Abstract

[Research Title]

Prediction System for Radionuclides Redistribution due to Wild Fire in Contaminated Regions

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The forest fire that occurred in Chernobyl in April 2020, known as the 2020 ChEZ forest fire, burned approximately 20% of the Chernobyl Exclusion Zone (ChEZ) and caused elevated levels of atmospheric ^{137}Cs observed as far as Kiev and various parts of Europe. Forest fires in areas with high concentrations of radioactive substances, such as those affected by nuclear accidents, can have significant societal impacts globally. Accurate estimation and prediction of the resuspension of radionuclides using atmospheric dispersion and hydrological models immediately after a fire are crucial for informing the public. This study aims to develop an integrated analysis AI for rapid estimation of forest fire areas and burn severity using local and satellite observations and to predict post-fire dispersion of radioactive substances using atmospheric and hydrological models. Based on collaborative efforts with Ukrainian research partners, including the Ukrainian State Nuclear Regulatory Inspectorate and Dr. Talerko, a total of 33 forest fires occurred in the Chernobyl Exclusion Zone (ChEZ) from April 1996 to April 2020. Only two fires exceeding the 0.25 km2 MODIS resolution occurred in 2015 and 2020, thus those were selected for further analysis. Using data provided by local firefighting and ChEZ management agencies, GIS data was compiled, integrating burn area records from the past 20 years. Advanced algorithms were developed for forest fire detection using MODIS observations, achieving detection accuracy equal to or surpassing existing NASA and ESA products (Hu et al., 2024). Real-time monitoring of forest fires was initiated as part of the project's emergency response following the invasion of Ukraine by Russian forces in February 2022 (Hu et al., 2023). The developed algorithms were also tested for applicability in Japan, demonstrating potential for high-resolution forest fire detection using Landsat satellite data. The resuspension of ^{137}Cs released into the atmosphere by the 2020 ChEZ fire was predicted using the atmospheric transport model. We demonstrated that ^{137}Cs from the fire could reach Kiev within a few hours, with concentrations in the air ranging from tens to hundreds of microbecquerels per cubic meter, about one order of magnitude higher than Kiev's background levels. Additionally, the SiBUC land surface water circulation model was used to forecast the outflow of radioactive substances, especially focusing on the Chernobyl Exclusion Zone. It considered the possibility of elevated radioactive concentrations post-forest fires, with simulations showing a significant increase in 2020.

[References]

Hu et al (2023) Sci. Rep. 13, 5236. https://doi.org/10.1038/s41598-023-32300-5

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