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Seismic event location with non-detecting stations

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Standard processing of seismic events includes the determination of event magnitude, hypocenter and origin time. Two separate problems are usually solved:

- determination of the hypocenter and origin time from phase onset times,
- determination of the magnitude from maximum amplitudes at the seismic stations that detected the event.

The standard algorithms for solving these two problems take as input the observed maximum amplitudes and phase onset times. We contend that valuable information is also available from seismic stations that could have, but failed to, record the event. We use the term “non-detects” to refer to such stations.

Seismologists have recognized the value of non-detects for magnitude estimation for almost 30 years, since the work of Ringdal (1976) on maximum likelihood estimation of event magnitude. Non-detects are also relevant for event location. For example, it is unlikely that an event has its epicenter close to a station that failed to detect the event; yet current location algorithms ignore the non-detecting station in determining the epicenter.

We present a method for event location that takes advantage of the information in non-detecting stations. Our method considers the problems of location and magnitude determination simultaneously. The issue of how “close” the epicenter might be to a non-detecting station is intimately related to the magnitude of the event. And the magnitude is related to location, as amplitudes must be “corrected” for epicentral distance and event depth to convert them into magnitude readings.