Observations of sea surface heights using an airborne radar altimeter for great tsunamis early detection

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Most tsunami forecasting systems rely on the predicted magnitude and epicenter of an earthquake. This system sometimes underestimates the tsunami, especially when the magnitude of associated earthquake is large and the tremor continues for a long time. Recently, attempts to detect the tsunami directly by satellite radar altimeter have been proposed (e.g., J. Gower, 2007). The studies suggest that satellite radar altimeters are capable of detecting the tsunami, however real-time detection is still difficult due to the low frequency of sampling possessed by satellite systems. In this study, we suggest to detect tsunami directly by airborne radar altimeters.
We performed nadir pointing observations using Frequency Modulated Continuous Wave (FMCW) radar, which is attached to the bottom of an airplane body. The radar observation procedure is basically similar to the present satellite radar altimeter. However, in airborne observation, airplane altitude is changing by a few meters at any time during the flight. Thus, a precise prediction of airplane positions by Global Navigation Satellite System (GNSS) is also important. We estimated the position and altitude by a baseline kinematic analysis. We then estimated the averaged sea surface height (SSH) by the radar altimeter observation and the GNSS analysis result.
We conducted airborne observations once in June 2016, and twice in December 2016. To check the precision of SSH measurements, the flight days and paths were decided according to the satellite SSH altimeter Jason-2 and Jason-3 schedules. We measured the SSH several times and compared with the Jason results. After correcting the geoid and tidal changes, we confirmed that our observation error is less than 10 cm in average, which is sufficient to capture large tsunamis offshore. In the future, we expect to form a dense observation network by using multiple commercial airplanes equipped with the same radar altimeter, which enables real-time tsunami detections. We also expect that future developments of the radar technology can lead to a low operational and maintenance cost compared to the existing tsunami observing systems.

Keywords: tsunami forecast, airborne observations, radar altimeter, GNSS

