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Imaging the spatio-temporal variations in deep tremor activity using cluster analysis techniques

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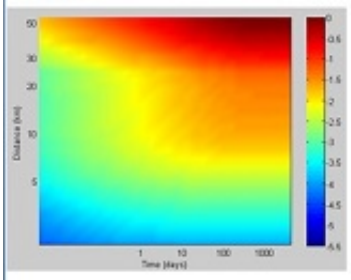
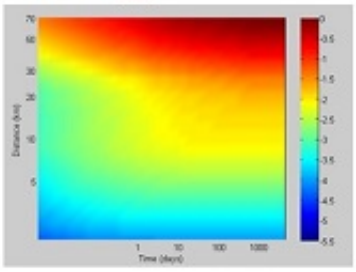
More than 15 years of seismic observations on slow earthquakes are available for the Nankai and Cascadia regions, due to the high density of seismic stations and constant improvements. It was observed that deep tremor activity exhibits highly non-Poissonian behaviour, consisting of short-period bursts separated by long periods of inactivity, as well as significant spatial variations throughout a tectonic region (Obara, 2011). Tremor activity in these regions has shown episodic behaviour with different recurrence interval. Modelling the space-time variations can help the unified understanding of the phenomenon. Catalogues with more than 30.000 (Idehara et al., 2014) and 130000 LFE's (Mizuno et al, 2019) are available for the world tremor databese. If we consider LFE's source as a spatial correlation structure which is evolving in time, in order to reveal the characteristics of this structure, we used the Grassberger Procaccia algorithm to calculate the combined correlation dimension (Tosi et al.,2008) of tremor activity (Cc (r, τ)), at both local and regional scale. The integral representation is shown as contour map (facilitating the possibility of using machine learning algorithms based on image processing for identifying the characteristic image of each tremor patch). Thus, implementing machine learning methods for LFE cluster analysis is required. After performing the cluster analysis, we could identify the specific spatio-temporal behaviour of each of the tremor patches in the studied regions, not just the features which were described in previous studies, such as recurrence intervals for short-term slow slip events (Idehara et al., 2014), tremor migration (for monitoring purposes), but also new features which could be used for forecasting.

LFE's clusters (2004-2016) in Nankai

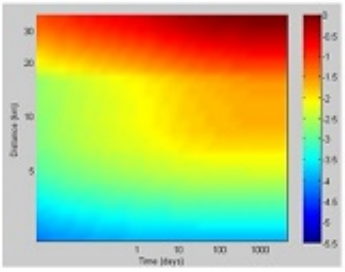
Tokai



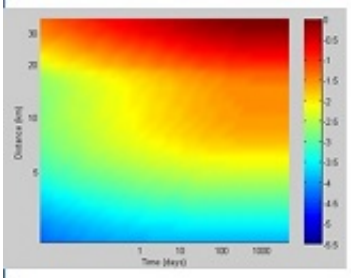
Western Kii



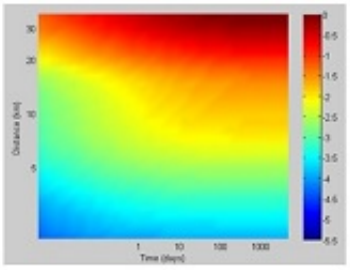
Eastern Shikoku



Central Shikoku



West Shikoku



Off Shikoku