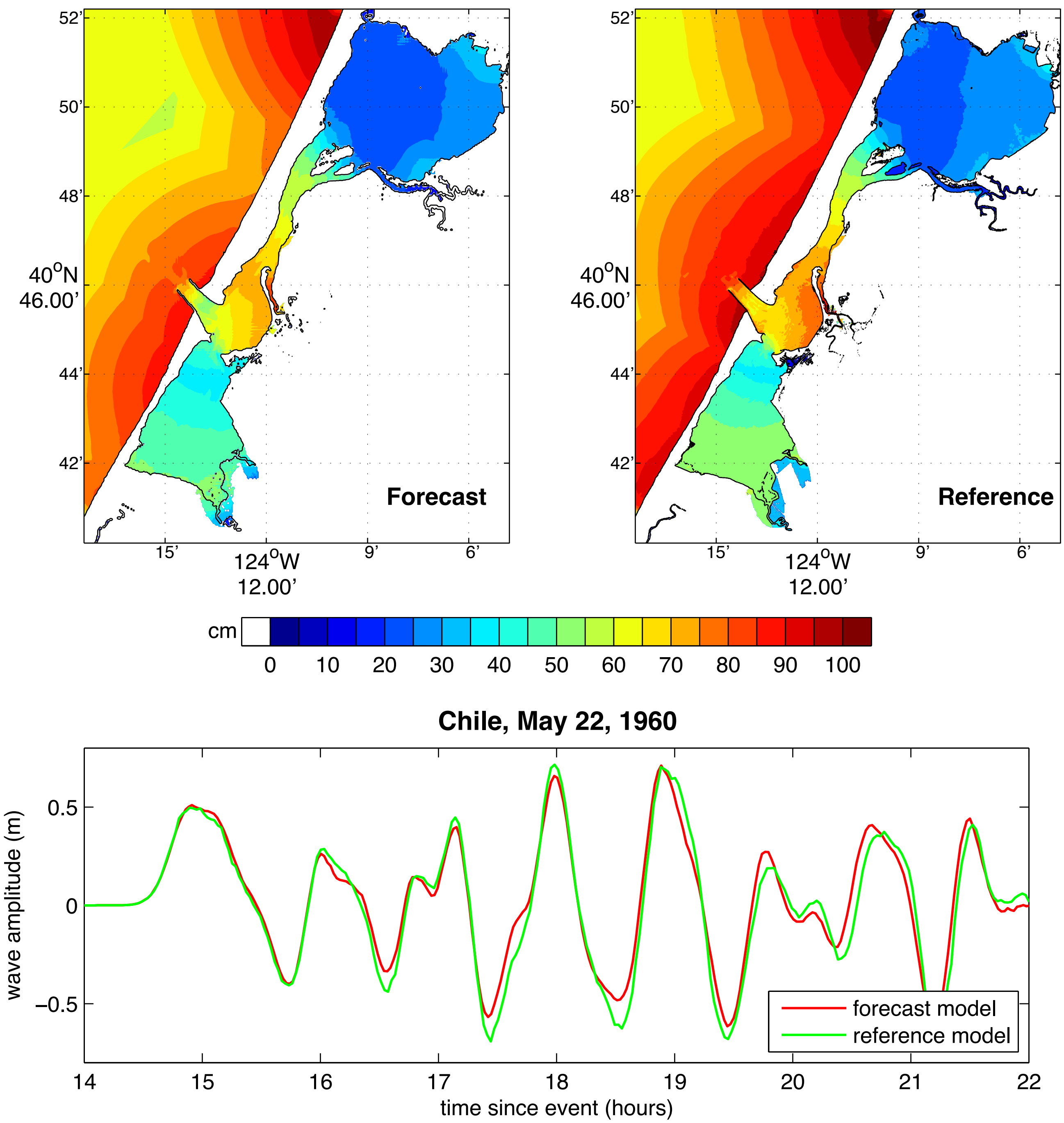


Figure 9 Model results for the 1960 Chile Mw 9.2 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge

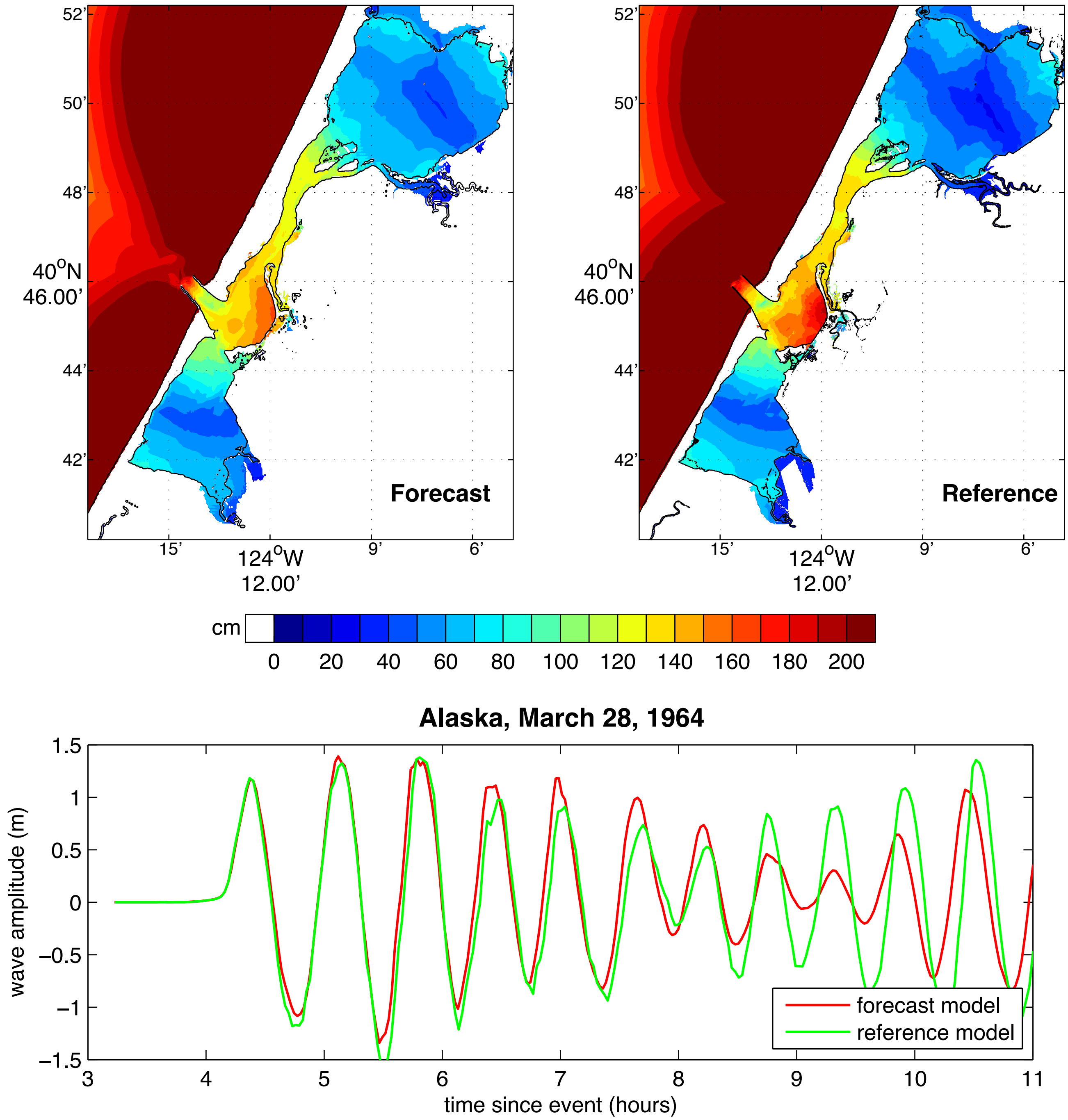


Figure 10 Model results for the 1964 Alaska Mw 9.2 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge

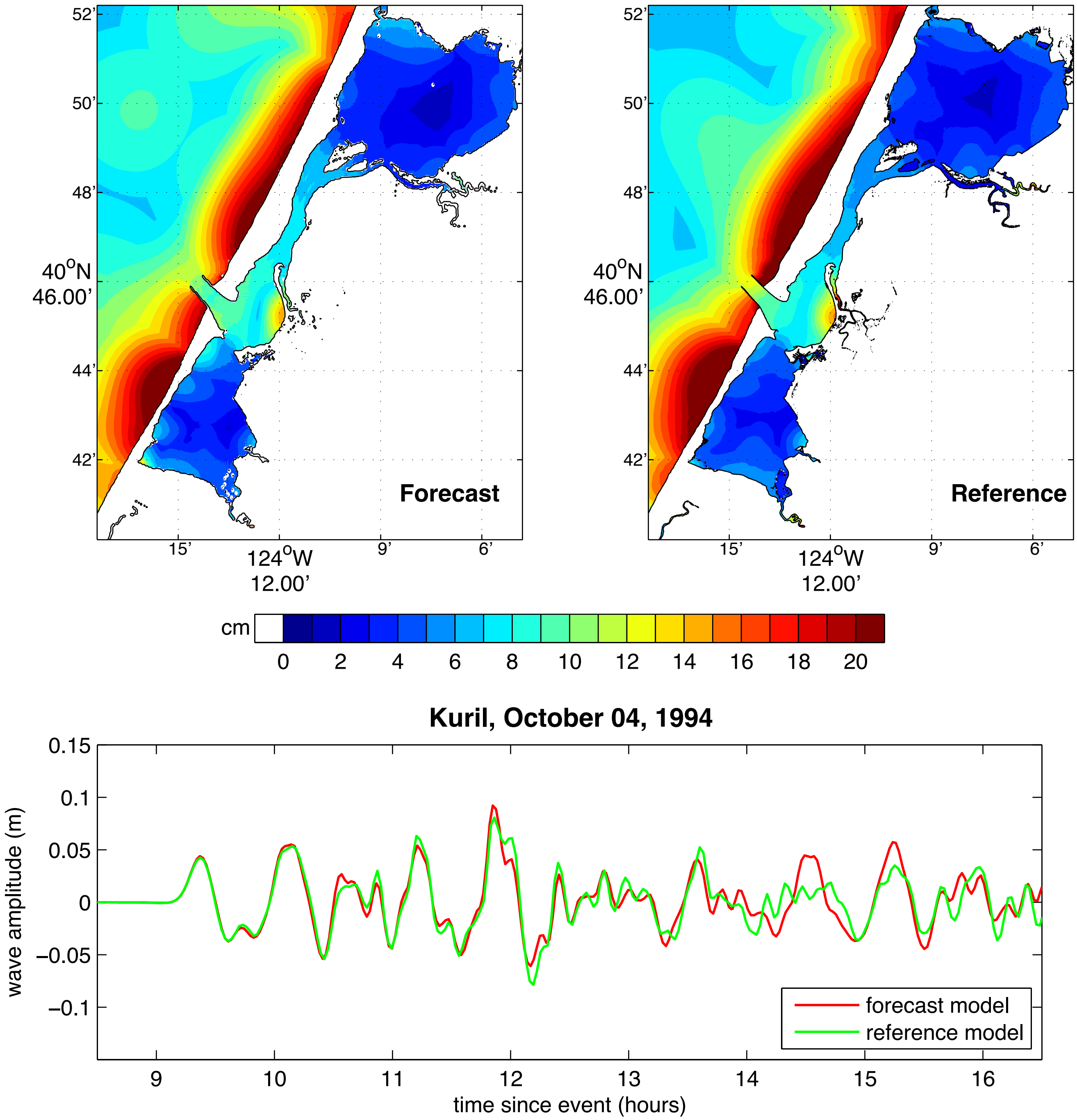


Figure 11 Model results for the 1994 Kuril Mw 8.3 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

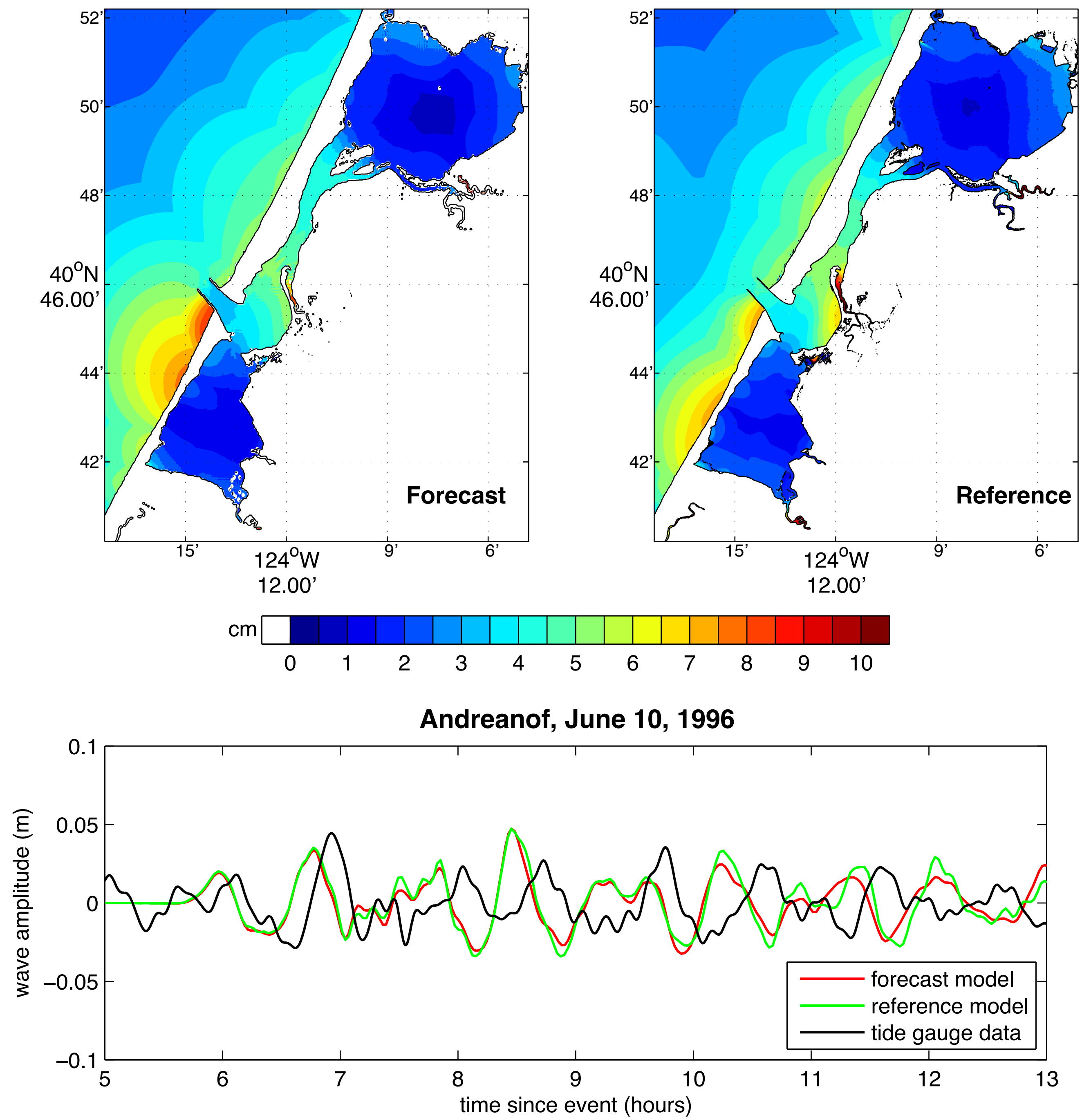


Figure 12 Model results for the 1996 Andreanof Mw 7.9 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

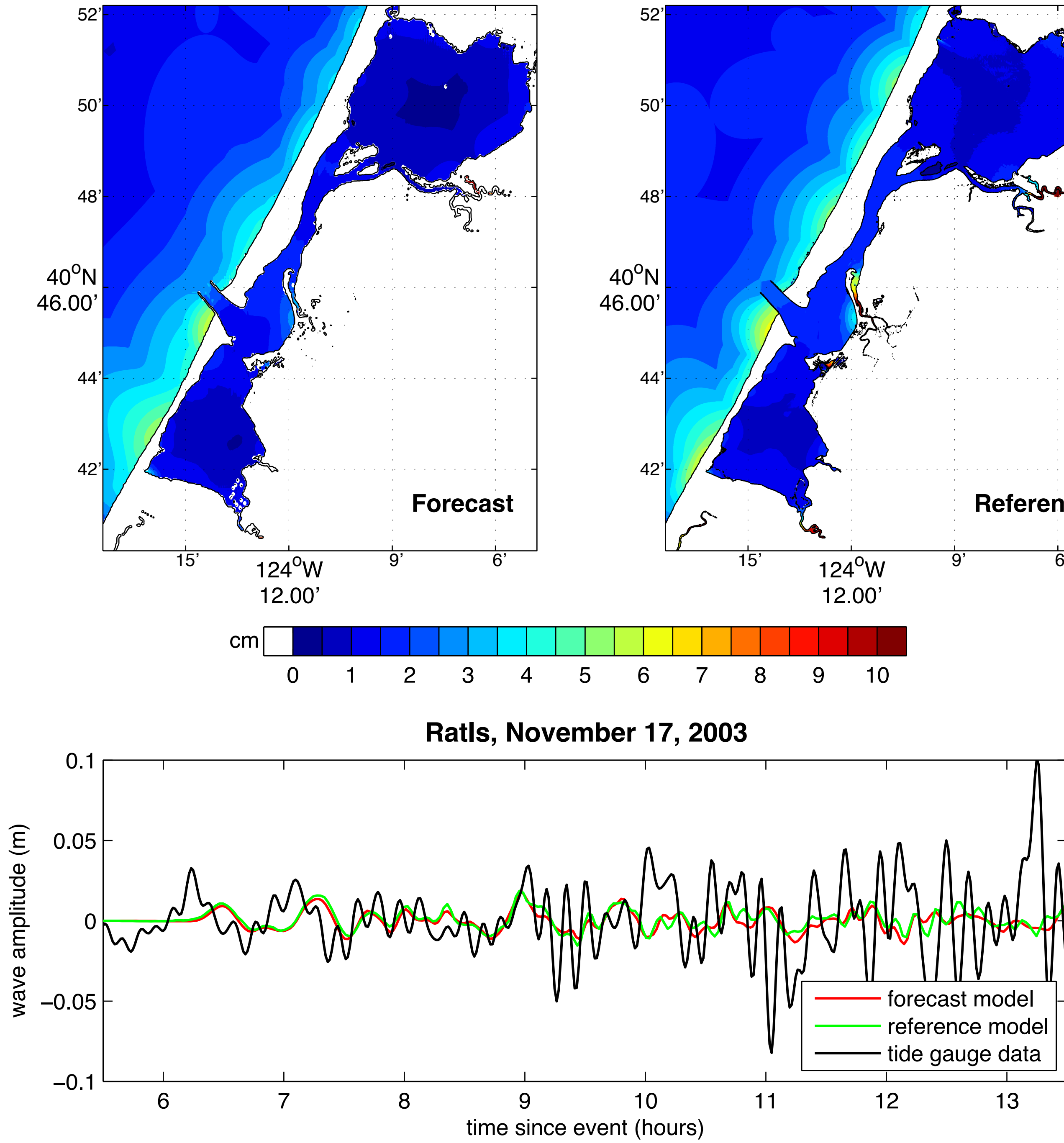


Figure 13 Model results for the 2003 Rat Island Mw 7.7 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

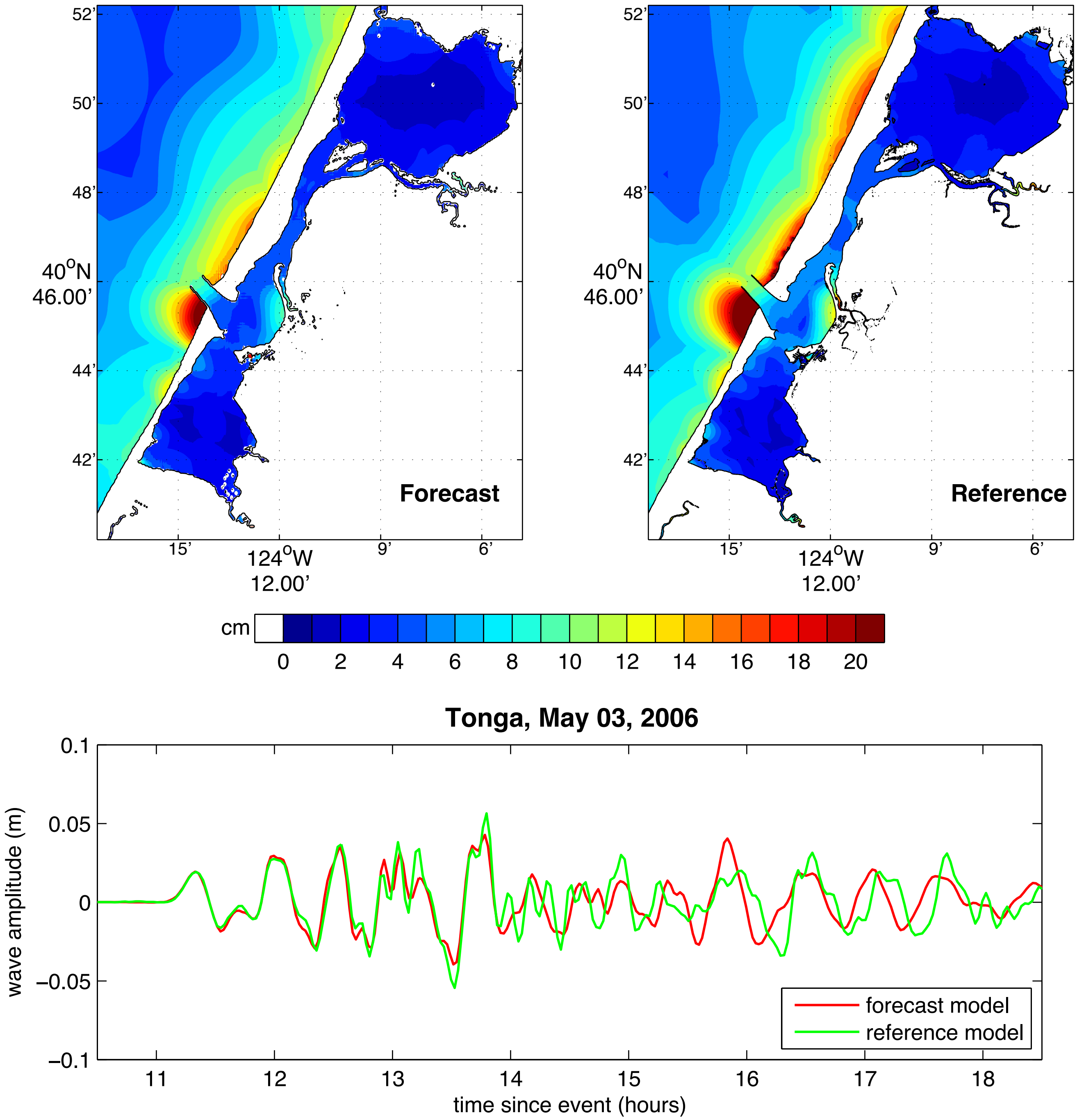


Figure 14 Model results for the 2006 Tonga Mw 8.0 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

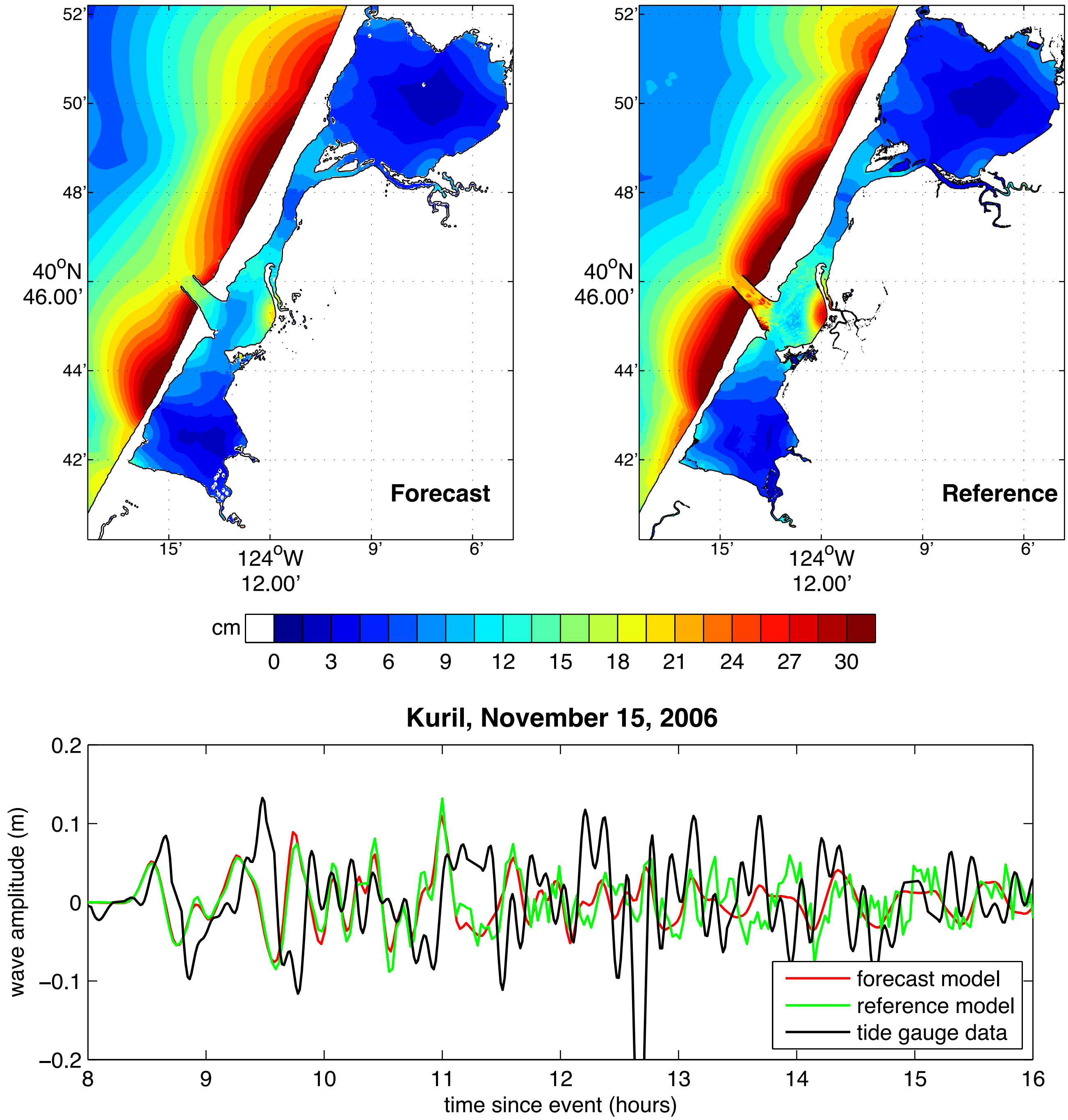


Figure 15 Model results for the 2006 Kuril Mw 8.3 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

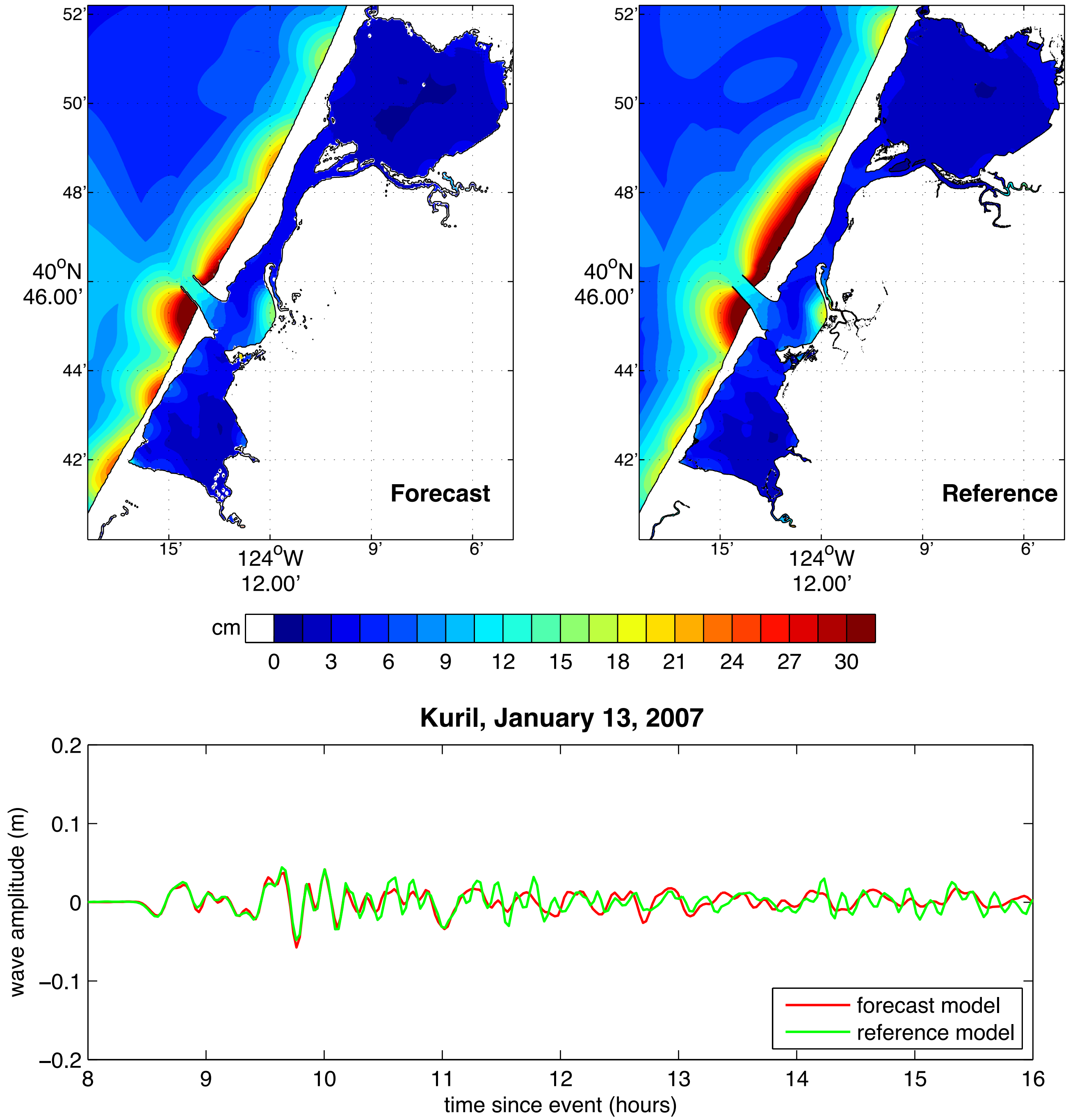


Figure 16 Model results for the 2007 Kuril Mw 8.1 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

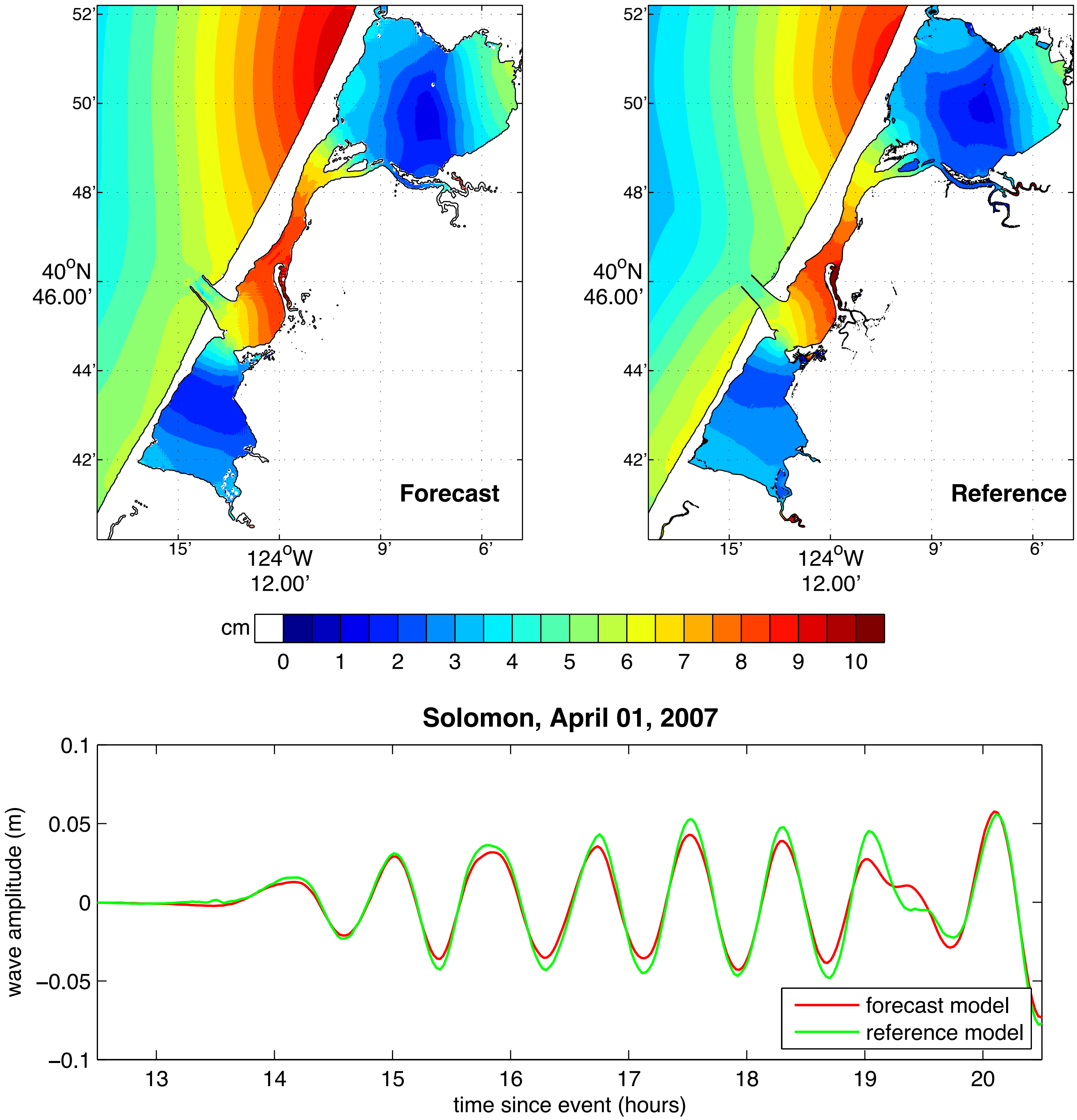


Figure 17 Model results for the 2007 Solomon Mw 8.1 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

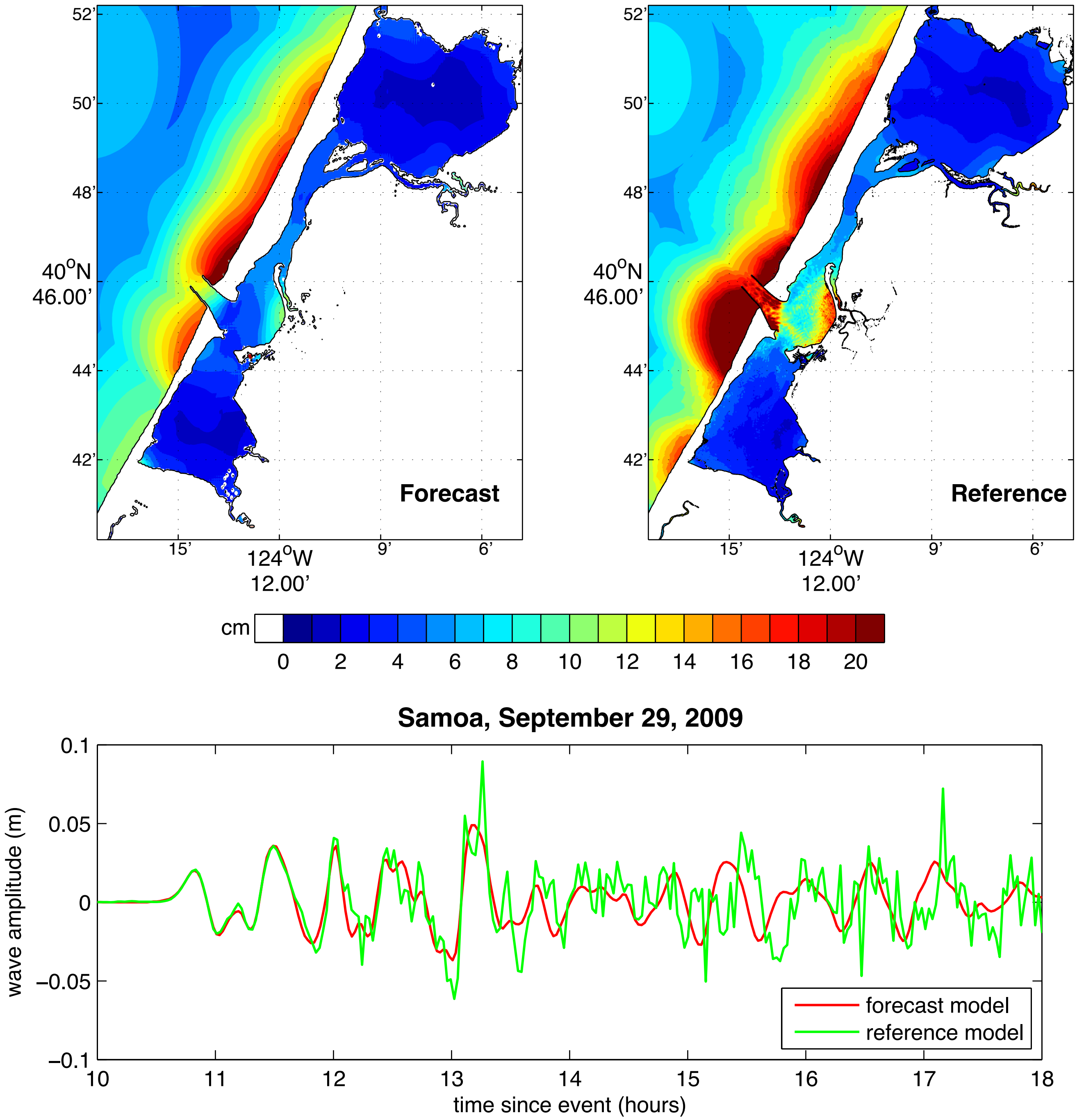


Figure 18 Model results for the 2009 Samoa Mw 8.0 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red) and reference model (green) wave amplitudes at the Eureka tide gauge.

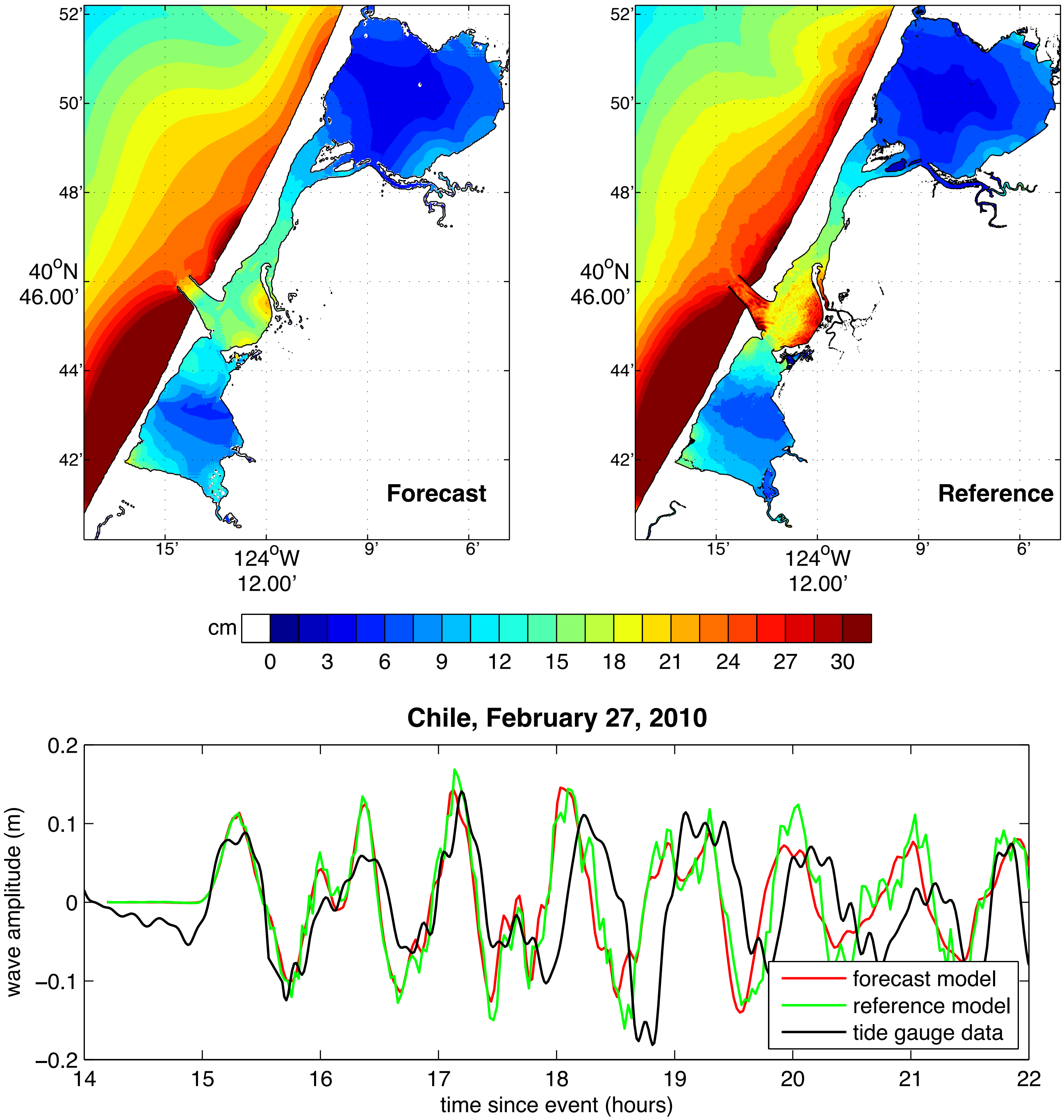


Figure 19 Model results for the 2010 Chile Mw 8.8 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red), reference model (green) and observed (black) wave amplitudes at the Eureka tide gauge.

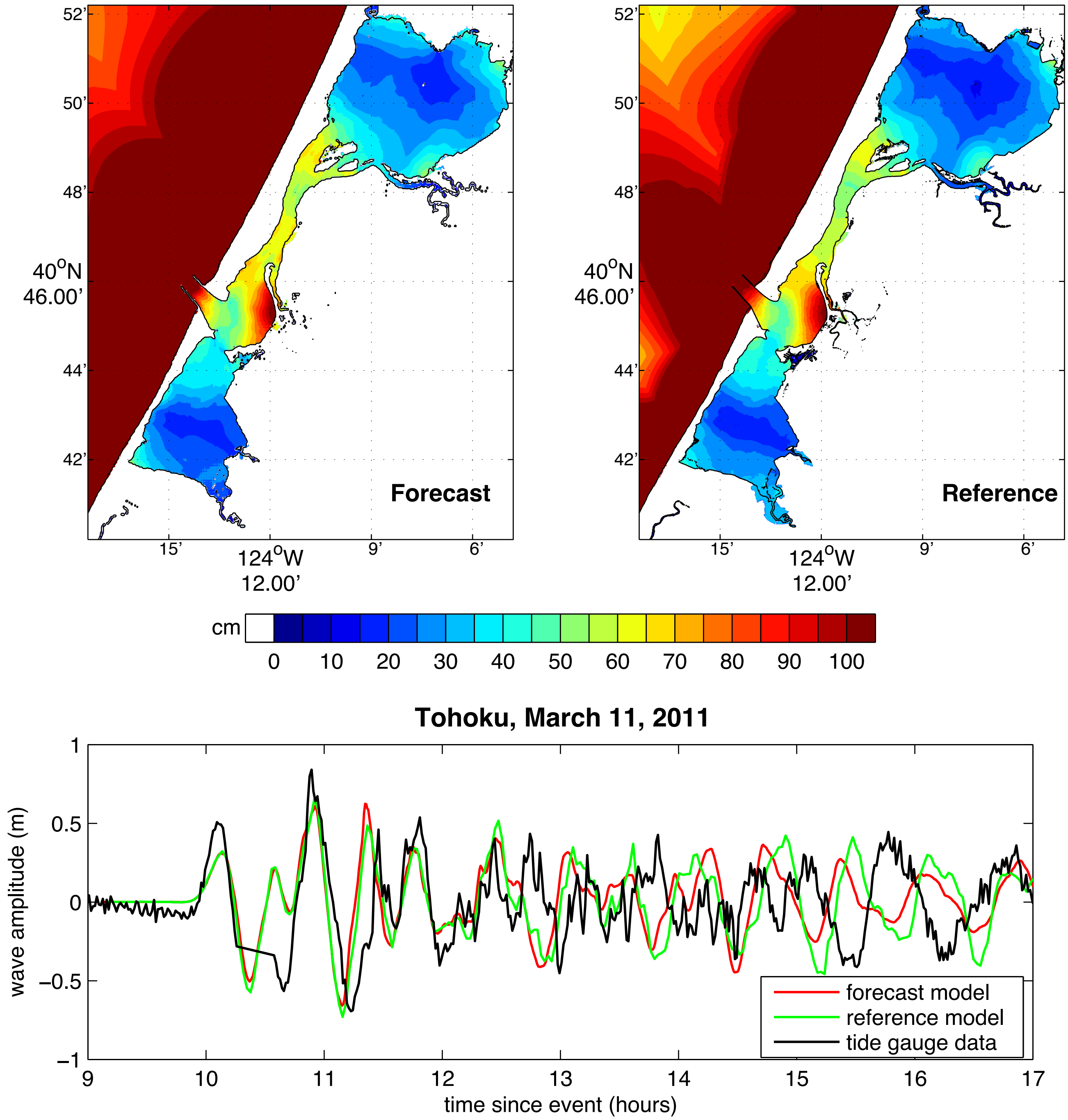


Figure 20 Model results for the 2011 Tohoku Mw 9.0 event. The upper two panels show, respectively, the forecast and reference model maximum wave height predictions. The lower panel shows the forecast model (red), reference model (green) and observed (black) wave amplitudes at the Eureka tide gauge.

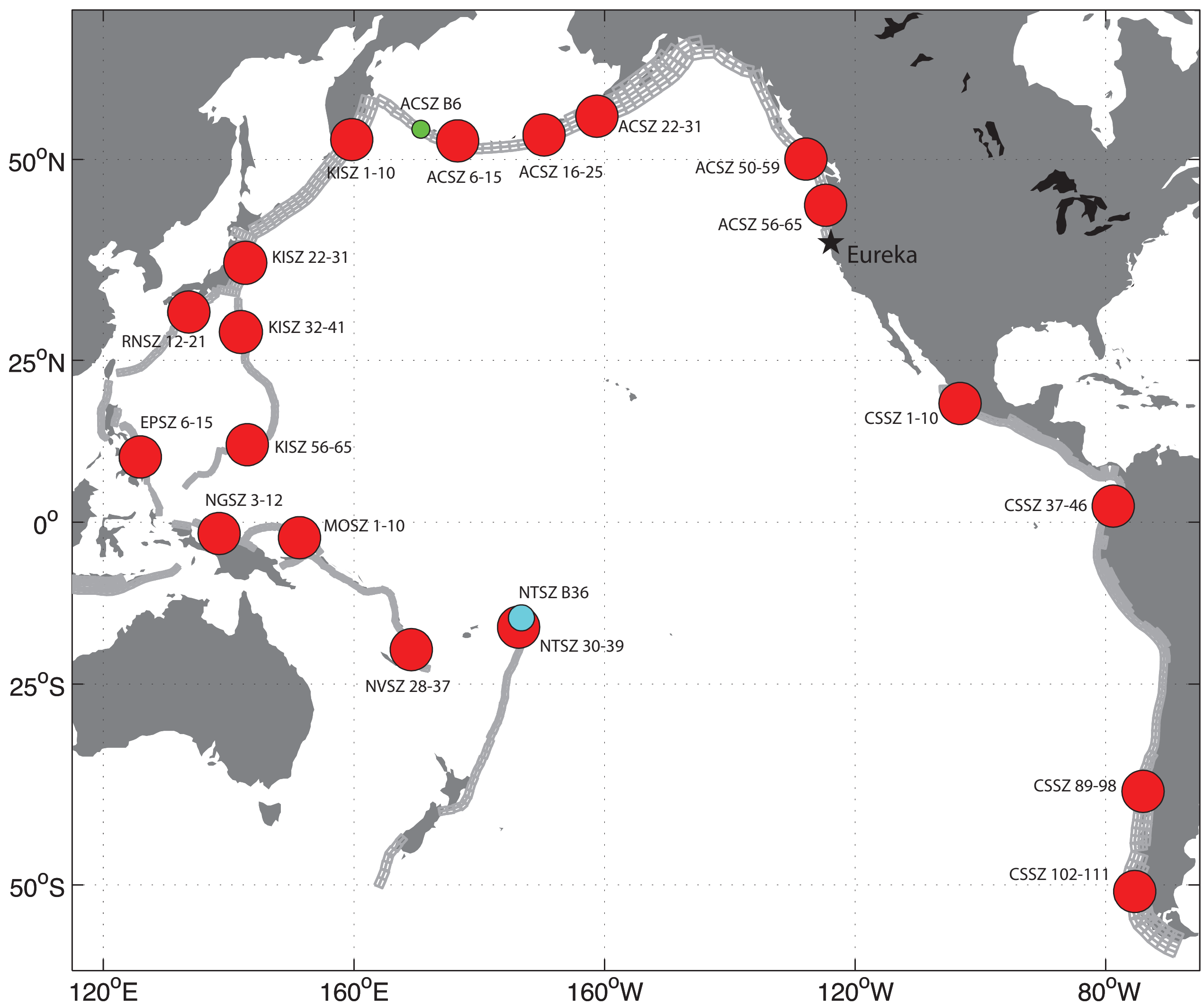


Figure 21 Map of the Pacific Ocean Basin showing the locations of the 19 simulated Mw 9.3 events (red circles) and the medium (Mw 7.5, blue circle) and micro event (green circle) used to test and validate the Eureka model. The solid star denotes the location of Eureka.

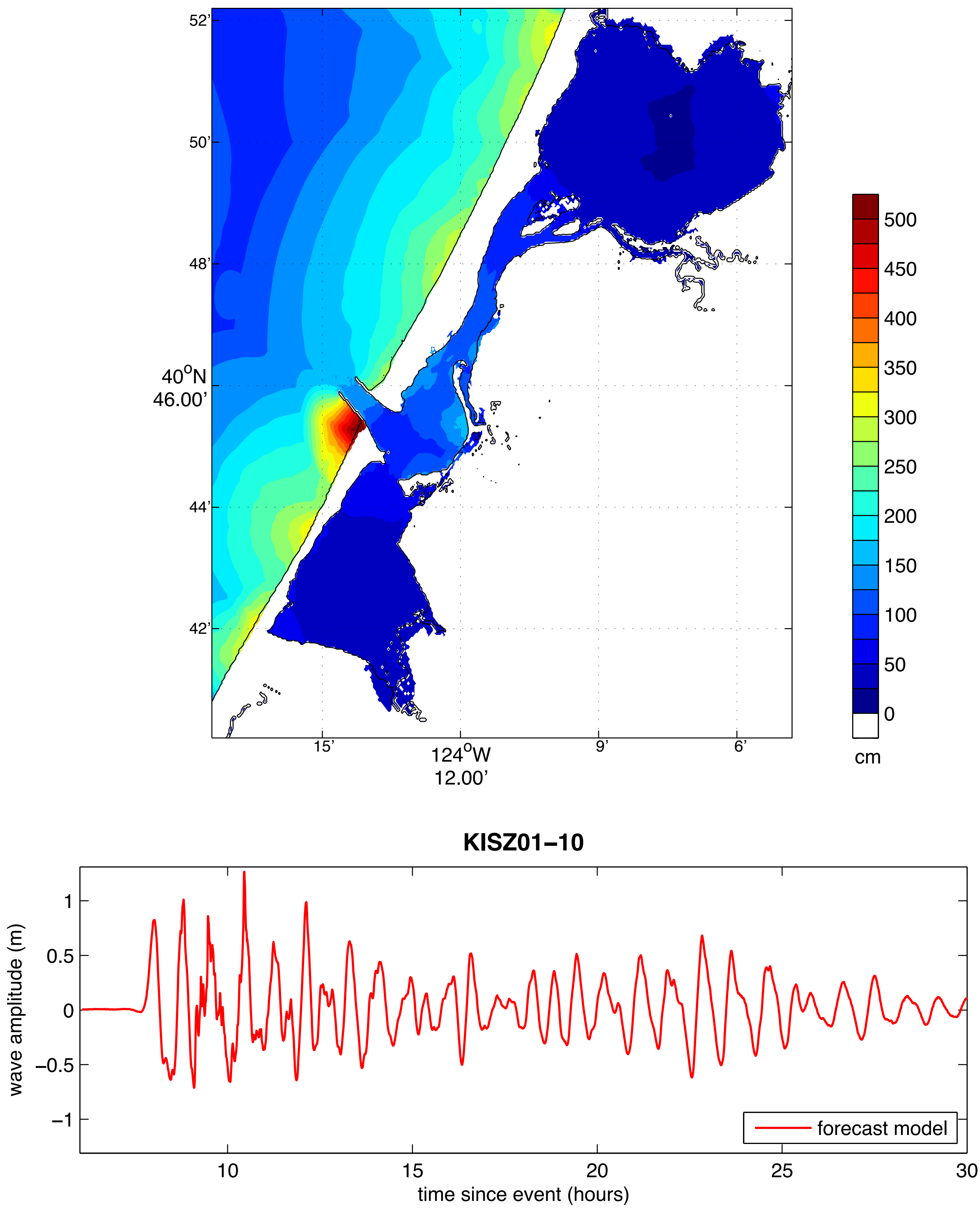


Figure 22 Results from the forecast model for the KISZ 1-10 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

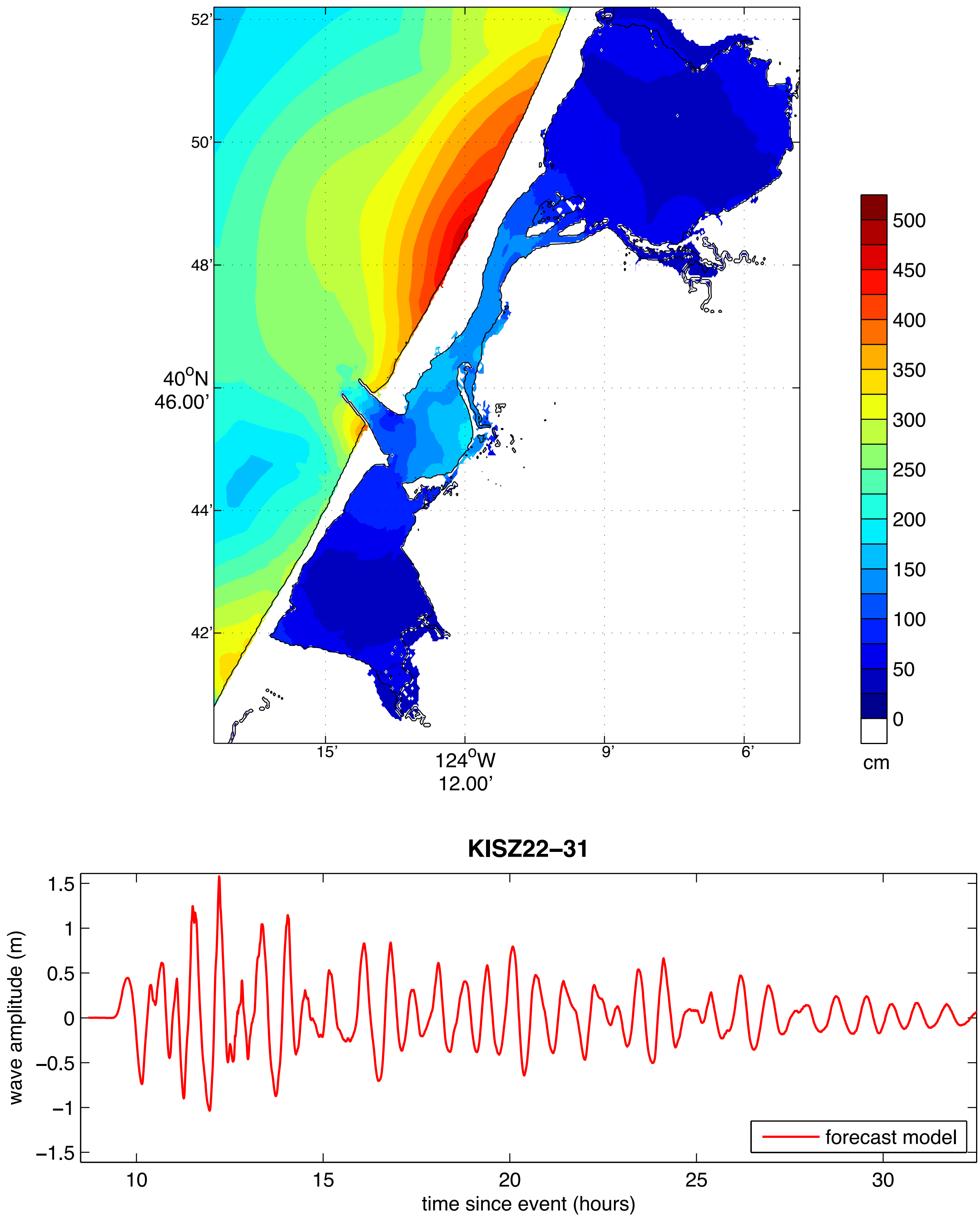


Figure 23 Results from the forecast model for the KISZ 22-31 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

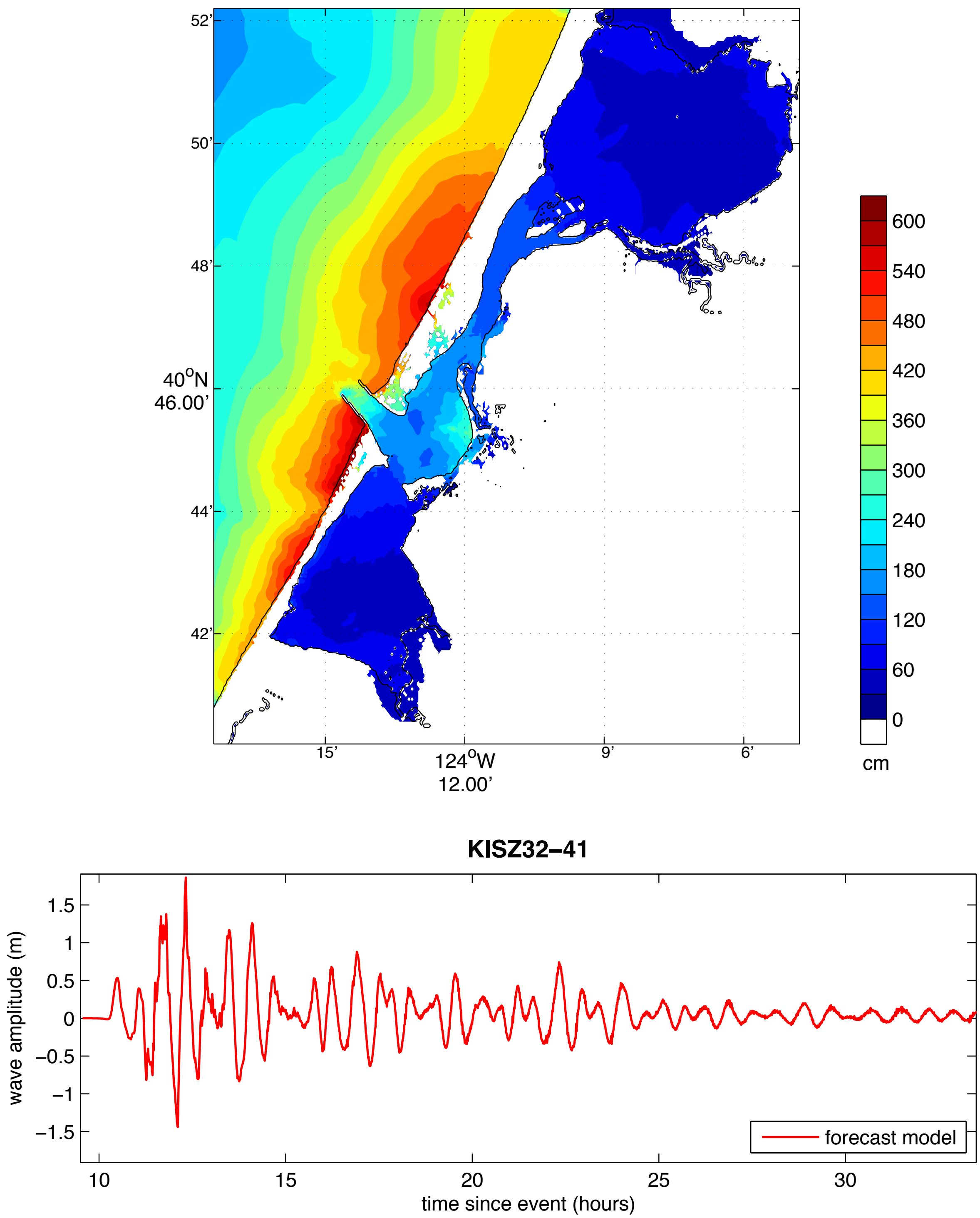


Figure 24 Results from the forecast model for the KISZ 32-41 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

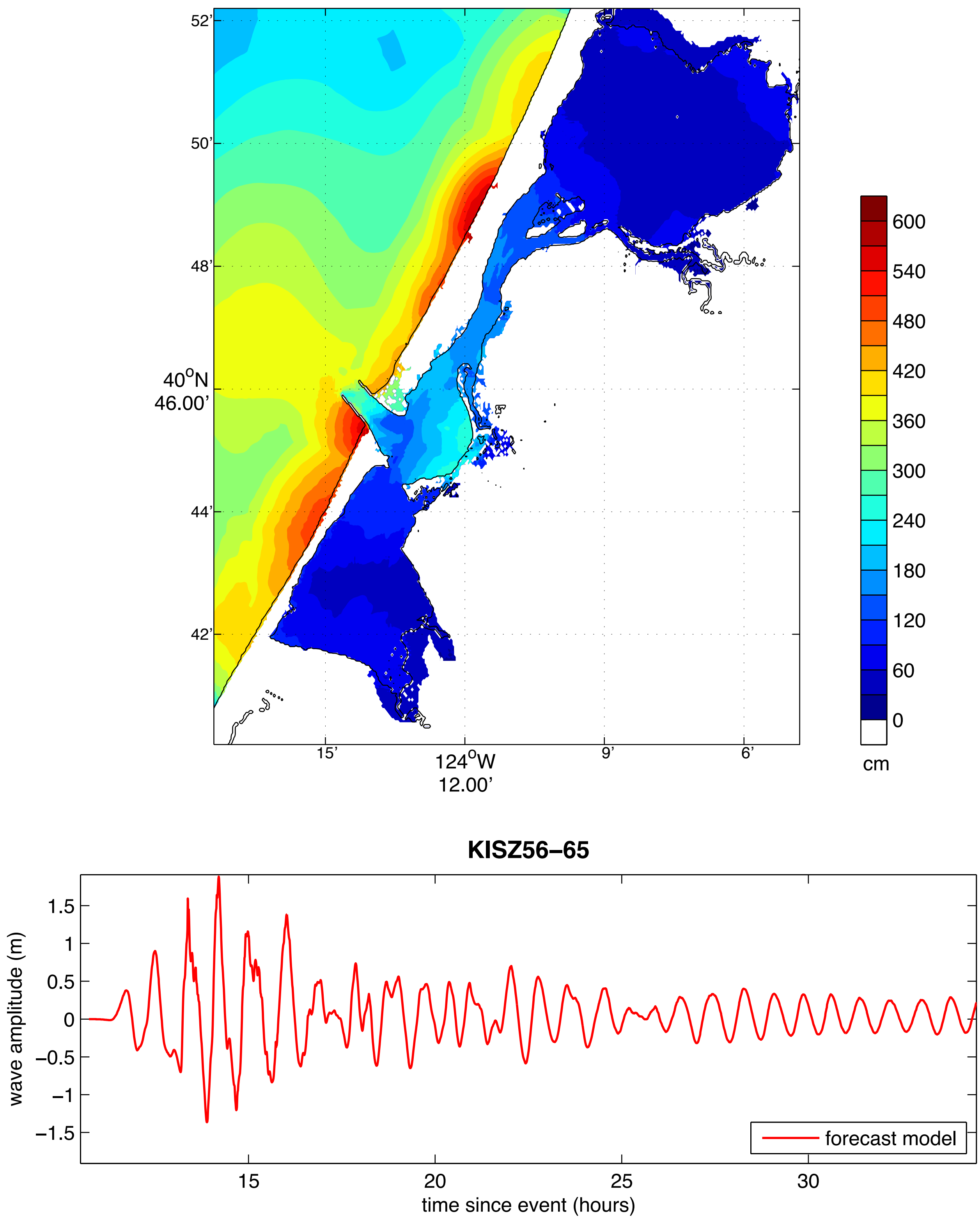
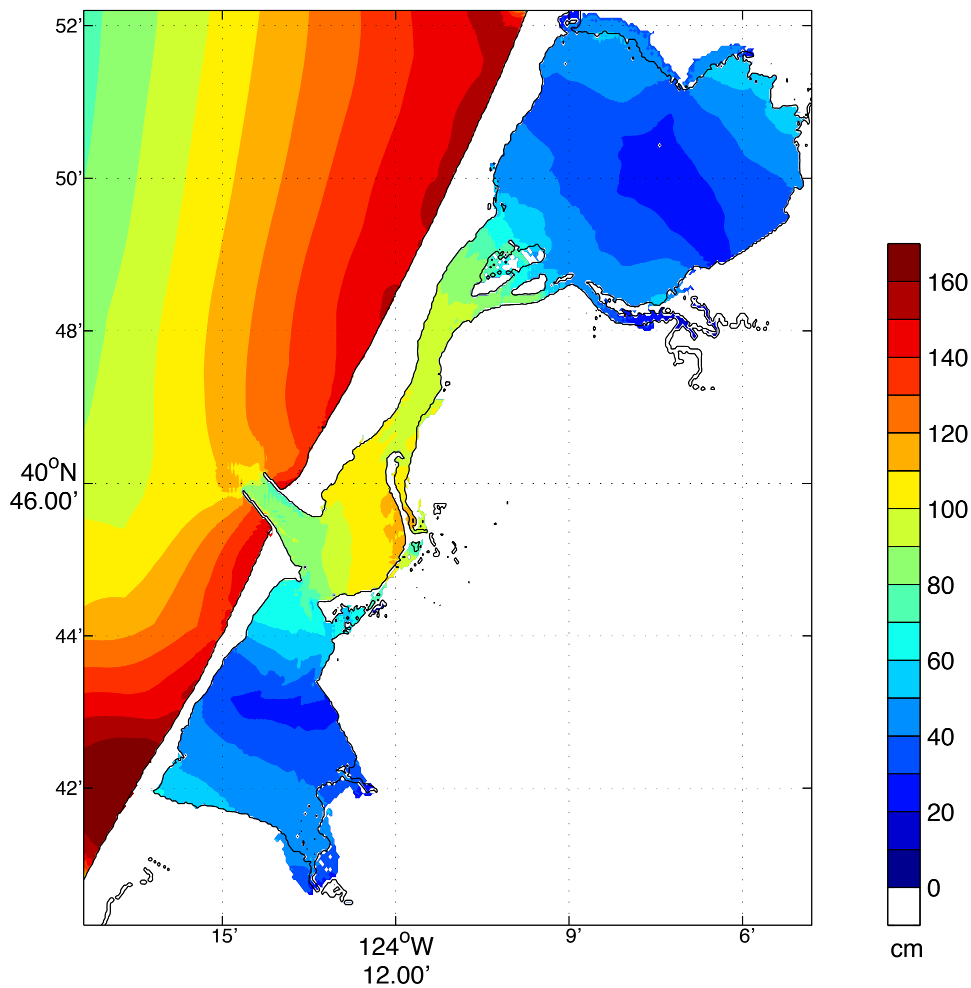


Figure 25 Results from the forecast model for the KISZ 56-65 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.



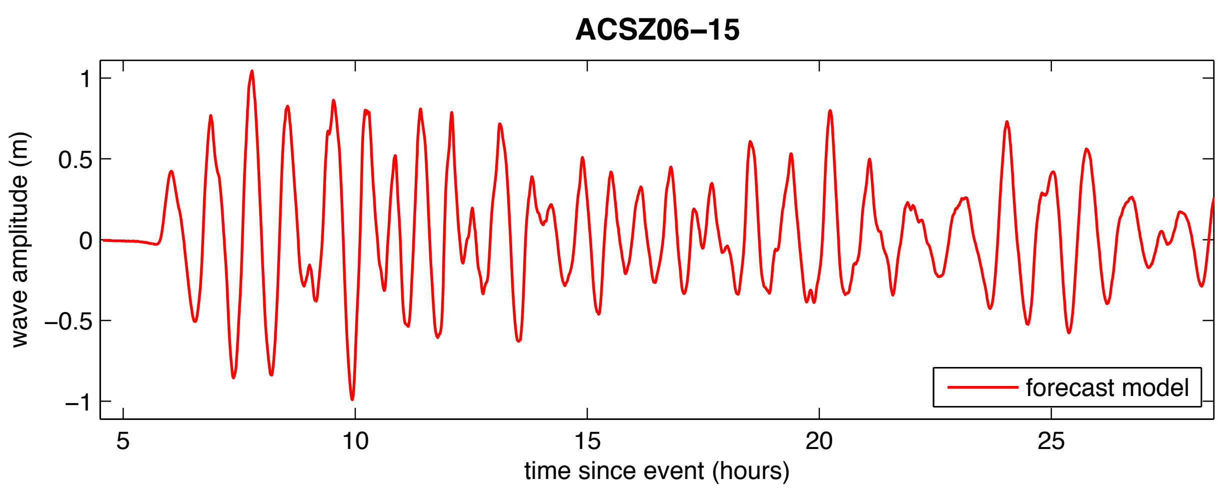
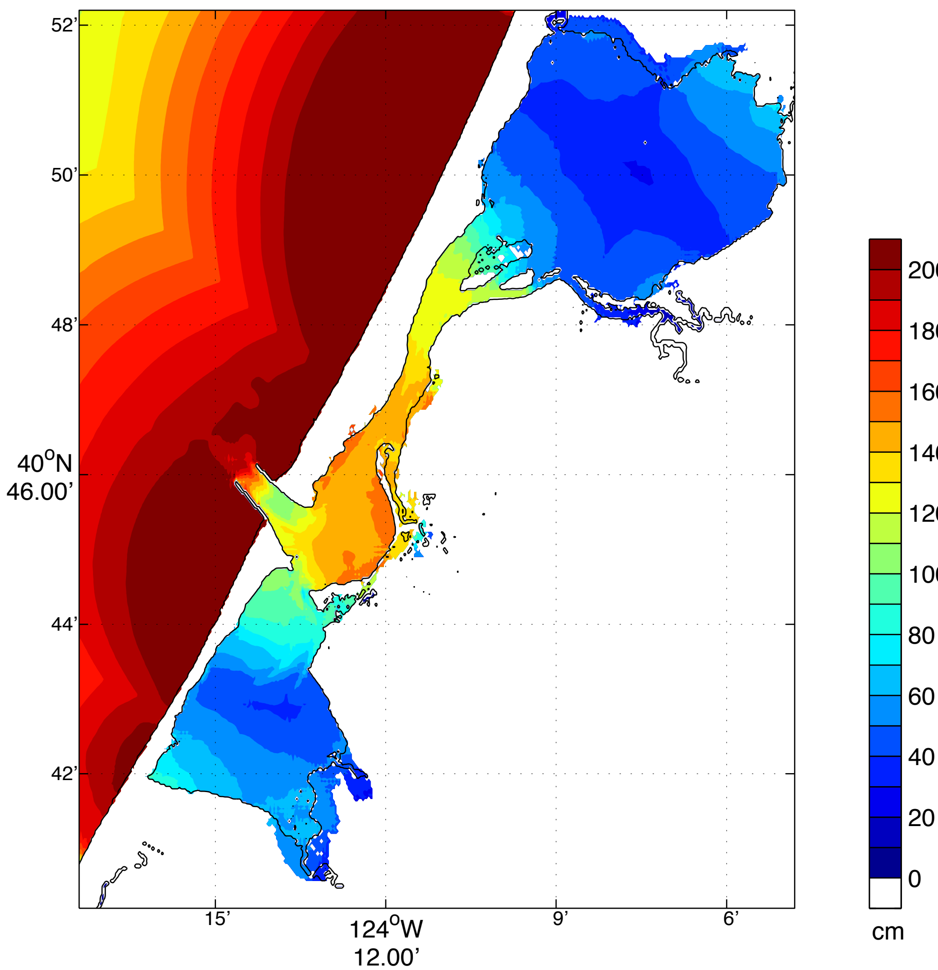


Figure 26 Results from the forecast model for the ACSZ 6-15 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.



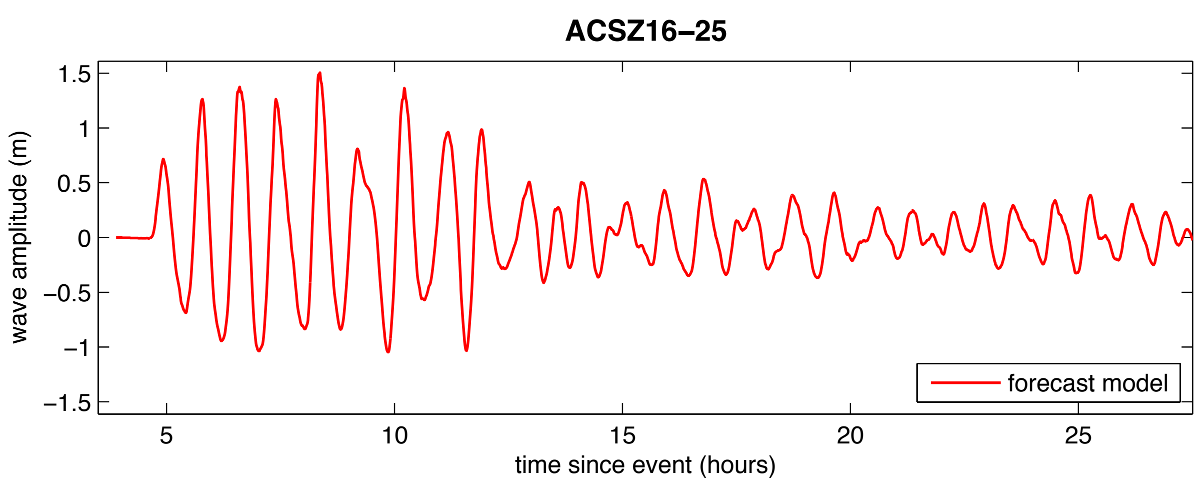


Figure 27 Results from the forecast model for the ACSZ 16-25 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

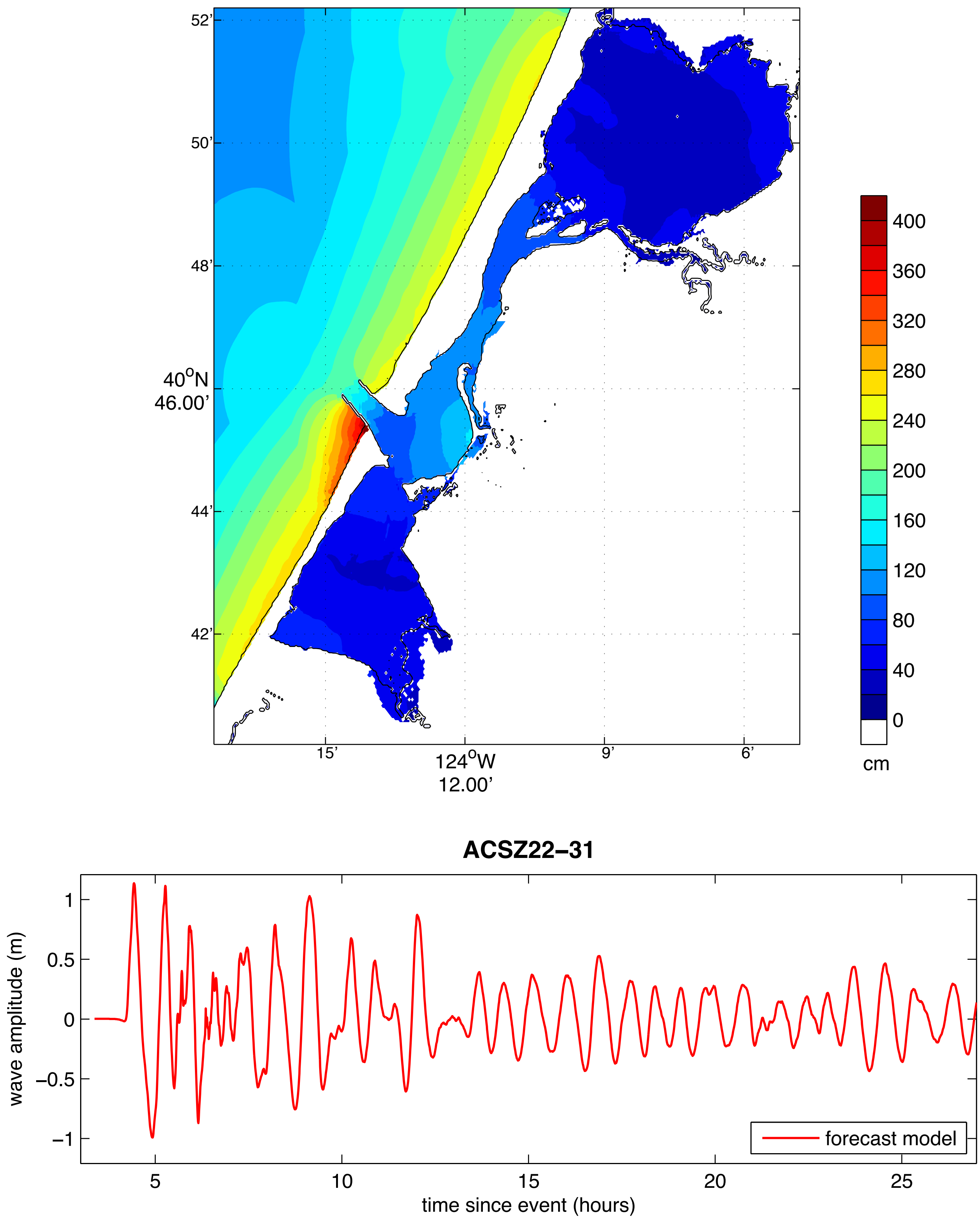


Figure 28 Results from the forecast model for the ACSZ 22-31 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

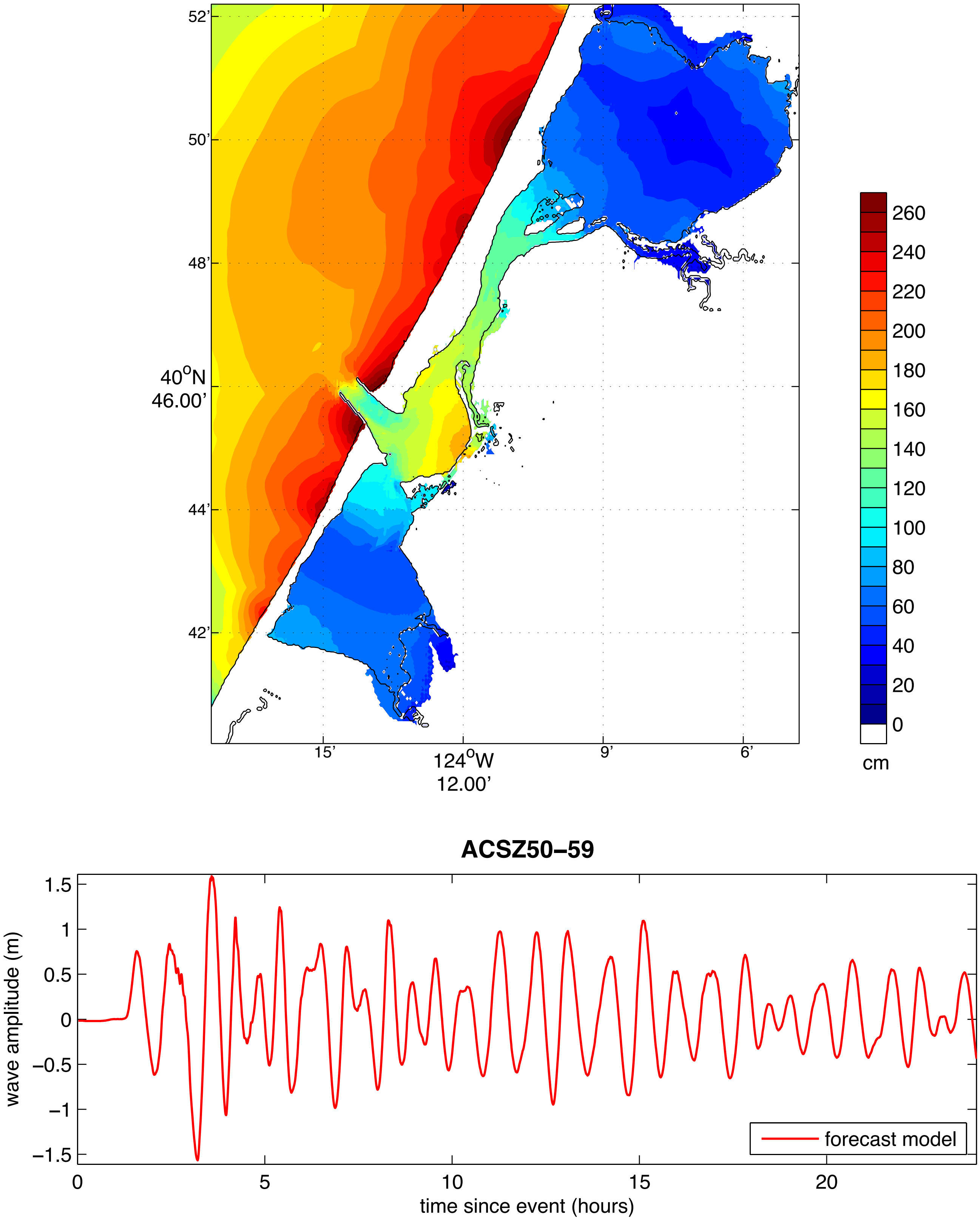


Figure 29 Results from the forecast model for the ACSZ 50-59 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

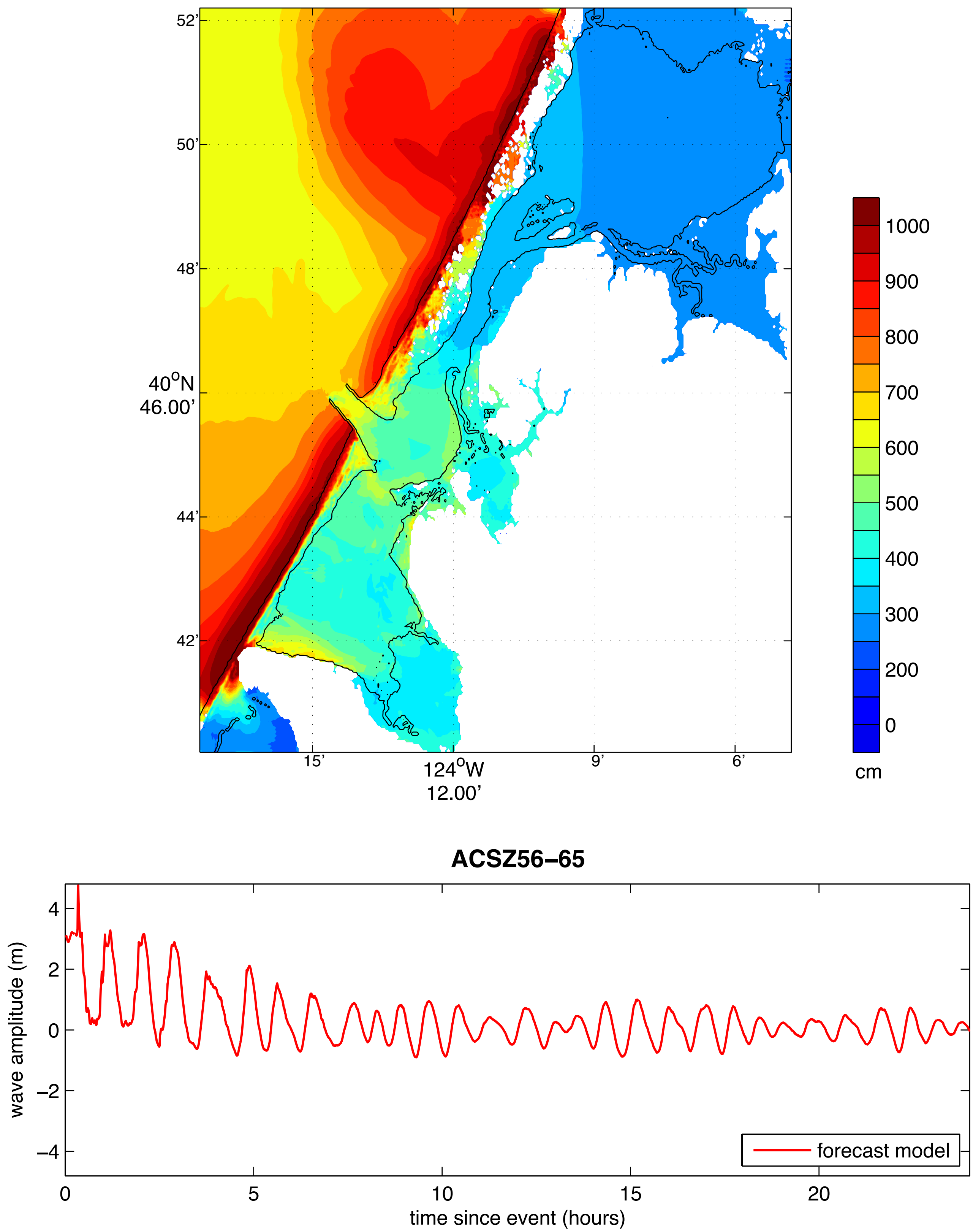


Figure 30 Results from the forecast model for the ACSZ 56-65 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

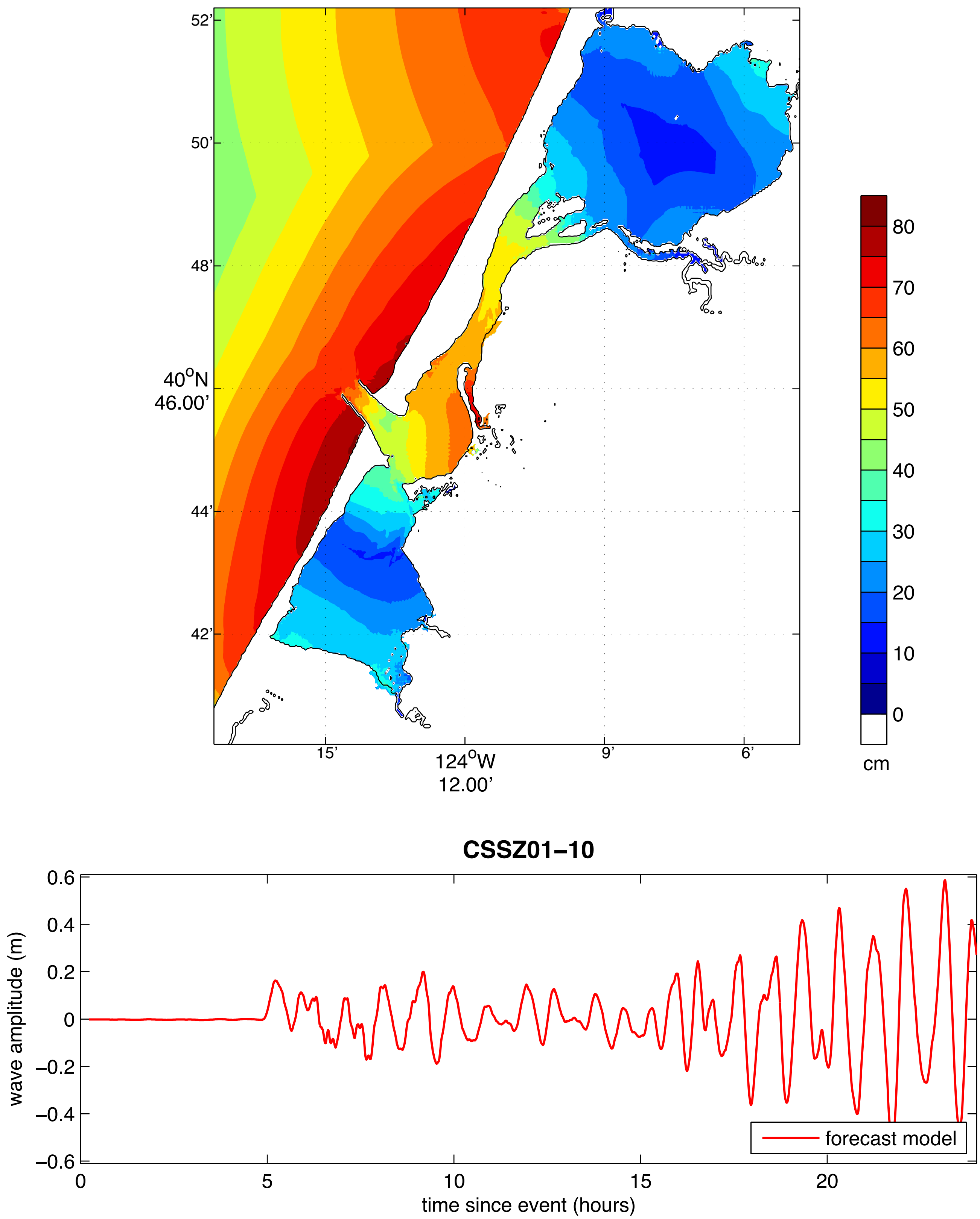


Figure 31 Results from the forecast model for the CSSZ 1-10 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

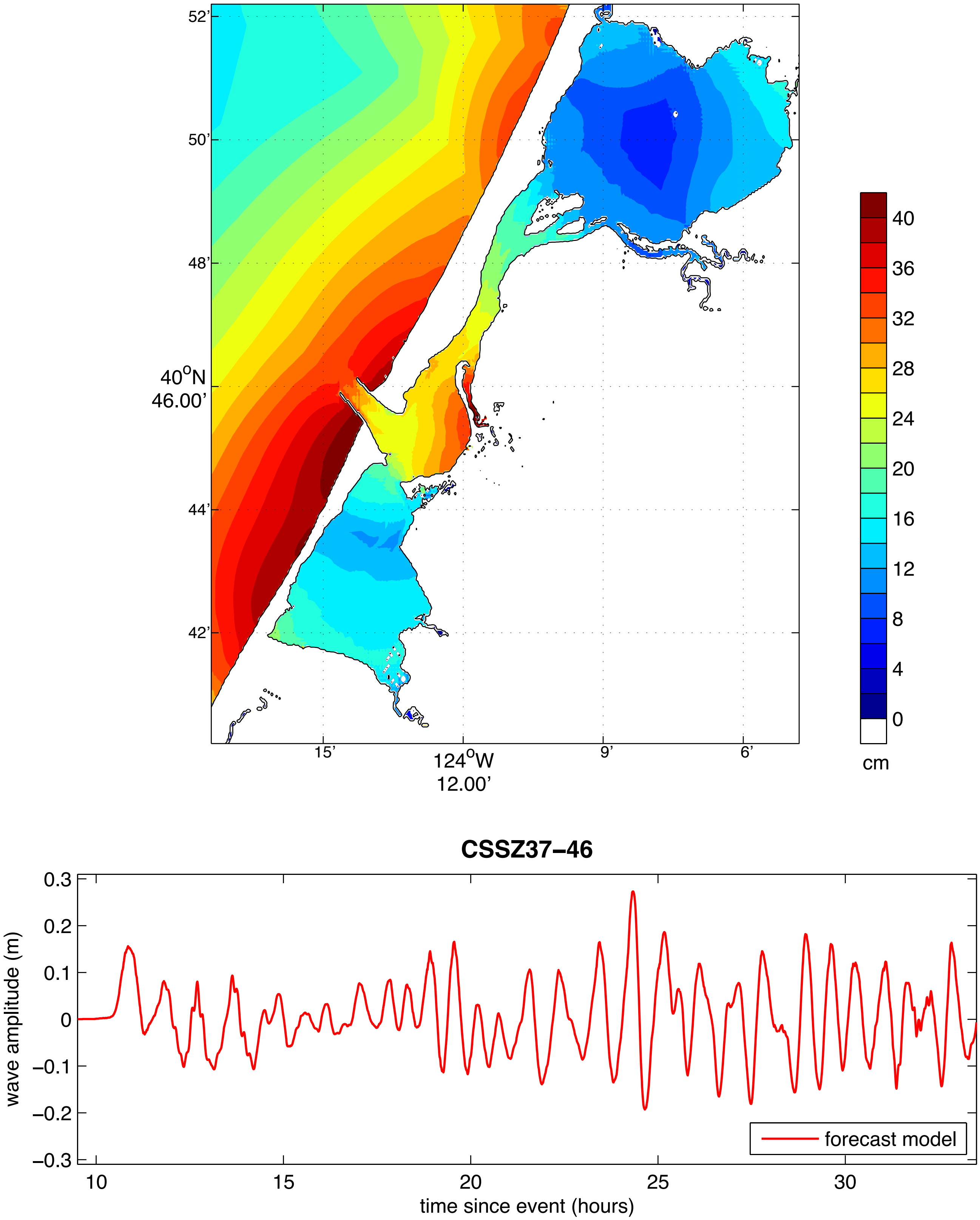


Figure 32 Results from the forecast model for the CSSZ 37-46 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

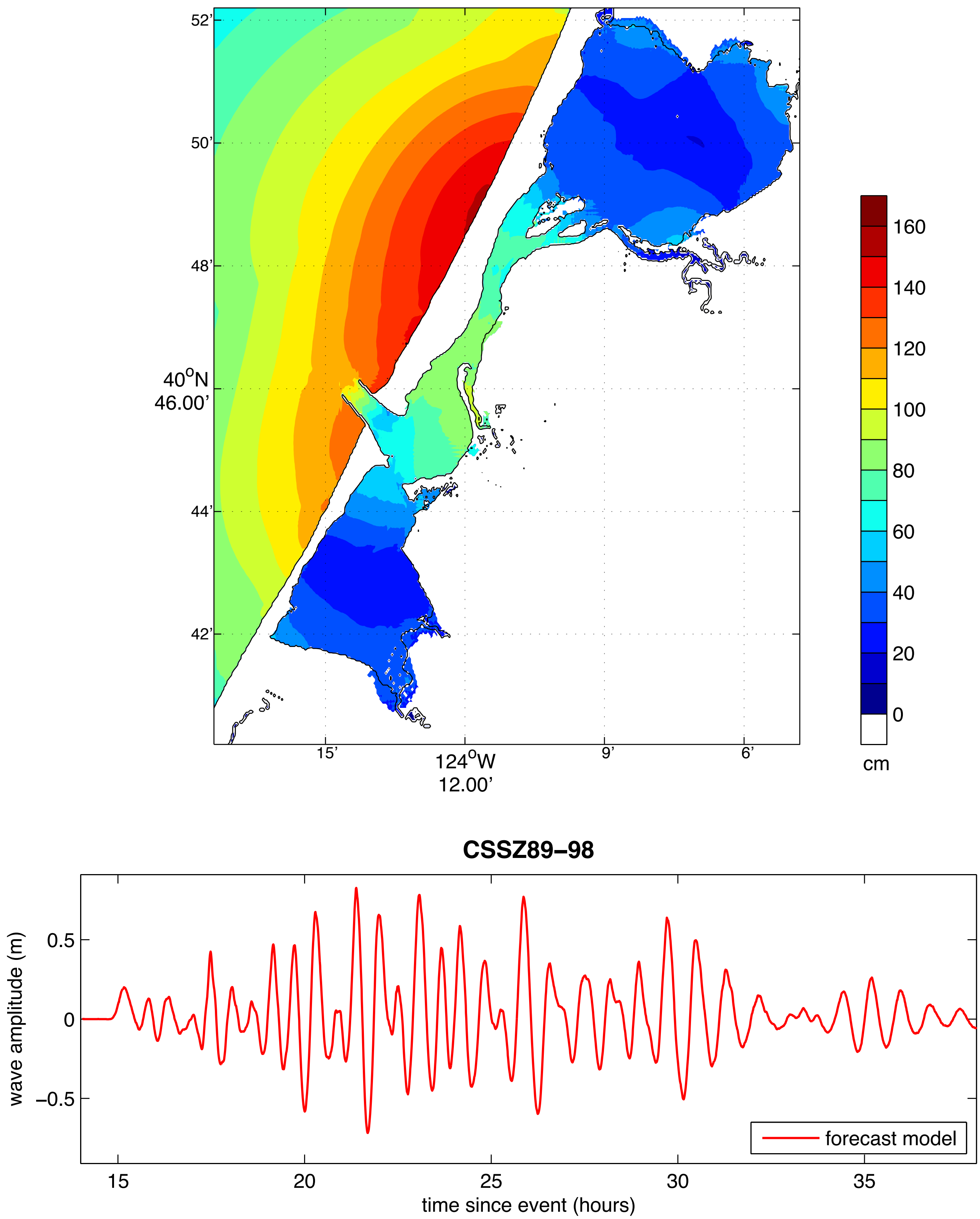


Figure 33 Results from the forecast model for the CSSZ 89-98 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

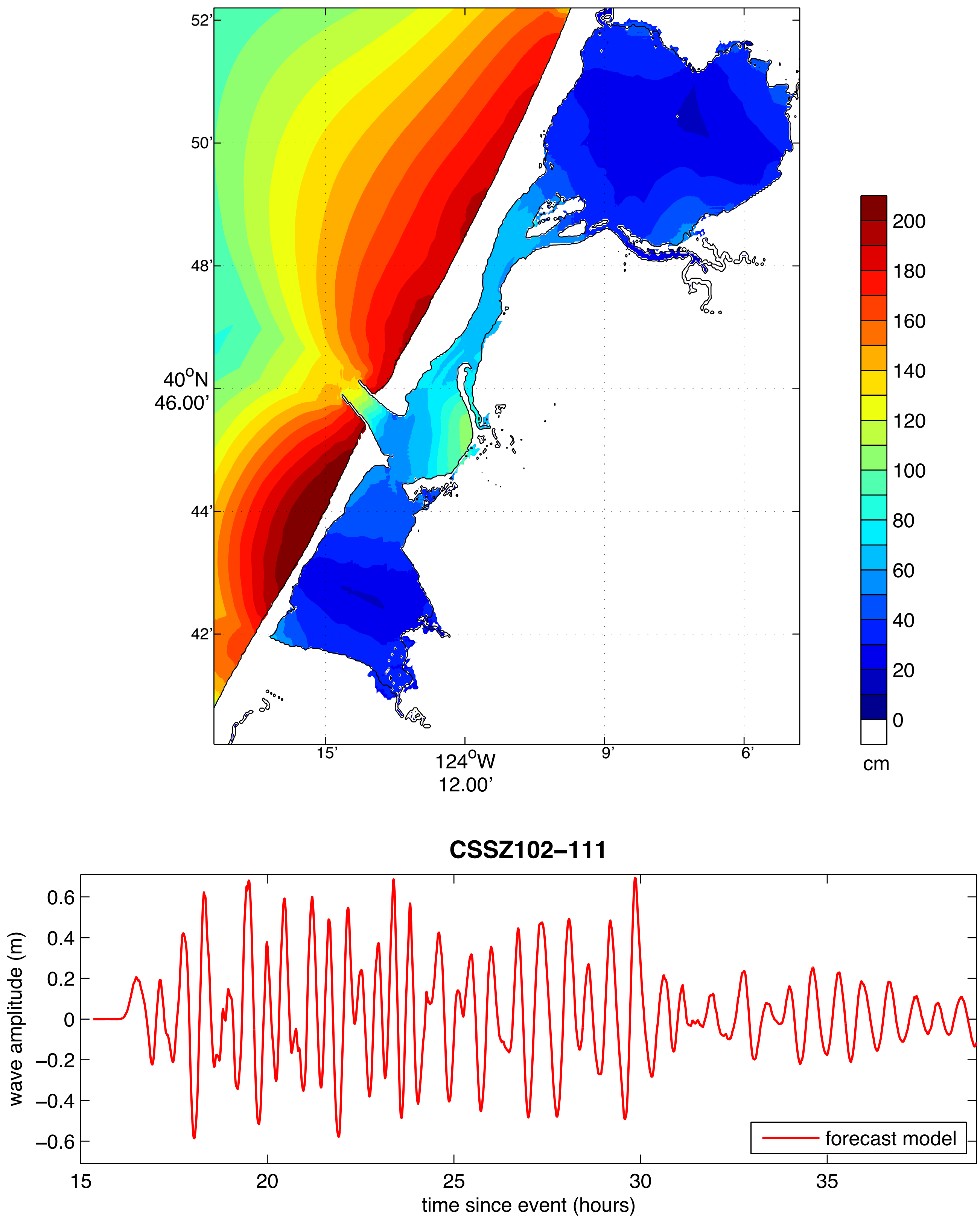


Figure 34 Results from the forecast model for the CSSZ 102-111 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

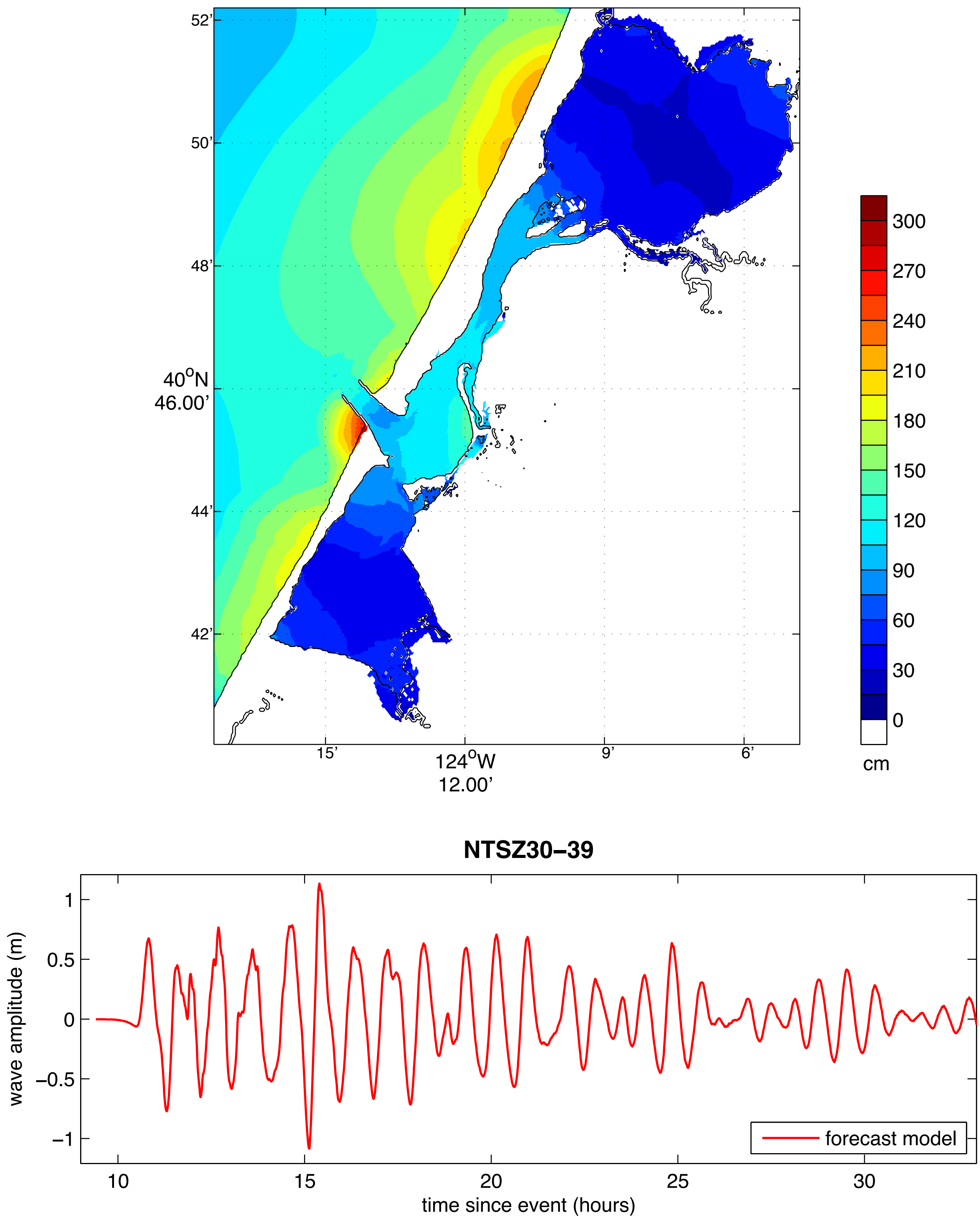


Figure 35 Results from the forecast model for the NTSZ 30-39 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

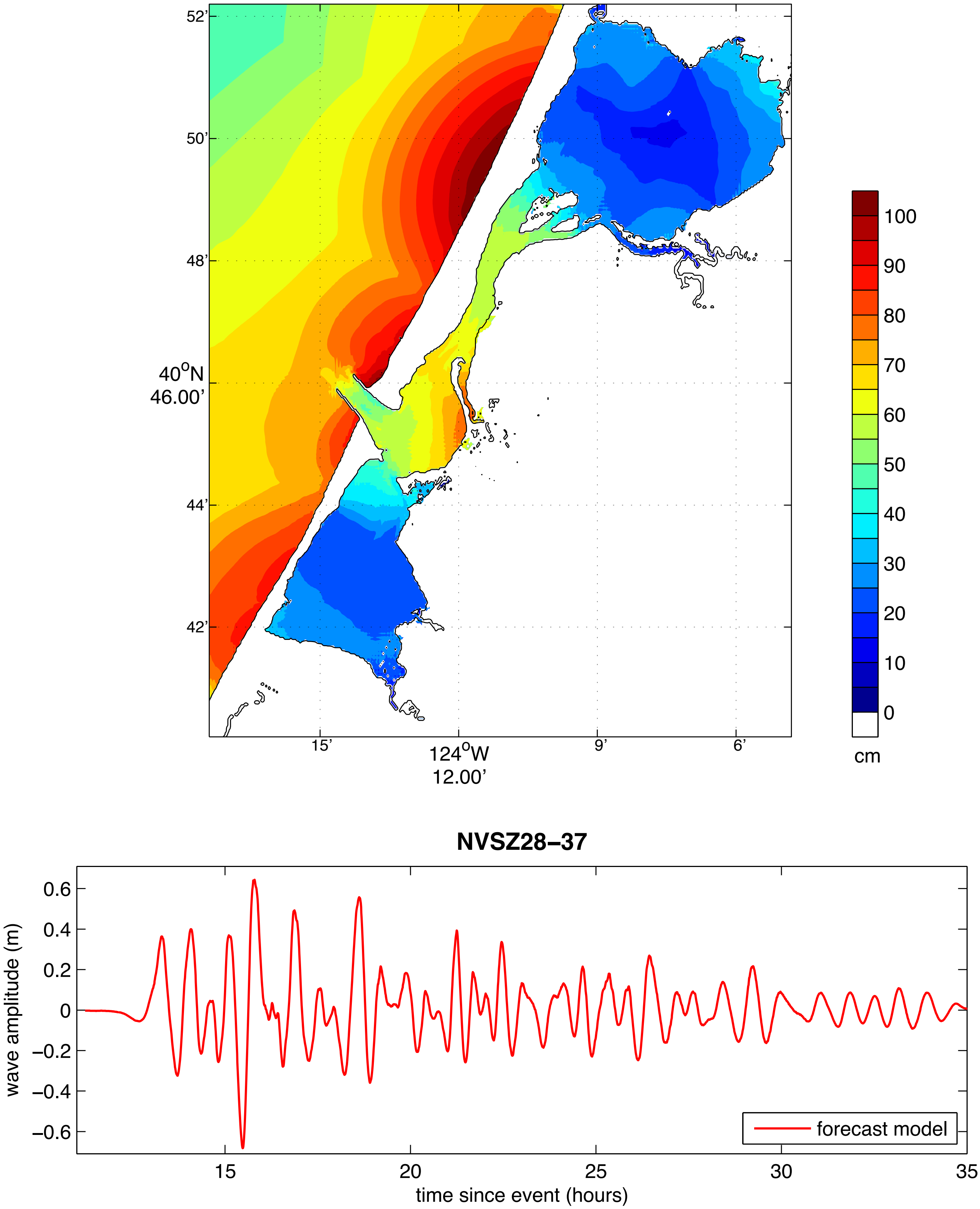


Figure 36 Results from the forecast model for the NVSZ 28-37 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

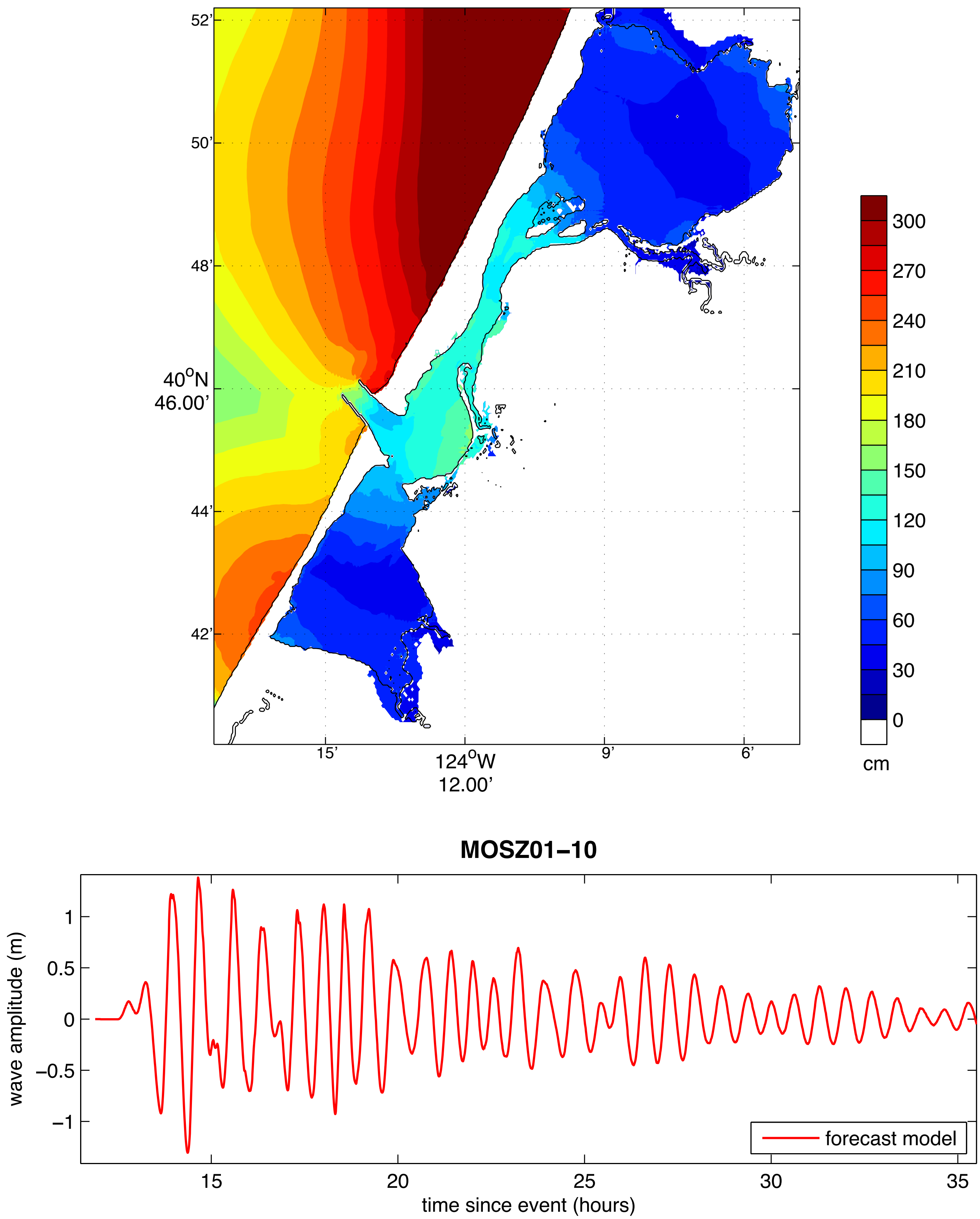
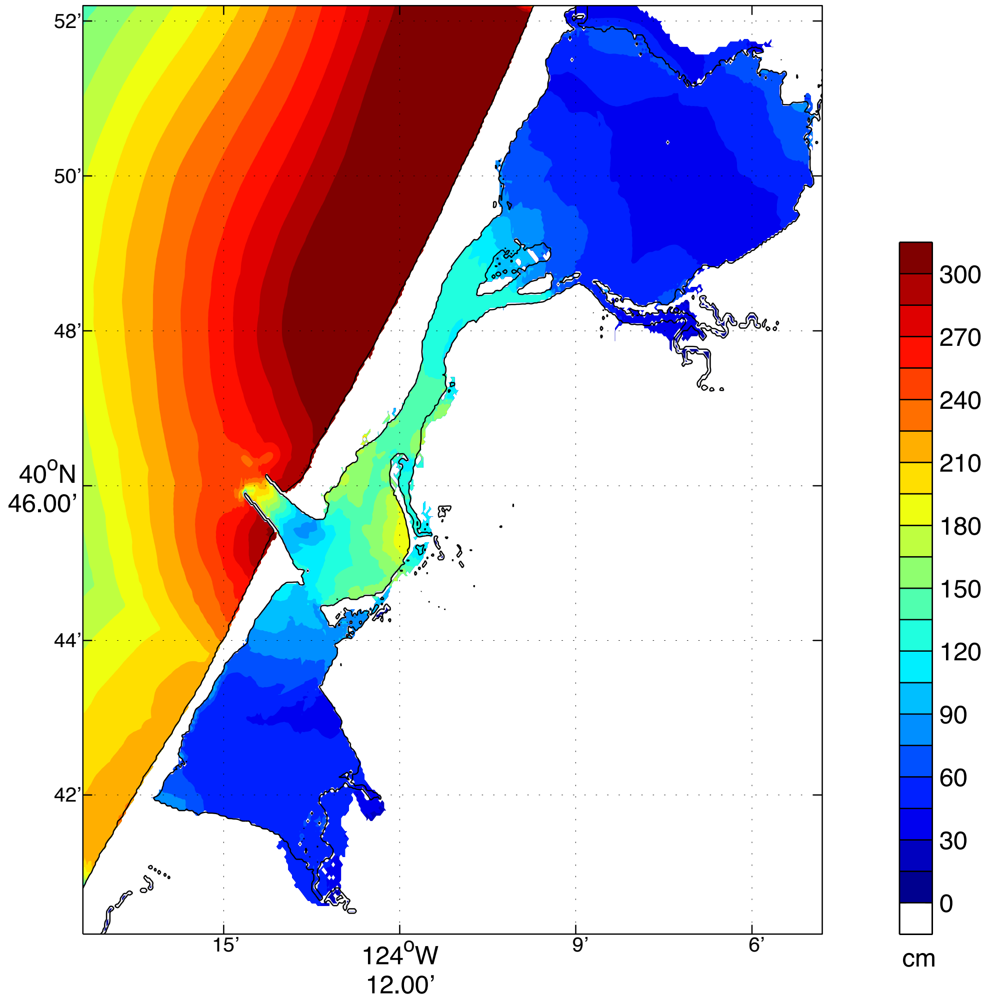


Figure 37 Results from the forecast model for the MOSZ 1-10 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.



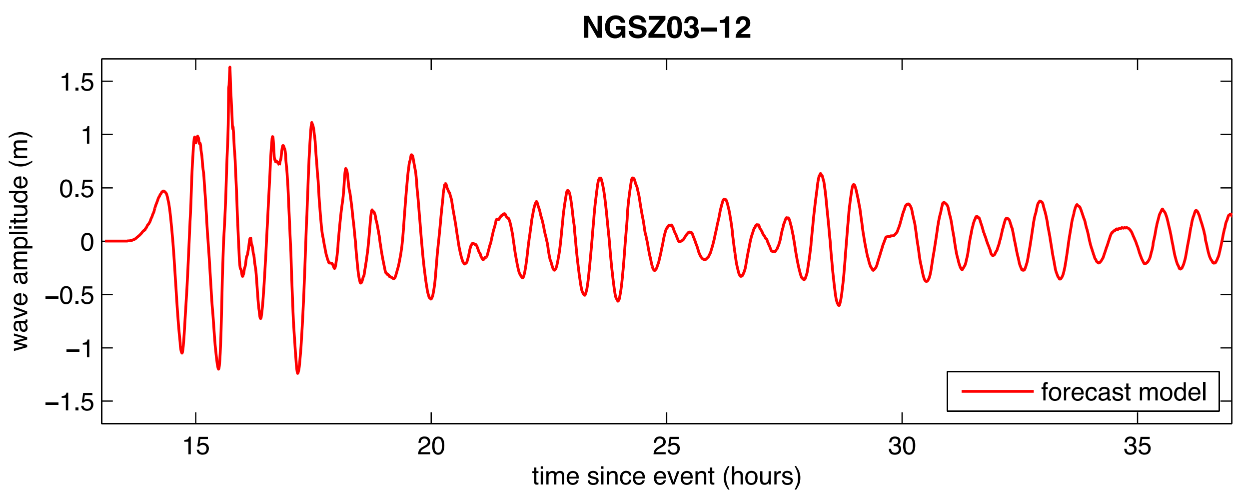


Figure 38 Results from the forecast model for the NGSZ 3-12 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

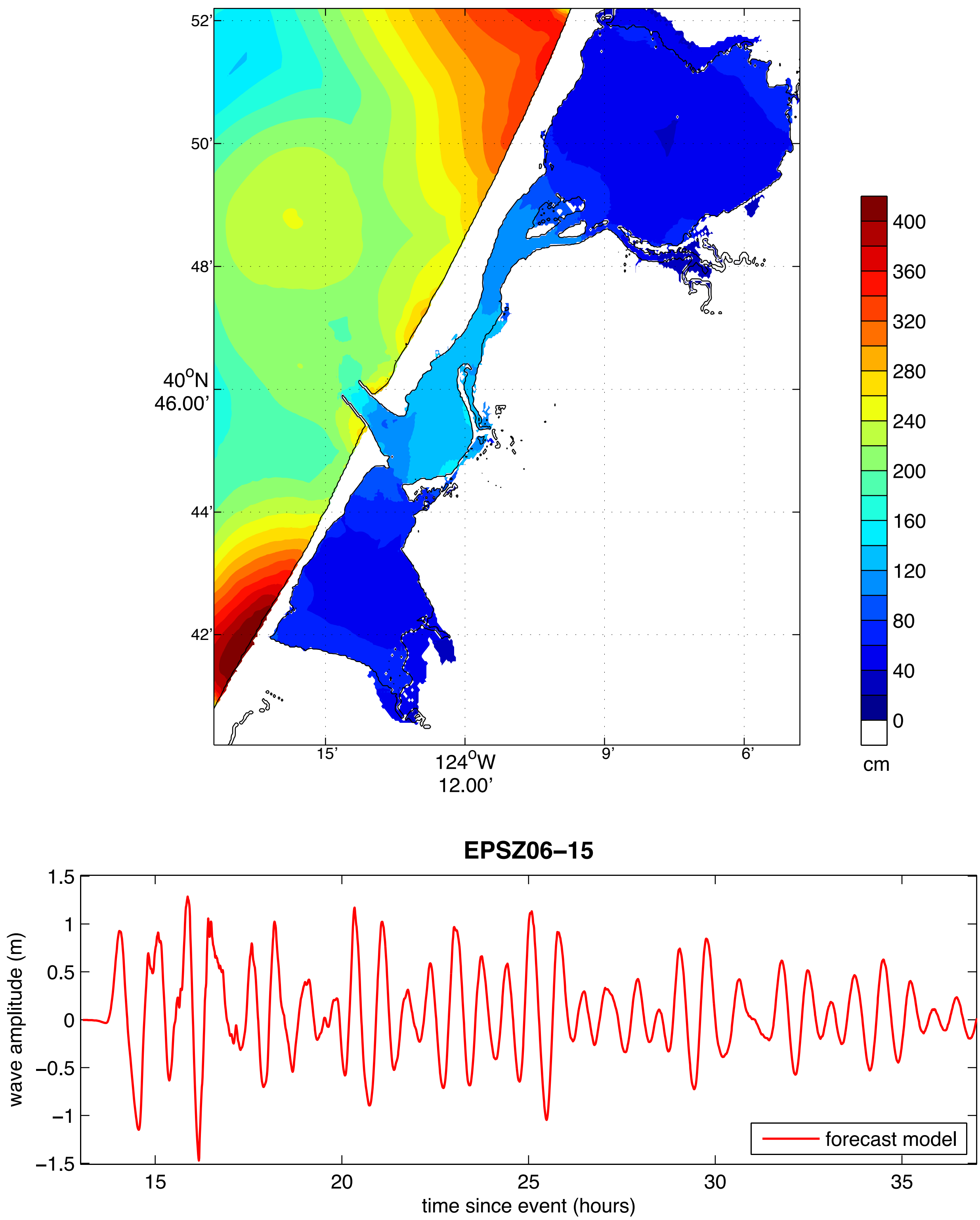


Figure 39 Results from the forecast model for the EPSZ 6-15 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

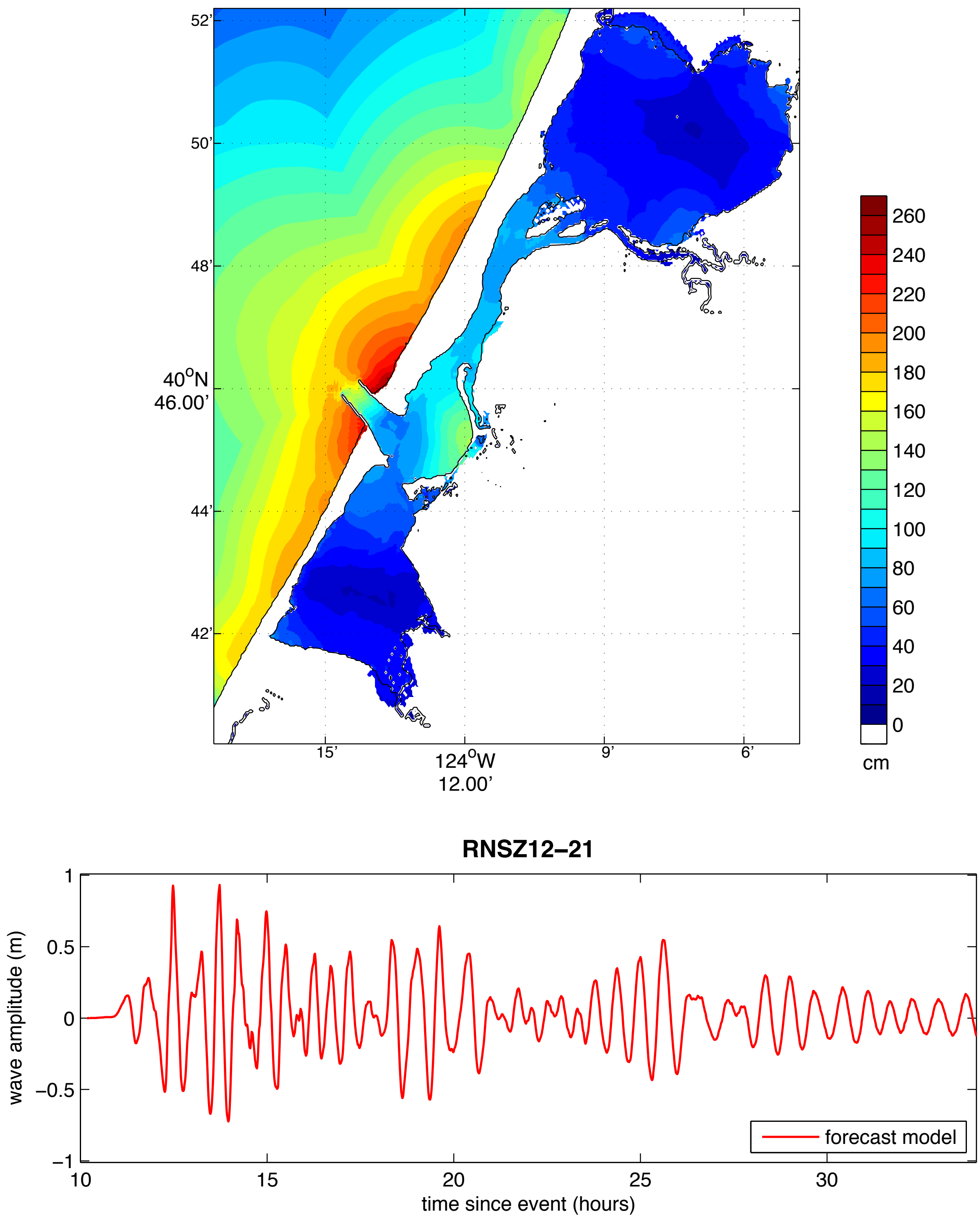


Figure 40 Results from the forecast model for the RNSZ 12-21 synthetic event. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

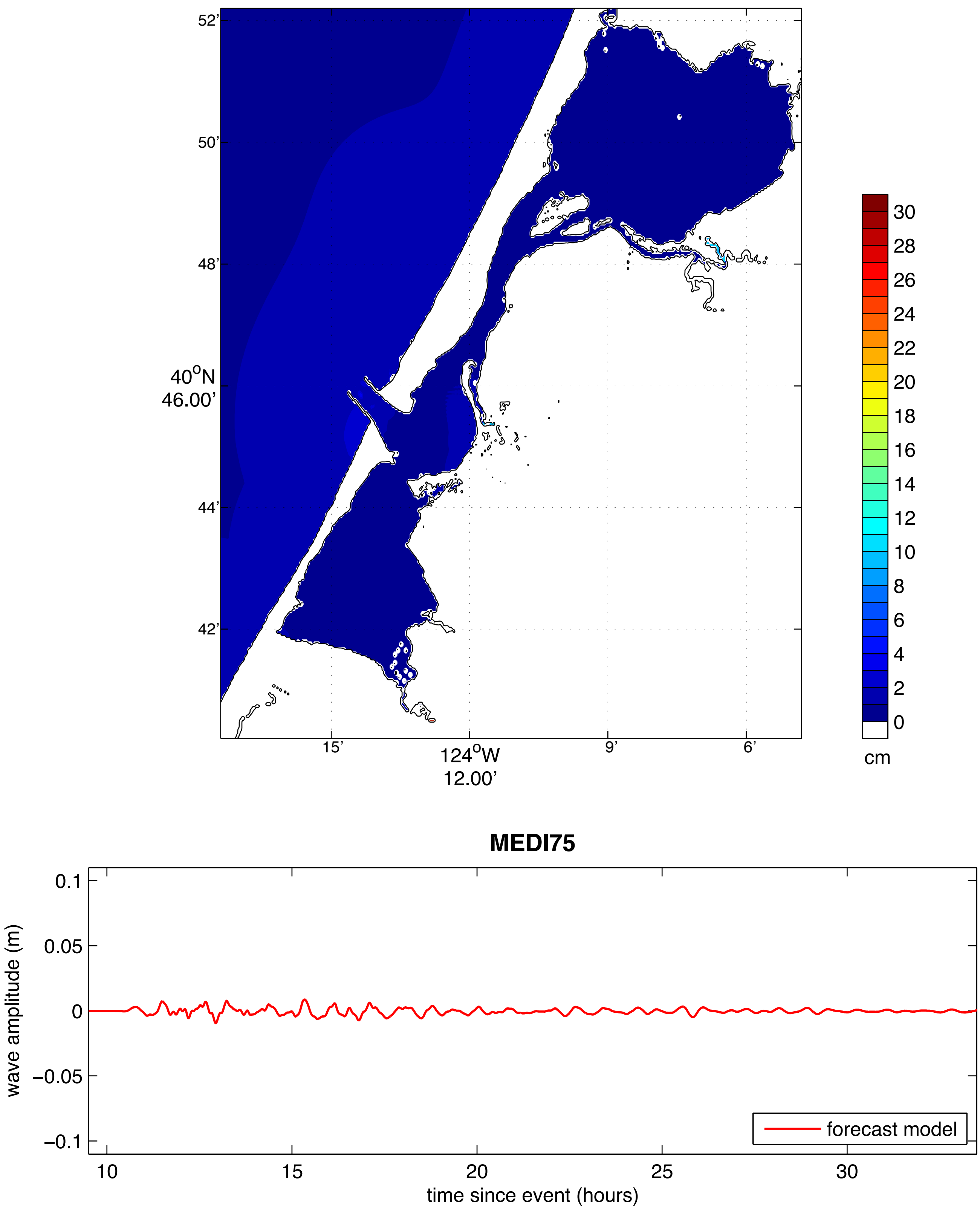


Figure 41 Results from the forecast model for the medium synthetic event, with a 1*NTSZb36 source. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

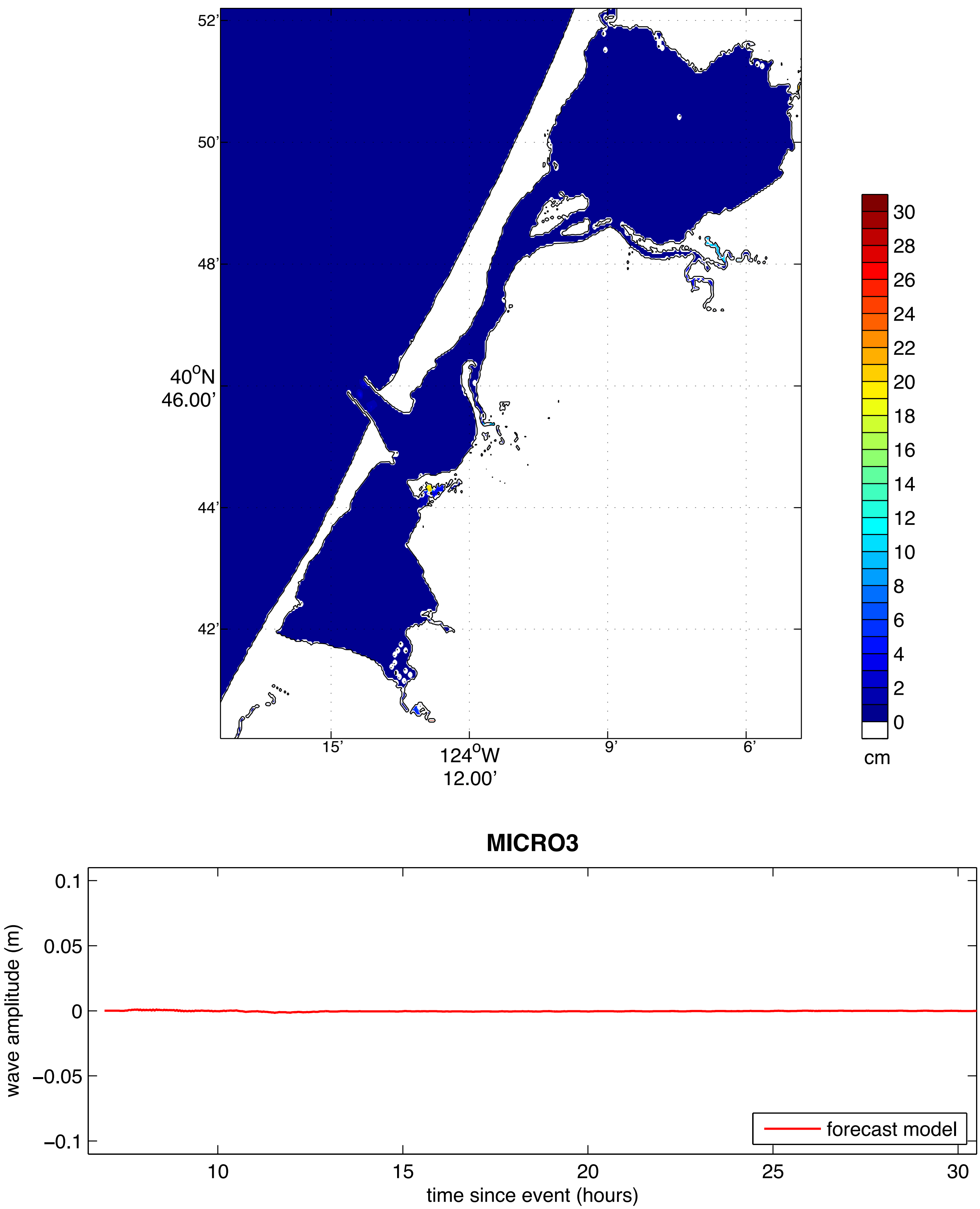


Figure 42 Results from the forecast model for the micro synthetic event which uses a source combination of 0.05*ACSZ b6. The upper panel shows the map of predicted maximum wave height in the Eureka C-grid and the lower panel shows the time series of wave amplitude at the tide gauge location.

Appendix A

Development of the Eureka, California tsunami forecast model occurred prior to parameter changes that were made to reflect modifications to the MOST model code. As a result, the input file for running both the optimized tsunami forecast model and the high-resolution reference inundation model in MOST have been updated accordingly. Appendix A1 and A2 provide the updated files for Eureka.

A1. Reference model *.infile for Eureka, California

```
0.0001  Minimum amplitude of input offshore wave (m)
5.0     Input minimum depth for offshore (m)
0.1     Input "dry land" depth for inundation (m)
0.0009  Input friction coefficient (n**2)
1       A & B-grid runup flag (0=disallow, 1=allow runup)
100.0   Blow-up limit (maximum eta before blow-up)
0.3     Input time step (sec)
120000  Input number of steps
9       Compute "A" arrays every nth time step, n=
3       Compute "B" arrays every nth time step, n=
360     Input number of steps between snapshots
0       ...Starting from
1       ...Saving grid every nth node, n=1
```

A2. Forecast model *.infile for Eureka, California

```
0.0001  Minimum amplitude of input offshore wave (m)
5.0     Input minimum depth for offshore (m)
0.1     Input "dry land" depth for inundation (m)
0.0009  Input friction coefficient (n**2)
1       A & B-grid runup flag (0=disallow, 1=allow runup)
100.0   Blow-up limit (maximum eta before blow-up)
1.6     Input time step (sec)
54000   Input number of steps
5       Compute "A" arrays every nth time step, n=
2       Compute "B" arrays every nth time step, n=
20      Input number of steps between snapshots
0       ...Starting from
1       ...Saving grid every nth node, n=1
```

Appendix B. Propagation Database: Pacific Ocean Unit Sources

Propagation source details reflect the database as of January 29, 2013. The development of Eureka, California forecast inundation model uses the propagation database as of 2011 thus there is a possibility of changes due to updates in the earthquake source parameters after this date.

Appendix B

Propagation Database: Pacific Ocean Unit Sources

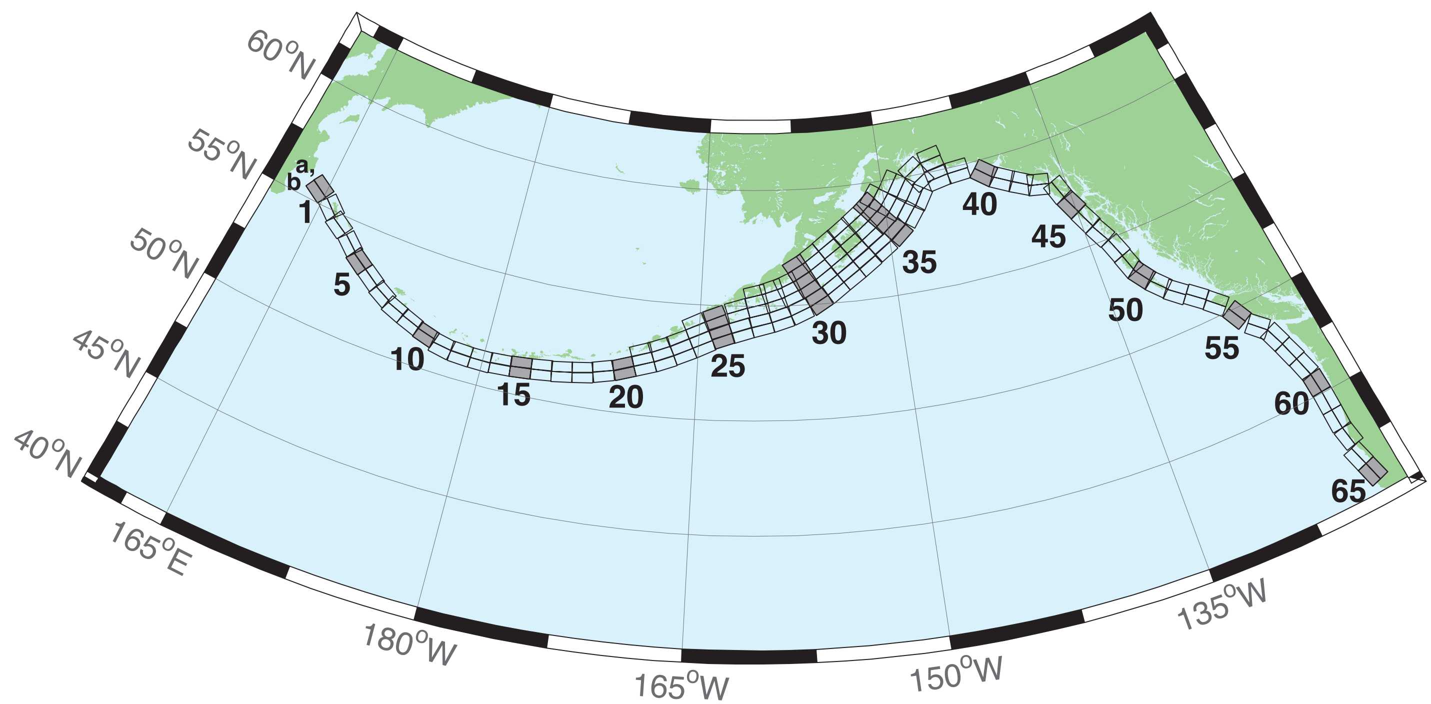


Figure B.1: Aleutian–Alaska–Cascadia Subduction Zone unit sources.

Table B.1: 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
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

Continued on next page

Table B.1 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

Continued on next page

Table B.1 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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
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

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Table B.1 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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

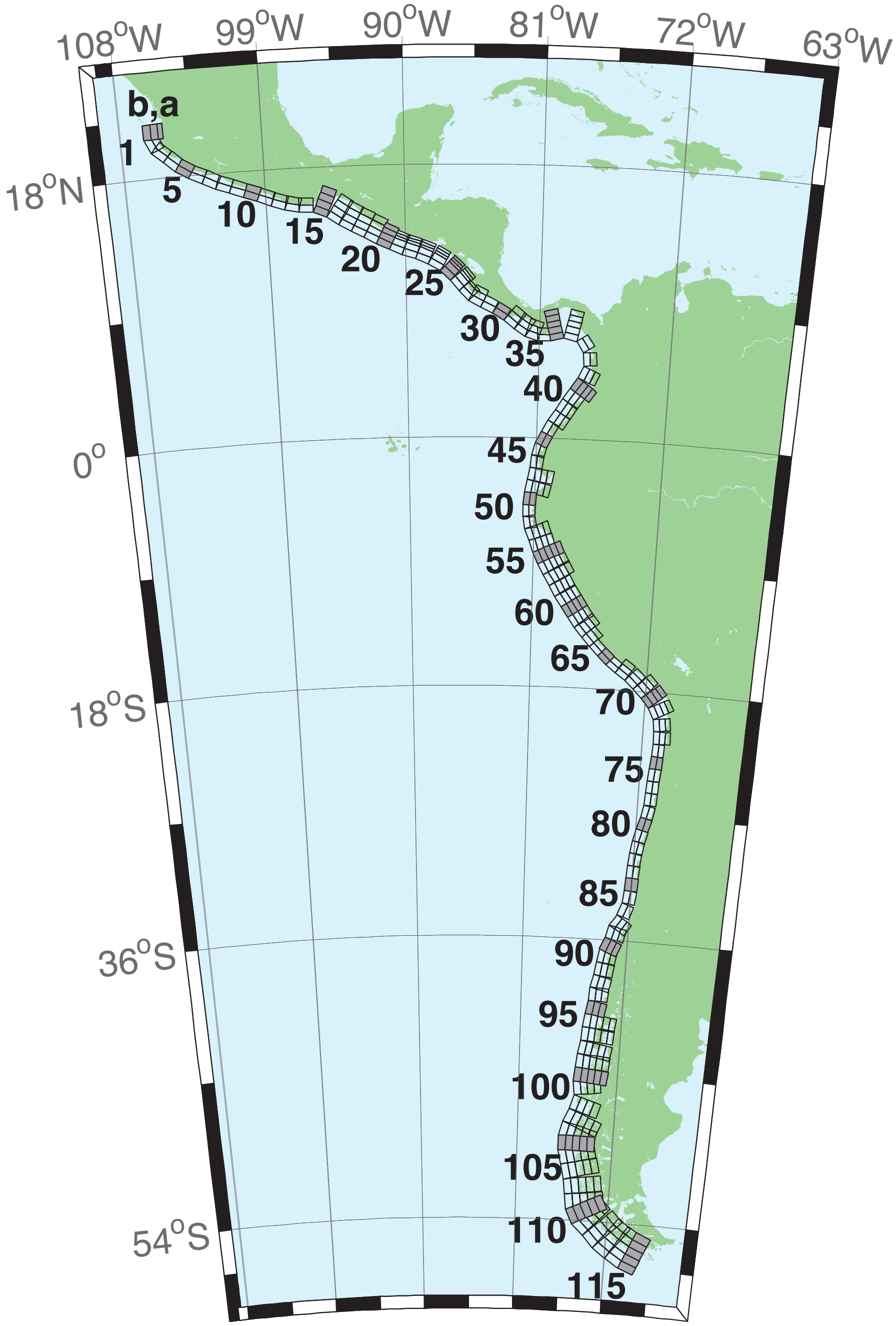

Figure B.2: Central and South America Subduction Zone unit sources.

Table B.2: 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
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

Continued on next page

Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

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Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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
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

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Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

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Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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
cssz–92a	Central and South America	286.4254	-38.0945	8.23	20	11.96

Continued on next page

Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

Continued on next page

Table B.2 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

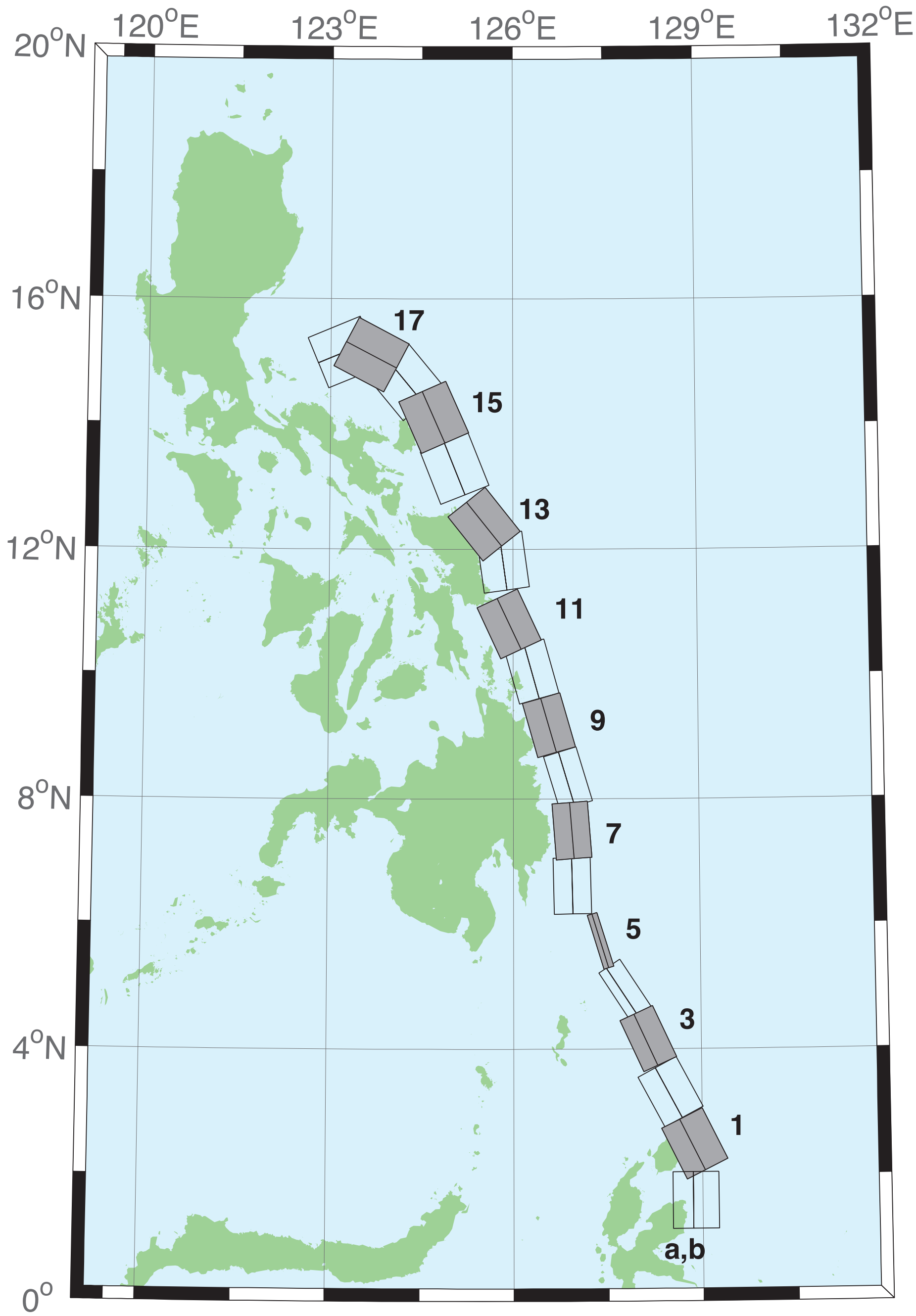

Figure B.3: Eastern Philippines Subduction Zone unit sources.

Table B.3: 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

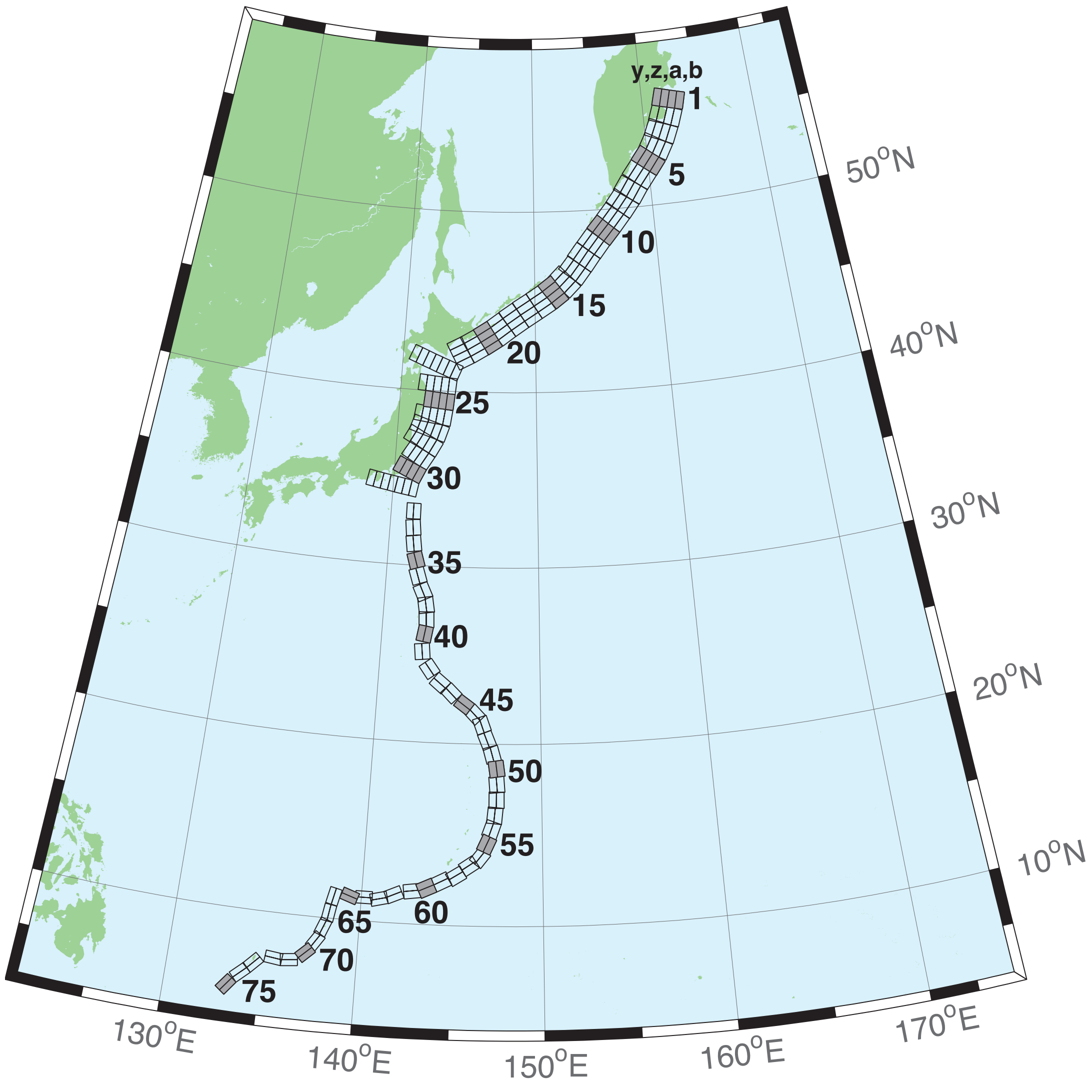

Figure B.4: Kamchatka-Kuril-Japan-Izu-Mariana-Yap Subduction Zone unit sources.

Table B.4: Earthquake parameters for Kamchatka-Kuril-Japan-Izu-Mariana-Yap Subduction Zone unit sources.

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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–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–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

Continued on next page

Table B.4 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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–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
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

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Table B.4 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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
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

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Table B.4 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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
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

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Table B.4 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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

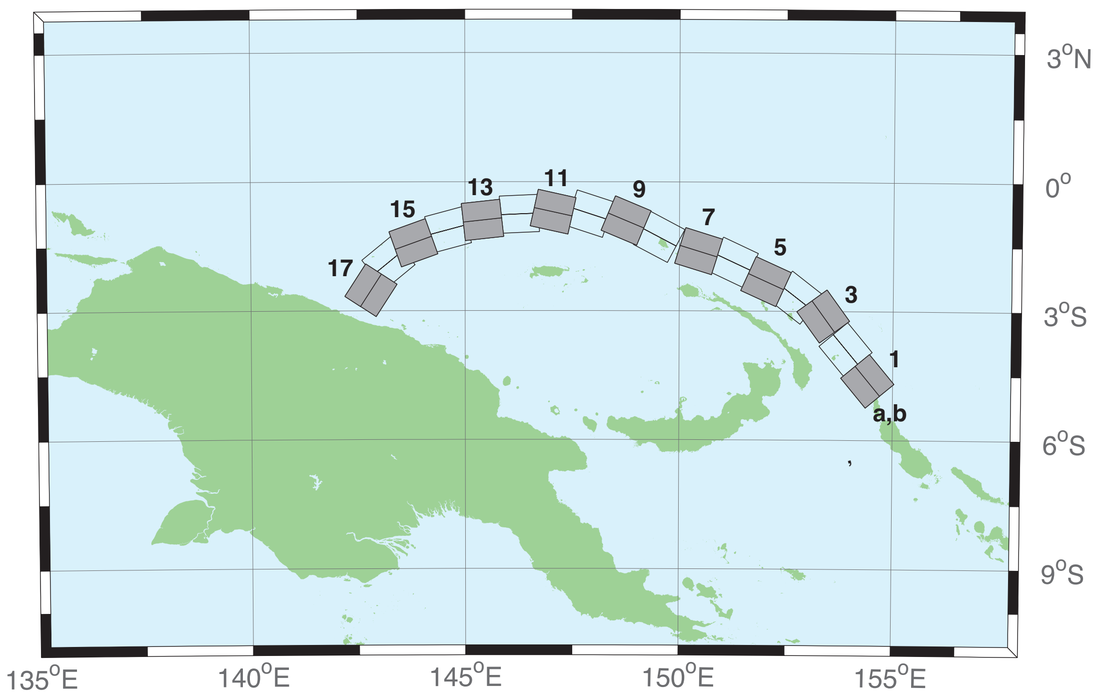

Figure B.5: Manus–Oceanic Convergent Boundary Subduction Zone unit sources.

Table B.5: 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	5
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	5.35
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	6.31
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	7.39
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	8.25
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	7.58
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	6.83
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	7.92
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	8.3
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	8.09
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	7.64
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	7.62
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	7.08
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	6.38
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	6.09
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	5
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	5

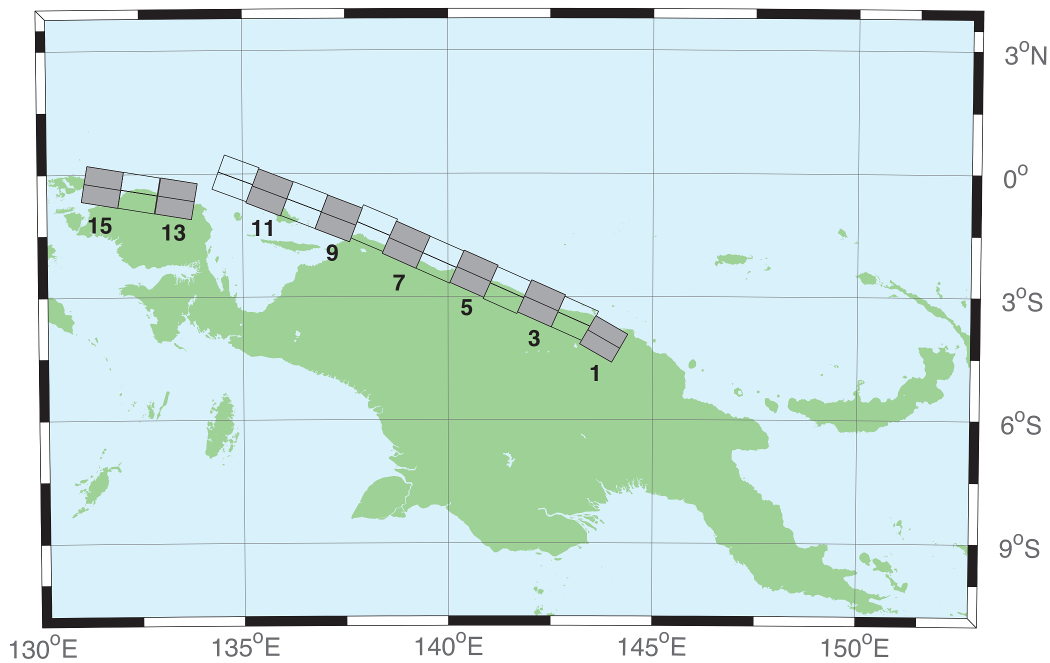

Figure B.6: New Guinea Subduction Zone unit sources.

Table B.6: 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

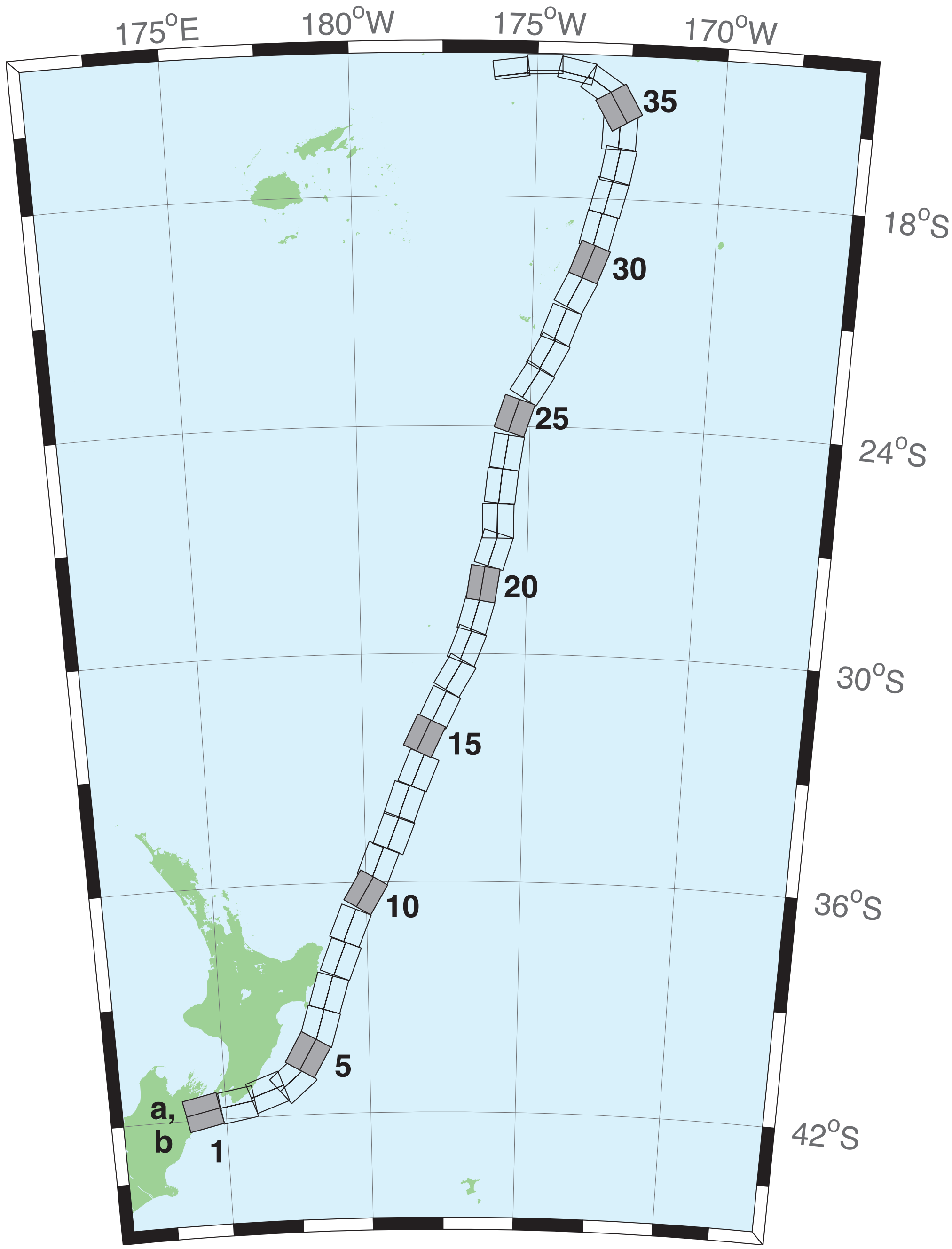

Figure B.7: New Zealand–Keradec–Tonga Subduction Zone unit sources.

Table B.7: Earthquake parameters for New Zealand–Keradec–Tonga Subduction Zone unit sources.

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
ntsz–1a	New Zealand–Keradec–Tonga	174.0985	-41.3951	258.6	24	25.34
ntsz–1b	New Zealand–Keradec–Tonga	174.2076	-41.7973	258.6	24	5
ntsz–2a	New Zealand–Keradec–Tonga	175.3289	-41.2592	260.6	29.38	23.17
ntsz–2b	New Zealand–Keradec–Tonga	175.4142	-41.6454	260.6	21.31	5
ntsz–3a	New Zealand–Keradec–Tonga	176.2855	-40.9950	250.7	29.54	21.74
ntsz–3b	New Zealand–Keradec–Tonga	176.4580	-41.3637	250.7	19.56	5
ntsz–4a	New Zealand–Keradec–Tonga	177.0023	-40.7679	229.4	24.43	18.87
ntsz–4b	New Zealand–Keradec–Tonga	177.3552	-41.0785	229.4	16.1	5
ntsz–5a	New Zealand–Keradec–Tonga	177.4114	-40.2396	210	18.8	19.29
ntsz–5b	New Zealand–Keradec–Tonga	177.8951	-40.4525	210	16.61	5
ntsz–6a	New Zealand–Keradec–Tonga	177.8036	-39.6085	196.7	18.17	15.8
ntsz–6b	New Zealand–Keradec–Tonga	178.3352	-39.7310	196.7	12.48	5
ntsz–7a	New Zealand–Keradec–Tonga	178.1676	-38.7480	197	28.1	17.85
ntsz–7b	New Zealand–Keradec–Tonga	178.6541	-38.8640	197	14.89	5
ntsz–8a	New Zealand–Keradec–Tonga	178.6263	-37.8501	201.4	31.47	18.78
ntsz–8b	New Zealand–Keradec–Tonga	179.0788	-37.9899	201.4	16	5
ntsz–9a	New Zealand–Keradec–Tonga	178.9833	-36.9770	202.2	29.58	20.02
ntsz–9b	New Zealand–Keradec–Tonga	179.4369	-37.1245	202.2	17.48	5
ntsz–10a	New Zealand–Keradec–Tonga	179.5534	-36.0655	210.6	32.1	20.72
ntsz–10b	New Zealand–Keradec–Tonga	179.9595	-36.2593	210.6	18.32	5
ntsz–11a	New Zealand–Keradec–Tonga	179.9267	-35.3538	201.7	25	16.09
ntsz–11b	New Zealand–Keradec–Tonga	180.3915	-35.5040	201.7	12.81	5
ntsz–12a	New Zealand–Keradec–Tonga	180.4433	-34.5759	201.2	25	15.46
ntsz–12b	New Zealand–Keradec–Tonga	180.9051	-34.7230	201.2	12.08	5
ntsz–13a	New Zealand–Keradec–Tonga	180.7990	-33.7707	199.8	25.87	19.06
ntsz–13b	New Zealand–Keradec–Tonga	181.2573	-33.9073	199.8	16.33	5
ntsz–14a	New Zealand–Keradec–Tonga	181.2828	-32.9288	202.4	31.28	22.73
ntsz–14b	New Zealand–Keradec–Tonga	181.7063	-33.0751	202.4	20.77	5
ntsz–15a	New Zealand–Keradec–Tonga	181.4918	-32.0035	205.4	32.33	22.64
ntsz–15b	New Zealand–Keradec–Tonga	181.8967	-32.1665	205.4	20.66	5
ntsz–16a	New Zealand–Keradec–Tonga	181.9781	-31.2535	205.5	34.29	23.59
ntsz–16b	New Zealand–Keradec–Tonga	182.3706	-31.4131	205.5	21.83	5
ntsz–17a	New Zealand–Keradec–Tonga	182.4819	-30.3859	210.3	37.6	25.58
ntsz–17b	New Zealand–Keradec–Tonga	182.8387	-30.5655	210.3	24.3	5
ntsz–18a	New Zealand–Keradec–Tonga	182.8176	-29.6545	201.6	37.65	26.13
ntsz–18b	New Zealand–Keradec–Tonga	183.1985	-29.7856	201.6	25	5
ntsz–19a	New Zealand–Keradec–Tonga	183.0622	-28.8739	195.7	34.41	26.13
ntsz–19b	New Zealand–Keradec–Tonga	183.4700	-28.9742	195.7	25	5
ntsz–20a	New Zealand–Keradec–Tonga	183.2724	-28.0967	188.8	38	26.13
ntsz–20b	New Zealand–Keradec–Tonga	183.6691	-28.1508	188.8	25	5
ntsz–21a	New Zealand–Keradec–Tonga	183.5747	-27.1402	197.1	32.29	24.83
ntsz–21b	New Zealand–Keradec–Tonga	183.9829	-27.2518	197.1	23.37	5
ntsz–22a	New Zealand–Keradec–Tonga	183.6608	-26.4975	180	29.56	18.63
ntsz–22b	New Zealand–Keradec–Tonga	184.0974	-26.4975	180	15.82	5
ntsz–23a	New Zealand–Keradec–Tonga	183.7599	-25.5371	185.8	32.42	20.56
ntsz–23b	New Zealand–Keradec–Tonga	184.1781	-25.5752	185.8	18.13	5
ntsz–24a	New Zealand–Keradec–Tonga	183.9139	-24.6201	188.2	33.31	23.73
ntsz–24b	New Zealand–Keradec–Tonga	184.3228	-24.6734	188.2	22	5
ntsz–25a	New Zealand–Keradec–Tonga	184.1266	-23.5922	198.5	29.34	19.64
ntsz–25b	New Zealand–Keradec–Tonga	184.5322	-23.7163	198.5	17.03	5
ntsz–26a	New Zealand–Keradec–Tonga	184.6613	-22.6460	211.7	30.26	19.43
ntsz–26b	New Zealand–Keradec–Tonga	185.0196	-22.8497	211.7	16.78	5
ntsz–27a	New Zealand–Keradec–Tonga	185.0879	-21.9139	207.9	31.73	20.67

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Table B.7 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
ntsz–27b	New Zealand–Keradec–Tonga	185.4522	-22.0928	207.9	18.27	5
ntsz–28a	New Zealand–Keradec–Tonga	185.4037	-21.1758	200.5	32.44	21.76
ntsz–28b	New Zealand–Keradec–Tonga	185.7849	-21.3084	200.5	19.58	5
ntsz–29a	New Zealand–Keradec–Tonga	185.8087	-20.2629	206.4	32.47	20.4
ntsz–29b	New Zealand–Keradec–Tonga	186.1710	-20.4312	206.4	17.94	5
ntsz–30a	New Zealand–Keradec–Tonga	186.1499	-19.5087	200.9	32.98	22.46
ntsz–30b	New Zealand–Keradec–Tonga	186.5236	-19.6432	200.9	20.44	5
ntsz–31a	New Zealand–Keradec–Tonga	186.3538	-18.7332	193.9	34.41	21.19
ntsz–31b	New Zealand–Keradec–Tonga	186.7339	-18.8221	193.9	18.89	5
ntsz–32a	New Zealand–Keradec–Tonga	186.5949	-17.8587	194.1	30	19.12
ntsz–32b	New Zealand–Keradec–Tonga	186.9914	-17.9536	194.1	16.4	5
ntsz–33a	New Zealand–Keradec–Tonga	186.8172	-17.0581	190	33.15	23.34
ntsz–33b	New Zealand–Keradec–Tonga	187.2047	-17.1237	190	21.52	5
ntsz–34a	New Zealand–Keradec–Tonga	186.7814	-16.2598	182.1	15	13.41
ntsz–34b	New Zealand–Keradec–Tonga	187.2330	-16.2759	182.1	9.68	5
ntsz–35a	New Zealand–Keradec–Tonga	186.8000	-15.8563	149.8	15	12.17
ntsz–35b	New Zealand–Keradec–Tonga	187.1896	-15.6384	149.8	8.24	5
ntsz–36a	New Zealand–Keradec–Tonga	186.5406	-15.3862	123.9	40.44	36.72
ntsz–36b	New Zealand–Keradec–Tonga	186.7381	-15.1025	123.9	39.38	5
ntsz–37a	New Zealand–Keradec–Tonga	185.9883	-14.9861	102	68.94	30.99
ntsz–37b	New Zealand–Keradec–Tonga	186.0229	-14.8282	102	31.32	5
ntsz–38a	New Zealand–Keradec–Tonga	185.2067	-14.8259	88.4	80	26.13
ntsz–38b	New Zealand–Keradec–Tonga	185.2044	-14.7479	88.4	25	5
ntsz–39a	New Zealand–Keradec–Tonga	184.3412	-14.9409	82.55	80	26.13
ntsz–39b	New Zealand–Keradec–Tonga	184.3307	-14.8636	82.55	25	5

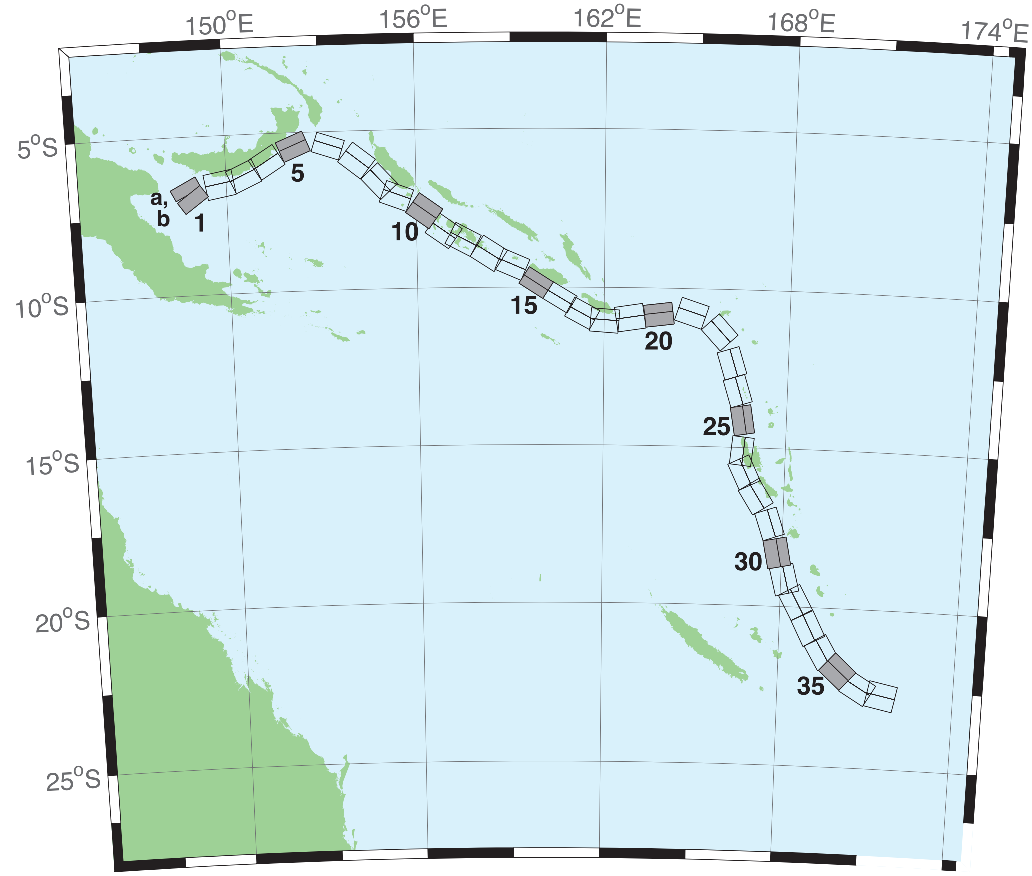

Figure B.8: New Britain–Solomons–Vanuatu Zone unit sources.

Table B.8: 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
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

Continued on next page

Table B.8 – continued

Segment	Description	Longitude(°E)	Latitude(°N)	Strike(°)	Dip(°)	Depth (km)
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

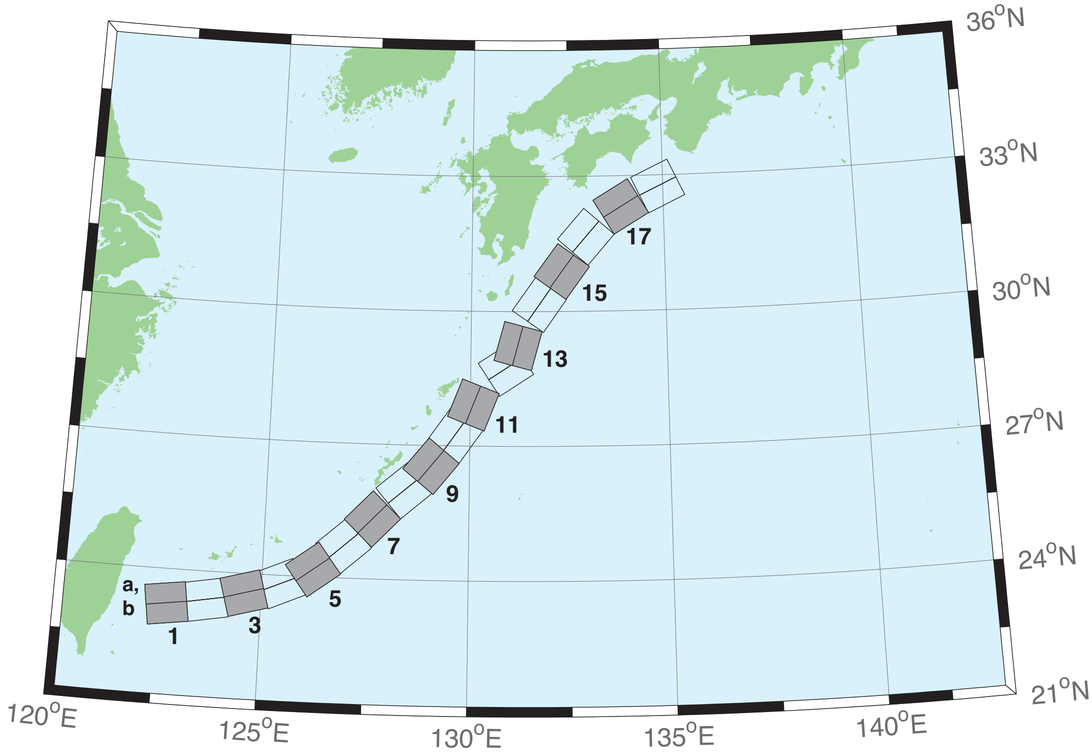

Figure B.9: Ryukyu–Kyushu–Nankai Zone unit sources.

Table B.9: 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

Appendix C – SIFT Testing

Authors: Lindsey Wright, Dylan Righi

1.0 PURPOSE

Forecast models are tested with synthetic tsunami events covering a range of tsunami source locations. Testing is also done with selected historical tsunami events when available.

The purpose of forecast model testing is three-fold. The first objective is to assure that the results obtained with NOAA's tsunami forecast system, which has been released to the Tsunami Warning Centers for operational use, are consistent with those obtained by the researcher during the development of the forecast model. The second objective is to test the forecast model for consistency, accuracy, time efficiency, and quality of results over a range of possible tsunami locations and magnitudes. The third objective is to identify bugs and issues in need of resolution by the researcher who developed the Forecast Model or by the forecast software development team before the next version release to NOAA's two Tsunami Warning Centers.

Local hardware and software applications, and tools familiar to the researcher(s), are used to run the Method of Splitting Tsunamis (MOST) model during the forecast model development. The test results presented in this report lend confidence that the model performs as developed and produces the same results when initiated within the forecast application in an operational setting as those produced by the researcher during the forecast model development. The test results assure those who rely on the Eureka tsunami forecast model that consistent results are produced irrespective of system.

2.0 TESTING PROCEDURE

The general procedure for forecast model testing is to run a set of synthetic tsunami scenarios and a selected set of historical tsunami events through the forecast system application and compare the results with those obtained by the researcher during the forecast model development and presented in the Tsunami Forecast Model Report. Specific steps taken to test the model include:

1. Identification of testing scenarios, including the standard set of synthetic events, appropriate historical events, and customized synthetic scenarios that may have been used by the researcher(s) in developing the forecast model.
2. Creation of new events to represent customized synthetic scenarios used by the researcher(s) in developing the forecast model, if any.
3. Submission of test model runs with the forecast system, and export of the results from A, B, and C grids, along with time series.
4. Recording applicable metadata, including the specific version of the forecast system used for testing.
5. Examination of forecast model results from the forecast system for instabilities in both time series and plot results.
6. Comparison of forecast model results obtained through the forecast system with those obtained during the forecast model development.
7. Summarization of results with specific mention of quality, consistency, and time efficiency.
8. Reporting of issues identified to modeler and forecast software development team.

9. Retesting the forecast models in the forecast system when reported issues have been addressed or explained.

Synthetic model runs were tested on a DELL PowerEdge R510 computer equipped with two Xeon E5670 processors at 2.93 Ghz, each with 12 MBytes of cache and 32GB memory. The processors are hex core and support hyperthreading, resulting in the computer performing as a 24 processor core machine. Additionally, the testing computer supports 10 Gigabit Ethernet for fast network connections. This computer configuration is similar or the same as the configurations of the computers installed at the Tsunami Warning Centers so the compute times should only vary slightly.

Results

The Eureka forecast model was tested with NOAA’s tsunami forecast system version 3.2.

The Eureka forecast model was tested with four synthetic scenarios and one historical tsunami event. Test results from the forecast system and comparisons with the results obtained during the forecast model development are shown numerically in Table 1 and graphically in Figures 1 to 5. The results show that the forecast model is stable and robust, with consistent and high quality results across geographically distributed tsunami sources and mega-event tsunami magnitudes. The model run time (wall clock time) was under 16.3 minutes for 10 hours of simulation time, and 6.5 minutes for 4 hours. This run time is within the 10 minute run time for 4 hours of simulation time and satisfies time efficiency requirements.

Four synthetic events were run on the Eureka forecast model. The modeled scenarios were stable for all cases tested, with no instabilities or ringing. Results show that the largest modeled height was 476 centimeters (cm) and originated in the Aleutian-California-Cascadia (ACSZ 56-65) source. Amplitudes greater than 75 cm were recorded for all of the test sources. The smallest signal of 83 cm was recorded at the far field Central and South America (CSSZ 89-98) source. Direct comparisons of output from the forecast tool with results of both the Tohoku 2011 historical event and available development synthetic events, demonstrated that the wave patterns were similar in shape, pattern and amplitude.

Figures

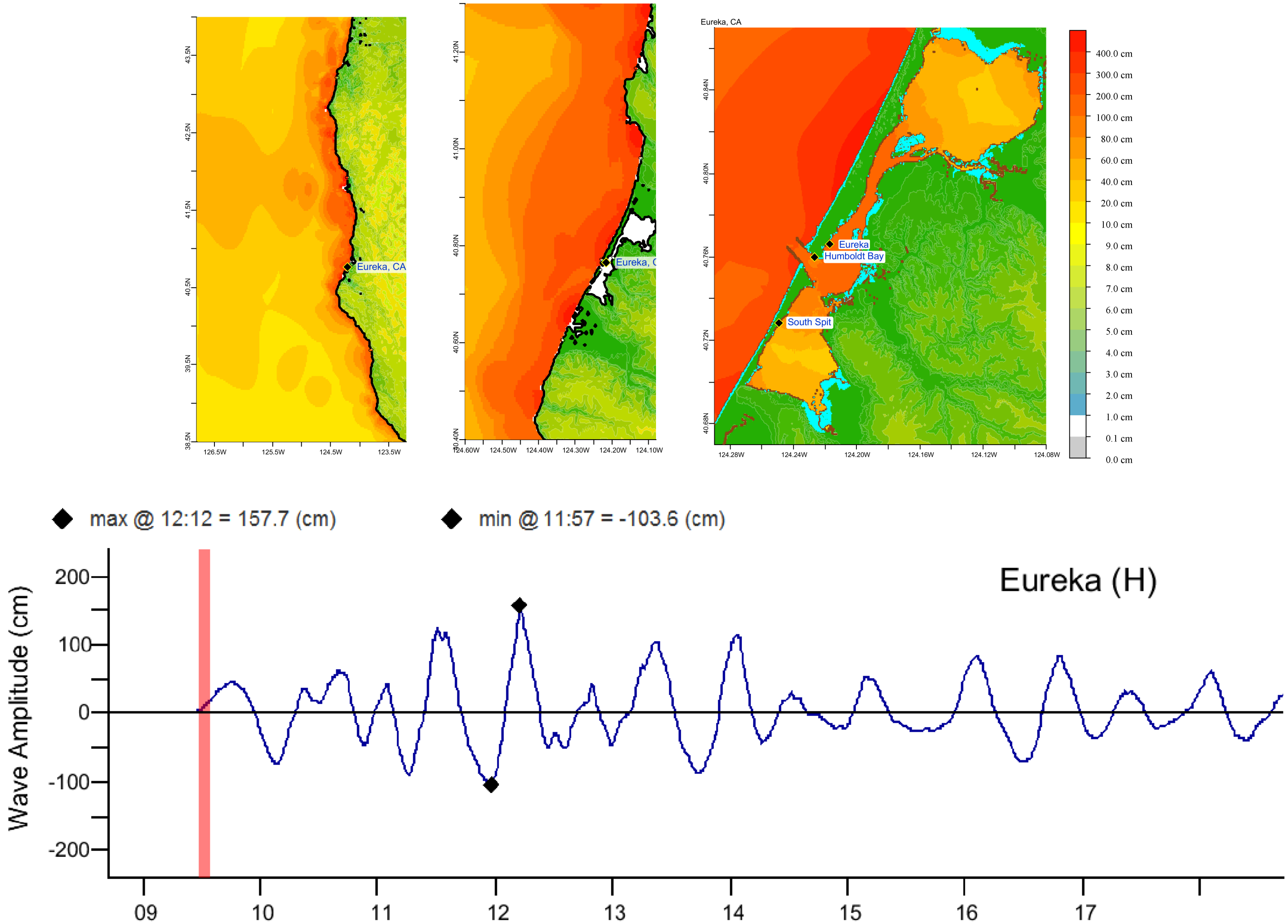

Figure 1: Response of the Eureka forecast model to synthetic scenario KISZ 22-31 (alpha=25). Maximum sea surface elevation for (a) A-grid, b) B-grid, c) C-grid. Sea surface elevation time series at the C-grid warning point (d).

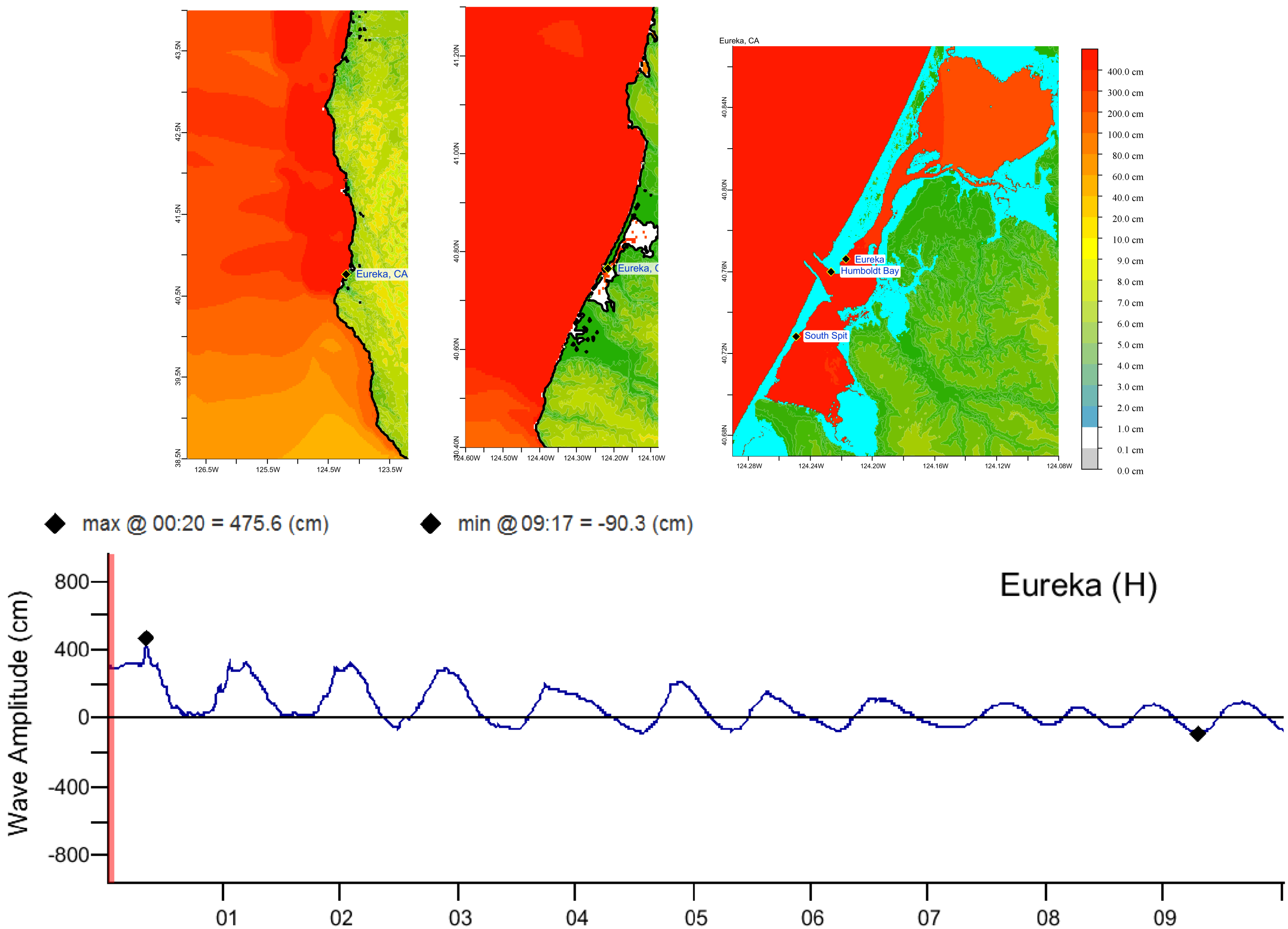

Figure 2: Response of the Eureka forecast model to synthetic scenario ACSZ 56-65 (alpha=25). Maximum sea surface elevation for (a) A-grid, b) B-grid, c) C-grid. Sea surface elevation time series at the C-grid warning point (d).

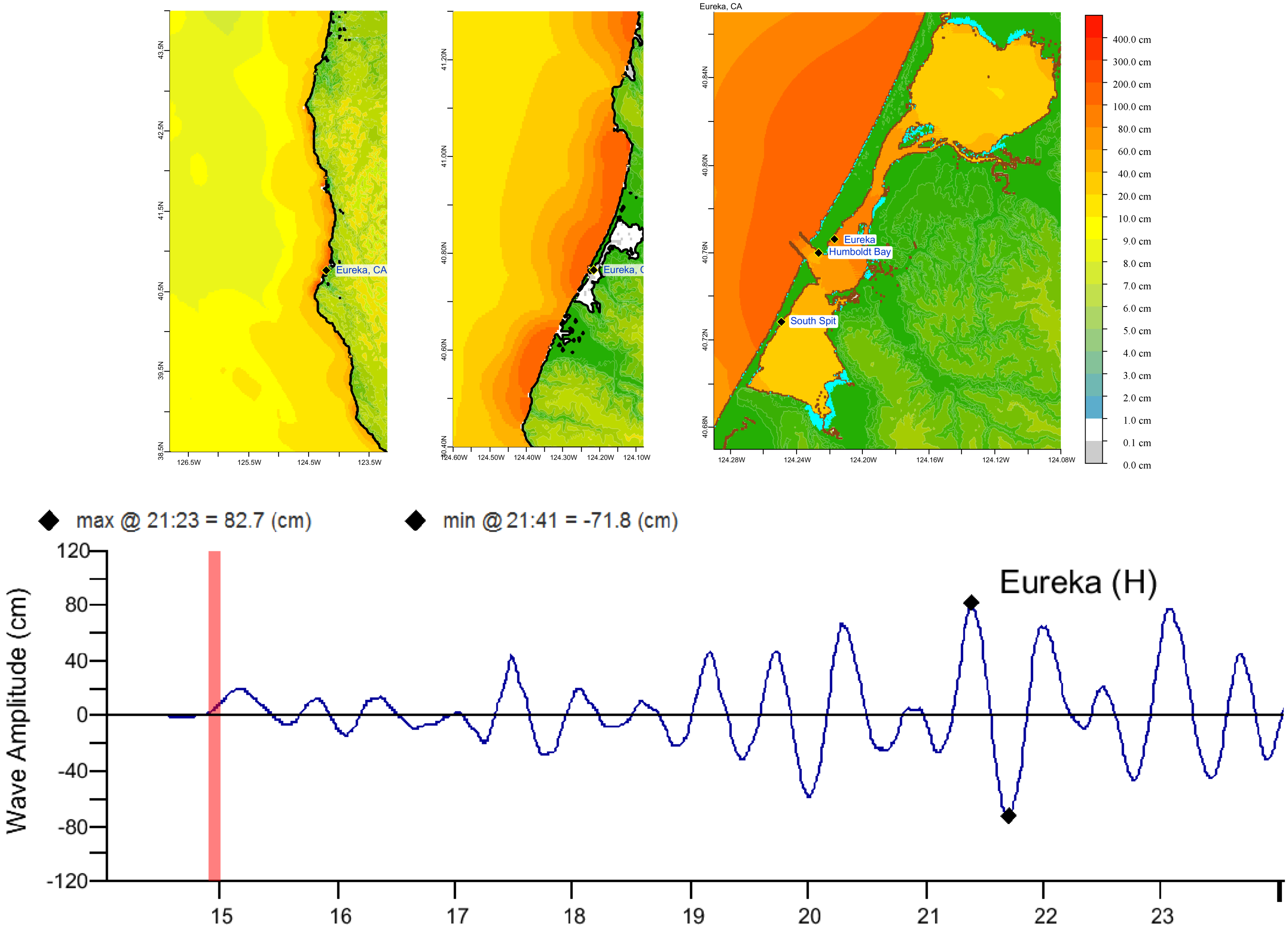

Figure 3: Response of the Eureka forecast model to synthetic scenario CSSZ 89-98 (alpha=25). Maximum sea surface elevation for (a) A-grid, b) B-grid, c) C-grid. Sea surface elevation time series at the C-grid warning point (d).

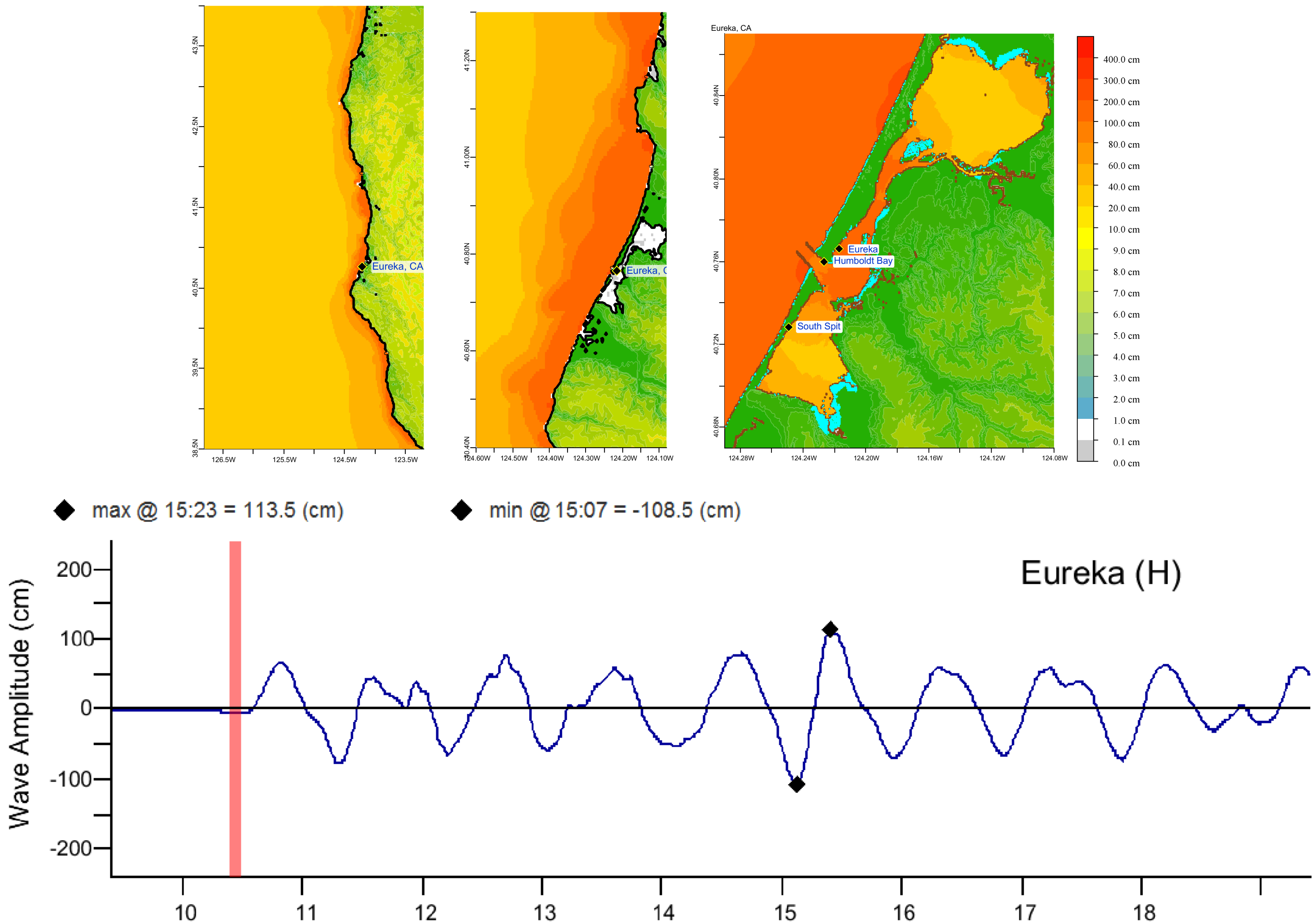

Figure 4: Response of the Eureka forecast model to synthetic scenario NTSZ 30-39 (alpha=25). Maximum sea surface elevation for (a) A-grid, b) B-grid, c) C-grid. Sea surface elevation time series at the C-grid warning point (d).

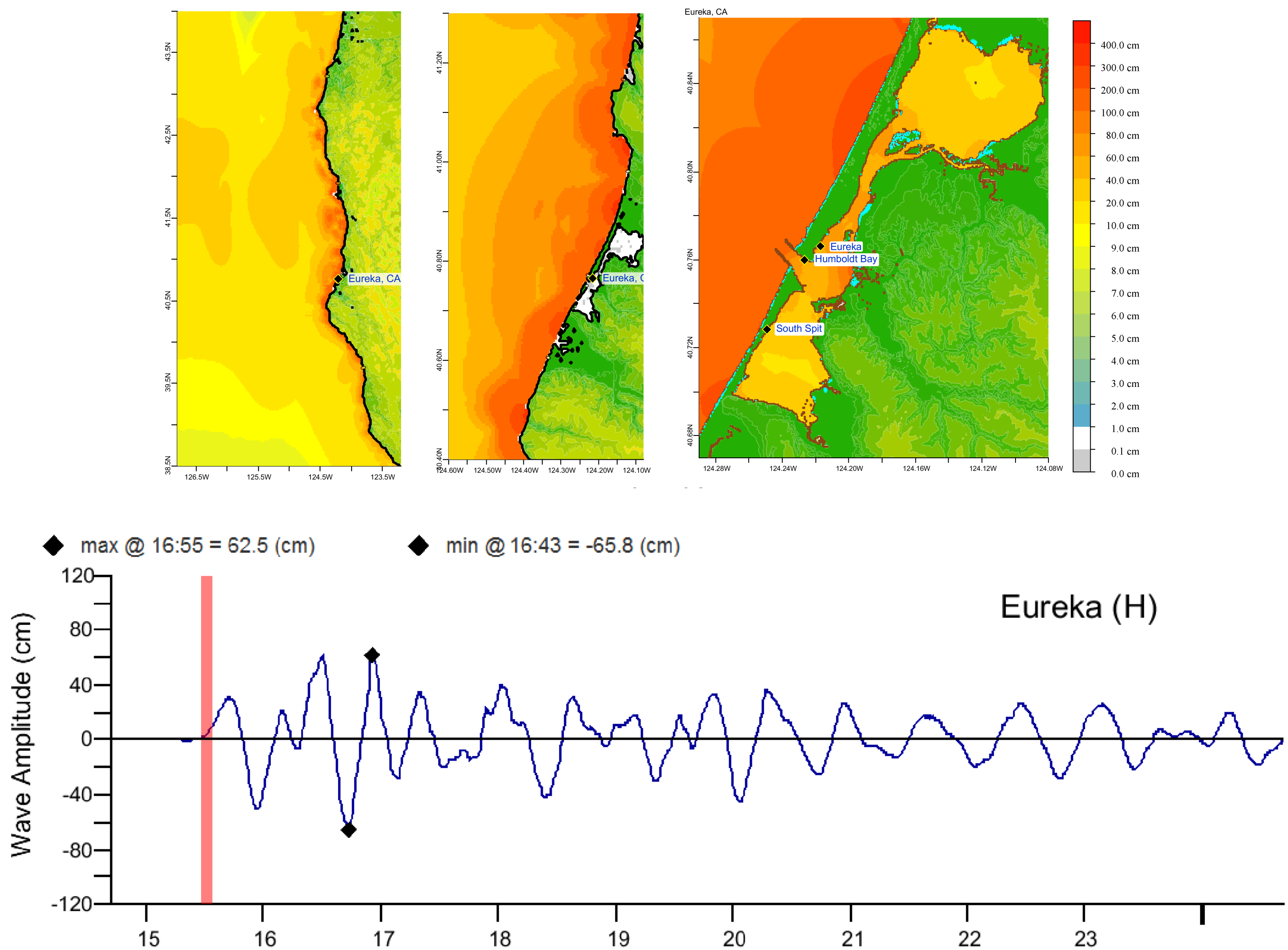

Figure 5: Response of the Eureka forecast model to the 2010 Chile tsunami. Maximum sea surface elevation for (a) A-grid, b) B-grid, c) C-grid. Sea surface elevation time series at the C-grid warning point (d).

Table

Table 1. Table of maximum and minimum amplitudes (cm) at the Eureka, California warning point for synthetic and historical events tested using SIFT 3.2 and obtained during development.

Scenario Name	Source Zone	Tsunami Source	α [m]	SIFT Max (cm)	Development Max (cm)	SIFT Min (cm)	Development Min (cm)
Mega-tsunami Scenarios							
KISZ 22-31	Kamchatka-Yap-Mariana-Izu-Bonin	A22-A31, B22-B31	25	157.7	157.8	-103.6	-103.5
ACSZ 56-65	Aleutian-Alaska-Cascadia	A56-A65, B56-B65	25	475.6	475.6	-90.3	-90.4
CSSZ 89-98	Central and South America	A89-A98, B89-B98	25	82.7	82.7	-71.8	-71.8
NTSZ 30-39	New Zealand-Kermadec-Tonga	A30-A39, B30-B39	25	113.5	113.5	-108.5	-108.5
Historical Events							
Tohoku 2011	Kamchatka-Yap-Mariana-Izu-Bonin			62.5		-65.8	