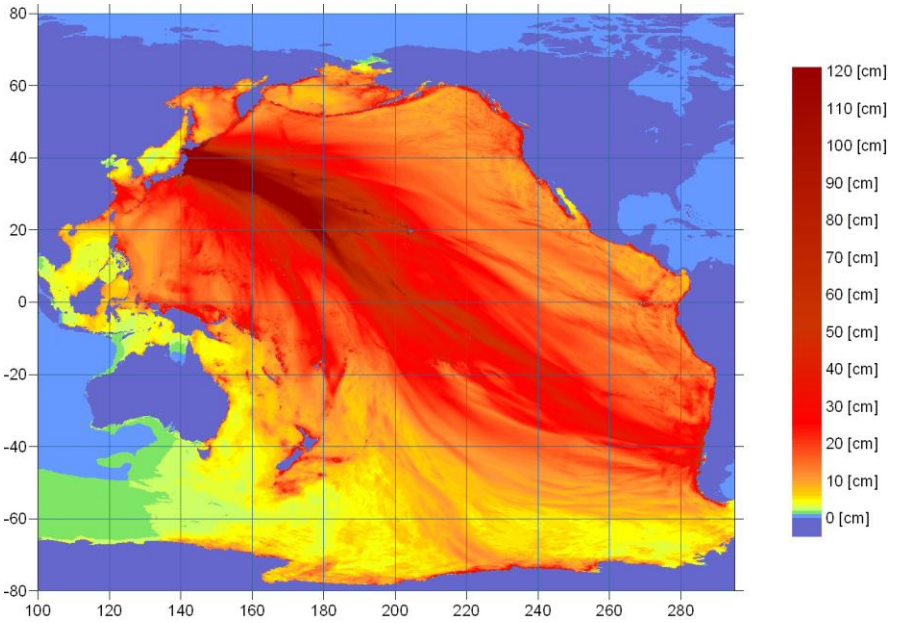
Earth Gauge
A National Environmental Education Foundation Program

Tsunami – March 11, 2011

On March 11, 2011 at 5:46 a.m. Coordinated Universal Time (UTC), a magnitude 8.9 earthquake occurred off the East Coast of Japan, causing widespread damage and a devastating tsunami near the Honshu region, in addition to tsunami activity across the Pacific Ocean, including along the U.S. West Coast, Hawaii and Alaska.

The earthquake was caused by thrust faulting (also known as "dip slip") in the subduction zone on the boundary of the Pacific and North America plates. A *subduction zone* is an area where two tectonic plates meet with one riding over the other. In the region where this earthquake occurred, the Pacific plate slides westward, thrusting under a small section of the North American plate and the Eurasian plate. This area is well known for its seismic activity. The March 11 event was preceded by strong foreshocks starting two days prior and several strong aftershocks have followed.



Left: *Tsunami energy map from the March 11, 2011 earthquake.*

Download *image from NOAA.*

Preliminary Facts

- *Date:* Friday, March 11, 2011
- *Time:* 5:46 a.m. Coordinated Universal Time (UTC); 2:46 p.m. Local Time at epicenter; 12:46 a.m. Eastern Standard Time (EST) (**Other time zones**)
- *Magnitude:* 8.9
- *Depth:* 15.2 miles
- *Location:* 38.322°N, 142.369°E; near the east coast of Honshu, Japan. **View USGS maps**.

Resources

- USGS Description and animation of **thrust faulting**
- USGS Image of the world's **tectonic plates**
- A detailed USGS **summary of the event**
- USGS **Earthquake FAQ page**
- NOAA **Pacific Tsunami Warning Center** and **West Coast and Alaska Tsunami Warning Center**
- USGS **Tsunami Information Links**
- USGS **WaterAlert**

Turn to the next page for basic information about tsunamis and preparedness.

What is a Tsunami?

Tsunami is a Japanese word meaning “harbor wave.” Tsunamis are ocean waves produced by underwater landslides or earthquakes. Tsunamis are not tidal waves – a tsunami is a series of waves that travels in the open ocean at average speeds of 450 miles per hour and up to 600 miles per hour. A tsunami will travel from the Aleutian Islands in Alaska to Hawaii in about five hours and to California in about 6 hours. A tsunami generated off the Portuguese coast will travel to North Carolina in about 8.5 hours.

Tsunami wave heights vary greatly. Tsunami waves in the open ocean have wavelengths that are hundreds of miles long, but a height of only a few feet. As tsunami waves approach coastal areas, wave speed decreases, but height increases. Heights can increase over 10 times as they approach the shoreline. Even if a tsunami does not inundate a coastline, it can still produce dangerous currents that may last for hours in harbors and along the shore.

Read NOAA’s ***Tsunami Story*** to learn more about tsunami generation, propagation, warnings and forecasts.

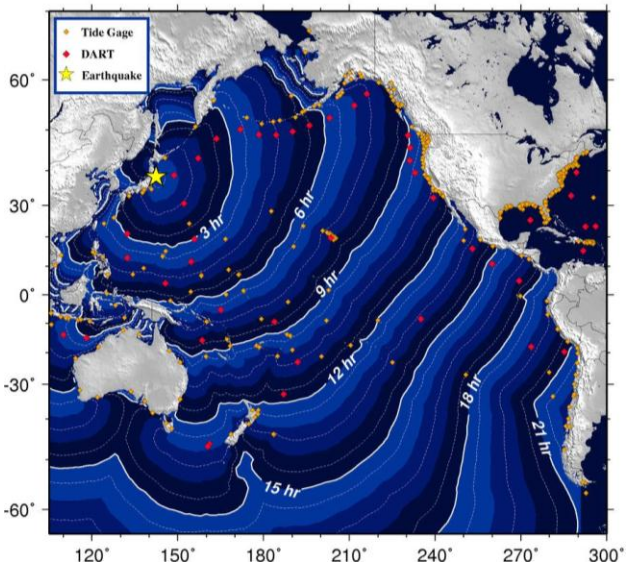
Tsunami Watches and Warnings

A *Tsunami Warning* means that a tsunami is imminent and coastal areas should take action and prepare for flooding.

- Earthquakes over 7.0 magnitude trigger warnings for coastal areas within two hours tsunami travel time from the earthquake epicenter. *Tsunami travel time* is an estimate of the time it will take for tsunami waves to reach a specific location from the earthquake epicenter.
- Earthquakes over 7.5 magnitude trigger warnings for coastal areas within three hours tsunami travel time.
- While earthquake magnitude is used to issue the initial warning, observed water level data is used to restrict, expand or cancel tsunami warnings.

A *Tsunami Watch* is issued in areas outside of the warning area and is based on the magnitude of the earthquake.

- Earthquakes over 7.0 magnitude trigger watches for coastal areas within one hour tsunami travel time outside the warning zone.
- Earthquakes over 7.5 magnitude trigger watches for coastal areas within three hours tsunami travel time outside the warning zone.
- Watches will either be upgraded to a warning or canceled, depending on the tsunami severity.



Above: *Tsunami travel times estimate from the March 11, 2011 earthquake.* ***Download*** *image from NOAA.*

What to do when a Tsunami Warning is Issued

Unlike storms that can be tracked days in advance, tsunamis cannot be predicted. This means that tsunami warning centers only have a few hours at most to forecast landfall and wave heights.

Look for tsunami warning signs from nature:

- A strong earthquake – one that lasts longer than 20 seconds or knocks you off your feet – is large enough to produce a tsunami.
- Strange sounds from the ocean or a tide that quickly recedes from the shore can indicate the leading edge of a tsunami wave.

If you see these signs, move inland one mile and get 100 feet or more above sea level. If that is not possible, get into a well-constructed building, well above ground floor – this is called *vertical evacuation*.

Find additional preparedness tips and learn more about tsunamis at **NOAA’s Tsunami page**.

Above: *A tsunami strikes Sri Lanka in 2004.* ***Download*** *image from NASA Earth Observatory.*