THE EFFECT OF VELOCITY STRUCTURE ON DOUBLE-DIFFERENCE EARTHQUAKE LOCATION

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ABSTRACT

The double-difference earthquake relocation technique is an appealing methodology when attempting to resolve seismicity at very high resolution. In this presentation, we show that relative earthquake location using double-difference methods requires an accurate knowledge of the velocity structure throughout the study region to prevent artefacts in the relative position of hypocenters. The velocity structure determines the ray paths between hypocenters and receivers. These ray paths, and the corresponding ray take-off angles at the hypocenters, determine the partial derivatives of travel time with respect to the hypocentral coordinates which form the inversion kernel that maps double-differences into hypocentral perturbations. Thus the large-scale velocity structure enters into the core of the double-difference technique. By employing a 1D layered model with sharp interfaces to perform double-difference inversion of synthetic data generated using a simple, 1D gradient model; we show that inappropriate choice of the velocity model, combined with unbalanced source-receiver distributions, can lead to significant distortion and bias in the relative hypocenter positions of closely spaced events. Thus the use of a double-difference technique for high resolution studies of closely spaced events does not preclude having a good velocity model for the whole study region. This study indicates also that the robustness of a double-difference inversion should be appraised using different data subsets and different velocity models for the same set of events.

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