Blind test for slip inversion

Jan Burjanek, Charles University, Prague

Method:

A parametrization of the slip evolution over the fault was done in following way: I assume rupture velocity, slip velocity function characterized by rise-time and static slip distribution. Static slip distribution is composed from a number of overlapping 2D Gaussian functions (see Figure 1). In such formulation the problem is non-linear, however fixing rupture velocity and rise-time for whole fault makes the problem linear in static slip.

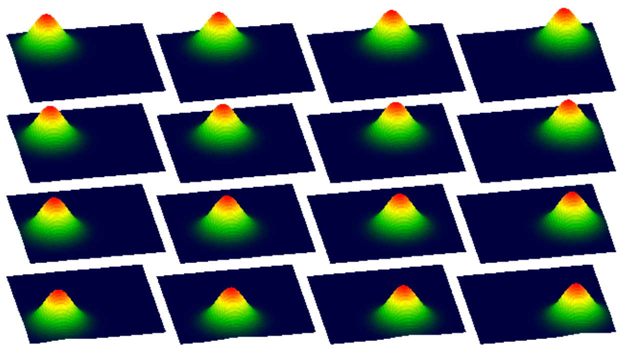

Figure 1: An example of slip parametrization.

The inversion algorithm works as follows, at first I fix rise-time and rupture velocity and calculate seismograms for each Gaussian function separately. Then linear inversion is performed to get optimal weights for these Gaussian functions. Such procedure is done for a number of rupture velocities and rise-times, optimal value of these are obtained by gridsearch. L2 norm is used as a objective function. The linear inversion for static slip is done with positivity constraint, so called 'Quadratic programming' was applied to solve such problem (Gill et al, 1986).

Although the fault has to be covered with large number of point-sources to model correctly smooth rupture propagation, the number of inverted parameters is just the number Gaussian functions plus 2 (constant rupture velocity and rise-time). The overlap of the Gaussian f. mustn't be too large to preserve good conditionality of the problem.

Results:

Fault was covered by 60x60 point-sources, velocity time histories were used for the inversion, calculation was carried out up to 0.75Hz. As I was working in such low frequency band I assumed apriory rise-time corresponding to Brune's pulse corner frequency of 1Hz. I made inversion for different number Gaussian f. (4x4, 4x7, ..., 4x16, ..., 16x16). A value of optimal Vr was stably 2700±50m/s and Mo 1.7e19±0.2e19 (errors are just maximum bounds). Of course slip distribution changed with number of inverted parameters (Figure 2). At first approximation I choose the model with lowest misfit – 13 Gaussian f. along dip and 16 Gaussian f. along strike (Figure 3), with reduction of variance equal to 99.9% for velocity time histories up to 0.75Hz (Figure 4), Vr=2675m/s and Mo=1.59e19.

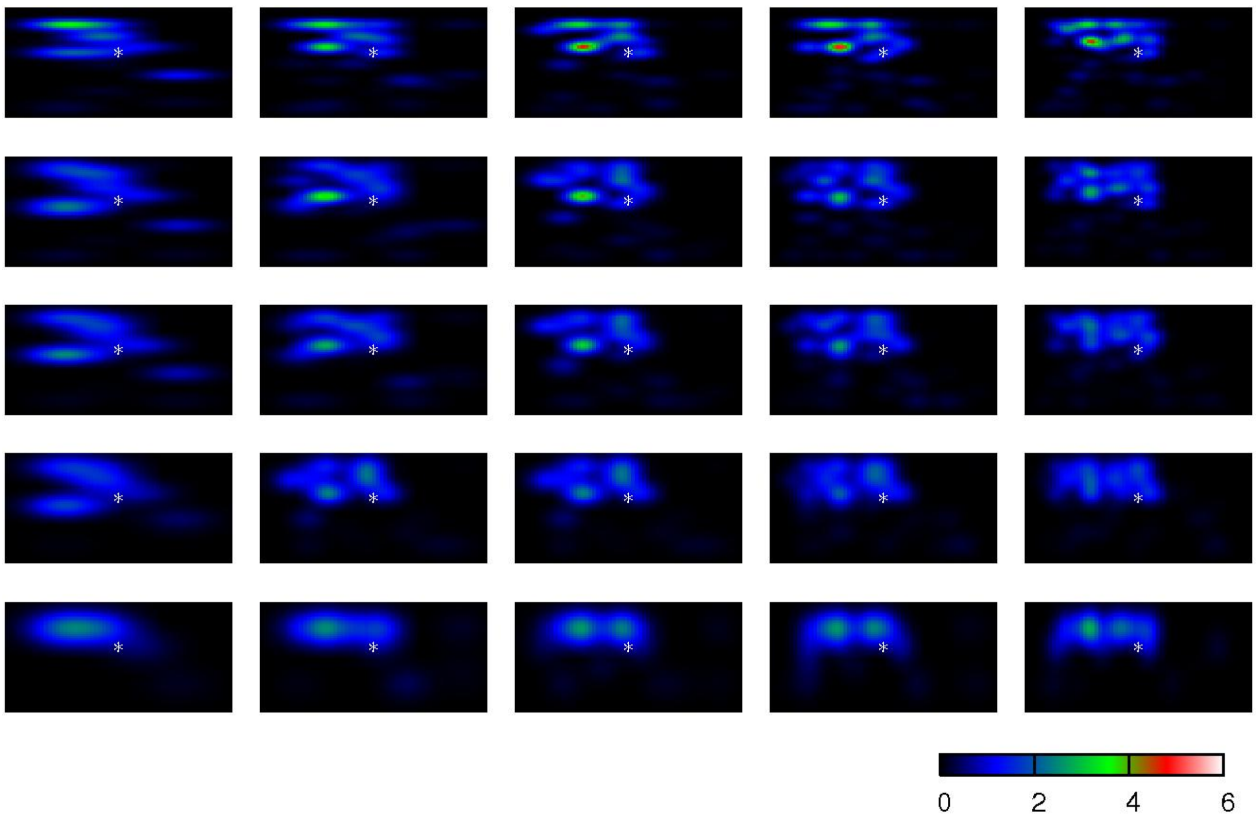

Figure 2: Optimal models for different number of inverted parameters.

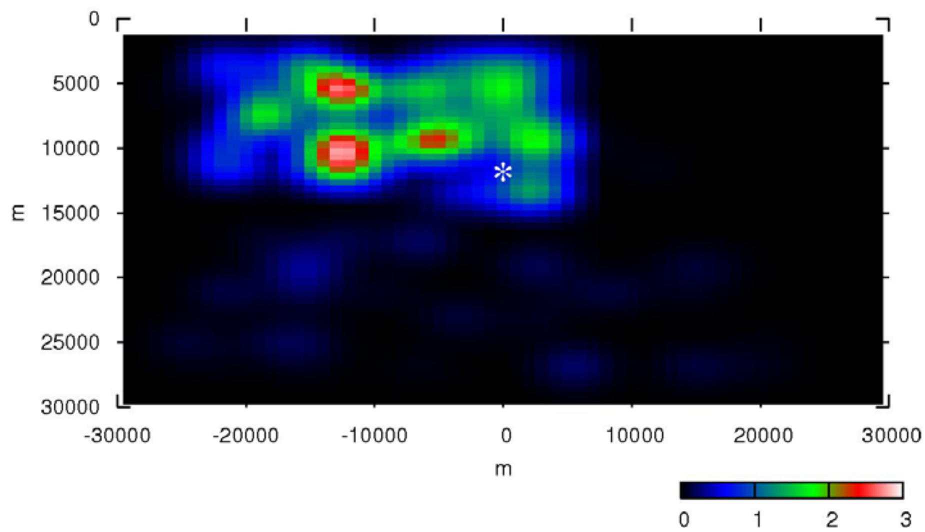

Figure 3: Model with lowest misfit.

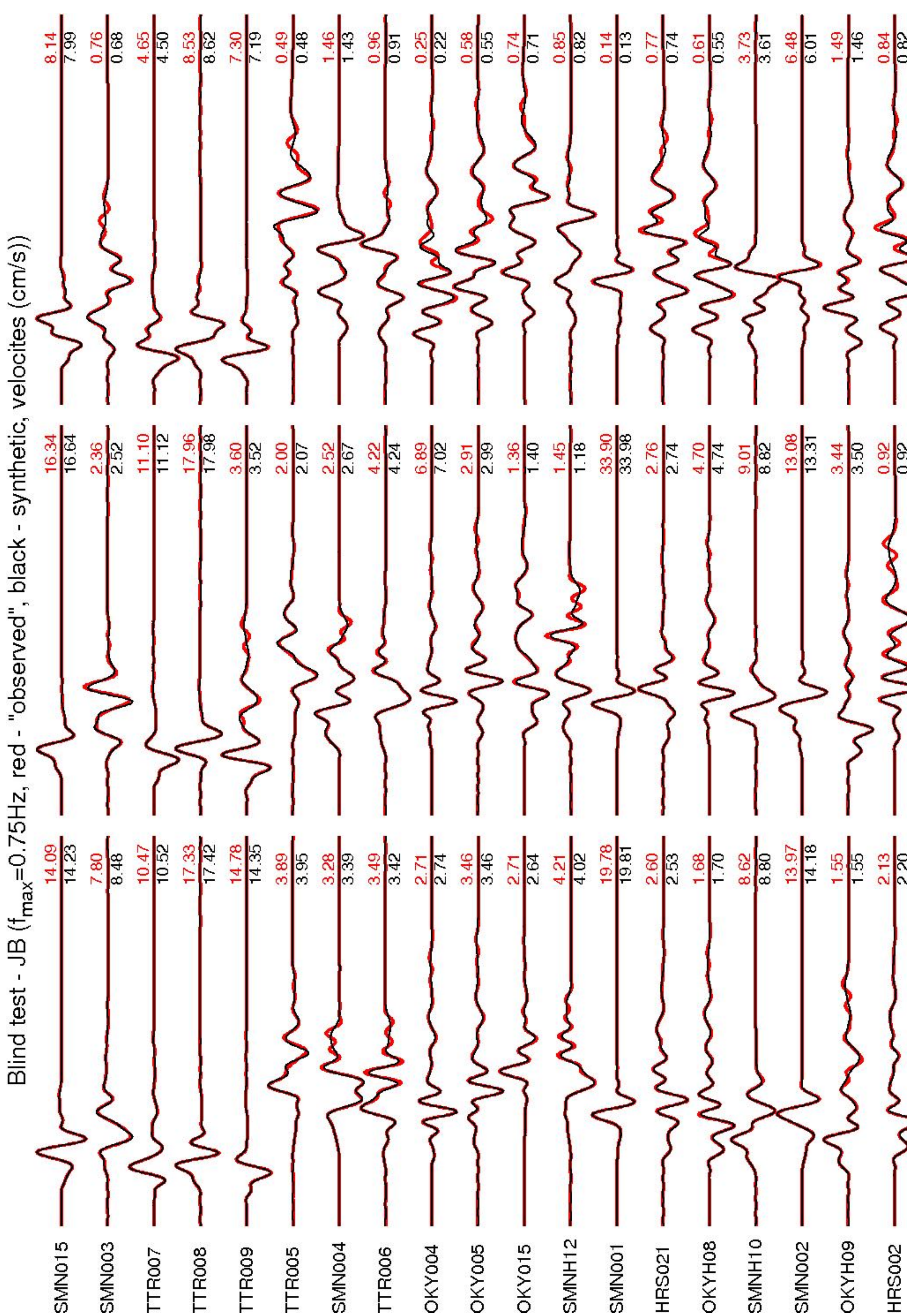

Figure 4: Observed and fitted seismograms for model with lowest misfit.