The Indirect Location Algorithm: a combination of the GPS and acoustic ranging techniques

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GPS observations have been recognized as the valuable source of information about such processes like tectonic plate movements, fault creeping, volcanic hazard mitigation, to name a few. Unfortunately, this very accurate technique can be used only at relatively small land ares, whereas the most interesting geophysical processes connected to deep earth processes usually occures in regions covered by oceans. Thus, there is a strong demand to extend the GPS technique to make possible static, geodetic measurements of a deformation of the ocean bottom crust.

This presentation discuss some theoretical aspects of the method which relays on the combination of the GPS positioning and the acoustic ranging techniques. The algorithm, called the indirect acoustic location, is an application of the Bayesian inversion technique to the location of the ocean bottom transponders based on the measurement of acoustic wave travel times when receivers (ship) positions are known with the limited accuracy. The method allows the systematic estimation of location uncertainties including all type of errors: GPS ship positioning errors, travel time measurement errors, modeling errors (including effects of velocity heterogeneities) which is a crucial point when the required location accuracy of 1-2 centimeters has to be achieved. The performance of the algorithm is illustrated with a numerical and real data examples.

The algorithm has been developed for positioning (location) of the acoustic transponders settle on the ocean bottom. However, it can also be used in a more standard seismological (rock mechanics) applications if sensor location uncertainties are of the same order as the required location accuracy.