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A multiple-criteria network optimization

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Optimizing a seismic network for locating earthquake is a crucial issue in seismology. Precise earthquake location is indeed the key factor for most sophisticated seismological analyses and for monitoring activities. Seismic monitoring of tectonic and volcanic areas involves the use of seismic networks which should have high efficiency in detecting and locating microearthquakes. Network testing and optimization should therefore be a basic procedure to plan, install and improve a monitoring seismic network. In this paper, we firstly review the most appropriate methods for network testing, using two different approaches based, respectively, on linearized and Bayesian methods. Furthermore, we developed and tested a complete optimization technique which allows to take into account different parameters (i.e. cost, transmission lines redundancy, etc.) in addition to the location quality. The new method is based on the direct comparison of all the possible networks resulting from the permutation of N stations in M sites (with M[U+F03E]N). The location performance of a network can be defined using different criteria; in our method we use either the determinant of the covariance matrix, which is generally used in literature, and the condition number of the coefficient matrix, a different approach which is new in this field. We show that our new procedure is very efficient for network optimization with respect to multiple criteria, and overcomes several problems of the actual procedures. The method is thus applied to the Campi Flegrei volcanic area, to optimize and improve its seismic monitoring network.