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Analysis of glacial seismic events from Greenland recorded by the POLENET/LAPNET experiment during the IPY 2007-2009

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Monitoring of glacial earthquakes from Greenland was one of the major targets of the POLENET/LAPNET passive seismic experiment in northern Fennoscandia (northern parts of Finland, Sweden, Norway and Russian Karelia) during the IPY 2007-2009. The POLENET/LAPNET array, with the average spacing between stations of 70 km, was designed to solve specific tasks of polar seismology. The collected POLENET/LAPNET dataset includes high-frequency continuous data (sampling rate from 50 to 100 sps) of 37 temporary stations, which were in operation during the time frame from 01.05.2008 to 31.09.2009, and of 21 stations of selected permanent networks in the Fennoscandia.

The first results of the experiment have shown that the POLENET/LAPNET array, located at regional distances from Greenland, recorded more such events than it has been recorded by the Global Seismographic Network (GSN) during the same observation period. Recordings of glacial earthquakes obtained by the array contain the long-period energy only. In many cases the events were recorded in groups within the time interval of up to 1 hour. Generally, the waveforms of events within the same group are different and the events not always originate from the same location. For some of the events it was possible to recognize not only the long-period surface wave, but also the first arrival of a long-period P-wave. This suggests that source duration of these events was long.

The waveforms of glacial seismic events recorded by the POLENET/LAPNET array can be subdivided into two major groups. The first group corresponds to classical glacial seismic events detected from the GSN data and reported in previous studies (Ekström et al, 2003, Ekström et al., 2006, Nettles and Ekström, 2010). The second group of waveforms is different from both long-period waveforms of glacial earthquakes recorded at teleseismic distances and from short-period glacial rumblings recorded at local distances. These long-period waveforms correspond to events which can be called “glacial tremors” or “long-period glacial rumblings”. They are characterized by longer duration, irregular shape and, in many cases, by the dispersed long-period “coda”.

In order to explain specific features of the observed waveforms, we performed a forward modelling of propagation of waves from sources in Greenland using the spectral-element method (SEM) (c.f. Komatitsch et al. (2002), Tromp et al., 2008). We tested different source mechanisms and source time functions and compared synthetic seismograms to the waveforms recorded at different POLENET/LAPNET stations. Our results suggest that diversity of the observed waveforms can be explained by diversity of their sources. Namely, the waveforms of events from the first group correspond to single source with long duration, while specific features of waveforms of glacial tremors can be explained by interference of signals from multiple events shifted in time.