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Testing the resolution of surface wave velocity measurements over small-aperture arrays

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Deployment of arrays of temporary broadband seismological stations over dedicated targets is common practice. Measurement of surface wave phase velocity across the array and its depth-inversion gives us information about the structure below the array which is complementary to the information obtained from body-wave analysis. The problem is that, from a surface wave analysis point of view, the size of these arrays is usually small and measuring phase velocity with adequate precision can be a challenge. The array configuration has however the advantage of providing directly a local phase velocity measurement and of reducing biases due to multipathing and diffraction by analysis of events in various backazimuths and epicentral distances. Pedersen et al. (2003) proposed a procedure to measure the phase velocities of surface waves at arrays of broadband stations which have an aperture much smaller than the wavelength of the surface waves analysed. The question is however: what do we actually measure with this technique and how do the measured phase velocity relate to the real structure below the array? We quantify this relation by performing a series of numerical simulations of surface wave propagation in 3-D structures and by measuring the apparent phase velocity across the array on the synthetics. A principal conclusion is that heterogeneities located outside the array can map in a complex way onto the phase velocities measured by the array. In order to minimize this effect, it is necessary to have a large number of events, at least 20 even in a noise-free environment, and to average measurements from events well-distributed in backazimuth. A second observation is that the period of the wave has a remarkably small influence on the lateral resolution of the measurement, which is dominantly controlled by the size of the array.