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Challenges of moment tensor inversion for shallow explosions: the January 6, 2016, North Korea nuclear test case

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The Democratic People's Republic of North Korea recently performed a new explosion on January 6, 2016, following former similar experiments in the last decade. The 2016 explosion produced similar seismic signals at regional distances than previous tests, but with exceeding amplitudes, supporting a larger moment release. We perform a careful seismological analysis, combining the inversion of full waveforms at regional distances and the modeling of seismic array beams at teleseismic distances, deriving the source depth, moment release and full moment tensor. We investigate the space of acceptable moment tensor solutions, which span from an unlikely dominant negative vertical compensated linear vector dipole to a dominant positive isotropic component, for which the overall best fit is found. An additional deviatoric term, including a double couple term, is likely due to near-source interactions with topographic and/or underground facilities features. An accurate resolution test based on a simulated annealing source inversion scheme reveals important source parameters trade-offs. Our findings can explain striking source parameters inconsistencies among studies on previous shallow explosive sources and proof that the resolution of shallow isotropic sources at regional distances is strongly hindered by source parameters trade offs, which affect the moment tensor decomposition as well as the depth and magnitude estimates. The discrimination of the true mechanism can be successfully achieved by combining the regional moment tensor inversion with the modelling of sesmic array beams at teleseismic distances.