Comparison analysis of wind distribution using different average wind data measured around the Hanul nuclear power plant

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1. Introduction

In the event of a radioactive material release accident, it is necessary to predict the behavior of radioactive materials to minimize the exposure of local residents around the Nuclear Power Plant (NPP). Since radioactive materials diffuse or precipitate according to weather conditions, in order to increase the accuracy of predicting the behavior of radioactive materials, the influence of meteorological factors should be analyzed accurately [1].

The meteorological factors most influencing the behavior of radioactive plumes are wind data such as direction and speed. The wind data is generally represented as time average value by collecting raw data measured every few seconds [2]. For example, the measurements are carried out every 2 seconds, but the using data are 10-minutes or hourly average values. In this case, analysis results may vary depending on which average value is used. Therefore, it is very important to use data with appropriate time intervals when predicting radioactive plume behavior or analyzing wind fields around nuclear facilities.

This study is a preliminary study on the analysis of the wind field around nuclear facilities. To check whether there was a significant difference in the results when using different time average data, we compared 10-minutes, hourly, and daily average wind data. For this, we collected and processed wind data (speed and direction) measured for 2 years (2019 and 2020) at the Hanul NPP, and draw wind rose diagrams for each year to show the frequency of wind direction and speed.

2. Material and Methods

2.1 Data collection

In this study, for analysis, 10-minute average wind direction and speed data provided by Korea Hydro & Nuclear Power (KHNP) were collected. The wind data were measured at 10 m of the meteorological tower located inside the Hanul NPP for 2 years from 2019 to 2020. The collected data were converted to hourly and daily average values by using Python, an advanced programming language. Tables I and II are examples of the hourly and daily average data frame for 2 years. The number of data in the two data frames differs by about 24 times.

Table I: Example of an hourly average data frame

Year	Month	Day	Hour	Average direction(°)	Average speed(m/s)
2019	1	1	1	246.02	3.14
2019	1	1	2	266.60	3.66
2019	1	1	3	255.05	3.51
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
2020	12	31	24	228.72	1.52

Table II: Example of a daily average data frame

Year	Month	Day	Average direction(°)	Average speed(m/s)
2019	1	1	259.44	2.49
2019	1	2	239.20	1.97
2019	1	3	243.36	1.41
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
2020	12	31	264.01	2.50

2.2 Wind rose

The wind rose diagram is a graph for concisely viewing how the wind speed and direction are distributed at the observation point. In this study, using windrose, one of the Python libraries, a wind rose diagram was created based on data frames.

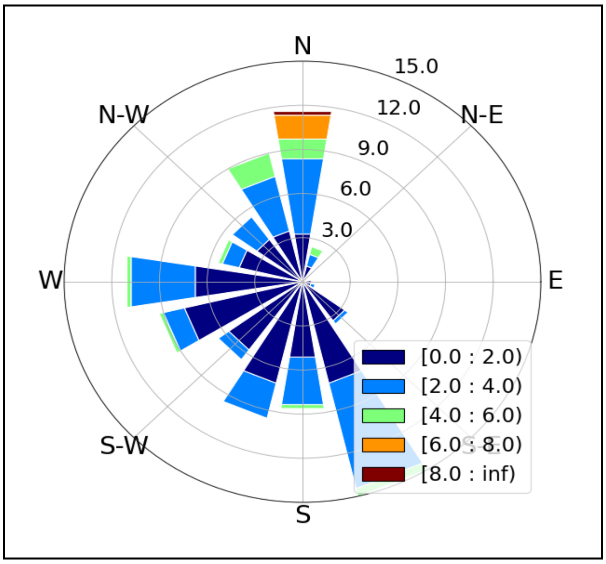

Fig. 1. Example of wind rose diagram.

Figure 1 is an example of a wind rose. The length of the graph for each direction means the frequency of the wind direction blowing in that direction, and the color in each graph indicates the frequency of the wind speed.

3. Results

Figure 2 shows wind rose diagrams that analyze the year of 2019 and 2020 data using average values for 10-minutes, 1-hour, and 1-day. As shown in (a) and (b), in 2019 wind rose using 10-minutes average data and hourly average data, the most dominant wind direction is SW. However, the S and SSE direction, which occurred relatively less in (a) and (b), occurred most frequently in (c).

Like the 2019 data, the 2020 wind rose diagrams had differences in results between using average data with short time intervals and that of the long time intervals. The wind direction that occurred the most when using 10-minutes and hourly average data is SW. However, the wind rose diagram drawn by using daily average data shows the SSE direction appeared most frequently.

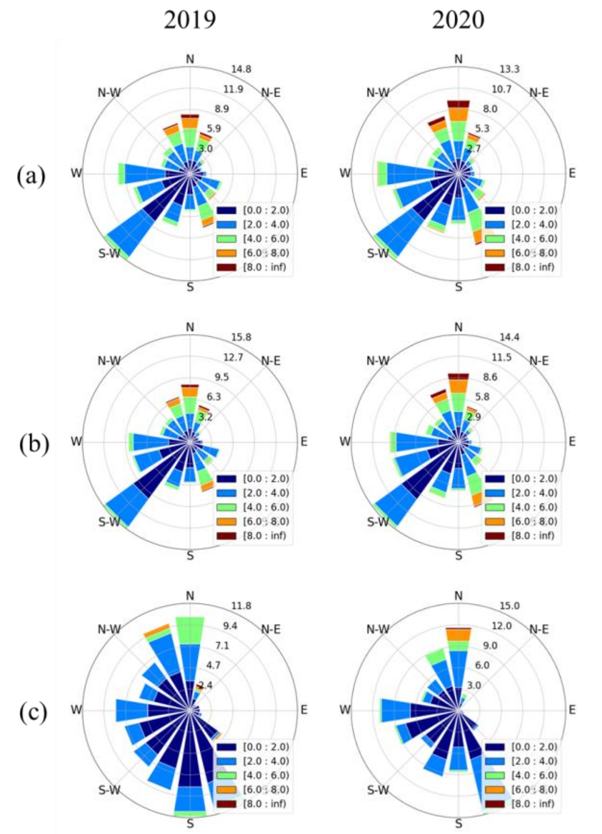

Fig. 2. Wind rose diagrams in 2019 and 2020 using different data set: (a) 10-minute average data, (b) Hourly average data, (c) Daily average data.

4. Conclusions

The behavior of radioactive plumes released from NPP by accidents is most affected by weather factors such as wind speed, wind direction, precipitation, and so on. In other words, since radioactive materials diffuse or precipitate according to weather conditions, it is important to use reliable data to implement resident protection measurement adequately.

This study is a preliminary study on the analysis of wind fields around nuclear facilities. To check if there was a significant difference in the results when using different time average data, we compared 10-minutes, hourly, and daily average wind data. For this, we used the wind rose diagram showing how the wind speed and direction are distributed at the observation point. As a result, it was confirmed that there was a marked difference in the results between using 10-minutes, hourly, and daily average data. Therefore, when conducting a study using meteorological factors, data with short time intervals should be used to increase the reliability of analysis results.

In a follow-up study, we plan to analyze in detail why the results when using long-interval data and short-interval data are noticeably different.

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