Geophysical Research Abstracts
Vol. 15, EGU2013-2434, 2013
EGU General Assembly 2013
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Disturbances in VLF signal caused by tsunami

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One of the few experimental techniques which can monitor perturbations of the ionization within the lower ionosphere uses long-wave (i.e. VLF and LF) probing. Here we present the first measurements of the response of the lower ionosphere driven by tsunamis caused by the November 15, 2006 (Kuril region) and the March 11, 2011 (Tohoku region) earthquakes. We used data from VLF receiver stations in Petropavlovsk-Kamchatsky (PTK) and Yuzhno-Sakhalinsk (YSH) in Russia. To analyze the VLF signal variations observed after the first earthquake the subionospheric NPM – PTK path was used because it lies along the propagation direction of the tsunami. The signal propagating along this path exhibited a significant decrease in amplitude during nighttime observations together with phase variations. To study the case of the Tohoku earthquake we employed data from two receivers: Petropavlovsk-Kamchatsky and Yuzhno-Sakhalinsk. This tsunami propagated approximately along the Hawaii – Yuzhno-Sakhalinsk path. Analysis showed that the signals received at both stations are very similar except for those from NPM transmitter which show large differences in comparison to the other transmitters. For this particular pair of propagation paths the signal recorded in Petropavlovsk-Kamchatsky traveled along an undisturbed path whereas that measured at Yuzhno-Sakhalinsk clearly showed an anomalous decrease in amplitude together with an increase in phase. The wavelet spectrograms of the data revealed the frequency of the maximum spectral amplitude in the range of periods of 8-30 min which corresponds to the internal gravity wave periods. These periods are in compliance with the periods observed in data recorded by the DART sensor buoys.
A qualitative interpretation of the observed effects was suggested in terms of the interaction of internal gravity waves with lower ionosphere.