Advantages of Determining an Earthquake Focal Mechanism Using Distributed Acoustic Sensing Data

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INTRODUCTION AND MAIN RESULTS

An earthquake focal mechanism (FM) is one of the key source parameters describing faulting kinematics and geometry. For weak seismic events, an ambiguity in FM determination is often connected with a lack of close seismic stations. Using of Distributed Acoustic Sensing (DAS) data can partly solve this issue.

In this study, we review existing methods of FM estimating based on DAS data. The most preferred approach has been selected. Some questions of its application are formulated and our first steps, aimed at answering them, are described.

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Introduction

Earthquake source parameters are valuable for solving different seismological problems, including ones in the context of monitoring the Comprehensive Nuclear-Test-Ban Treaty. A focal mechanism (FM) is one of the key parameters describing faulting kinematics and geometry. FMs of earthquakes with M_w>~5.0 are routinely calculated by different seismological centers and published in catalogs. FMs of weak seismic events are widely obtained from body wave first-motion polarities recorded by regional networks of seismic stations. Nevertheless, in many cases, a number of regional seismic stations and network geometry do not allow determining FMs of weak events.

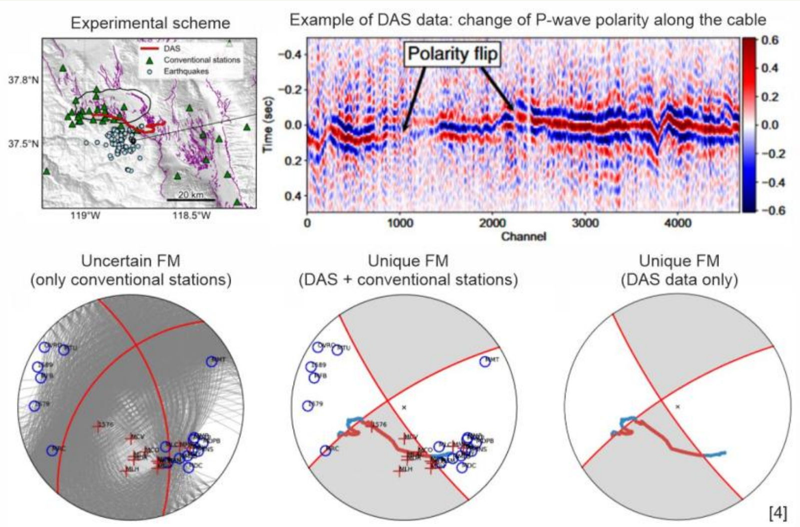
Distributed Acoustic Sensing (DAS) is a rapidly developing technology allowing recording seismic waves with optical fibers and an interrogator. Cable segments can be regarded as virtual sensors measuring deformation, temperature, and some other parameters.

DAS advantages:
- large lengths of virtual seismic network;
- extremely high spatial resolution;
- broad frequency range;
- pre-existing telecommunication cables can be used as DAS sensors;
- etc.

Methods

Different methods of FM determining with DAS data:
- seismic moment tensor inversion from DAS deformation data in boreholes fro isotropic [1] and anisotropic [2] medium;
- FM determination from ratio of maximum amplitudes of P- and S-waves [3];
- FM determination from P-wave first-motion polarities obtained from cross-correlation of records at different channels and records of different earthquakes (see the figure below) [4].

From our point of view the last method is the most perspective due to its simplicity, applicability in a wide magnitude range, and availability of open DAS data.



Future goals

Our future goals connected with establishing practical recommendations and limitations of the method described in [4]. The main questions are connected with determining (i) proper epicentral distances to the cable for events of different magnitudes, (ii) azimuthal coverage and geometry of DAS cables, (iii) minimal number of conventional seismic stations.

To achieve these goals, we use open DAS data:
- Underwater DAS Detection (https://osf.io/4bjph/);
- PoroTomo (https://gdr.openei.org/submissions/848);
- Global DAS Month data [5].

We process them with freely available DASPy package (https://pypi.org/project/DASPy-toolbox/). By now, we are familiar with all the necessary procedures connected with data reading (in different formats) and processing and have collected a set of initial DAS data for earthquakes of different magnitudes. The study is continued…

References

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