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# Assessing the reliability of the modified 3-component spatial autocorrelation technique

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For the prediction of site amplification effects during earthquakes it is of great interest to improve the knowledge about the subsurface seismic wave propagation properties. Within this context, the analysis of ambient vibrations using different array methods has become more popular in recent years as a cost effective and practicable tool. The determination of the dispersion curves of surface waves allows inverting for the 1D-velocity-structure. The spatial autocorrelation method (SPAC) after Aki (1957) is one of several array techniques which can be used for the determination of the surface waves dispersion characteristics. It is possible to estimate the dispersion curves of Rayleigh and Love waves and their respective portion in the wavefield by analysing the spatial autocorrelation function of all three components of the wavefield. The determination of Love wave dispersion curves is a matter of particular interest because in contrast to Rayleigh waves they don't depend on the P-wave velocity structure. This simplifies the inversion for the S-waves velocity depth profile. The simultaneous use of Rayleigh and Love wave dispersion curves additionally allows for a reduction of the non-uniqueness of the inversion problem. Finally, the determination of the proportion of Rayleigh and Love waves within the wavefield provides further insights into the character of ambient vibrations. Within this work, the modified spatial autocorrelation method (MSPAC, allowing the use of arbitrary array configurations ) introduced by Bettig et al. (2001) was extended on all wavefield components. The method was first tested using several synthetic data sets. In a second step real wavefield data from ambient vibration array measurements within the Lower Rhine Embayment, the Southern Rhine Graben and the city of Hamburg were used. Both, the synthetic and real data

sets have been acquired within the European SESAME project (Site EffectS assessment using AMbient Excitations). In the case of the synthetic data sets, the estimated dispersion curves were compared with the theoretical values from the forward computation. Our results show that both the Rayleigh wave portion and the dispersion curves of Rayleigh and Love waves can be well determined. In a further step, we investigated the influence of body waves and higher mode surface waves using synthetic data sets. Whereas no significant portion of body waves could be recognized from the results, higher surface wave modes are clearly identified within higher frequency bands. For the evaluation of dispersion curves estimated from the observed data sets, Rayleigh wave dispersion curves of other studies obtained by frequency wavenumber (f-k) analysis were available. The results of both MSPAC and f-k techniques agree with each other within their error bounds. For both analysis methods we found that the valid frequency range is limited due to decreasing resolution and aliasing. It has been observed that to lower frequencies the velocities were better resolved by the MSPAC-method leading to more realistic results. The analysis of ambient vibration recordings measured at several sites within Germany showed a consistently high portion of Love waves of approximately 80 %. The determination of Love wave dispersion curves was therefore favoured by such a strong energy contribution in the wavefield. Thus it was possible to determine Love wave curves in addition to the already known Rayleigh wave phase velocities for all sites. The measured relative portions of Love waves are in agreement with values previously found by other authors at different sites worldwide.