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Evaluating long range middle atmospheric variability for global infrasound monitoring

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Global scale infrasound observations confirm that the detection capability of the International Monitoring System (IMS) deployed to monitor compliance with the Comprehensive Nuclear-Test ban Treaty (CTBT) is highly variable in space and time. Previous studies estimated the radiated source energy from remote observations using empirical yield-scaling relations accounting for the along-path stratospheric winds. However, these relations simplified the complexities of infrasound propagation as the wind correction applied does not account for an accurate description of the middle atmosphere along the propagation path. In order to reduce the variance in the calculated transmission loss, massive frequency and range-dependent full-wave propagation simulations are carried out, exploring a wide range of realistic atmospheric scenarios. Model predictions are further enhanced by incorporating fine-scale atmospheric structures derived from a two-dimensional horizontal wave number spectrum model. A cost-effective approach is proposed to estimate the transmission losses at distances up to 8,000 km along with uncertainties derived from multiple gravity wave realizations. In the context of the future verification of the CTBT, this approach helps advance the development of network performance simulations in higher resolution and the evaluation of middle atmospheric models at a global scale with limited computational resources.