Development History

Research

From 1982-1986, the Pacific Marine Environmental Laboratory (PMEL) developed a reliable deep ocean bottom pressure recorder (BPR). In 1986, a long-term research field program was begun to use the BPR to collect quality deep-water data during a tsunami. Nearly 100 one-year deployments in the next decade showed that tsunami waves could be routinely captured in the deep ocean.

1st Generation: DART

First generation prototype development began in 1995. In August 2000, four DART systems were deployed and reporting data. This first generation was composed of two separate parts; a BPR and a separately moored surface buoy. The system was capable only of one-way communication and transmitted four sea level observations each hour.

2nd Generation: DART II

Second generation technology was developed ~2004. Two-way communication between the BPR and NOAA Tsunami Warning Centers allowed for on-demand command and control. The 2004 Indian Ocean tsunami fueled development of the U.S. DART tsunami detection array, which was completed just four years later in 2008 with 39 systems (largely DART IIs) in the Pacific Basin, western Atlantic, and Caribbean Sea. The array is now owned and maintained by the NOAA National Weather Service National Data Buoy Center. DART technology was patented and transferred to industry partner SAIC, who builds and sells DART systems.

3rd Generation: DART-ETD

Developed by PMEL in 2007 to integrate the BPR and surface buoy into one easy to deploy (ETD) system. DART-ETD changed the way deep-water oceanographic moorings were deployed: utilizing small vessels, minimally trained staff, and requiring less than 30 seconds. DART-ETD offers the same two-way communication as DART II and are also available from SAIC. The first commercial deployment was in 2010.

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Contact

For more information about DART technology, please visit website:

http://nctr.pmel.noaa.gov/DART

NOAA Center for Tsunami Research
www.nctr.pmel.noaa.gov

DART 4G

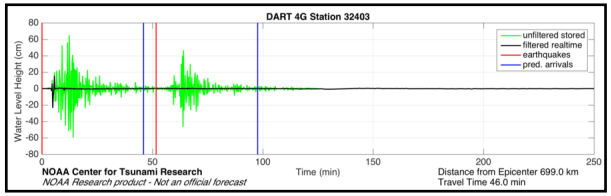
Deep-ocean Assessment and Reporting of Tsunami

4th Generation
Tsunami Observation System

4th Generation: DART 4G

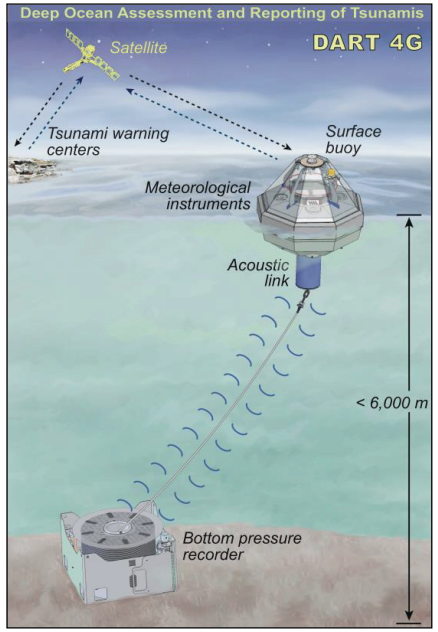
Development on 4th generation DART technology was begun in 2013 for the purpose of forecasting tsunamis in the immediate area of generation. An enhanced version of the DART Easy To Deploy, the DART 4G, incorporates advanced sensors, updated software, and power management to detect and precisely measure tsunamis more frequently than ever before. The increased number of measurements allows for earthquake signals to be separated from tsunami waveforms so that the 4G can be sited closer to where an earthquake occurs than any predecessor DART.

DART 4G systems are deployed offshore Oregon and central Chile for testing. The 4G technology is being transferred to commercial partner SAIC and is under evaluation by the National Weather Service (National Data Buoy Center) for refresh of the DART II operational array technology.



Time series recorded by a test DART 4G deployed offshore Oregon. The green line shows data as stored inside the BPR on the seafloor. The black line shows the same data sent via satellite after processing removed the earthquake signal. The red bars show the time of two earthquakes and the blue bars are predicted time of tsunami arrival.

DART 4G System



The DART 4G system consists of a surface buoy tethered to an anchored seafloor bottom pressure recorder (BPR)

BPR

Detects and measures tsunamis with amplitudes as small as 1 mm in 6,000 m of water.

Surface Buoy

Serves as the communication link between the BPR and Tsunami Warning Center staff. An acoustic modem transmits data from the BPR on the seafloor at regular intervals to the surface buoy. When a tsunami is detected, the BPR sends data to the surface buoy more often. All data sent to the surface buoy are relayed to a ground station via satellite.

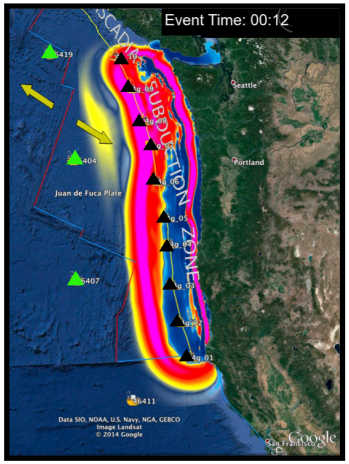
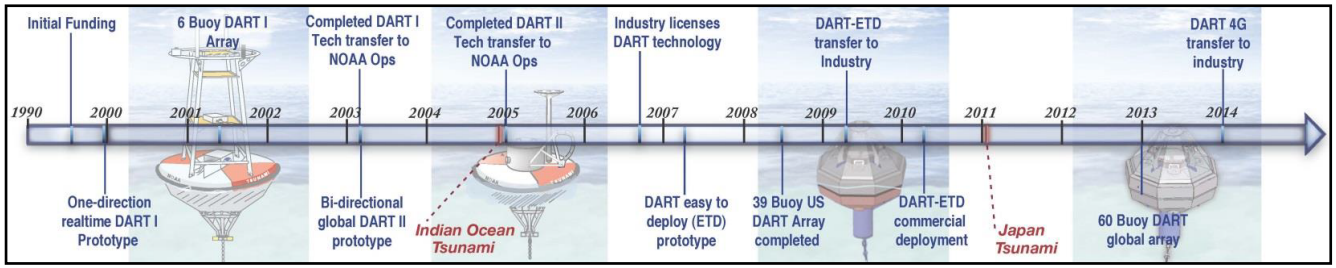
Tsunami Forecasting

Before DART, the source of a tsunami was based only on earthquake data. Now, as a tsunami moves across the ocean and passes over a DART, the system reports actual tsunami measurements to Tsunami Warning Centers. These sea level data are then used to estimate the conditions that generated the tsunami, usually different from the conditions that produced the earthquake. Replacing an earthquake source with a source that matches observations of the wave leads to more accurate model forecasts. This, in turn allows local emergency personnel to take more effective actions to save lives and protect property.

The new detection capabilities of the DART 4G offers populations nearby a tsunami source the potential of receiving early warning and forecasts, now typically afforded those far afield. Modeling scenarios using a network of DART 4Gs along the Cascadia subduction zone show that nearby coastal populations could receive warning faster than ever before, possibly as an earthquake is still rupturing.

A Cascadia subduction rupture scenario with a 4G network (black triangles) envisioned close to the trench along the length of potential rupture. Time of tsunami detection by nearest 4G is expected to be on order of 10 minutes.

Three currently deployed DART II systems are identified by bright green triangles.



DART Development Timeline →