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3D moment tensor inversion of the North Korean nuclear test on September 3, 2017

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On September 3, 2017, the Democratic People's Republic of Korea (DPRK) conducted its sixth nuclear test after 2006, 2009, 2013 and two tests in 2016. Only eight minutes later another, weaker seismic event occurred in the epicentral area of the nuclear test.

To distinguish explosions from tectonic earthquakes seismic waveforms are an important source of information. In this study I invert long period (T = 25-70 s) seismic waveforms of regional seismometers with source-receiver distances of up to 2000 km to determine the full moment tensor and thus the isotropic and the non-isotropic portion of the detonation. While the isotropic part of the seismic source is an important parameter to discriminate explosions and earthquakes, the non-isotropic part may give hints on the containment or near-source effects. To invert for the seismic moment tensor I calculate synthetic waveforms using a 3-dimensional Earth model.

The moment tensor inversion of the 2017 nuclear test results in a source with significant explosive part combined with a low double couple (DC) shear component. Observed shear energy may result from the source process itself and/or conversions due to heterogeneities in the subsurface.

Thus, the 2017 source mechanism is similar to the tests of 2016 (M_W 5.1 and M_W 5.2), but it has a much higher magnitude of M_W 5.8. In contrast, the DPRK nuclear test of 2013 (M_W 5.0) showed a significantly larger DC component in the source mechanism. I perform Jackknife tests to show the dependance of the inverted data.

The second, weaker event of 03.09.2017 (M_W 5.0) also has a low DC content, but in combination with implosive, isotropic and CLVD part that hints to a structural collapse.