

## Locating earthquakes around Antarctica by using neural networks based on deep learning

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Seismic activity inside Antarctic plate is low but there also exists unusual large earthquakes, such as 1998 Balleny Islands earthquake (Figures 1). The traditional method of locating earthquakes may not be adequate to those earthquakes, which occur where the seismic activity is low and seismic network is sparse. We propose a new approach combining numerically computed theoretical seismograms and deep machine learning. Theoretical seismograms for a realistic three-dimensional Earth model are calculated, and these seismograms are used to create snapshots of spatial images for seismic wave propagation at the surface of the Earth. Subsequently, these snapshots are used as a training dataset for a convolutional neural network. Neural networks are established for the determination of hypocentral parameters such as the epicenter, depth, origin time, and magnitude, and these networks are applied to actual seismograms to demonstrate the feasibility of this procedure to locate earthquakes. The advantages of using the proposed approach to locate earthquakes are as follows: The accuracy of determining the hypocenter parameters can be increased by accumulating theoretical seismograms for various locations and sizes of earthquakes as the learning dataset of deep machine learning; a three-dimensional Earth structure can be incorporated without additional computational cost to locate earthquakes; and seismologically rare but inevitable cases, such as earthquakes that occur where the seismic activity is low, can be included in the learning dataset.

Keywords: icequakes, hypocenter determination, synthetic seismograms

## Earthquakes in Antarctica 1976 – 2018

