On adiabatically crust-invariant parameters of seismic pulse propagation.

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Introduction

The *Energetic Envelopes -Transform*(**EET**) is introduced that allows us to find some statistical parameters of a seismic wavefield which are nearly-invariant with respect to a local crustal structure. It is shown, that two main wavefield intensity components occur in the vicinity of the free surface, namely **P**-*Energetic Wavelets* (**P-EW**) and **S-EW**, which exhibit distinct group velocities being quite different from P_n, S_n or L_g phase velocities.

EE-Transform and Kinematics of Energetic Wavelets

The 'raw' z-component high-frequency records φ (with digitizing frequency $\geq$ 40 Hz) are prefiltered in the band 2-4 Hz and the $\tilde{\varphi}^2$ is filtered with **EE**-filter.

Theoretical base of EET is that pulse propagation in a random stratified medium should create a wave energy train with diffusion in space/time. It obeys the *Kolmogorov, or Fokker-Plank, equation*), which in terms of a mean intensity $u = |\varphi|^2$ of normal modes can be expressed as a one-way wave equation for energetic wavelets propagating with a mean *group slowness* S_g and with *diffusive broadening* of the wavelet *in time domain*:

$$(\partial_r + S_g \partial_t - D^2 \partial_t^2 + \varepsilon) \, u(r,t) = 0 \tag{1}$$

Indeed, if an initial energetic pulse has a form of a Gauss wavelet $u(r_0,t) \propto \exp\{-t^2/\tau_0^2\}$ then the wavelet on a distance $r = r_0 + \Delta r$ has a form

$$u(r,t) \propto \exp\{-\frac{(t - S_g \Delta r)^2}{\tau_0^2 + D^2 \Delta r}\} \exp\{-\varepsilon \Delta r\} \tag{2}$$

The expression 2 allows to see how a wavelet peak is moving with an average group velocity S_g and the wavelet itself is subjected to diffusion in a coordinate system moving with the wavelet peak. Note here, that dispersion as a base of the group velocity S_g is of geometrical nature of pulse paths in a layered medium and hence the dispersion is a *nonlocal* parameter.

The EET-filter is designed on the base of the *diffusion regularization*, that we wrote, e.g., in [1]. The outcome of the EE-transform, applied to real data from Germany, Italy and Norway, is presented in Figure 1, `top, right`.

The exposed EW-kinematics shows that with respect to the seismic wave propagation it is possible to insert a *basic* reference model: slowly (*adiabatically*) varying stratified/gradient media, while a local crustal structure can be treated as random perturbations. The fairly robust EW-kinematics can be helpful for decoding of seismic records in the crust tomography. Besides an inversion of of EE-forms yields much more reliable (and cheap) estimates of seismic event epicenters [2], [3], which in its turn can provide with the more accurate crust images .

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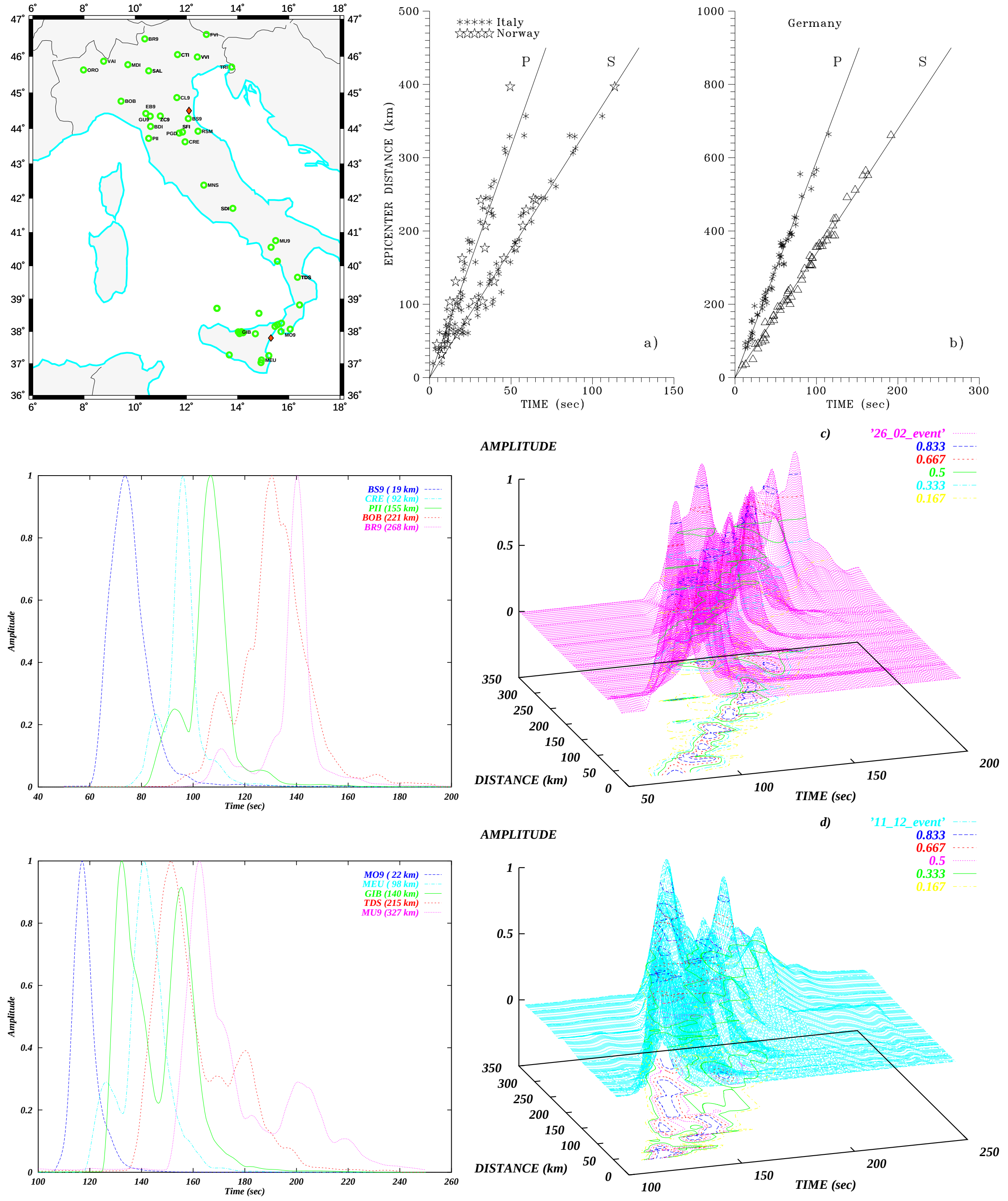

Figure 1: **Energetic Wavelets.** `Top, left` Examples of EE-transformed **real** data are given with Italian network station records. `Top, left:` • Epicenters of events 26.02.1995 (12.08 E, 44.49 N) and 11.02.1995 (15.61 E, 37.81 N) are marked by the *rhombus*, N.Italy stations are marked by *rings*. `Below, left:` • a set of EE-transformed records from 26.02.1995- event; `right:` the same records unrolled with respect the epicenter distance; `Bottom:`• records of the 11.02.1995-event. Note the *linear spreading* of EW (`c`) being typical of *diffusion processes*. `Top, right:` • preliminary estimates of P- and S-EW *travel times curves* on the base of Italian, Norwegian and German networks' data. The corresponding EW-velocities are 6.3 km/s and 3.5 km/s for Italy/Norway (`left`) and 5.9 km/s and 3.4 km/s for Germany (`right`).