Puysegur Subduction Zone tectonics: What does 4 years of earthquakes teach us?

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The Puysegur Subduction Zone, located along the Fiordland Coast, is one of Earth's most remote subduction zones. It is a key case study for early subduction processes and poses significant earthquake and tsunami hazards for large parts of Aotearoa New Zealand and Australia. However, it has been comparatively understudied to other New Zealand regions. Previous studies have provided us with key conceptual models for the Australian Plate's geometry, which have produced relatively poorly constrained subduction interface models. In addition, the region's stress state is resolved only at low resolution, and key subduction zone transitions along the Alpine and Puysegur Faults remain largely unresolved.

Using ~4 years of continuous seismic waveform data from a series of permanent and temporary deployments, we have constructed an extensive, high-quality earthquake catalogue using a semi-automated workflow. This workflow combines deep-learning-based detection with automated phase association and earthquake (re-) location procedures. In addition, we conduct several steps to improve the intermediate results, such as manually evaluating the phase arrivals and removing duplicate P-phases using kurtosis. Finally, we use this catalogue to construct a new 3D slab interface model for the Puysegur Subduction Zone, reevaluate the stress state of the overriding and subducting plates at higher resolution using ~1,000 focal mechanism solutions, and incorporate some recent moderate-to-large earthquakes into its tectonic framework, including the M6.8 2025 Puysegur Bank earthquake.