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Space-time combined correlation integral and earthquake interactions

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Scale invariant properties of seismicity argue for the presence of complex interrelations (Bak et al., 2002; Corral, 2004; Marsan and Bean, 2003; Parson, 2002). We propose a new method, based on the space-time combined generalization (Cc) of the correlation integral (Grassberger and Procaccia, 1983), that leads to a self-consistent visualization and analysis of both spatial and temporal correlations. From the space-time combined correlation integral we define the time correlation dimension Dt and the space correlation dimension Ds. The analysis has been applied on global medium-high seismicity in the time period between 1973 and 2004. The behaviour of both Dt and Ds and the comparison with the analysis applied on the reshuffled catalogue, show that earthquakes are correlated in time even on long distances, within spatial ranges varying over elapsed time. In particular, we found that the shrinking in space of the temporal correlation follows a power-law relation For relatively short spatial ranges (around 100 km) events are time clustered and correlated for long time intervals (around 3 years). Over longer distances time correlation lasts for a short period (less than 30 days for 1000 km). The term ‘aftershock’ can be redefined on the base of our findings: aftershocks are all earthquakes connected to one reference event preceding them, as revealed by their temporal correlation (low Dt) without considering their magnitude.