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Repeating earthquakes on the Chile Subduction zone following the Maule 2010 Earthquake

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Repeating earthquakes showing identical waveforms are thought to represent stick-slip movement on small asperities driven by surrounding aseismically sliding areas. Such events have the potential to measure slip rates directly on a fault interface and such techniques have been successfully implemented in numerous locations, most notably on the San Andreas Fault and, more recently, the Japan subduction zone.

Following the 2010 Mw 8.8 Maule earthquake, an international collaboration resulted in the set up of a large seismic network to investigate aftershock activity. The International Maule Aftershock Dataset (IMAD) collated from this network provides an excellent opportunity to study repeating earthquakes in the context of aftershock activity.

Using data from the first 9 months following the main shock we identify similar events on the basis of waveform similarity at multiple stations (cross correlation coefficients > 0.9 over 7 sec window), and group using the clustering algorithm of Maurer and Diechmann (1995). Thus far this technique has been applied to a band of deep seismicity (40-50km) running NE-SW inland along the length of Chile, which is distributed in elongated trench parallel groups of seismicity. Of the 9229 events analysed 1561 (17%), were found to be part of clusters of similar events, though approximately 50% of events were part of doublets as opposed to larger multiplets. These small (average Ml 3-3.5), highly similar earthquakes are distributed throughout the deep seismicity band and multiple similar clusters can be found in each group of seismicity. Moment tensor inversions of larger similar events reveal slab interface thrust type focal mechanisms. It is thought that repeating earthquake asperities may delineate the border between larger locked and creeping areas of the fault plane (Sammis & Rice, 2001), thus we hypothesise that this band of clustered seismicity may represent the transition zone between the locked and aseismically sliding regions of the down going slab. Following this theory identification of offshore clustered seismicity may aid in better defining the limit of the coseismic rupture area, which varies greatly between published coseismic slip models.

Initial investigations into recurrence times between similar events within clusters, reveal a complex variation with time rather than the simple increase in recurrence time following the main event anticipated. It is hoped that relative location of repeating events may now be improved using a double difference relocation algorithm, allowing more detailed investigation of cluster distribution and location/timing relationships.