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The 2011 off the Pacific coast of Tohoku Earthquake; seismicity and tsunami

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At 14:46 JST on March 11th 2011, The 2011 off the Pacific coast of Tohoku Earthquake (Mw9.0) occurred at the depth of 24 km in off Sanriku. The maximum seismic intensity (JMA's seismic intensity scale) of 7 is observed at Kurihara (Miyagi prefecture) and 6 lower to 1 at quite large area from Hokkaido to Kyusyu. This earthquake also caused tsunami. The very high tsunami are observed along the Pacific coast of northeast Japan. More than 9.3 m high tsunami is observed at Soma (Fukushima prefecture). The ground motion and tsunami of this earthquake caused a great disaster. We report about the seismic activity, the tsunami warning and advisory by JMA, and the observed height of the tsunami.

1. Seismicity

Around the hypocenter of The 2011 off the Pacific coast of Tohoku Earthquake, earthquakes which magnitudes are more than 5.0 often occurred (ex. Mj5.5 earthquake on February 16th 2011), and sometimes, earthquakes which magnitudes are more than 6.5 occurred (ex. Mj6.8 earthquake on October 31st 2003). Mj7.3 and Mj6.8 earthquakes occurred 2 and 1 day before the Mw9.0 earthquake.

After The occurrence of 2011 off the Pacific coast of Tohoku Earthquake, the seismicity in and around the source region became high. The all mechanisms of the Mw9.0 earthquake and two earthquakes (Mj7.3 and Mj6.8) occurred on March 9th and 10th are thrust fault, and they occurred at the plate boundary. However, after the Mw9.0 earthquake on March 11th, high seismicity regions are also found in outer rise and in the crust of the upper plate, and not only thrust earthquakes but also many normal-fault-type earthquakes occurred in the aftershock region (in and around the source region). For example, Mw7.5 earthquake occurred at 15:25 JST on March 11th in outer rise, and in the crust of the upper plate, Mj7.0 earthquake occurred at 17:16 JST on April 11th in Hamadori (Fukushima prefecture).

2. Tsunami

At 14:49 JST, 3 minutes after the occurrence of The 2011 off the Pacific coast of Tohoku Earthquake, JMA issued 'tsunami warning (major tsunami)' to Iwate, Miyagi and Fukushima prefecture, and issued 'tsunami warning (tsunami)' and tsunami advisory to many other coast of Japan. At 15:14 JST, based on the observed height of offshore GPS buoy (received from Ports and Harbours Bureau, MLIT), JMA increased the tsunami warning and advisory. JMA kept watching the tsunami height and increased the tsunami warning and advisory several times. At 03:20 JST on March 12th, JMA issued tsunami warning and advisory for all tsunami forecast regions. After that, kept watching the tsunami height, JMA started decreasing tsunami warning and advisory. At 17:58 JST on March 13th, all tsunami warning and advisory are lifted.

JMA use observed tsunami height at 183 tsunami station in Japan. However, for some stations, because of power outage or drifting of the stations themselves, the real-time observed tsunami heights were not available. Later, some of the data could be collected, and it became clear that the highest height of tsunami were observed since the observation at tsunami stations started; the tsunami height was over 9.3 m at Soma (Fukushima prefecture), over 8.5 m at Miyako, over 8.0 m at Ofunato (Iwate prefecture), over 7.6 m at Ayukawa (Miyagi prefecture). The tsunami of this earthquake are also observed at oversea tsunami stations.

Keywords: The 2011 off the Pacific coast of Tohoku Earthquake, mechanism, tsunami, tsunami warning