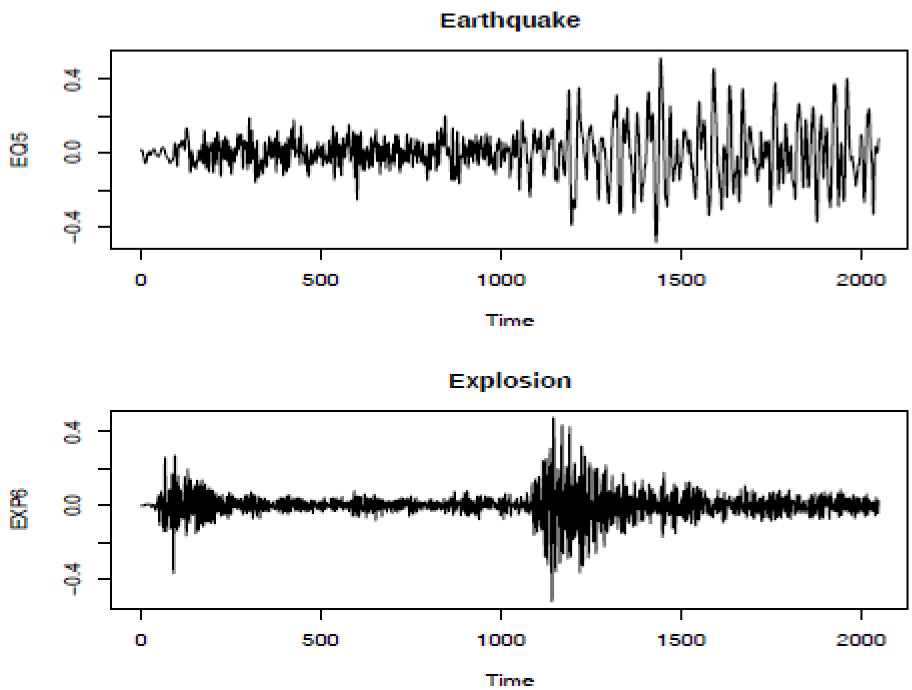

Fig. 1.7. Arrival phases from an earthquake (top) and explosion (bottom) at 40 points per second.

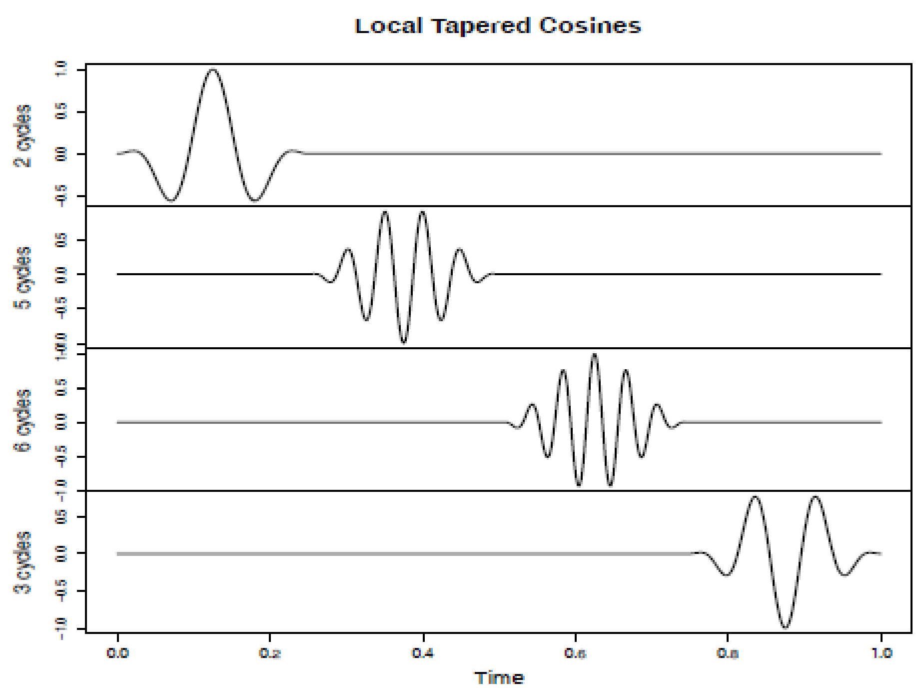

Fig. 4.19. Local, tapered cosines at various frequencies.

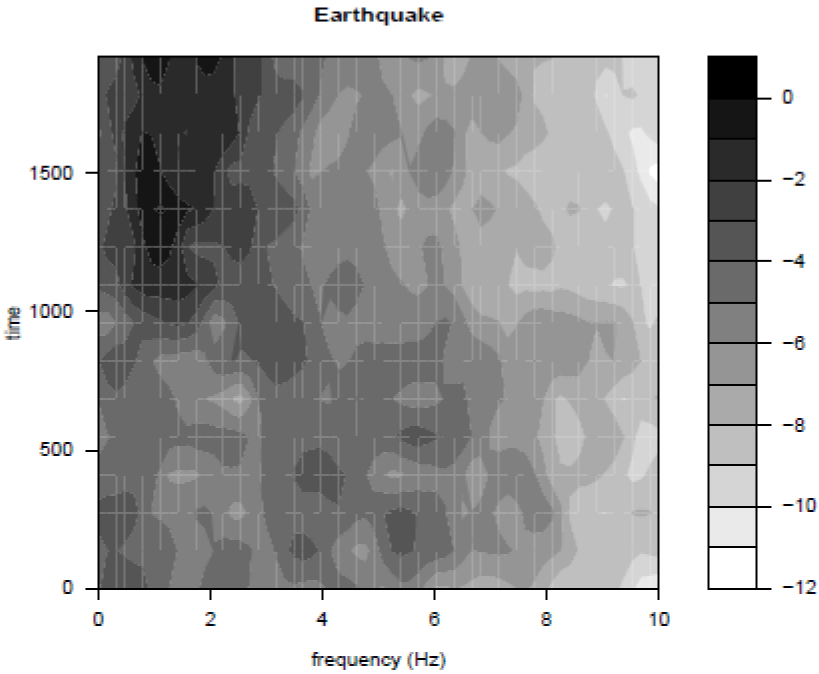

Fig. 4.17. Time-frequency image for the dynamic Fourier analysis of the earthquake series shown in Figure 1.7.

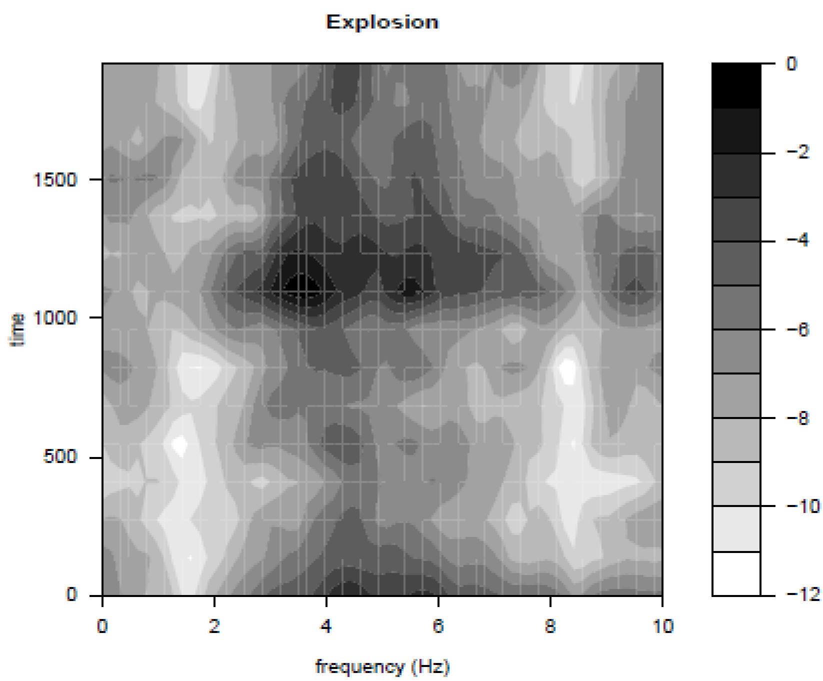

Fig. 4.18. Time-frequency image for the dynamic Fourier analysis of the explosion series shown in Figure 1.7.

in the images, darker areas correspond to higher power. Specifically, in this example, let x_t, for t = 1; ... ; 2048, represent the series of interest. Then, the sections of the data that were analyzed were [x_{tk+1}; ... ; x_{tk+256}}, for t_k = 128k, and k = 0; 1; ... ; 14; e.g., the first section analyzed is {x1; : : : ; x256}, the second section analyzed is {x129; : : : ; x384}, and so on. Each section of 256 observations was tapered using a cosine bell, and spectral estimation was performed using a repeated Daniell kernel with weights 1/9{1; 2; 3; 2; 1}.;

The S component for the earthquake shows power at the low frequencies only, and the power remains strong for a long time. In contrast, the explosion shows power at higher frequencies than the earthquake, and the power of the signals (P and S waves) does not last as long as in the case of the earthquake.

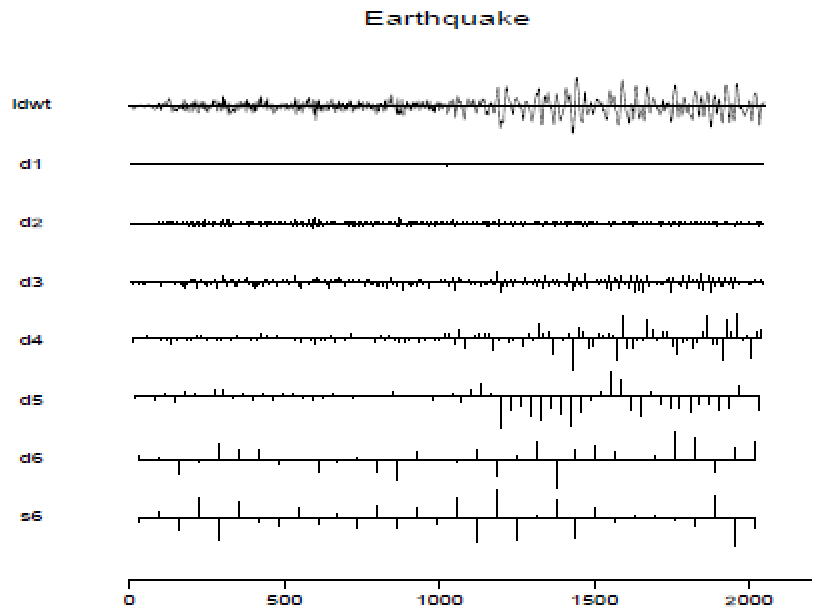

Fig. 4.22. Discrete wavelet transform of the earthquake series using the symmlet8 wavelets, and $J = 6$ levels of scale.

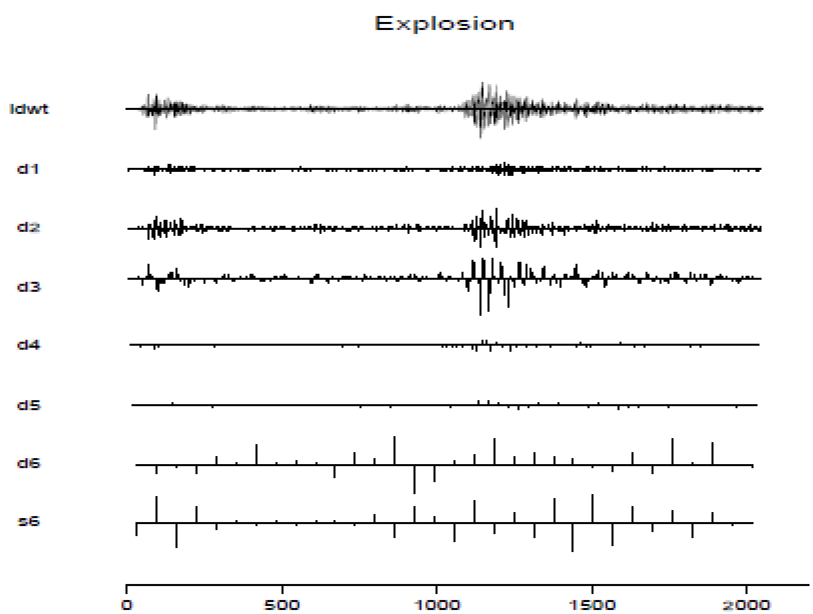

Fig. 4.23. Discrete wavelet transform of the explosion series using the symmlet8 wavelets and $J = 6$ levels of scale.

Comparing the DWTs, the earthquake is best represented by wavelets with larger scale than the explosion. One way to measure the importance of each level, $d1, d2, \ldots, d6, s6$, is to evaluate the proportion of the total power (or energy) explained by each. The total power of a time series x_t, for $t = 1, \ldots, n$, is $TP = \sum_{t=1}^{n} x_t^2$. The total power associated with each level of scale is (recall $n = 2^{11}$),

$$TP_6^s = \sum_{k=1}^{n/2^6} s_{6,k}^2 \quad \text{and} \quad TP_j^d = \sum_{k=1}^{n/2^j} d_{j,k}^2, \quad j = 1, \ldots, 6.$$

Because we are working with an orthogonal basis, we have

$$TP = TP_6^s + \sum_{j=1}^{6} TP_j^d,$$

and the proportion of the total power explained by each level of detail would be the ratios TP_j^d/TP for $j = 1, \ldots, 6$, and for the smooth level, it would be TP_6^s/TP. These values are listed in Table 4.2. From that table nearly 80% of the total power of the earthquake series is explained by the higher scale details $d4$ and $d5$, whereas 90% of the total power is explained by the smaller scale details $d2$ and $d3$ for the explosion.

Table 4.2. Fraction of Total Power

Component	Earthquake	Explosion
s6	0.009	0.002
d6	0.043	0.002
d5	0.377	0.007
d4	0.367	0.015
d3	0.160	0.559
d2	0.040	0.349
d1	0.003	0.066

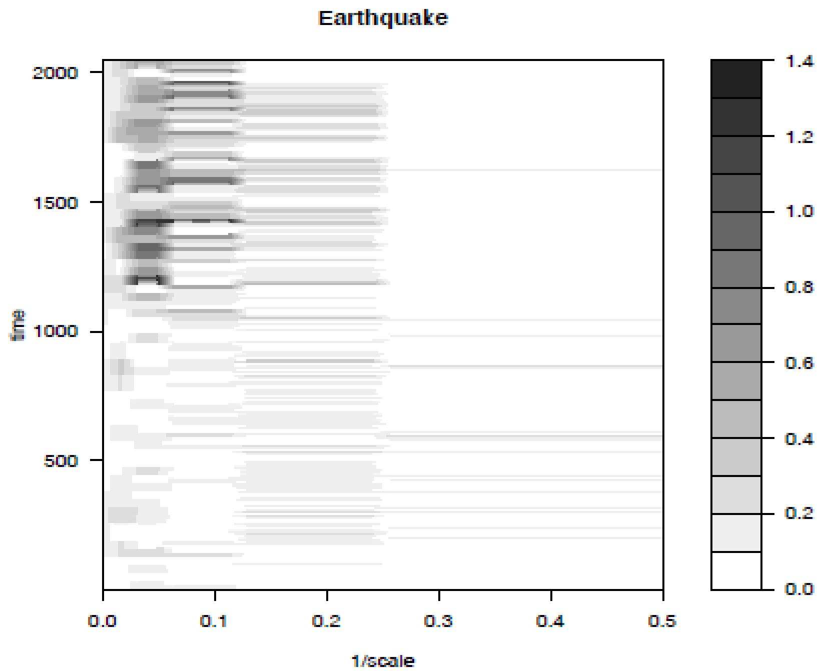

Fig. 4.24. Time-scale image (scalogram) of the earthquake series.

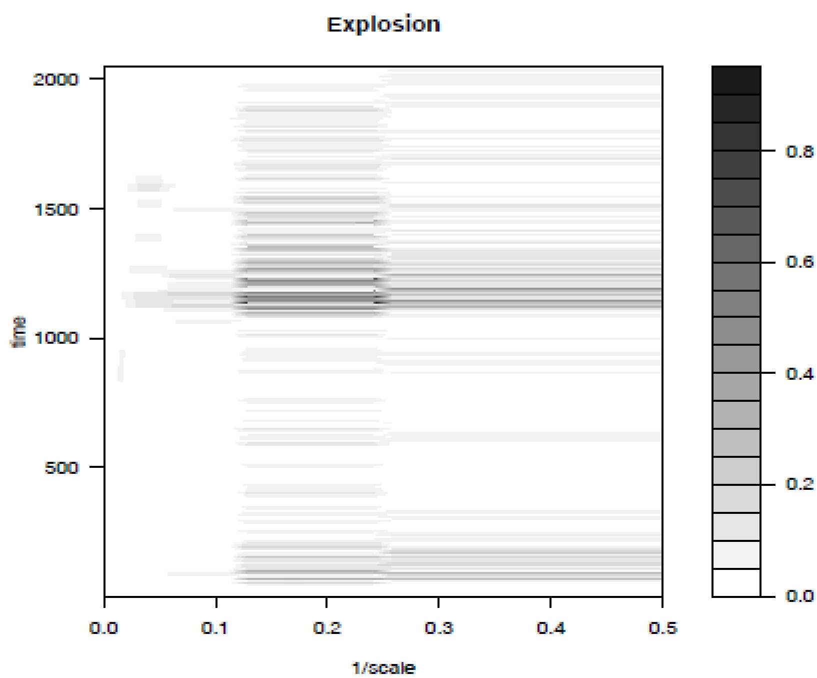

Fig. 4.25. Time-scale image (scalogram) of the explosion series.

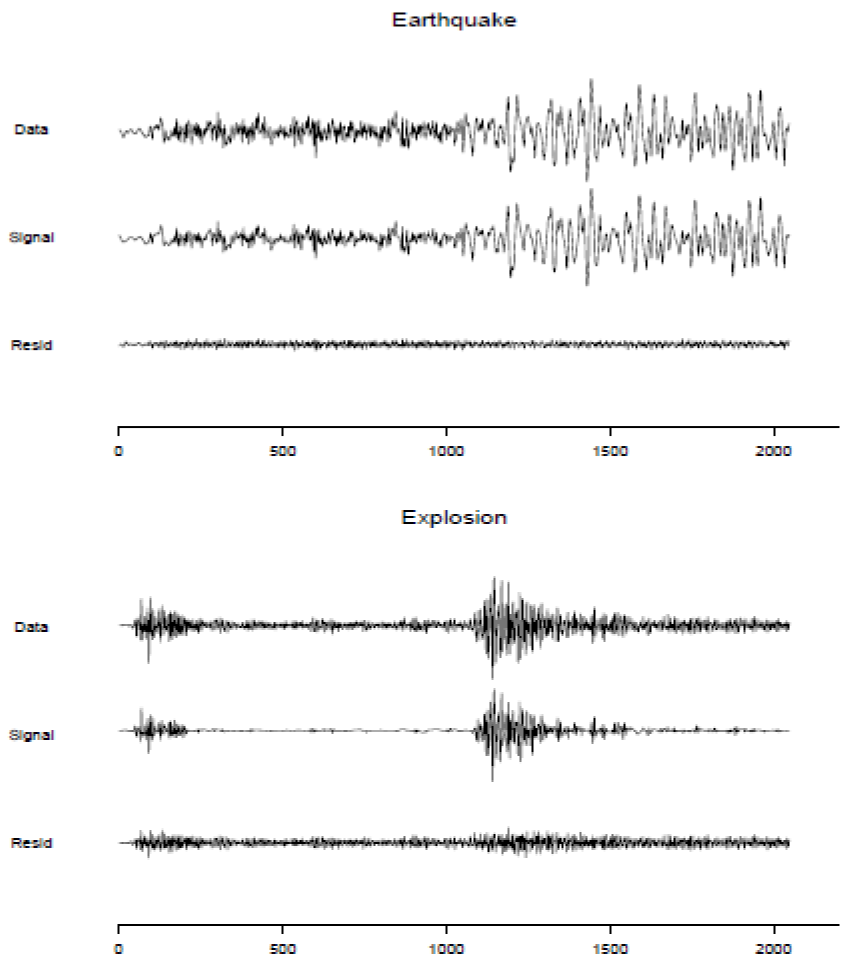

Fig. 4.26. Waveshrink estimates of the earthquake and explosion signals.