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A Test of NDIR-based Sensors for the Near Real-time Analysis of CO_2

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Abstract

In this study, the reliability of NDIR-based sensors wasexplored by evaluating the comparability between measurement systems in the near real-time analysis of CO_2. For this purpose, replicate analyses were performed using sensors of two different model types(H-550 and B-530, ELT Company, Korea). Three replicate data of each sensor type collected continuously by side-by-side analysis in three second intervals(a duration of 304 hour) were evaluated for the relative performance of NDIR sensors. The reproducibility of sensors, when assessed by relative standard error(RSE %) values of all sensor units, showed moderate changes with time with the overall mean of 2.33%. When CO_2 measurements from all NDIR sensor units were evaluated by correlation analysis, the results showed strong comparability, regardless of the model type. The overall results of this study suggest that NDIR sensors are reliable enough to produce highly comparable data at least in a relative sense.

1. Introduction and Method

In this study, the relative performance of CO_2 sensors was tested using two different NDIR-based sensor types produced by ELT Company inKorea. These sensors models(H-550 and B-530) are different in terms of their detection ranges, i.e., B-530 has detection range of 0-10,000ppm, while H-550 can measure CO_2 in the range of 0-50,000ppm(refer to Table 1 for their specifications). During this study, all six sensors were operated to record CO_2 concentrations concurrently for a 304 hour duration(~13 day: 21 May to 1 June, 2007) at 3 second intervals. This side-by-side analysis of CO_2 sensors was conducted under the same environmental conditions at the Atmospheric Environ- ment Laboratory, Sejong University, Korea. All data sets primarily recorded at 3 second intervals were utilized as raw data after being converted into hourly(or daily) mean values. The results obtained from this study were then evaluated to examine the relative performance for real-time CO_2 measurements in air. To properly apply this sensing system to the analysis of CO_2 in ambient air, more experiments are currently underway to describe analytical properties of this sensor including its absolutereliability; the results of our continuing efforts will be described subsequently in our future publications.

2. Results and investigation

During the comparative experiment conducted in a laboratory environment, the CO_2 concentration data were obtained at three second interval as a side-by-side analysis with six sensor units for a continuous duration of 304 hours. The temporal patterns(hourly and daily) of CO_2 measured during the entire study showed that performance of each individual sensor unit showeda good correlation in terms of CO_2 concentration regardless of the sensor type. The results of the CO_2 analysis were compared in terms of RSE(%) values using the data measured concurrently at hourly intervals throughout the study period. According to this analysis, a moderate change in RSE values was

observed throughout a 304 hour period with a mean RSE of 2.33%. The results of the correlation analysis further indicated that all 6 sensor units used in this study yielded fairly good correlation with each other. A comparative analysis with other methods suggests that the NDIR method can be used to produce stable data in terms of reproducibility.

In the present study, the relative performance of the NDIR CO_2 sensor was evaluated in a range of the concentrations which is comparable to that of the ambient air(i.e., ~400ppm range) results of routine monitoring task on CO_2 levels are commonly made from the various authentic agencies such as WMO and IPCC. Based on the results of present study, we are currently testing the possibility for the application of this sensing system to the routine analysis of CO_2 in ambient air with simultaneous measurement of relevant meteorological parameters.

Table 1. A statistical summary of CO_2 concentration data measured using two different sensor types(H-500 and B-530 model) (21May to 01June 2007: 304 hour duration): Results derived using [A] 3 second raw data and [B] hourly data are compared(All concentrations in ppm unit).

		Sensor units					
		H1[1]	H2[1]	H3[1]	B1[2]	B2[2]	B3[2]
[A] 3 second data	Mean ± SD (Median)	438 ± 36.3 (436)	445 ± 40 (442)	407 ± 39.8 (396)	396 ± 34.2 (391)	448 ± 31.7 (442)	439 ± 30.2 (433)
(raw data)	Range	333-668	335-678	307-666	323-557	317-678	335-668
	N	383,662	383,660	383,581	383,406	383,469	383,555
[B] After conversion into hourly intervals	Mean ± SD (Median)	438 ± 33.8 (437)	445 ± 37.2 (445)	407 ± 37 (401)	396 ± 30.9 (392)	448 ± 29 (442)	439 ± 27.4 (433)
	Range	372-586	368-601	330-572	336-522	391-595	386-582
	N	304	304	304	304	304	304

[1] and [2] denote the model No H-500 and B-530 series of sensor units for CO_2 measurements used in this study, respectively