Field: ***Earth Science/ Geoscience/ Environment***

Planning Group Members:

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Session Topic:

Earthquake, submarine landslides and tsunamis - their causes and effects

With the recent disaster in south-east Asia, geohazards suddenly reached a high public awareness. Events like submarine earthquakes and landslides may generate destructive "tidal waves", or tsunamis, speeding toward shore.

Some of the largest and most recent known landslides worldwide (the Storrega slide northwest off Norway, about 7000 years ago) and the largest documented landslide in Canada (Grand Banks slide, 1929) both occurred in the marine environment. The understanding of submarine landslides has been restricted because of our inability to observe the detailed morphology and structure of the landslide deposits and scars in the past. Modern marine geophysical survey technologies such as multibeam sonar and 3D seismic reflection are capable of providing geomorphologic data at very high resolution.

The session " Earthquakes, submarine landslides and tsunamis - their causes and effects" during the 2nd JGFoS Symposium to be held in Japan will focus on actual scientific knowledge about the reasons for such geohazards, hot spots where these events most likely occur in near future, our current technological ability in prediction and forecasting such destructive events and their socio-economic consequences.

The speakers from Germany are Dr. Marion Jegen-Kulcsar from the IFM-Geomar Leibniz Institute of Marine Sciences at the University of Kiel and Prof. Dr. Achim Kopf from the Research Center Ocean Margins (RCOM) at Bremen University. The speakers from Japan are Prof. Dr. Yuichiro Tanioka from Institute for Seismology and Volcanology of the Hokkaido University and Dr. Masao Nakatani Earthquake Research Institute of the Tokyo University.

Earth Science/ Geoscience/ Environment
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Earthquake, submarine landslides and tsunamis - their causes and effects

Speaker:
Yuichiro Tanioka, Hokkaido University

The 2004 Great Sumatra-Andaman Tsunami

1. Introduction

The source processes of large earthquakes are usually studied using seismological data, waveforms recorded at seismographs located around the world. When large earthquakes occurred beneath the ocean floor, large tsunamis are generated by those earthquakes as well as seismic waves. For example, the 2004 Sumatra-Andaman earthquake generated huge tsunamis which caused the catastrophic disaster: the casualties over 250,000 mostly in Indonesia, Sri Lanka, Thailand, and India. Those tsunamis are typically recorded at tide gauges located along coasts around oceans. The tsunami waveforms recoded at those gauges are useful to study the source processes of large tsunami and earthquakes. In this presentation, we discuss the source processes of the 2004 great Sumatra-Andaman earthquake as an example.

2. Instruments to record tsunamis

Tide gauges are the most typical instruments recording tsunami waveforms. However, more recently, ocean bottom pressure gauges are installed in the deep ocean to observe tsunamis. In Japan, we have six cable systems, and one to three ocean bottom pressure gauges are connected to each cable system. Tsunamis observed at those ocean bottom pressure gauges are not only useful for an early tsunami warning, but also important for earthquake and tsunami source studies. Satellite altimetry can also record large tsunamis such as the 2004 Sumatra tsunami. Actually, two satellite, “Jason-1” and “TOPEX/Poseidon” flew over the Indian Ocean when the 2004 Sumatra tsunami propagated through and recoded the tsunami.

3. Method

Tsunamis are numerically computed using the finite different method (Satake, 2002). The initial condition of the tsunami computation is the ocean bottom deformation caused by a large earthquake. The observed tsunami waveforms recorded at the above instruments are compared with computed tsunami waveforms to study the initial ocean bottom deformation caused by the earthquake. Because the source processes such as fault parameters or size of the faults are responsible for the ocean bottom deformation, we can estimate the source processes of the large earthquake from the observed tsunami waveforms.

4. The source process of the 2004 Sumatra-Andaman earthquake

Rupture process of the 2004 Sumatra-Andaman earthquake is estimated using five tsunami waveforms observed at tide gauges (Sibolga Belawan, Colombo, Vishakhapatnam, and Prot Blair) and tsunami height data obtained from two satellite altimetry data, “Jason-1” and “TOPEX/Poseidon”. The coseismic vertical deformation surveyed along the coast of Sumatra Island, Nicobar Islands, and Andaman Islands, are also used to constrain the fault model.

The average rupture speed of the 2004 Sumatra-Andaman earthquake is estimated to be about 2 km/s from tsunami waveform analysis. The rupture extends about 1200 km toward north-northwest along the Andaman trough. The large slip of more than 20m is estimated on the plate interface off the northwest coast of Sumatra Island in Indonesia. The other large slip of 10-15m is estimated on the plate interface near Little Andaman and Car Nicobar Inlands. The slip amount beneath North and Middle Andaman Islands are small, about 1m. The total seismic moment is calculated to be 7.8 x 10^{22} Nm (Mw 9.2) which is similar to the other studies using seismic waves (Park et al., 2005, Ammon et al., 2005). Our estimated slip amount off Sumatra Island is larger than the slip amounts estimated by the other studies, such as Ammon et al (2005). This large slip should be responsible for large tsunami run-up heights of about 35m surveyed along the northwest coast of Ache province in Sumatra Island.

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Neuroscience/ Medicine
Planning Group Members: Alfons Schnitzler and Hidemi Watanabe

Neural Communications

Speaker:
Kiyoshi Nakahara, The University of Tokyo

Direct Functional Comparisons of Human and Monkey Brain
Kiyoshi Nakahara

In search for biological basis of cognitive functions, macaque monkeys have been widely used as an experimental model, mainly in anatomical, electrophysiological and lesion studies, whereas investigations of the human brain have mainly relied on brain imaging and neuropsychological methods. To integrate these two lines of investigation, a natural and promising approach is to make direct comparisons of brain between the two species not only anatomically but also functionally.

Functional magnetic resonance imaging (fMRI) is the most widely used non-invasive brain imaging method in human studies, and the recent advent of this method in non-human primates has opened the way for making such a direct comparison of brain activation. Whereas most of these comparative imaging studies have been carried out in sensory domain such as visual system, our group have been attempting to apply this method to comparisons of higher cognitive functions.

In this talk, I will present application of fMRI to comparative investigation of the prefrontal cortex (PFC), which is evolutionally most developed in primates among other mammals, and supports high-level cognitive functions. Flexible changes of behavior (cognitive set shifting) in adapting to current situation is one of the characteristic functions of the PFC. Our fMRI experiments identified brain activation related to cognitive set shifting in focal regions of the PFC in both monkeys and humans [1]. These possible functional correspondences were located in cytoarchitectonically equivalent regions in the posterior part of the ventrolateral PFC.

The “comparative fMRI” presented here would be a powerful tool to elucidate similarities and differences of neuronal networks between humans and monkeys, and may provide insights into the evolution of cognitive function unique to humans.

References
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