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# Optimization and testing of microseismic monitoring networks: least-squares vs. Bayesian approach

Anna Tramelli, Claudia Troise, Giuseppe De Natale, and Massimo Orazi
Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Napoli, Italy (anna.tramelli@ov.ingv.it)

Localization of seismic events is the fundamental problem of seismology, and the main goal for which seismic networks are designed and installed. Precise earthquake location is in fact the key for all the most sophisticated seismological analyses, and of all monitoring activities. In the last decades, optimal design of dense microseismic networks has became more and more important for a wide range of activities. The last ones include seismic monitoring in tectonic and volcanic areas, as well as monitoring of induced seismicity during activities implying deep fluid injection/withdrawal, such as oil and gas recovery, geothermal exploitation, EGS field stimulation and waste fluid disposal. The resolving power of seismic networks on earthquake location can be computed in two basic ways. The first one is based on the linear approximation of an intrinsically non-linear problem as the earthquake location is, thus implying the computation of variance/covariance matrices of the linear inverse problem at the location point, which contain errors on space location and origin time parameters. The second approach is to fully consider the non-linear nature of the problem, and to use a bootstrap procedure to estimate confidence limits of maximum likelihood values or, alternatively, a Bayesian approach based on the probability estimation on the various parameters. The last approach is the only one which gives a complete picture of the uncertainty of the solution, taking into account the non-linear character of the problem. In this work, we compare two methods to enlighten the respective vantages/problems for network design and optimization on seismic location. Both methods we have built are applicable with a wide range of data, including P and S arrivals as well as P wave polarization. Furthermore, both methods allow to consider borehole seismic stations. Using the two methods, we discuss the relative merits of each one for optimization and testing of seismic networks. We show that the use of a Bayesian approach gives a more complete and unbiased information about the resolving power of seismic networks with respect to location parameters, for various kinds of applications. Such applications include the design and optimization of the microseismic network we are going to install for scientific and monitoring purposes in the framework of the Campi Flegrei Deep Drilling Project (CFDDP).