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to atmospheric transport of radionuclides using physics-based and machine learning models

Radionuclides from underground nuclear explosions can migrate through soil and rock, eventually reaching the surface and entering the atmosphere. Once airborne, they can be carried by winds to detectors located downwind. The detectability of these radionuclides is affected by the geographical and geological features of the test site, particularly in remote areas with complex terrain, which can complicate monitoring efforts. To predict the atmospheric transport of these radionuclides accurately, advanced modeling techniques are necessary. Traditional models often fail to account for the complexities of the terrain, leading to inaccuracies in dispersion predictions. The Lawrence Livermore National Laboratory has developed a fast-running LES model called Aeolus, designed to simulate the turbulent flow of air and radionuclide dispersion in complex environments. However, long-duration simulations can be computationally expensive, limiting real-time monitoring capabilities. To address these challenges, we have created a machine learning (ML) model that utilizes data from the Aeolus to predict transport over several weeks. This model is integrated with the NUFT (Numerical Underground Flow and Transport) model, which simulates contaminant movement through porous media. By combining ML with traditional modeling, we enhance our ability to predict dispersion, improving monitoring through better pattern recognition and adaptability to varying conditions.

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