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Automatic monitoring of long-term glacier dynamics using single station observations and fuzzy logic classification: a case study from Spitsbergen

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Changes in the global temperature balance were proved to have a major impact on the cryosphere and therefore retreating glaciers are the symbol of the warming climate. Long-term measurements of geophysical parameters provide the insight into dynamics of those processes. Here we explore the possibility of monitoring glaciers' dynamic activity using data recorded by nearby regional, permanent seismological stations. We develop an automatic procedure capable of detecting the glacier-induced seismic events. In order to distinguish between glacier- and non-glacier-origin signals using the data from only one seismic station in the area, we developed a fuzzy logic algorithm based on the seismic signal frequency and the energy flow analysis. We study the long-term changes in glacier-induced seismicity in vicinity of the Hansbreen glacier (southern Spitsbergen). Our research has revealed that the number of detected glacier-origin events over the last two years has doubled. We also observed that the seasonal events distribution correlates best with the temperature lagged by one month. To further support our observations, we have analysed 5-year-long seismological data recorded by a broadband station located in Ny-Ålesund (western Spitsbergen). Distribution of glacier-origin signals detected in the vicinity of the Kronebreen glacier shows a steady increase from year to year, however not as significant as for the Hornsund dataset.