S014-05 - *From Strain to Rotation: Connecting Waveform Gradients*

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Abstract

While observations of rotational ground motions have a wide range of potential applications ranging from elastic wavefield separation to earthquake source inversion, rotational seismology remains a niche field, mainly due to the small number of reliable sensors that are currently available. This is in contrast to the unprecedented spatial resolution provided by DAS, even in remote or urban areas. Because of the potentials of strain and rotation observations in seismology, it is natural to emphasize the similarities and differences between these measurements. We demonstrate that both measurements provide information related to complementary parts of the displacement gradient tensor: the symmetric part (strain measured by DAS) and the anti-symmetric part (rotation measurements). We study the extent to which one of these observables may be derived from another and demonstrate a clear link between both measurements. Furthermore, we introduce a way to obtain rotational ground motion from areal strain recordings, potentially increasing the degrees of freedom retrieved from DAS measurements.

This study is divided into three subsequent parts: (1) A theoretical formulation to approximate rotation data from areal strain data; (2) Numerical examples to synthesize rotational waveforms from arrays of strain recordings for different acquisition parameters; (3) Real-data examples for rotations derived from recordings of a DAS-array next to the ROMY ring laser in Fürstenfeldbruck (Germany) from an active source sensor test in November 2019.

Our initial results suggest that, for sufficiently small gauge lengths (the length over which strain or strain-rate is calculated in DAS acquisition systems) and channel spacings, and for certain acquisition geometries, it is possible to estimate rotational components of the wavefield from measurements of strain.

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