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Analysis of CFD Simulations and CTBTO Monitoring Data for Radon Displacement Detection in UNE Scenarios

Radionuclide monitoring is one of the CTBT verification technologies that measures radioactive particles and noble gases generated by nuclear explosions. Detecting underground nuclear explosions (UNEs) is challenging as these events are unlikely to release radioactive particles into the atmosphere. To address this, monitoring noble gases more likely to escape into the atmosphere has been proposed for additional confirmation of seismic events. This paper builds on the hypothesis that UNEs can induce radon displacement (222Rn and 220Rn) towards the surface due to subsurface pressurization.

Building upon the foundational work by Jonathan L. Burnett, Timothy L. Stewart, Martin E. Keillor and James H. Ely (2021), this study conducts a comparative analysis of Computational Fluid Dynamics (CFD) simulations and real-world radon monitoring data obtained from the Comprehensive Nuclear-Test-Ban Treaty Organization. CFD modeling is employed to simulate radon transport dynamics under varying geological and environmental conditions, aiming to replicate scenarios where UNEs may cause detectable radon anomalies. These results are compared against historical data from CTBTO monitoring stations to evaluate the consistency between modeled predictions and observed radon displacement patterns.

This work examines the potential and limitations of CFD modeling as a complementary tool for interpreting radon anomalies detected by CTBTO stations.

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