Japan Geoscience Union Meeting 2011
(May 22-27 2011 at Makuhari, Chiba, Japan)

HDS026-P01 Room:Convention Hall Time:May 22 10:30-13:00

Rupture area of the 1958 Etorofu earthquake occurred in Kurile subduction zone estimated from tsunami waveforms

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The great Etorofu earthquake (Mw 8.3) occurred in Kurile-Kamchatka subduction zone on 6 November 1958. A location of the epicenter of the 1958 great earthquake is 44.38?N, 148.58?E, depth = 80 km. This earthquake was originally defined as an interplate earthquake although the depth was slightly deep. However, the earthquake was characterized by a high stress drop, a low aftershock activity at shallow depth, large high-frequency seismic waves, a large felt area, and a relatively small aftershock area. Therefore, the 1958 great earthquake was recently defined as a slab event. The 1963 great Kurile earthquake (Mw 8.5) occurred on the east of the 1958 earthquake. The 1969 great Kurile earthquake (Mw 8.2) and 1994 great Kurile earthquake (Mw 8.3) occurred on west of the 1958 earthquake. The 1963 and 1969 events were interplate earthquakes, but the 1994 event was a slab earthquake. The 1958 earthquake generated a tsunami which propagated through the Pacific Ocean. Maximum height of the observed tsunami was 4-5 m in Shikotan Island. In this paper, parameters (dip, depth, slip amount) of the 1958 great earthquake were estimated using tsunami waveforms recorded at 13 tide gauge stations along the Pacific Ocean. Strike and Rake of the fault model were fixed to be 225 and 90 degrees, respectively. A rupture area previously estimated from aftershocks within 3 days, 150 km*80 km, was used at first. The tsunami was numerically computed using interplate and slab earthquake model changing dip and depth. Parameters of the interplate earthquake model are dip = 20 degree, depth = 16 km. Parameters of slab earthquake models are dip = from 20 to 60 degree every 10 degree, depth = from 27.5 km to 47.5 km every 10 km. We found that a slab earthquake model of dip = 40 degree, depth = 37.5 km best fit observed and computed tsunami waveforms. Next, tsunami waveforms were calculated using various source models which have different rupture area at the same other parameters. However, the computed tsunami waveforms from the original rupture area, 150 km*80 km, best explained the observed tsunami waveforms. The seismic moment was calculated to be 1.5*10**21 Nm (Mw 8.1) assuming that the rigidity is 6.5*10**10 N/m**2.

Keywords: 1958 Etorofu earthquake, Kurile, tsunami, great earthquake

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Finite-difference modeling of tsunami as a seismic wave based on the Cowling approximation of self-gravitation effect

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Since Ward(1980,JPE), farfield tsunami simulations have been done based on the normal mode theory for a self-gravitating global earth model with sea layer. Recently, this method was extended to the modeling of atmospheric gravity wave (infrasound) as well as long-period seismic waves (solid-earth oscillation) and/or tsunami (e.g. Kobayashi, 2007, GJI; Watada, 2009, JFM). In this study, we focus on the shallow part of the earth including sea and use a local version of elastodynamic equation for self-gravitating flat earth model to simulate nearfield tsunami. We simplify the equation by ignoring the perturbation of the gravitation potential (i.e. retaining the initial acceleration of gravity; called the Cowling approximation) and assuming the acceleration of gravity to be constant over the computational domain. We reformulate the equation into a velocity-stress form which is a set of the first-order equations and does not include the displacement but the particle velocity, and discretize it with a staggered-grid finite-difference time-domain method which is often employed for strong-motion simulation. This scheme can model both of seismic waves and tsunami due to nearfield oceanic earthquakes at the same time. In the presentation we will show some computational examples.

Keywords: Tsunami, numerical simulation, Cowling approximation, self-gravitating effect, seismic wave

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Thermal correction at a tsunami frequency of ocean bottom pressure gauges of real-time observatories around Japan

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In-situ ocean bottom pressure (OBP) records obtained from data acquisition system of Hewlett-Packard, Inc. (hereafter HP) are known to include significant, spurious pressure signals correlated to output changes of the mounted thermometer. The data acquisition system of OBP is mostly adapted to cabled, real-time seafloor observatories around Japan. We reported overall dependency of the OBP records on the temperature changes in broad frequency bands from a secular change to a tsunami range (Inazu et al., 2010, Meeting of Seismological Society of Japan). In this paper, effects of rapid temperature changes ($>$ 0.003deg.C/min.) on the OBP records at the tsunami period range ($<$ 30min.) are evaluated and corrected. Similar investigation was conducted by Hirata and Baba (2006) for the station data off Kushiro under JAMSTEC. In this study, OBP data derived from the HP acquisition system at six stations of the off Cape Muroto system (JAMSTEC) and the off Kamaishi system (ERI/Univ. of Tokyo) in addition to the off Kushiro system. The correction suggested in the present study can reduce spurious pressure signals correlated to the rapid temperature changes by millimeters in amplitude at the tsunami period in which representative standard deviation of OBP is around 1 mm. The correction is especially necessary for the OBP records obtained at one station of the Cape Muroto system (MPG2). Because the rapid temperature changes occur most frequently (O (1/day)) at the MPG2 station while such temperature changes are found to occur less frequently ($<$ O (1/year)) at other stations.

Keywords: ocean bottom pressure, tsunami, temperature, correction

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Contribution of DONET to early tsunami forecasting: Brief review and status report

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DONET, i.e., Dense Ocean-floor Network System for Earthquakes and Tsunamis has started in partly operation since 2010. DONET has been developed for the purpose of not only geophysical scientific use but also mega-thrust earthquake-related disaster mitigation. An observatory of DONET consists of various sensors, such as broadband seismometer, seismic accelerometer, tsunami meter, differential pressure gauge, hydrophone, and thermometer. In the current presentation, we focus on tsunami meters, of which a quartz crystal broadband pressure sensor with thermal compensating is employed. We need to evaluate long term sensor drift and carry out tide assimilation in order to extract tsunami component from the original observation with high accuracy. Before deployment of tsunami meter under the ocean-bottom, we carried out the laboratory experiment, which demonstrated both the constant loading pressure of 20 MPa, i.e., equivalent 2,000 meters deep and the constant temperature of 2 degree C environment for duration of one month. Initial sensor drift could be observed to be 5 to 20 centimetres at the end of the laboratory experiment. After the deployment under the ocean-bottom, we compute tide component based on the series of pressure observation by using harmonic coefficient technique. Thus predicted tide component is subtracted from the pressure observation in real-time. Although a few centimetres low frequency residuals remains, we could observe several tsunamis from the recent far-field earthquakes by DONET tsunami meters. About 20 min earlier tsunami detection prior to the coastal tide gauges could be achieved. Thus DONET now can contribute to effective tsunami observation in SW Japan.

Keywords: tsunami, DONET, quartz pressure gauge, Nankai Trough