Atmospheric Dispersion Simulation Considering the Circulation Effect at the Ulchin Nuclear Site

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1. Introduction

A level 3 PSA (Probabilistic Safety Assessment) has become one of the important issues after the Fukushima accident. To prepare an effective strategy for an evacuation as a basis of the emergency preparedness, it may need an understanding of the atmospheric dispersion characteristics of radiation releases into the environment, mainly depending upon the weather conditions of a radiation release location, i.e., a nuclear site. To predict the atmospheric dispersion accurately, the specific conditions of the radiation release location should be considered. Since nuclear power plants are located on coasts or riversides, sea and land breezes might be one significant factor.

In this work, atmospheric dispersion was simulated for the Ulchin site in Korea. A total of 8 simulations were performed for each season and day/night. As a result, it was observed that the wind direction change with time has a large effect on atmospheric dispersion.

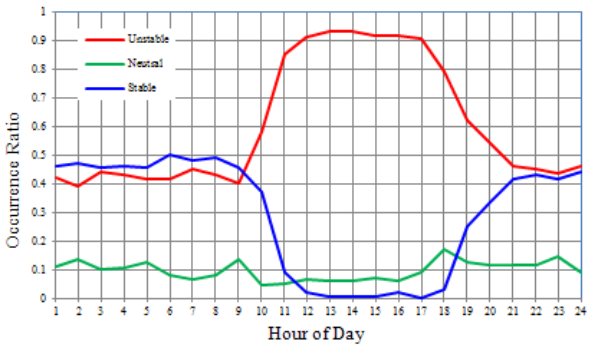
2. Atmospheric Stability Class

Han and et al. analyzed the atmospheric stability using weather data for the year 2004 of a domestic nuclear site on the east coast of the Korean peninsula [1]. Fig. 1 provides daily atmospheric stability charts for winter and summer, showing the following basic features [1]:

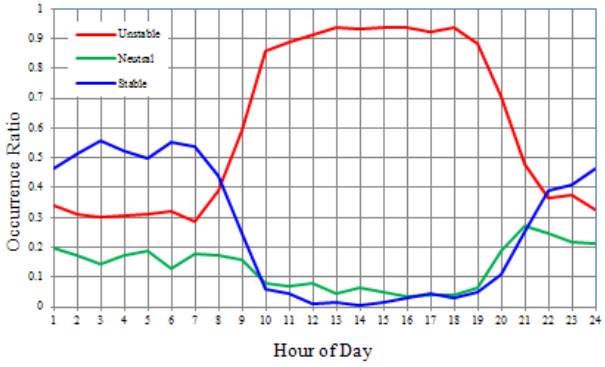
- The atmospheric stability was changed according to day or night.
- In the daytime, the atmosphere became strongly unstable (> 90%), whereas the dominant tendency of atmosphere in the nighttime was stable (~ 50%) or some was unstable (~ 30%).
- The transient time was changed by the duration of day and night according to the seasonal differences.
- In summer, a stable class was observed with a higher frequency compared with winter.

3. Simulation of Atmospheric Dispersion

This study focuses on repeatable weather patterns according to time scale such as seasonal and day/night. CALPUFF is used to simulate atmospheric dispersion [2]. In the puff model, the atmospheric circulation effect can be simulated.



(a) Winter season



(b) Summer season

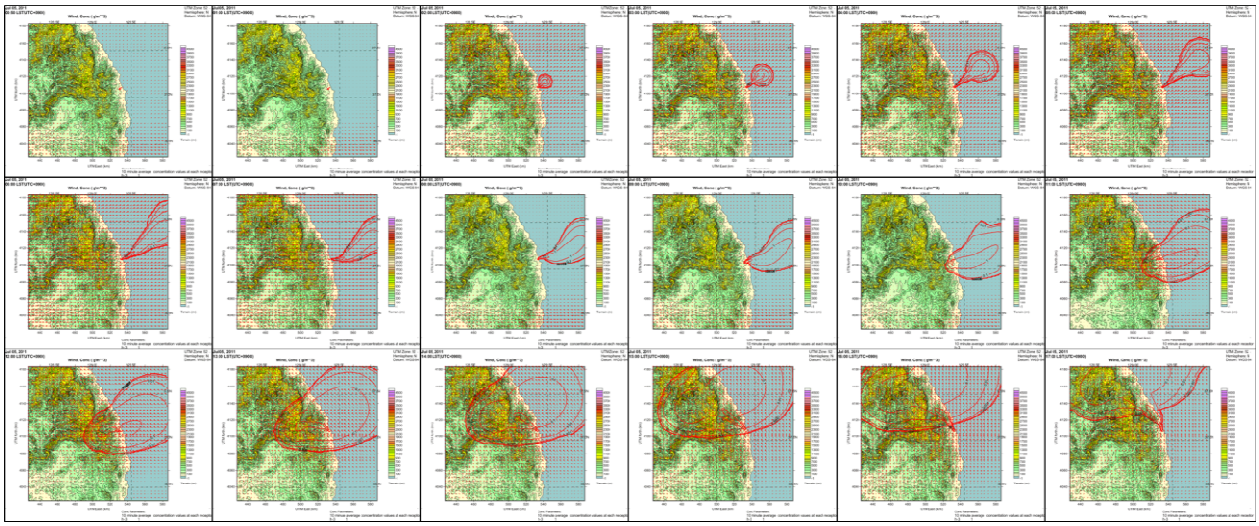
Fig. 1. Daily atmospheric stability charts for seasons [1]

The data used for simulations are as follows:

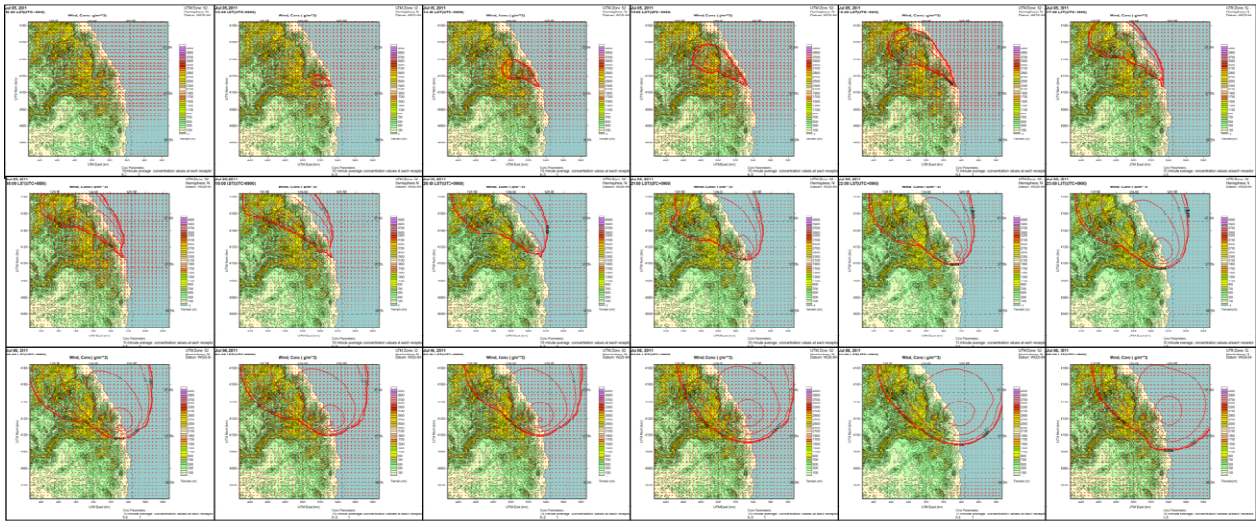
- Location: Ulchin nuclear site
- Weather data: year 2011
- Radiation release: Assumed as constant
- Simulation cases: 8 (four seasons and day/night)

The simulation results for the summer season are shown in Fig. 2. As shown in the figure, the dispersion direction is gradually changed with time.

- When the simulation is started at noon, the dispersion direction is toward the sea by the land breeze effect, but the direction is changed as sea breeze effect increases.
- On the other hand, if the simulation start time is midnight, the dispersion direction is toward land at the beginning and gradually changed by the land breeze.



(a) 2011 July, 5th 00:00 ~ 5th 17:00



(b) 2011 July, 5th 12:00 ~ 6th 05:00

Fig. 2. Simulation results

- The circulation effect is the largest in the summer season compared to other seasons. On the other hand, the winter season has the smallest circulation effect.
- In the winter season, the atmospheric circulation effect is relatively small, so that only a small amount of the released radiation is dispersed to land.

4. Conclusion

In this work, the atmospheric dispersion at the Ulchin nuclear site was simulated. The simulations were performed for each season and day/night to observe the effect of the atmospheric circulation effect. As a result, it was observed that the atmospheric circulation has a large effect on the atmospheric dispersion and the effect is changed by the weather condition over time.

Acknowledgements

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[2] J. S. Scire, and et al. A User's Guide for CALPUFF Dispersion Model, Earth Tech, Inc, 2000