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A PROBABILISTIC SEISMIC HAZARD ASSESSMENT USING THE SPECTRAL SOURCE MODEL

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ABSTRACT
To improve the methods for evaluating seismic hazard at regional and local scales, it is necessary to define realistic seismic motions that are adapted to the context of each study. The spectral source model, based on a "k^{-2}" dislocation distribution (Herrero et Bernard, 1994) is particulary well adapted to such applications, allowing to produce broad band realistic accelerograms at any distance from the sources. The main properties of this model are the description of the rupture complexity, and the consideration of the directivity effects. We present here an application of this model in a probabilitic seismic hazard assessment, in the Provence region: we show that taking into account earthquake distribution in space and time laws, we can produce seismic hazard maps associated to specific return period.

KEYWORDS: Ground motion, k^{-2} dislocation, kinematic model, directivity effects , probabilistic application.

Presentation of the spectral source model

The spectral source model called SASSOM (Synthetic Accelerograms from a Spectral Source Model) is a kinematic model in which the fault plane is discretized in many elementary faults. The strong motion is calculated in the far field approximation by summation of all the individual contributions along the isochrone lines. The rupture complexity is described by a particular dislocation distribution characterized in the wavenumber space by a k^{-2} spectral decay and stochastic high wave number phases. Herrero and Bernard (1994) showed that such a dislocation allows to generate realistic accelerograms with ω^0 high frequencies level. Figure 1 presents an example of k^{-2} dislocation, calculated for a magnitude 5.5 event, with a stress drop of 4 MPa.

Realistic broad band accelerograms computation

To compute the strong motion following parameters are needed :
1- The velocity structure (possibility of layered medium)
2- The dimension of the fault, its depth and focal mechanism, and the associated stress drop (or seismic moment)
3- The rupture velocity, the position of the nucleation on the fault, and the type of rupture (circular, Haskell unilateral or bilateral)
4- The maximal desired frequency, which controlls the spatial discretization and the computation time
5- The position of the station (distance and directivity from the source)

The standard model (Herrero, 1994) uses a k^{-2} dislocation distribution. The kinematic of the rupture is described by the rupture velocity and the rise time, which are constant on the whole fault plane. The rise time is very short, i.e. the source time is a quasi Heaviside function. Such a method allows to generate synthetics which have the classical "ω^{-2}" spectral decay, and present a specific directivity effect: for stations in the direction of the rupture propagation the model predicts a C_d^2 amplification of the high frequency spectral level, where C_d is the directivity coefficient defined by,

$$C_d = \frac{1}{1-\frac{c}{V_r}cos(\theta)}$$

(θ is the directivity angle between the station and the rupture propagation, $\frac{c}{V_r}$ is the ratio of S wave velocity and

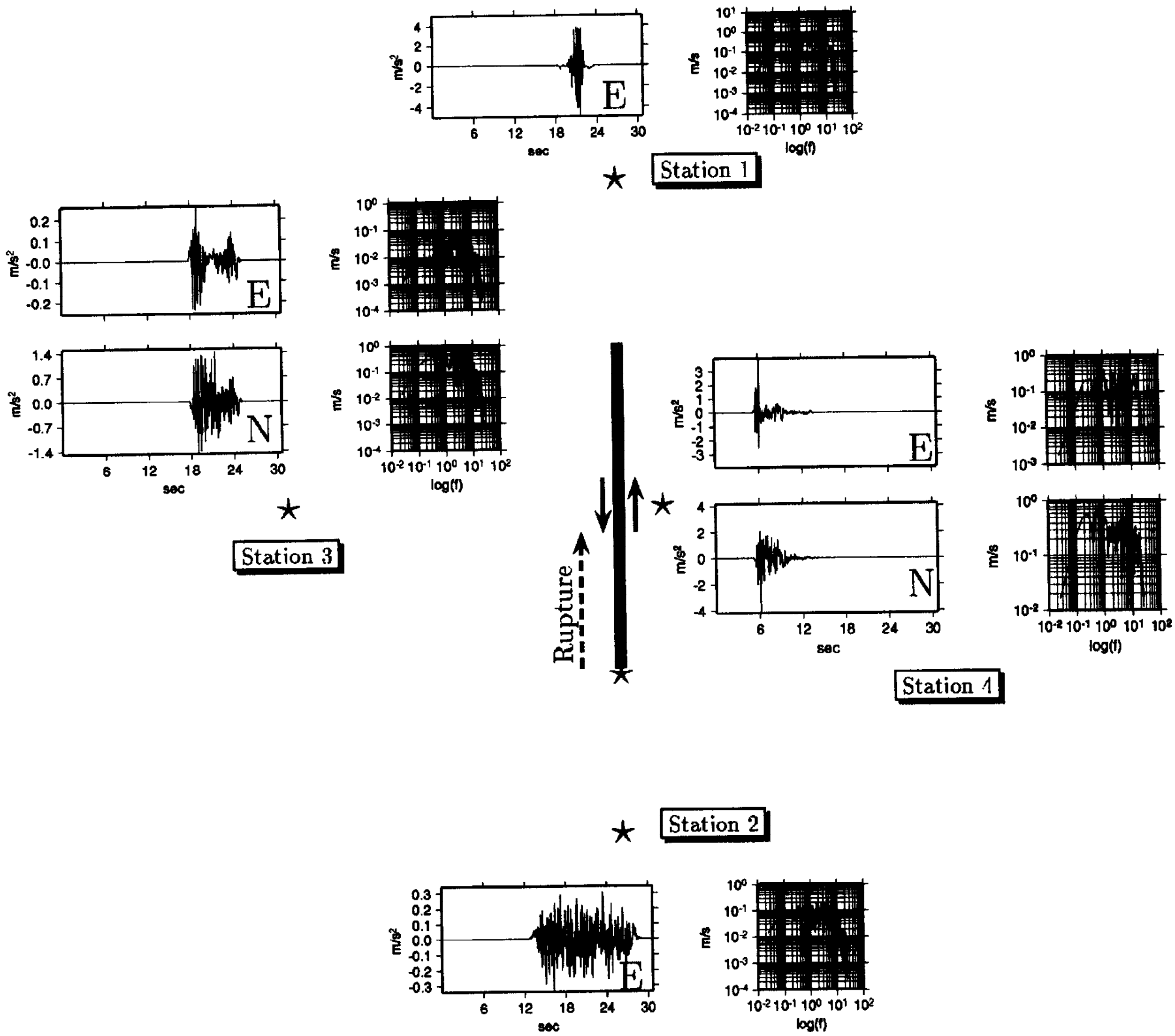

Figure 2: Synthetic accelerograms and spectra for non-directive, directive and anti-directive stations. The real position of the station is represented by the star. The horizontal components of the direct S wave are presented. The time origin is the nucleation time.

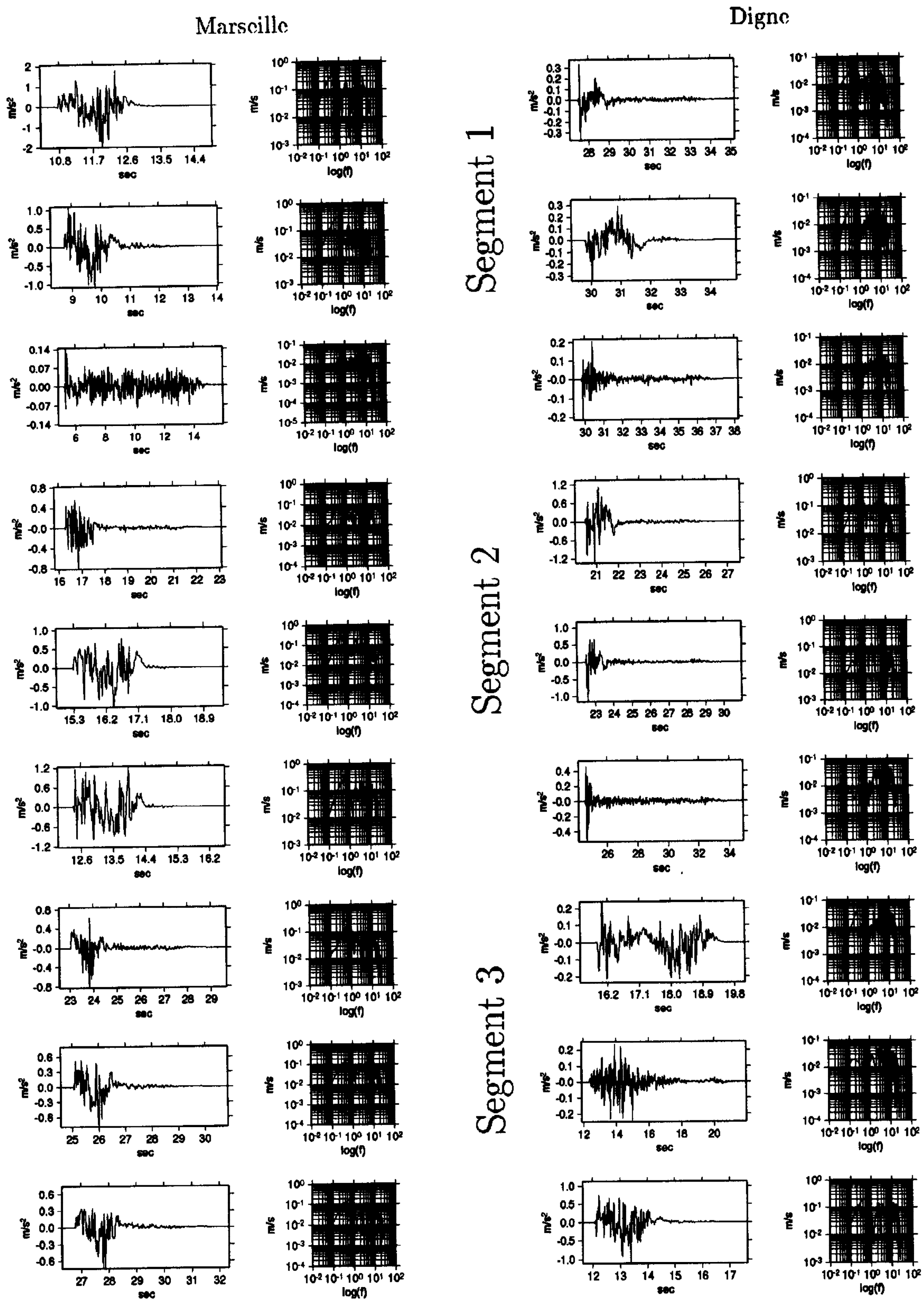

Figure 4: Signals and spectra variations at Marseille and Digne locations, for 3 tests on each segment. The influence of the nucleation position is clearly showed.

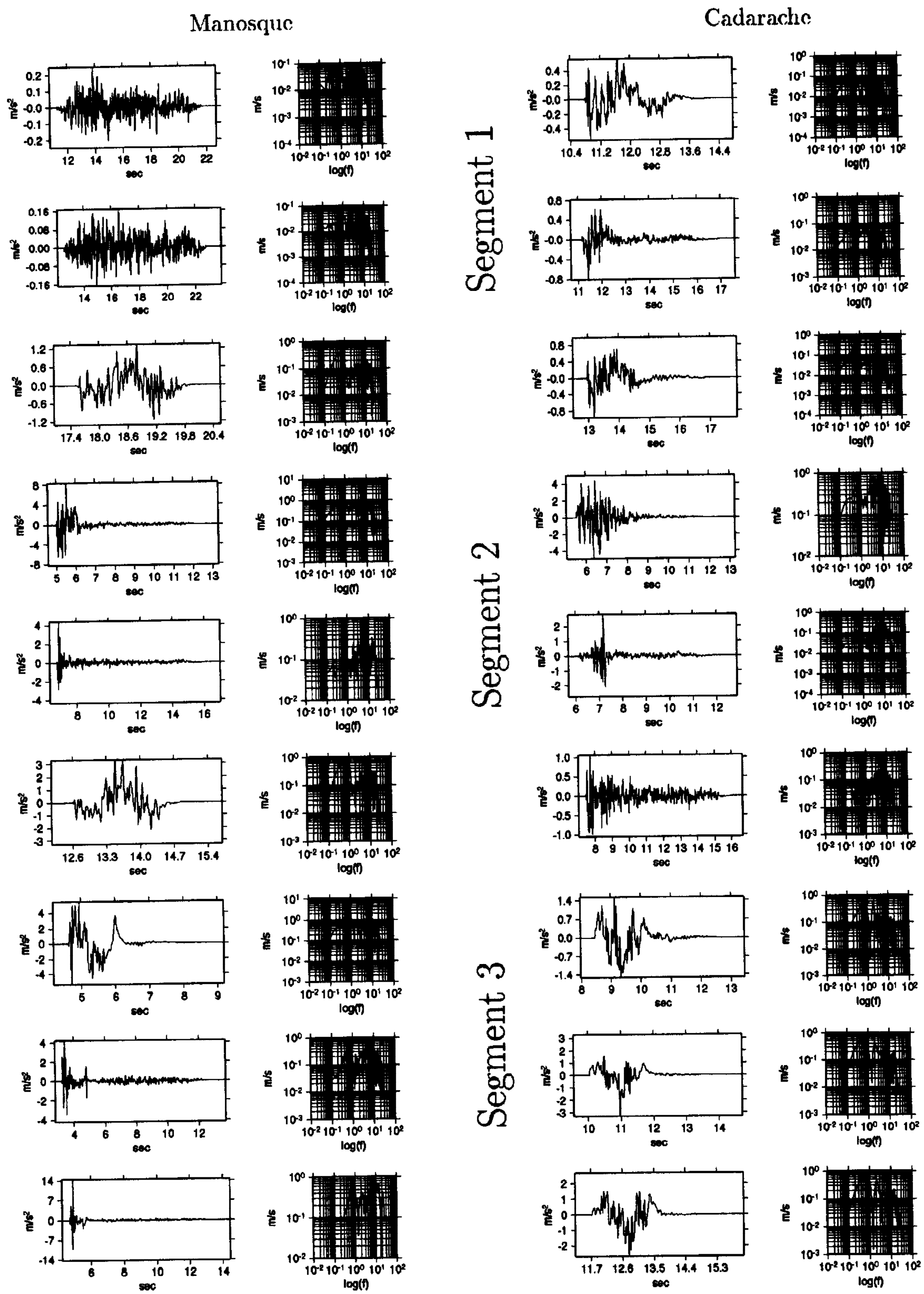

Figure 5: Same comments than for Figure 4, for Manosque and Cadarache