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Application of 1-Hz VADASE Single Frequency GNSS for Seismology

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The 6 February 2016 Mw 6.5 Meinong earthquake produced extreme disaster and caused about 10 buildings collapsed and 117 death in the Tainan city of SW Taiwan. This moderate earthquake was well recorded by eight 1-Hz single-frequency (SF) and one dual-frequency (DF) GNSS stations along the 6-km-long, N70°E-striking dextral Hsinhua fault system (HHFS) that located at about 30-km northwest of the epicenter, where we installed GNSS stations about 4 month before the event. High-rate GNSS data from eight 1-Hz SF, twenty 1-Hz and five 50-Hz DF GNSS stations throughout the HHFS area were collected and analyzed for the seismic waveforms of this event. Kinematic positioning solutions of SF GNSS stations are estimated using the VADASE software to derive the seismic waveforms and co-seismic displacements for this event. The SF GNSS is based on L1-only single phase observations collected at 1-Hz station by using the VADASE (Variometric Approach for Displacements Analysis Stand-alone Engine) approach based on standard GNSS broadcast orbits and rapidity used to ascertain the receiver movements over short intervals at centimeters accuracy level. Results show that the pre-event time-series analysis (120 seconds before the earthquake) demonstrated a common noise level at $\sim$0.5 cm and 1.0 cm for the horizontal and vertical components, respectively. We compared the velocity time-series between a SF station and a nearby 40-m-away DF GNSS station, the differences are $\sim$3 mm/s and $\sim$6 mm/s in the horizontal and vertical components, respectively. Our results showed that the eastern part of HHFS presented larger amplitudes in north-south component, in contrast to the larger east-west amplitude for most of the other stations. Our results indicate a high variability of seismic waveforms near HHFS, and show that the dense low-cost L1-only 1-Hz SF GNSS network ensures a more detailed coverage of near-fault monitoring and clearly demonstrates the feasibility of GNSS Seismology.