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*Gerstenberger Matt[1]、Wallace Laura[1]、Fry Bill[1]、Kaneko Yoshihiro[1]、Rhoades David[1]、Hamling Ian[1]、Christophersen Annemarie[1]、Williams Charles[1]
*Matt Gerstenberger[1], Laura M Wallace[1], Bill Fry[1], Yoshihiro Kaneko[1], David Rhoades[1], Ian Hamling[1], Annemarie Christophersen[1], Charles A Williams[1]

1. GNS Science, Lower Hutt, New Zealand
1. GNS Science, Lower Hutt, New Zealand

The November 14th, 2016, Mw 7.8 Kaikoura, New Zealand earthquake affected a large part of central New Zealand. The event ruptured more than 20 faults and caused significant damage and shaking in many areas. Additionally, the main shock triggered two slow slip events (SSE) and a large region of afterslip on the adjacent Hikurangi subduction zone that. The post-earthquake subduction slip events encircled a section of the subduction zone that has been interseismically coupled since observations began; the coupled region is large enough to produce an M8 or larger earthquake. The unique character of the triggered SSEs and afterslip and their proximity to the locked patch beneath the capital city of Wellington raised concerns from scientists and government officials.

GNS Science has been regularly forecasting aftershock probabilities since the 2010 Canterbury Earthquake Sequence; the Kaikoura triggered SSEs provided a difficult challenge to the ongoing forecasting efforts and required a new approach to incorporate the effect of the SSEs and afterslip into the forecasts. Understanding the impact of SSEs on future seismicity is limited, yet government officials required guidance about the potential for future large earthquakes. This need was further strengthened by an M_w 6.1 on the subduction interface offshore the North Island that was likely triggered by the SSEs. In this presentation we will describe the multi-faceted approach we used to estimate probabilities of large events on the Hikurangi megathrust, including the influence of SSEs. We developed a suite of models and observations and evaluated them jointly to determine 1-year and 10-year forecasts for central New Zealand. These methods included simple stochastic models of stress interactions, statistical clustering models, physics-based simulators and observations of seismicity during past SSE. Results suggest that the impact of the SSE on earthquake likelihood has largely diminished in the year since they began, and we estimate an approximately 30% probability of a M7.0 or greater earthquake in the central New Zealand region within the next decade.

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