Instrument performance in M8.3 Tokachi-Oki earthquake

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Abstract

The 25 Sept 2003 M8.3 Tokachi-Oki Earthquake produced a huge dataset of strong motion recordings, from a variety of networks. This provides an opportunity to analyse sensor performance for multiple sensor types and locations.

The ability of strong motion inertial sensors to recover permanent displacements is investigated, using the dense GPS network as displacement references. When the sensors are placed in quiet and stable sites, the sensors can record the permanent offsets to high accuracy. Tilts apparently larger than the background tectonic tilt from the thrust event affect many records. Certain sites have high rate GPS located close by to the seismic stations. This GPS data is shown to constrain the long period motion uncertain in inertial sensors, and combining the two motions can determine ground motions from 100Hz to DC, as well as defining the two horizontal tilts.

The performance of strong motion velocity sensors (deployed sparsely in the near-source region through the F-Net Network) is evaluated by comparison with accelerometers. Once the instrument responses have been removed, both sensors are equally sensitive to tilt, and so in such a strong earthquake, permanent displacements are corrupted by this widespread effect. Further, the sensor model deployed in F-Net was procured by Caltech through IRIS funds, and was shown to be unable to correctly record velocities above 20cm/s. The expected clip is 200cm/s. This low clip problem was also observed during the earthquake. An improved model that records data well in excess of 200cm/s has been developed by the manufacturer, and tested satisfactorily at Caltech. The long period noise of both strong motion velocity sensors is a significantly improvement to current accelerometers.

F-Net is a nationwide 80 station broadband network with low gain and high gain broadband velocity seismometers at each station. Comparisons of records from both sensors during an earthquake allow investigation into the performance of the three broadband sensors deployed by F-Net; the STS-1, STS-2 and CMG-1. All broadband sensors clip out to 500km during the mainshock, and some stations clip out to 1000km. The clip level and calibration of the STS-2 (with regard to the strong motion sensor) are consistent with expectation. The CMG-1 and STS-1 have more variation in their gains, and the CMG-1 has a more variable clip level than the other sensors. Comparing the peak magnitudes from a large earthquake is shown to provide a good snapshot of network health.