

**CANADIAN OCEAN SCIENCE NEWSLETTER  
LE BULLETIN CANADIEN DES SCIENCES DE L'OcéAN**

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## OCEAN SCIENCE PROGRAMS

### The 11 March 2011 Tohoku Tsunami

*Submitted by Richard Thomson, Alexander Rabinovich, and Isaac Fine; Fisheries and Oceans Canada, Institute of Ocean Sciences, Sidney, British Columbia*

The powerful images from Japan of the extensive devastation caused by the March 11, 2011 Magnitude ( $M_w$ ) 9.0 Tohoku earthquake and tsunami are a stark reminder of the possible consequences of living near major subduction zones along the coast of the World Ocean. Peru, Chile, Indonesia, the Kuril Islands, the Kamchatka Peninsula, and the west coast of North America are among the many areas of the Pacific Ocean vulnerable to such megathrust events. The 2011 event in Japan follows the catastrophic tsunami caused by the magnitude 9.2 earthquake off the coast of Sumatra in December 2004 in the Indian Ocean and the more recent South Pacific tsunamis generated by the Mw 8.8 Samoan earthquake of September 2009 and the 8.9 Chilean earthquake of February 2010. Earthquakes of these magnitudes generate trans-oceanic tsunamis that wreak havoc over large areas of the ocean, but even moderate earthquakes can trigger submarine landslides which cause regionally destructive waves, as occurred on 17 July 1998 in Papua New Guinea following a local magnitude 7.1 earthquake. The high velocity flooding waters of tsunamis can surge far inland from the coast and are responsible for strong and rapidly changing currents that do major damage in ports and harbours along the coast. For example, most of the damage to southern California arising from the February 2010 Chilean tsunami was due to tsunami-induced currents in the harbours

The Tohoku earthquake occurred at 05:46:23 UTC (14:46 local time) at a depth of 32 km at 38.322°N, 142.369°E, roughly 130 km seaward of the northeast coast of Honshu Island, Japan. It is in this region that the Pacific plate is subducting below a “finger” of the North America Plate. The first tsunami waves generated on the western side of the rupture zone reached the coast of Japan within a few tens of minutes. Maximum waves in excess of several meters arrived at the coast about an hour later causing wave run-up of 10 to 15 m and pronounced inland inundation. Waves emanating from the rupture zone spread out over the open Pacific at jet-like speeds of up to 800 km/hour and began reaching the mainland coast of North America about 7 hours later. The first wave hit Amchitka in the Aleutian Islands around 0930 UTC and

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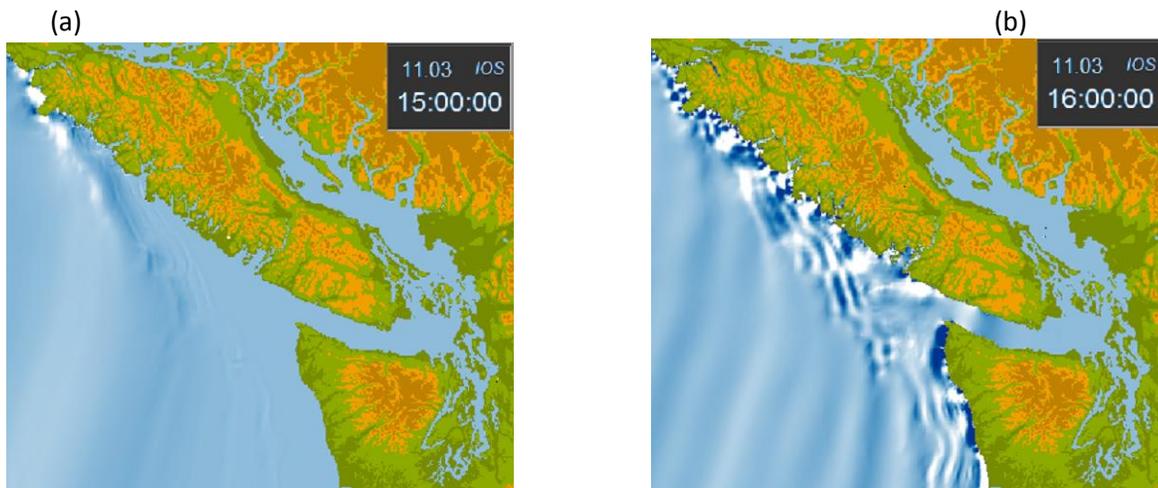
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The Canadian National Committee of the Scientific Committee for Oceanic Research (CNC-SCOR) fosters and facilitates international cooperation. It is a non-governmental body that reflects the multi-disciplinary nature of ocean science and marine technology.

Le Comité national canadien du Comité scientifique de la recherche océanographique (SCOR) favorise et facilite la coopération internationale. Il reflète la nature multidisciplinaire de la science océanique et de la technologie marine.

the southeast coast of Alaska (e.g., Yakutat and Sitka) about four hours later. Waves then arrived on the north coast of Vancouver Island, British Columbia at 1440 UTC (0640 local time) and the south coast of the island and north coast of Washington State about an hour later (Figure 1a,b). The tsunami entered Juan de Fuca Strait about 1540 UTC and started propagating up-strait, arriving at tide gauges located at Victoria, Patricia Bay (Saanich Inlet), and Metro Vancouver at 1630, 1722, and 1750 UTC, respectively. Waves also propagated into Puget Sound, arriving at Seattle and Tacoma at 1734 and 1750 UTC (i.e., 11 h 48 min and 12 h 04 min after the earthquake), respectively. Due to multiple reflections from large-scale topographic irregularities in the ocean, significant tsunami waves associated with the event kept arriving along the west coast of North America for the next 6 hours.



*Figure 1. Numerical simulation of the 11 March 2011 Tohoku tsunami arriving at Vancouver Island on the west coast of British Columbia and then propagating southward to Washington State and into Juan de Fuca Strait (Institute of Ocean Sciences, regional tsunami model). (a) Tsunami at 1500 UTC and (b) at 1600 UTC on March 11. Wave crests are shown in white and wave troughs in dark blue. Note waves entering Juan de Fuca Strait in (b).*

Waves of 25 cm amplitude were recorded in the offshore region by high-resolution, real-time reporting bottom pressure recorders maintained by NEPTUNE Canada at 2600 m depth in Cascadia Basin. These waves were then amplified as they shoaled within coastal waters to over 100 cm height (trough to crest) at Henslung on the northwest coast of the Queen Charlotte Islands, 155 cm at Winter Harbour on the northwest coast of Vancouver Island, and 130 to 135 cm at Tofino and Port Alberni on the southwest coast of the island (Figure 2). Tsunami waves of 115 cm were recorded at Port Angeles (eastern Juan de Fuca Strait), over 50 cm at Victoria (and nearly 100 cm in the nearby Gorge waterway, both in the eastern strait), 11 cm at Pat Bay in Saanich Inlet (north of Victoria), and 7 cm near Vancouver. Even Tacoma and Seattle, within Puget Sound, observed waves over 10 cm. The highest waves on the west coast of North America were recorded at Crescent City, California where wave heights were in excess of 4.5 m and one person was swept to his death trying to take pictures of the incoming tsunami.

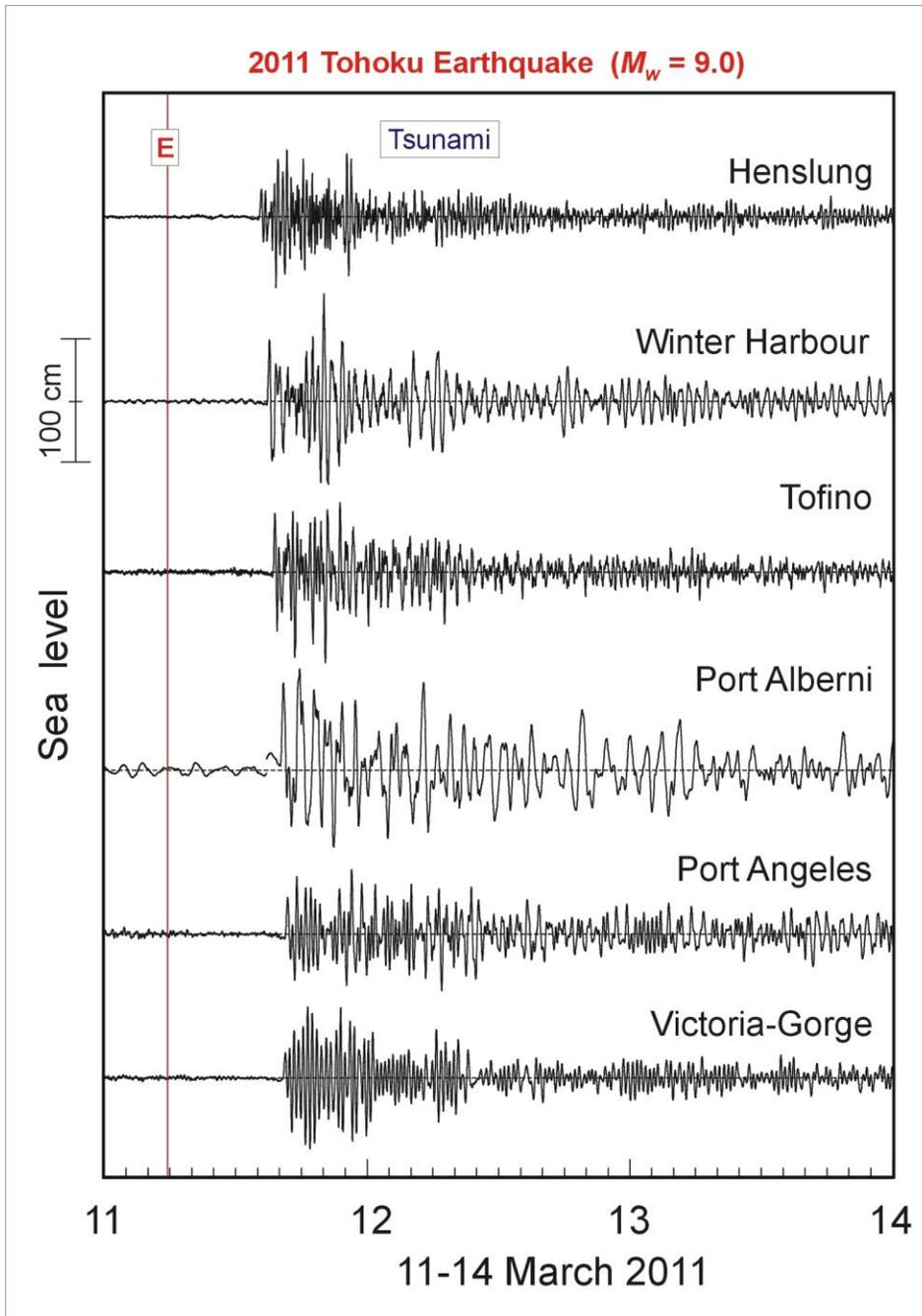


Figure 2. Plots of detided, low-pass filtered water levels recorded by selected coastal tide gauges on the west coast of Canada and United States for the period 11 to 14 March, 2011. Henslung (Langara Island) is located off the northwest coast of the Queen Charlotte Islands; Winter Harbour, Tofino, and Port Alberni are on the west coast of Vancouver Island, and Port Angeles and Victoria are located at the eastern end of Juan de Fuca Strait. The letter “E” denotes the time of the earthquake in Japan. Wave heights are in centimetres.

A magnitude 9.0 megathrust earthquake in the Cascadia Subduction Zone extending from northern Vancouver Island to northern California is expected to cause a tsunami very similar to that which occurred in Japan, with the first waves arriving from the source region striking the nearby coast within 15 to 20 minutes of the

earthquake. The Pacific west coast is the home of tens of thousands of residents and is visited by hundreds of thousands of tourists every year. Based on experience from the 26 December 2004 Indian Ocean event, people living near to the coastline now know to get to higher elevation once the ground starts shaking. The recent event off Japan has now made people living along the coast even more concerned about what is likely awaiting them in the future. Japanese historical records show that the last megathrust earthquake and tsunami event along the Cascadia subduction zone occurred over 311 years ago, on 26 January, 1700 and many scientists believe the region is overdue for another major event. The magnitude 9.2 Alaska earthquake on March 27, 1964 that caused major damage along the west coast of North America, including an approximately 8 m tsunami in Port Alberni on the west coast of Vancouver Island, is a reminder that the subduction zone off the Aleutian Islands and Alaska (which has been relatively quiet for the past 47 years) is another possible source region for a megathrust earthquake and tsunami. As many experts keep reminding us, it is not a matter of “if” but a matter of “when”. Although such events cannot be avoided, we can find ways to mitigate their catastrophic impacts.

### **Update: SCOR WG 134 on the Microbial Carbon Pump in the Ocean**

SCOR WG 134 on The Microbial Carbon Pump in the Ocean prepared a supplement to the journal *Science* issued on May 13<sup>th</sup> and available in electronic form ([click](#)). The supplement brings together past articles published in *Science* with new review papers. SCOR appreciates the efforts of the working group, under the leadership of the co-chairs Nianzhi Jiao and Farooq Azam, and contributions from several different co-sponsors, including Xiamen University, the U.S. National Science Foundation, national SCOR committees, and ASLO.

### **Ocean Acidification**

The US National Academies have published a report “Ocean Acidification: A National Strategy to Meet the Challenges of a Changing Ocean” ([click](#)). A key finding of the study is that a global network of chemical and biological observations is needed to monitor changes in ocean conditions attributable to acidification.

### **CARBOCHANGE (Changes in carbon uptake and emissions by oceans in a changing climate)**

This 4-year (2011-2015) research program is a consortium of 28 research institutions (Europe, USA, Canada, Morocco, South Africa) funded through the European Union. The program will focus on combining observational data and model simulations to quantify net ocean carbon uptake under changing climate conditions. A kickoff meeting was held March 8-10, 2011 in Bergen, Norway. Canadian participation is led by Helmuth Thomas, the CRC Chair in Marine Biogeochemistry at Dalhousie University ([click](#)).

## **PERSONNEL**



### **Alfonso Mucci**

Al Mucci is the recipient of the Michael J. Keen Medal for 2011. The Keen Medal is awarded annually by the Marine Geosciences Division of the Geological Association of

Canada to a scientist who has made a significant contribution to the field of marine or lacustrine geoscience. A professor in the Department of Earth and Planetary Sciences at McGill, his main interests are the application of chemical thermodynamics, kinetics and surface chemistry to the characterization of mineral-solution interactions in aquatic environments, carbonate geochemistry, the early diagenesis of marine and coastal sediments, and trace metal and environmental geochemistry in freshwater and marine systems. An Associate Editor of *Geochimica et Cosmochimica Acta* and *Marine Chemistry* as well as Associate Guest editor of *Aquatic Geochemistry*, he is a past winner of the President's Medal (now the Hutchison Medal) of the Geological Association of Canada, a Fellow of the Royal Society of Canada (Academy of Science), and is a member of the Canadian National Committee of SCOR.

## MEETINGS

### **CMOS Congress, 5-9 June 2011, Victoria**

A final reminder to attend the 45<sup>th</sup> annual CMOS Congress in Victoria at the beginning of next month. The plenary speakers are: Clara Deser and Randall Martin (June 6); Peter Brewer and Phil Mote (June 7); Shin-Ichi Ito and David Battisti (June 8); and Jim McWilliams and Thomas Stocker (June 9). The detailed Congress schedule ([click](#)) and abstracts are now available.

### **10<sup>th</sup> International Conference on Mercury as a Global Pollutant, 24-29 July, Halifax, NS**

The preeminent international forum for discussion of science and policy issues related to mercury in the environment, this conference is held every two or three years. With two marine-oriented sessions, it will explore linkages among mercury sources to the environment, terrestrial and aquatic transport and fate, and health risks associated with exposures of humans and wildlife to mercury ([click](#)).

### **Gordon Research Conference on Chemical Oceanography, 14-19 August 2011, Andover, NH**

The topic for the 2011 Conference is: Linking the Time and Space Scales of Chemical Oceanography ([click](#)). Talks will address topics that cross time and space scales, ranging from molecular processes occurring in fractions of a second to large-scale oceanic (and whole earth) processes occurring across deep time (and into the future). Talks within each session will also be structured to explore linkages.

### **International Quiet Ocean Experiment, 30 August-1 September 2011, Paris**

SCOR and the Partnership for Observation of the Global Oceans (POGO) have been developing over the past year the idea of an International Quiet Ocean Experiment (IQOE). An international group of ocean scientists concluded that it would be worthwhile to convene an open science meeting to develop a Science Plan for the IQOE, a focused international science effort that may last a decade. This plan will include background information to document the importance of the issue of sound in the ocean and its effects on marine organisms; will identify information gaps; and describe research, observations, and modeling activities needed to fill these gaps.

The IQOE Open Science Meeting will be held on 30 August-1 September 2011 ([click](#)) at UNESCO Headquarters in Paris. As a foundation for the work and as a service to those interested in the topic of the effects of sound on marine organisms, the organizers have developed a web portal to literature and other information, called the Aquatic Acoustic Archive ([click](#)). Please contact Ed Urban for further information ([click](#)).

## JOBS & TRAINING

No vacancies submitted.

*Looking for work? Try the CMOS site ([click](#))*

## GENERAL

### IMBER Data Management Cookbook

The IMBER Programme Office has released a 16-page manual of good practice for data management in ocean science ([click](#)). While the idea for this compendium of recipes - to make data management (DM) digestible - came from the IMBER community, the recipes are in no way restricted to IMBER, but should be suitable for any project that gathers data and wishes them to be available and useful in the long-term. IMBER is primarily a marine project, so the examples are cruise based. The data management principles should apply to any marine science project.

### Ocean Summer School Information Portal

Last August, a group of organizations that sponsor capacity development activities related to ocean science met at the University of Bremen (Germany) to share current activities and help coordinate efforts on capacity development. One need identified was for a portal for ocean science summer schools. Many such schools take place each year, but there has been no single web site where graduate students and early career scientists can find out what is available. The International Oceanographic Data and Information Exchange (IODE) of UNESCO's Intergovernmental Oceanographic Commission (IOC) offered to set up and maintain such a portal, the Ocean Summer Schools site, which is now launched ([click](#)).

The portal provides a listing of coming courses and the means to seek further information. An RSS feed is available to inform subscribers about new entries to the list. New courses can be added by contacting Ed Urban ([click](#)).

### New Research Vessel at the University of Victoria

UVic has acquired a 33 m vessel, the former *MV Tsekoa II*, as a donation from Fisheries and Oceans Canada. Funded by the Canadian Foundation for Innovation and the BC Knowledge Development Foundation, UVic will refit the



ship with a full suite of scientific instruments for work in coastal waters. The vessel will be used for coastal ocean research, as a ROV platform in support of ocean observatory maintenance, and to explore “green shipping” technologies through the installation of a hybrid fuel-cell drive system. The reconfiguration should begin this summer.

### **Glacial Loss Accelerating in Canada’s Arctic**

The work of University of Alberta PhD graduate Alex Gardner, published recently in *Nature* ([click](#)), has revealed evidence that water loss from the glaciers and ice caps in the Canadian Archipelago accelerated towards the end of the last decade in response to warmer summer temperatures.

Gardner, a former student of Earth and atmospheric science professor Martin Sharp (A co-author on the paper), spent six years monitoring Arctic ice and found that in 2009 the ice-loss rate was four times larger than estimated by NASA for the mid- to late-1990s. The losses were so sharp that Gardner and his colleagues believe the Canadian Arctic Archipelago was the single largest contributor to global sea-level rise outside Greenland and Antarctica between 2007 and 2009.

### **Reform at the IPCC**

Responding to the report of the InterAcademy Council, struck to investigate the workings of the IPCC, delegates from IPCC member states have agreed to a package of reforms that include a 13-member Executive Council and a new conflict-of-interest policy. The Executive Council will oversee daily operations and make decisions between plenary sessions. The IPCC’s next report, on whether climate change is increasing the likelihood of extreme weather events, is due towards the end of this year.

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Previous newsletters may be found on the CNC/SCOR web site.  
Les bulletins antérieurs se retrouvent sur le site web du CNC/SCOR.

Newsletter #58 will be distributed on July 15, 2011. Please send contributions to Bob Wilson, [wilson@telus.net](mailto:wilson@telus.net)  
Bulletin #58 sera distribué le 15 juillet 2011. Veuillez faire parvenir vos contributions à Bob Wilson, [wilson@telus.net](mailto:wilson@telus.net)

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