

Slow slip events (SSEs) are gradual fault movements that release tectonic stress over days to months without producing strong shaking. They can reveal important changes in earthquake-prone plate boundaries (Bürgmann, 2018; Wallace, 2020). Along New Zealand's Hikurangi margin, SSE signals are often only millimetres in size and are difficult to separate from noise in Global Navigation Satellite System (GNSS) records, which track how the ground moves over time.

This research develops a reproducible machine-learning pipeline to screen GNSS data for short periods that may contain signs of SSEs. Daily East, North, and Vertical displacement data from five Hikurangi GNSS stations between November 2010 and December 2024 were pre-processed to remove long-term trends, seasonal effects, outliers, offsets, and common-mode noise. Because confirmed examples are scarce, simulated slow-slip signals were injected within real background noise to give the machine learning models more examples from which to learn. Three detection approaches were evaluated, ranging from a simple model to an advanced artificial-intelligence model capable of learning patterns across stations and over time.

The best-performing model was the convolutional neural network. It correctly classified 85% of the test periods, produced no false alarms, and detected 56% of known SSEs. These results indicate that the model is highly reliable when it identifies a potential event, although it still misses some known cases. This suggests machine learning can support high-confidence screening of GNSS records and help researchers detect subtle SSEs more efficiently.

In this presentation, I will explain why this problem is difficult, how the workflow was built, and what these results mean for monitoring slow fault movement in New Zealand.

Keywords

Slow slip events, GNSS, machine learning, convolutional neural network, Hikurangi subduction zone, geophysics

References

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