Differential arrival times for event location with DAS data

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Standard seismic networks typically use absolute arrival times of specific seismic phases to estimate source locations. In this context, multiple sensors are positioned over a monitored area, aiming to minimize the azimuthal gap to known seismicity clusters. Distributed Acoustic Sensing (DAS) technology, which converts fiber optic cables (FOCs) into very dense seismic arrays, is nowadays used for similar purposes. DAS has the additional advantage of being able to exploit preexisting telecommunication FOCs (Telecom-FOCs). However, since the original installation purpose for Telecom-FOCs doesn't align with seismological needs, the spanned azimuthal directions can be limited. Hence, relying on absolute arrival times for event location might result in uncertain locations, given poor waveform moveouts and site-specific sources of noise in the data. Nevertheless, the intrinsic DAS channels' spatial density provide a good opportunity to test multi-channel cross-correlation techniques. Here, to assess the potential benefit from using differential arrival times for event location, we cross-correlate all possible DAS channel pairs and identify P-wave time delays. We focus on well-known test environments (i.e., known event locations) and

use a Hamiltonian Monte Carlo algorithm to estimate hypocentral parameter uncertainties, considering both absolute and differential arrival times. We demonstrate how differential arrival times better constrain the events' azimuthal directions compared to absolute arrival times. However, computational costs are inevitably higher due to the significant increase in data points when considering all the P-wave delays. A mitigation to this issue is reached by selecting measurements based on thresholds for the minimum cross-correlation index and maximum interchannel distance. This work illustrates how to potentially alleviate DAS geometrical limitations on event location by exploiting selected differential arrival times.