Radiological Emergency Preparedness after the Early Phase of an Accident : Focusing on an Air Contamination Event

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Introduction

Toxic materials in an urban area can be caused by a variety of events, such as accidental releases on industrial complexes, accidents during the transportation of hazardous materials and intentional explosions. Most governments around the world and their citizens have become increasingly worried about intentional accidents in urban area after the 911 terrorist attack in the United States of America. Even though there have been only a few attempted uses of Radiological Dispersal Devices (RDDs), accidental releases have occurred many times at commercial nuclear power plants and nuclear waste disposal sites.

When an intentional release of radioactive materials occurs in an urban area, air quality for radioactive materials in the environment is of great importance to take action for counter-measures and environmental risk assessments. Atmospheric modeling is part of the decision making tasks and that it is particularly important for emergency managers as they often need to take actions quickly on very inadequate information[1]. A simple model such as HOTSPOT required wind direction and source term would be enough to support the decision making in the early phase of an accident, but more sophisticated atmospheric modeling is required to adjust decontamination area and relocation etc after the early phase of an accidental event.

In this study, we assume an explosion of ^{137}Cs using RDDs in the metropolitan area of Soul, South Korea. California Puff Model (CALPUFF) is used to calculate an atmospheric dispersion and transport for ^{137}Cs.

Method

In air quality engineering science, mathematical models are widely used for understanding the causes and consequences of air pollution or accidents, predicting the impact of radioactive pollutant sources, and exploring the effects of proposed control techniques before they are implemented. CALPUFF is widely used to assess the radiological consequences caused by accidental releases and intentional explosions of nuclear materials reflecting time-varying source terms. CALPUFF is also an advanced, integrated Gaussian puff modeling system for the simulation of atmospheric pollution dispersion and a multi-layer, multi-species non-state puff dispersion model that simulates the effects of time and space varying meteorological conditions on pollution transport, transformation and removal. This model has been adopted by the United States Environmental Protection Agency

(US EPA) in its Guideline on Air Quality Models as a preferred model for assessing long range transport of pollutants and their impacts on Federal Class Iareas and on a case-by-case basis for certain near-field applications involving complex meteorological conditions[2].

Results & Discussion

The release rate (Bq/hr) was assumed as released 60 % of total ^{137}Cs at the time of the accidental release, and then decreased exponentially for 4 hrs. To make diagnostic wind field, MM5 (Fifth-Generation NCAR/Penn State Mesoscale Model) results with 1 km ×1 km resolution were used and observed meteorological data was assimilated to improve the wind field accuracy. Figure 1 shows spatial distributions of 4-hr averaged ^{137}Cs concentrations in the air. Figure 1 shows the simulated surface winds at 09:00 June 1 in 2009 over the CALPUFF domain, which is overlaid on the terrain plot. Figure 2 shows spatial distributions of 4-hr averaged ^{137}Cs concentrations in the air.

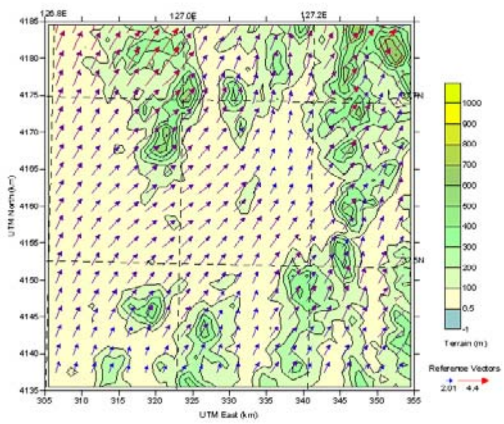

Figure 1. Simulated surface wind fields over the CALPUFF domain (09:00 June 1, 2009).

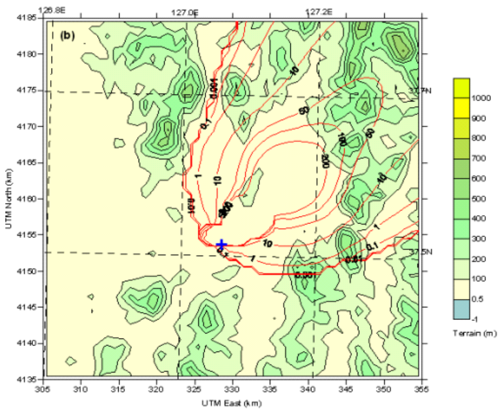

Figure 2. 4 hr averaged 137Cs concentration (Bq/m3) on June 1, 2009

Morbidity and mortality in case of the accidental release in the metropolitan area of Seoul are 6.31E-05 and 9.25E-05, respectively. This means that about 6.31 persons among 100,000 persons could die and about 9.25 persons among 100,000 persons could fall ill caused by the ^{137}Cs inhalation.

Conclusions

Atmospheric dispersion and quantitative radiological risk analysis for 137Cs were performed assuming an intentional explosion in the metropolitan area of Soul, South Korea after the early phase of emergency. These kinds of atmospheric modeling and risk analysis could provide a means for decision makers to take action on important issues such as the cleanup of the contaminated area and countermeasures to protect the public caused by radiological emergencies.

References

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2. Scire, J.S. et al., A user's guide the CALPUFF dispersion model, Earth Tech, Inc. (2000)