Confirmation of the accuracy of three-component Texan data by comparison to colocated three-component RT-130 data

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A long-time goal of the controlled-source seismic community has been to acquire full-wavefield seismic data with dense spatial resolution. A group of Texas universities in the 1990s developed the Reftek RT-125 single channel 'Texan' instrument that grew into a pool of 2700 instruments during the EarthScope years. Subsequently in 2008, Stanford University developed a 3-to-1 'pigtail' cable that connects three Texan instruments to a single three-component (3C) sensor. This allows researchers to deploy easy-to-install 3C sites in order to collect dense 3C data. However, each Texan instrument has its own internal clock subject to its own clock drift rate. As Texans are not equipped with GPS and are unable to have GPS-corrected timing while deployed, corrections are made using a total accumulated drift determined by time-stamping after instrument collection and assuming that the drift is linear. This raises a concern that analysis methods which require detailed cross-component comparison and precise timing, such as shear wave splitting, may be suspect or have larger uncertainties.

We report here on a study of Texan instrument drift that is calibrated using colocated GPS-based Reftek instruments. The 2011 active source Seismic Array Hikurangi Experiment (SAHKE) in North Island, New Zealand was designed to investigate the physical parameters controlling the plate boundary and to characterize slip processes beneath North Island. This experiment included 3C Texan stations within a dense linear array (Fig. 1). A total of 12 onshore seismic shots were recorded on 835 seismic stations (277 3C and 558 1C sensors) at 50-100 m spacing. Data collection was continuous during five consecutive nights. Three of the 3C Texan sites included colocated RT-130 instruments with attached GPS and thus provides reference timing. In this study, we directly compare the colocated 3C Texan and 3C RT-130 instrument data via cross-correlation lag per station-component in order to quantify Texan drift (Fig. 2A). After Texan drift-correction, the cross-correlation lag between the two signals allows us to measure any persisting drift and evaluate how well the 3C Texan configuration is able to provide an accurate measurement of the 3C vector wavefield (e.g, Fig. 2B-E). Our goal here is twofold: To quantify pre-drift correction differences between colocated stations and to compare drift-corrected and lag-corrected signals to ensure the accuracy of the time corrected data. We present results that quantify clock drift disparities, investigate correction methods, describe how time-corrections are applied to seismic data by IRIS, and assess the applicability of 3C Texan data for multi-component seismic analyses.

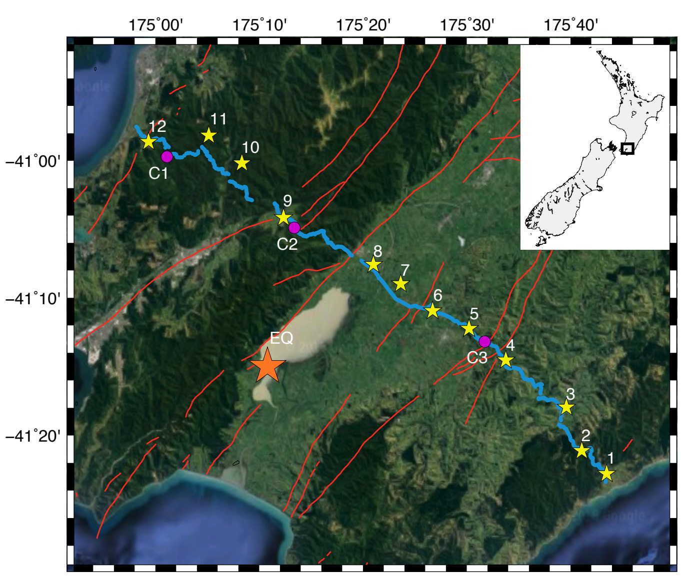

Figure 1: SAHKE experiment location map. Blue circles show station locations (spaced 50-100 m). Numbered yellow stars show locations of the 12 borehole seismic sources. Purple circles show positions of the colocated stations. The orange star is the epicenter of the earthquake shown in Fig. 2.

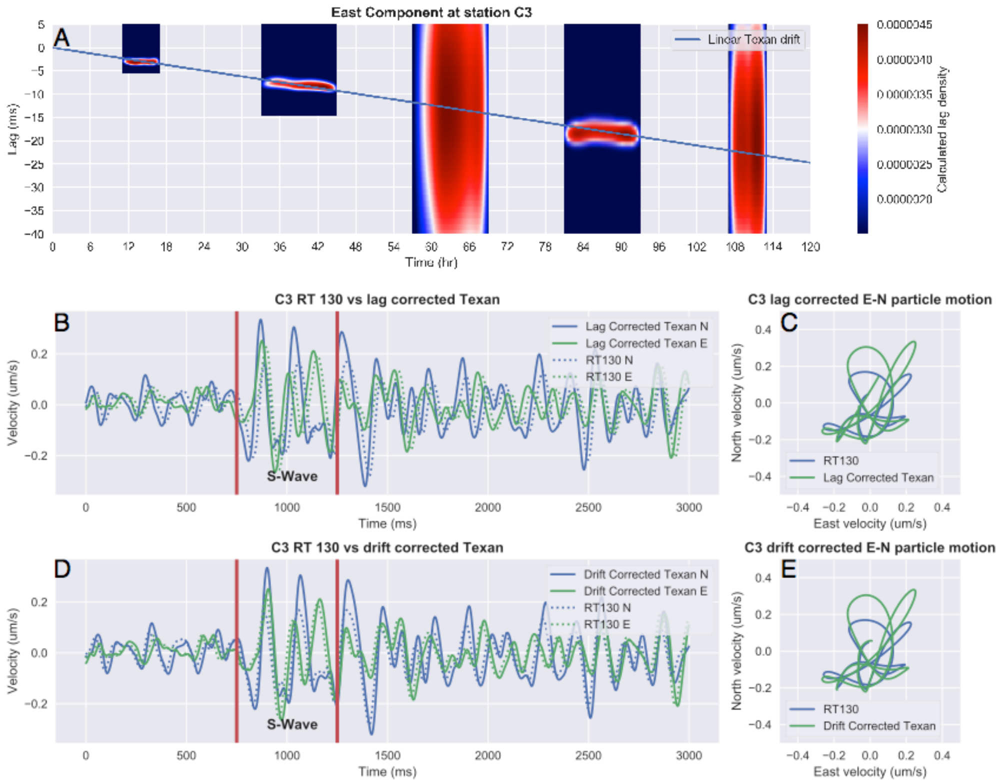

Figure 2: A: Density of calculated lags for station C3 over five nights of continuous recording. Blue line shows linear drift determined by Texan front- and back-end timestamps. B: Seismogram of earthquake (Figure 1, orange star) S-wave recorded on C3 showing Texan signal corrected with lag. Red lines delineate interval used in particle motion plot. C: Particle motion plot of the horizontal plane. D: Same as C, but with drift corrected Texan data. E: Same as D, but using drift corrected Texan data