Brittle-Ductile Interactions in California

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This paper introduces a statistical technique, based on the recently developed Multiscale Trend Analysis (MTA), for quantifying correlations between non-stationary processes observed at irregular non-coincident time grids. We apply this technique to studying the temporal correlation between the dynamics of the ductile and brittle layers in the lithosphere using seismicity of California during 1940-2003. Our results confirm the previously reported strong positive correlation between the coda Q-1 and seismicity and its drop before major earthquakes observed in California. The proposed technique has significant advantages over the conventional correlation analysis: (1) MTA allows one to work directly with non-coincident time series without preliminary resampling the data; (2) The correlation is defined via the stable objects --- trends --- rather than noisy individual observations, hence it is highly robust; (3) The correlations are quantified at different time scales. The suggested technique seems promising for the wide range of applied problems dealing with coupled time series.

The figure illustrates the brittle-ductile correlation analysis in California, 1940-2003. Horizontal axis represents time, vertical axis represents scale of correlation. Blue area depicts scale-time where the brittle and ductile layers were correlated; pink areas where they were uncorrelated. As suggested by Aki's Brittle-Ductile Interaction Hypothesis, the correlation is destroyed at progressively larger scales as a large regional earthquake approaches. The destruction of correlation at scales larger than 6 years is only observed a couple of years prior to the Loma Prieta and San Simeon earthquakes.