Geophysical Research Abstracts
Vol. 14, EGU2012-13729, 2012
EGU General Assembly 2012

Parameterization of Compressional Seismic Velocity Fields using the Haar Wavelet

H. M. Perin (1,2), A. C. Martinez (1), L. G. Guimarães (3), and W. M. Figueiró (1)

(1) UFBA (Federal University of Bahia), IGEO (Geosciences Institute), CPGG (Geophysics and Geology Research Center), Salvador, Brazil (figueiro@cpgg.ufba.br, adcmartinez@hotmail.com, Phone: 55 71 32838520), (2) UNEB (Bahia State University), Salvador, BA, Brazil (helciomoreira@yahoo.com.br), (3) UFRJ (Federal University of Rio de Janeiro), PENO-COPPE-UFRJ, Ilha do Fundão, Rio de Janeiro, RJ, Brazil (lgg@peno.coppe.ufrj.br)

Two-dimensional (2D) seismic compressional velocity fields, extracted from geological models, are parameterized by means of the Haar wavelet. The coefficients of the Haar series are calculated using integral formulas proposed by the wavelet theory. The primary objective of this work is to be assured that such parameterization can represent the velocity field (the seismic model) in a satisfactory way (it means: with reasonable accuracy and few coefficients) and, then, as a secondary objective, to prepare appropriated conditions to estimate such velocity field by some posterior inversion procedure (for example, seismic tomography), where the model parameters are the wavelet series coefficients. Different kind of geological models are considered, such as: homogeneous layers with horizontal interfaces (multilayers), intrusion of high velocity, salt dome with oil traps, and break of the continental shelf; all of them are assumed to be heterogeneous, isotropic, and with seismic velocity varying inside a wide range from 1.5 to 8.0 km/s. In brief terms, the Haar wavelet theory proposes an elemental function defined in the following way: it is equal to +1 (plus one) if it has variable in the interval [0, 1], and equal to 0 (zero) if not, it is called scale function (or father wavelet). This last function allows us to obtain another one called wavelet function (or mother wavelet) that is defined as: it is equal to +1 if its variable is in $[0, \frac{1}{2})$, it is equal to -1 (minus one) if its variable belongs to $[\frac{1}{2}, 1)$, and it is equal to 0 (zero) for other cases. This two functions produce a family of other functions (daughter wavelets) that constitute an orthonormal basis, that when written as a linear combination (an infinite series), it can represent transient functions. If a function belong to the space generate by the basis derived from the wavelet function, the elements of such basis are sufficient to represent it. If not, some terms originated by the scale function must participate in the series. Two kinds of wavelet series are used: one-dimensional (1D) and 2D, in both cases they represent a 2D field. It is natural to use a 2D series to represent (parameterize) a 2D field, but the same cannot be said when the series is 1D. In this case, it is necessary to use a strategy in order to see a 2D model by means of a 1D series. It is done putting a curve on the velocity field and it is seen by a function that is just the velocity field restricted to such curve. The used curves are functions like sine function or some variant of the saw-tooth function, both periodic and with sufficiently high frequency in order to provide a good covering of the model. In this way a 2D function can be seen, approximately, as a 1D function and, then, be represented by a 1D series. The motivation for this study is to try to use some advantage offered by the wavelets, such as: compression (or, in other words, to represent the maximum with the minimum). Another motivation is to pay attention to the model, instead of, and more than, to the data or to the relationship between data and model. This work search for a better representation of models to be used in inversion projects and, for this aim, they must be parameterized in a well defined and economic way. Some obtained results are: for all models the increase of coefficients improves accuracy, for the multilayers models the use of a few amount of coefficients makes the representation (using all elements of the orthonormal basis) better than using only daughter functions derived from the wavelet function and the two possibilities become closer when the number of coefficients increases, for the model of the break of continental shelf it was employed the 2D wavelet series and it showed a good resolution even in the case of the model with rugosity (not smooth interfaces), the complicated model of the salt dome had a very good representation where it was possible to identify clearly the reservoir position, and filtering is used in order to eliminate small coefficients without an important loss of accuracy. As conclusion, for an empirical study, without a heavy use of results originated from the wavelet theory, the model is recognized without difficulty when a high number of coefficients is used, but they can be reduced using filtering and using relations between them.