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

Seiji Tsuboi[1], Daisuke Sugiyama[1], Masaki Kanao[2], Yoshiaki Ishihara[3] and Takahiko Murayama[4]
[1]*Japan Agency for Marine-Earth Science and Technology*
[2]*National Institue of Polar Research*
[3]*National Institue of Environmental Studies*
[4]*Japan Weather Service*

Seismic activity inside Antarctic plate is low but there also exists unusual large earthquakes, such as 1998 Balleny Islands earthquake (Figures 1 and 2). 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.

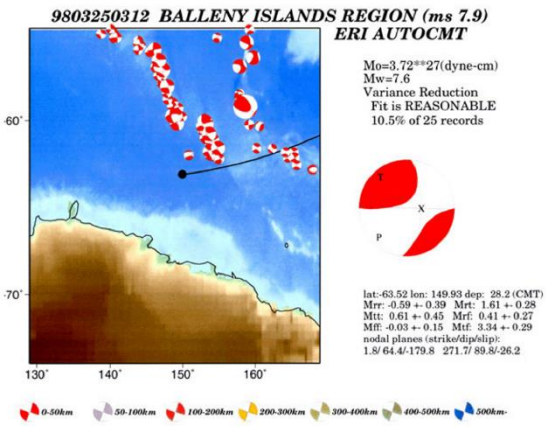


Figure 1. Location and focal mechanism of 1998 Balleny Island event. (Tsuboi et al., 2000).

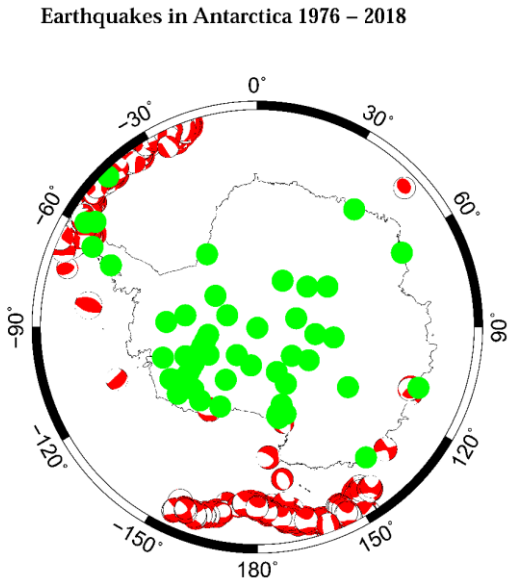


Figure 2. Seismic activity in the Antarctica based on GCMT. Green dots show seismic stations.

## References

Tsuboi, S. et al., The March 25,1998 Antarctic Earthquake: Great earthquake caused by postglacial rebound, Earth, Planets and Space, 52 133-136 2000.