Response to James Hudson's comments

First of all we would like to express our great appreciation to Dr. James Hudson for the very detailed corrections and comments. We will make all the recommended corrections in the revised manuscript but those are too numerous to mention in this response document. So here we describe only the responses to the comments that require some specific explanation.

P8, L6. This is not a "power law relationship." I recently reviewed a paper that took this literally and made a completely different relationship, which was not what Twomey did and was wrong. You are not doing this here but the word "power law" is inappropriate for this relationship. You need to define C; it is N1%.

The general form of a power law relationship is $f(x) = ax^k$. For the Twomey equation, $N(S) = CS^k$, then f(x) ➔ N(S), a ➔ C, x ➔ S and k ➔ k can be matched. Therefore the Twomey equation can be considered as a power law relationship. However, it is also true that this relationship does not usually hold for an entire supersaturation range in atmospheric clouds. So in the revised manuscript we will remove the words "power law," following Dr. Hudson's recommendation. We will insert ", where C is $N_{1\%}$" within the parenthesis.

P9, L9-10. Comment: But diesel vehicles are larger and consume more fuel.

At the end of the sentence, we will insert "although it should be noted that diesel vehicles are larger and consume more fuel."

P9, L22. Cite Hudson (1991); see p2451 bottom of 1st column-top of 2nd column and Figs. 6 and 7.

We will add the following sentence at the end of the paragraph: "Hudson (1991) suggested diesel engine as an obvious source of CCN from the traffic."

P10, L18-19. Is this total, seasonal or annual?

This is out of total measurement days.

P14, L27. Define M.

"Mm^{-1}" is a commonly used unit for aerosol scattering coefficient ($1\ Mm^{-1} = 10^{-6}\ m^{-1}$) that we think requires no explanation.

P15, L16. Insert , red after m.

We will add ", purple" after m since that was the color we used in the figure.

P15, L17. There is no solid line. There is a dashed line. Is this a regression?

We will change the expression as the “dashed line.” It is not a regression line but drawn just for an explanatory purpose.

P16, L19. One flight is not much evidence.

Our original intention was to say that a general westward gradient of aerosol concentrations is not found above PBL. We will change the sentence as follows: “Westward gradient of CCN concentration is apparent only in the flight on Oct. 11, 2009 (Fig. 14), which may indicate that the general westward gradient of aerosol concentrations (Fig. 11) or AOD (Kim et al., 2011b) is mostly confined at the lower atmosphere.”

Section 4.1. The term “particle formation” often/usually refers to elusive natural processes. This is certainly not the case in the very polluted air masses of eastern Asia. Gas to particle production in polluted air is not so profound. Did this involve clouds?

We have no real time cloud measurement but based on our daily recording, the phenomena took place on both cloudy and sunny days. It is also noteworthy that it was very sunny on Oct. 18, 2009 (illustrated in Fig. 15). Moreover, several observational studies in the region suggested that such phenomena often occurred under clear sky conditions (e.g., Yum et al., 2007; Kim et al., 2009) or in the neutral/slightly unstable atmosphere (Buzorius et al., 2004). So we do not think that clouds were a prerequisite for such phenomena.

P18, L8. Yum et al., 2007 not listed in references.

It is listed at P24, L8-11.

P19, L1. Semicolon after range.

We suppose that L2 was meant. We do not think that a semicolon is needed after the word “range.”

Figure 5. Note here or in text that this is local standard time and that daylight saving time was not observed in Korea, if that is the case.

Korea does not observe daylight saving time and it will be noted in the figure caption.

Figure 6. Is this for all seasons?

Yes but except for the traffic data that we were able to obtain only for an autumn season as noted in P9 L8-9.

Figure 13. Cannot distinguish symbols. Are these dashed lines regression?

The fact that the symbols are not distinguishable in this figure would imply that there were no significant regional differences. So we will mark all the data with one symbol (circle) in the revised figure. The dashed lines are not a regression line but drawn just for an explanatory purpose as mentioned above.

Figure 17. What are the two symbols?

The filled circle represents N_{CN} and open circle $N_{0.6\%}$. We will add the legend in the revised figure.

Response to the anonymous referee's comments

Page 5, Line16: Is the size distribution measured by TSI SMPS 3936?

Yes, it is. The TSI SMPS 3936L10 has the size cut of D_p = 10 nm and in this study the aerosol size distribution for the 10 nm – 414 nm D_p range was measured. This will be explained at P5, L16.

Page 7, Line 4/Figure 3: What do you mean "instrumental differences"? Please explain. Is it possible that there is an issue with instrument? Such as flow fluctuation?

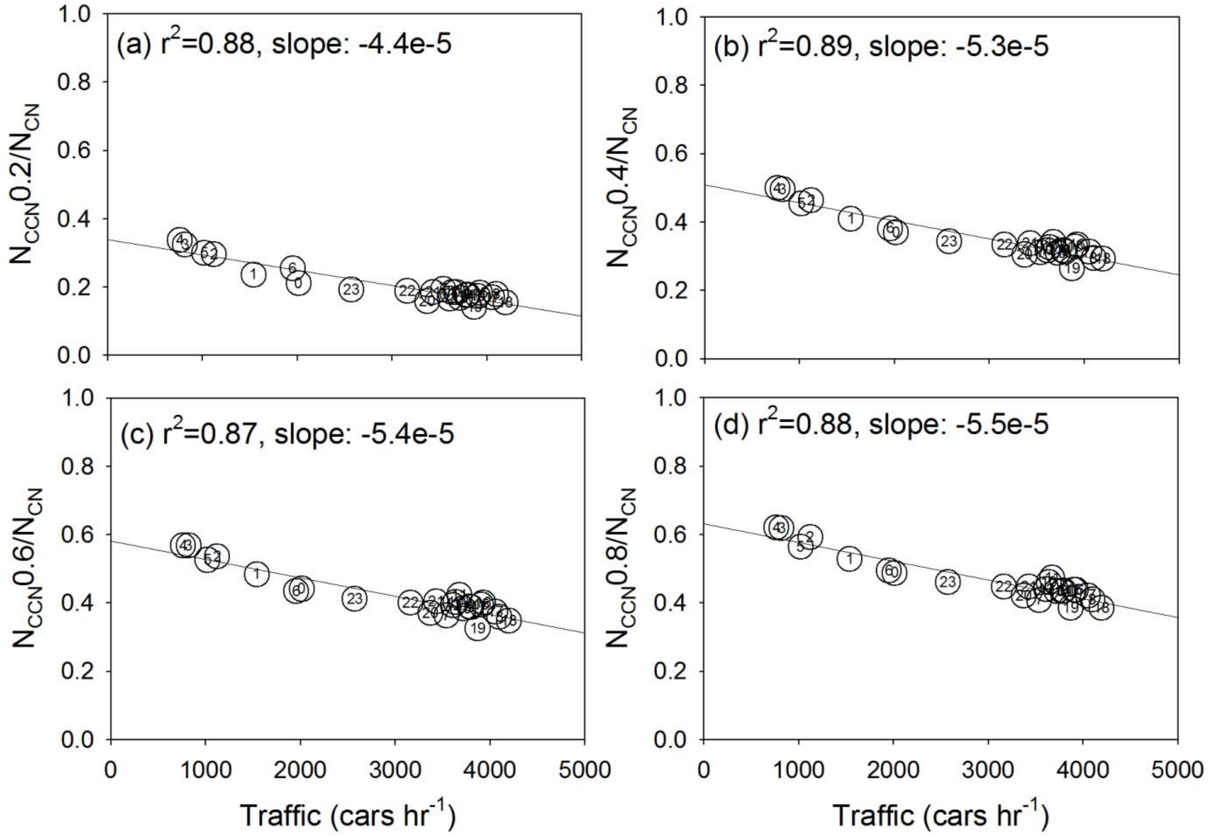
By "instrumental differences" we mean that discrepancy can arise due to different operating principle of CCNC and CPC. For example, CCNC requires particle-free sheath air, the volume flow rate of which is ten times larger than that of the sample air and therefore small difference in optics count can lead to large difference in number concentration. The flow rates of CCNC and CPC were regularly calibrated with a volume flowmeter and only the data that did not suffer from significant flow fluctuation are presented in Fig 3.

Page 7, Line 17-18: What does author try to point out here? Please clarify.

We want to point out that the higher concentration in winter cannot be solely attributed to emission from heating. To clarify, we will add the following sentence: "Therefore, the higher concentration in winter cannot be solely attributed to emission from heating."

Page 9, Ling 18/Figure 7: It seemed that with increase of traffic amount, Nccn/Ncn decreases. Maybe plot using Traffic vs Nccn/Ncn will better support the discussion.

Following is the N_{CCN}/N_{CN} plotted against traffic.



As the referee suggested, N_{CCN}/N_{CN} decreases with increasing traffic amount for all S but little change in slope (from -4.4e-5 to -5.5e-5) is observed while S changes from 0.2% to 0.8%. So the figure does not fit our purpose to show that N_{CCN} at higher S are more relevant to traffic emission than N_{CCN} at lower S. Therefore we prefer the original Fig. 7.

Figure 1: why there is no error bars for Ncn?

Following is the figure with error bars. In the revised manuscript, Fig. 1 will be changed accordingly. To note is that following the recommendation by the other referee, Dr. James Hudson, "N_{CCN}0.6" will be changed to "$N_{0.6\%}$" and likewise change will be made for other supersaturations.

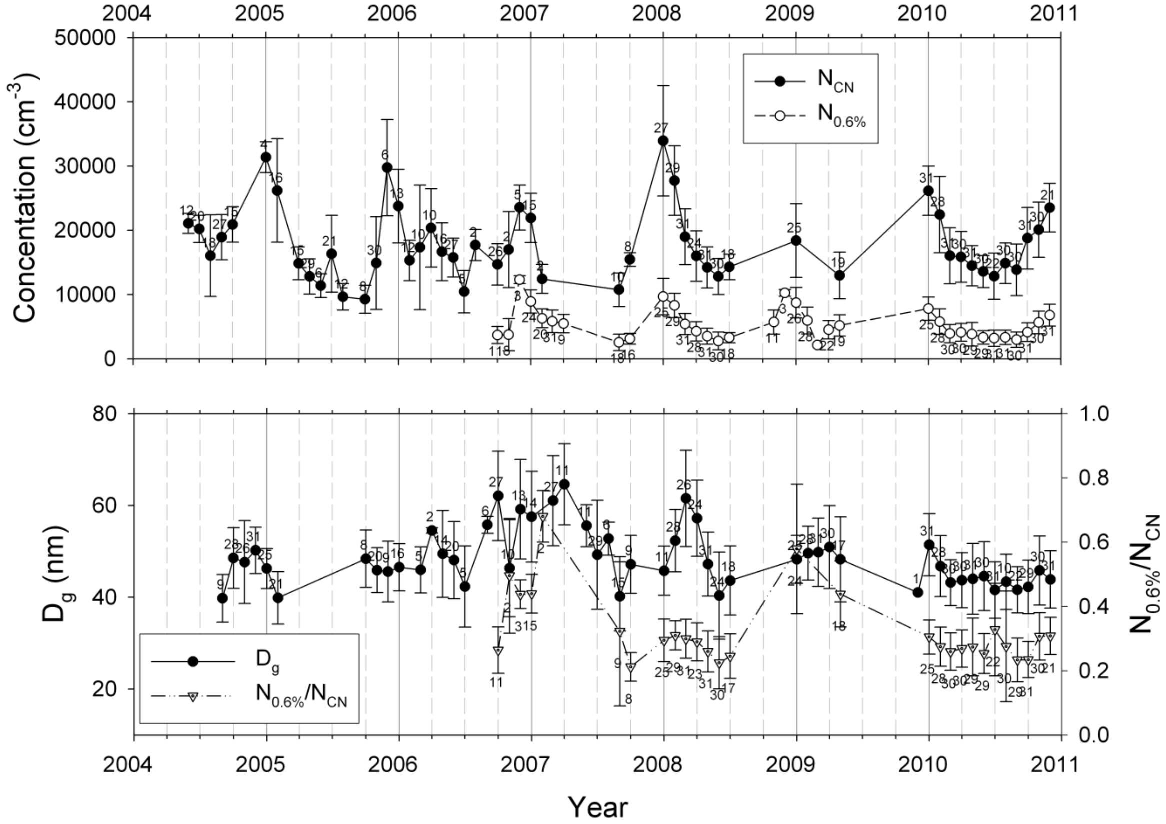


Figure 5: Please add error bars to the plots.

The following is the figure with error bars. In the revised manuscript Fig. 5 will be changed accordingly.

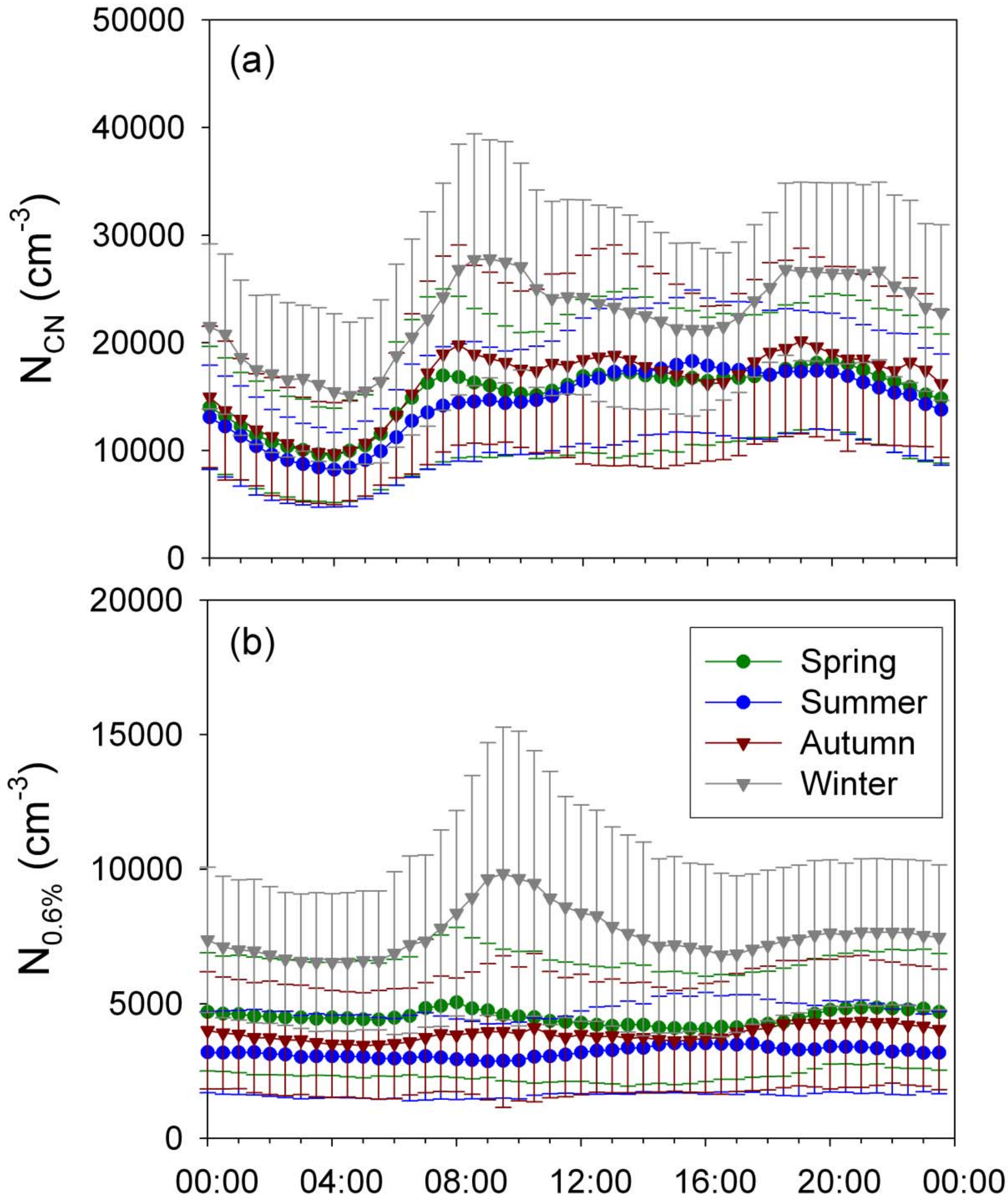
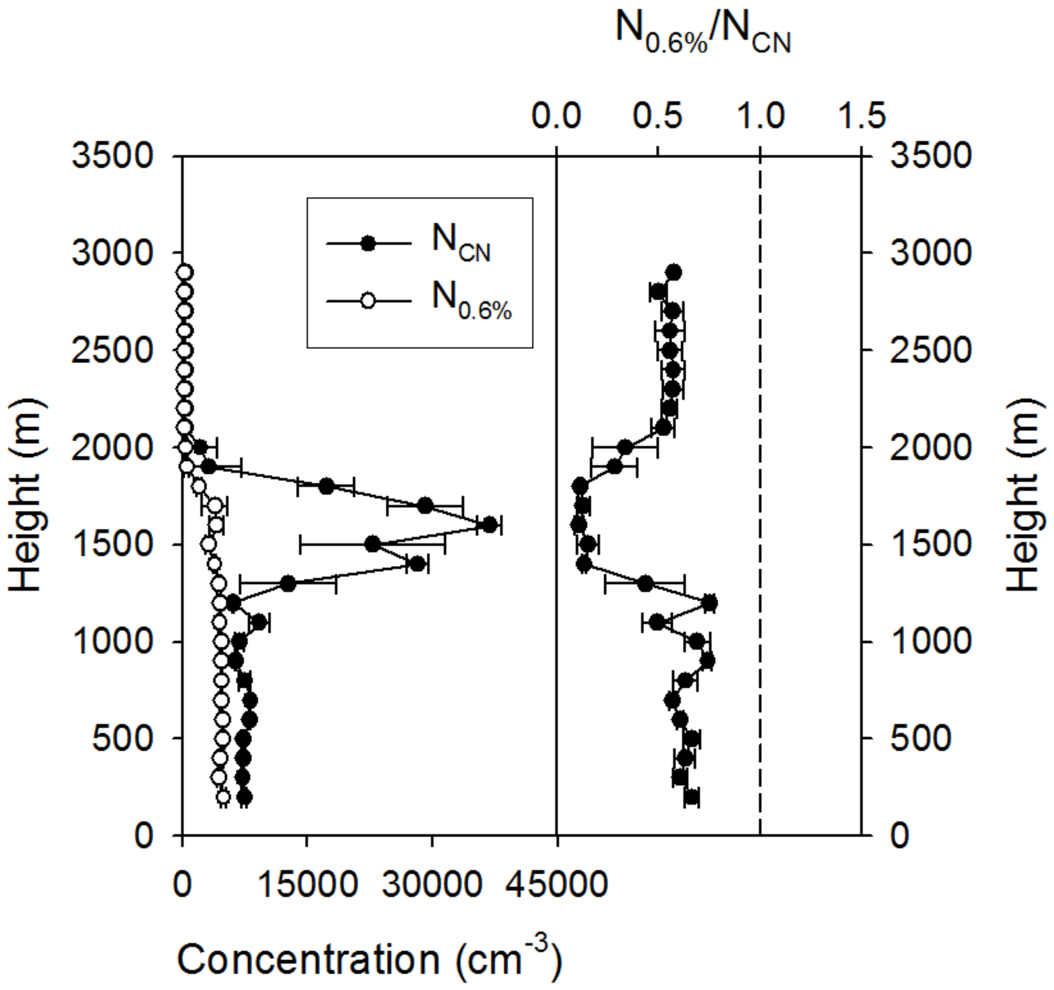


Figure 17/18: plots need legends.

Legend for Fig. 17 will be added as shown below.



For Fig. 18 we do not think that additional legend is necessary because most of the information is explained in the figure caption. However, we will clarity that the number in front of and behind the slash is $N_{0.6\%}$ and N_{CN}, respectively. The following will be the new caption for Fig. 18: "Figure 18. Composite map of the average $N_{0.6\%}$ (before the slash) and N_{CN} (after the slash) measured on the ground (flag), over the sea (ship) surface or in the boundary layer below 1100 m altitude (aircraft), in and around the Korean Peninsula. The data presented in this study are shown in the shaded boxes."