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looped inference approach for more efficient gravitational field mapping during OSI

Gravitational field mapping (GRV) is permitted by paragraph 69 of the CTBT treaty (1996; UN A/50/1027) for deployment during the continuation period of an on-site inspection (OSI) to look for features relevant to underground nuclear explosions (UNEs), including tunnels used for horizontal emplacements, underground voids and collapse features. Whilst the technique offers one of the best resolutions with depth of permitted geophysical techniques, it requires comparatively long measurement acquisition times, making the typical spatial resolution of the survey sparse, and increases both the time cost and inspection team functionality (ITF) risk of a GRV mission. This paper discusses an approach developed and tested for civil engineering applications using an in-field looped Monte Carlo algorithm and a No U-turn sampler (NUTS) to sample the Bayesian posterior distribution during the survey. The method prioritises sampling in spatial regions where model parameter variation creates the largest forward modelled gravity variation, thus giving the most valuable information on the target location. By using this method to determine the optimum location of the next measurement point, the number of measurements required to achieve a successful survey outcome can be greatly reduced. We present results from OSI specific use cases and assess potential benefits.

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