Parameter estimation and deformation analysis of sand waves and mega ripples.

Introduction.

Given are nine years, (1992,..., 1997, 2000, 2001, 2002), of Multibeam Echosounding data, interpolated to a 5m × 5m grid of a seabottom area of 1 km² in the Euro channel approach. We want to model possible ongoing deformation during this period and obtain parameters for sandwaves and mega ripples.

Vertical deformation analysis at single grid points.

Linear vertical deformation at a single grid point can be traced by classical deformation analysis: a linear model \( \lambda \) with, in this case, \( m = 9 \) years of depth observations \( d_i \) and a \( m \)-parameter vector \( x \) is adjusted and tested on itself, or against other models:

\[
\hat{d} = \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_m \end{bmatrix}, \quad H_y \ E[d] = Ax, \quad D[d] = Q_d.
\]

The adjustment step consists of projecting the observations into the model space, while in the testing step the test statistic, that is, the weighted sum of residues between the observed depths and the adjusted depths, is compared to a critical value.

Example: constant velocity model.

In the constant velocity model, the depth \( d(t) \) at time \( t \) is a linear function of time. That is

\[
d(t) = d_0 + v \cdot t,
\]

where \( d_0 \) denotes the depth at the beginning of the measurements and \( v \) denotes the deformation per year.

The residues for a constant depth model.

More complicated alternative: local-global sandwave model.

To give a local description of the motion of the mega ripples we use the equation that describes a plane wave

\[
\psi(x,y,A,k,\theta,v,t,d) = A \sin[k(x \cos \theta + y \sin \theta)] - vt + \phi_0 + d
\]

Wave number, velocity and average depth

We determine the wave number of the mega ripples simply by counting the number of crests. The average depth can be obtained by the linear tests of above. The covariogram of variation of depth in time at all grid points shows periodic correlation giving an indication for the propagation velocity of the mega ripples.

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