P1.26 MONITORING OF BACKGROUND ATMOSPHERE ON CLIMATE OVER KOREA PENINSULA

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1. INTRODUCTION

High quality and reliable climatological data including atmospheric chemical properties are needed for the future diagnostic trend and understand of current situations on climate change. The purpose of this project is to clarify the surface observations and the techniques of data analysis regarding to climate change focused on the background atmosphere over Korean peninsula.

The works include understanding and analyzing (1) The characteristics of greenhouse gases and its future trend, (2) The physical and chemical properties of atmospheric aerosol, (3) Chemical Transport Model, (4) Stratospheric Ozone layer over Korea region, (5) Impacts of global warming and urbanization on the air temperature over Korea peninsula.

2. RESULTS AND DISCUSS

2.1. The Characteristics of Greenhouse Gases and Its Future Trend

WMO WDCGG No. 28 has represented the global mean concentration of atmospheric CO_2 for a year 2002 showed a level of 374 ppm and the annual increasing rate corresponded 1.6 ppm/year. Indeed, Atmospheric CO_2 measured in the background atmosphere of the Korean Peninsula showed 375 ppm at Gosan, Jeju and 383 ppm in Korea Global Atmosphere Watch Observatory (KGAWO), respectively (see Fig. 1). Also, annual mean increasing rate of Gosan super site for the period 1990-2002 showed a range from 1.17 to 2.02 ppm similar with global mean increasing rate, while the higher increasing rates from 2.30 ppm up to 4.07 ppm illustrated in KGAWO. From these monitoring results, it indicates that KGAWO has been exposed from anthropogenic effects than Gosan super site.

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Fig. 2 is a comparison of KGAWO throughout 24h ***in situ*** measurement with Gosan super site throughout 48 times/year flask sampling. Higher concentrations of atmospheric CO_2 revealed at KGAWO since 2000.

Fig. 3 and 4 represented the expectations of atmospheric CO_2 in both observatories by future 2010. From these two figures it could be predicted CO_2 concentration of KGAWO would be over 400 ppm while that of Gosan super site would be reached up to 390 ppm in future 2010.

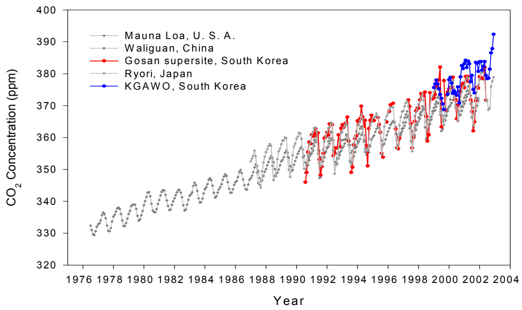

Fig. 1. Global trend of atmospheric CO_2.

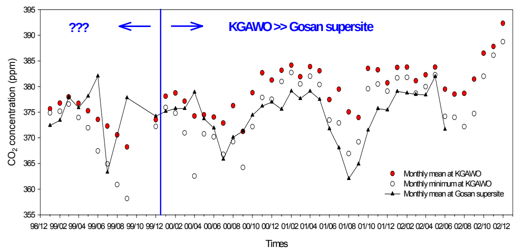

Fig. 2. Monthly mean (red circle) and daily-monthly minimum (white circle) of atmospheric CO_2 at KGAWO and monthly mean (triangle and solid line) of atmospheric CO_2 at Gosan super site.

2.2. The physical and chemical properties of atmospheric aerosol

Atmospheric particle number concentration and particle size distribution having 8 size classes in the diameter range 0.3 ㎛ to 25 ㎛ were measured with

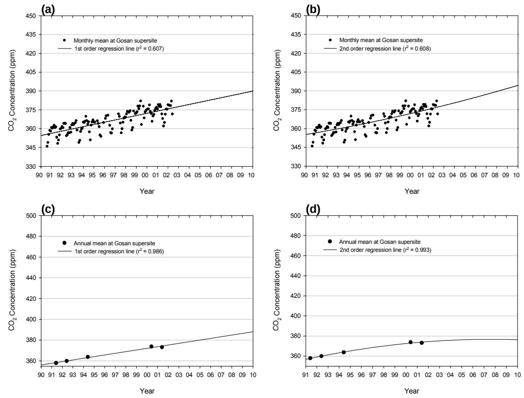

Fig. 3. Expectations for atmospheric CO_2 of Gosan super site by future 2010.

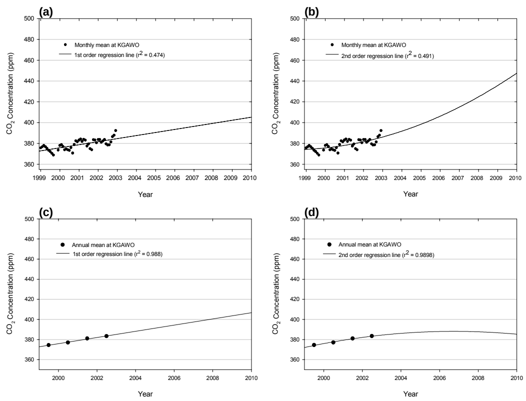

Fig. 4. Expectations for atmospheric CO_2 of KGAWO by future 2010.

an Optical Particle Counter (OPC), from May 2001 to June 2003, on every hour at Gosan station, Jeju Island. The aerosol number concentration at this site was found about factor of five to ten lower than that of at Seoul and Anmyeondo. The results also show that small particles (< ~ 1 ㎛) have no seasonal variation in number concentration while coarse ones (>2.2 ㎛) do it with a maximum in spring and a minimum in summer reflecting the strong influence of sand storm in spring in this region and wet scavenging activity in summer. The diurnal variation is detected for coarse particles showing the peak at 14 to 15h local time probably due to the sea salt particles from local land/sea breeze, but it disappears with the decrease of particle size (Fig.5 and Fig.6). In relation to the meteorological conditions, the number concentration showed a positive correlation with relative humidity for small particles (0.5   2.23 ㎛), while no or a negative correlation with the increase of particle size (3.67   25 ㎛). This trend was inversed for the case of wind speed: aerosol number concentration showed a small decreasing tendency with increasing wind speed for small particles but the high wind speed in winter season increased coarse particle concentration. However, no significant correlations were detected for fine particles (0.3 ~ 0.5 ㎛) with such meteorological parameters. Finally, particles most efficient in light extinction were found to be at the size of about 0.5 ~ 1 ㎛.

Fig. 7 illustrates the day-to-day variations of

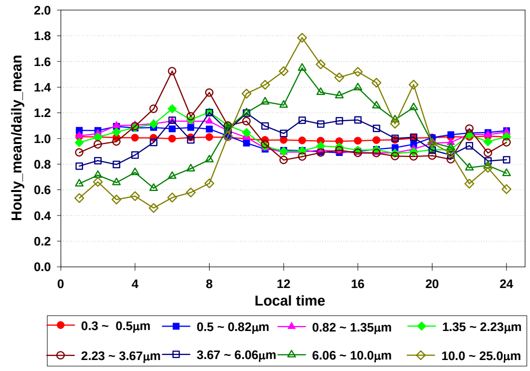

Fig. 5. Diurnal variation of aerosols number concentration May 2001 to June 2003 at Gosan super site.

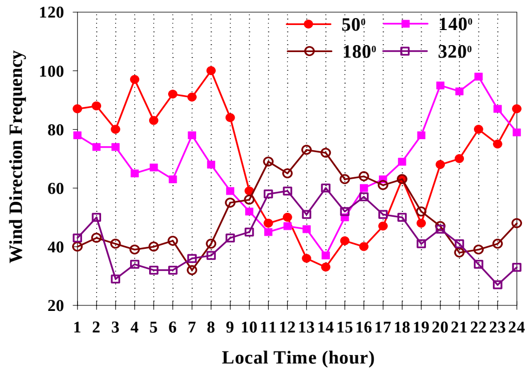

Fig. 6. Occurrence of wind direction at Gosan super site obtained from observed hourly wind direction data from May 2001 to June 2003.

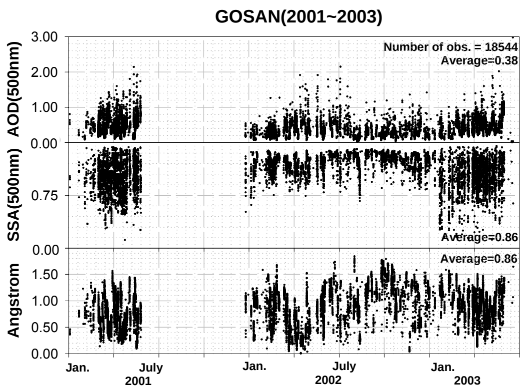

Fig. 7. Variations of aerosol optical parameter (AOD, SSA, Ångström) at Gosan, Korea (2001.1 - 2003.4).

Aerosol Optical Depth (AOD) at 500 nm, Ångström exponents (α) and Single Scattering Albedo (ω) during the periods from January, 2001 to December 2003. The parameters were obtained from the spectral solar radiation of the observations of skyradiometer at Gosan, Jeju. The annual pattern with increase to maximum turbidity in spring is apparent. These observations indicate that AOD at 500 nm very frequently exceeds 0.7 within the range 0.2 ~ 2.3, and SSA (ω) in the range of 0.5 ~ 0.99. AOD during summer season show higher value than winter because of high humid air in summer.

Relatively lower values of Ångström parameters at Gosan than other global observatories mean large aerosol size dominate the site. The origin of this aerosol is, most likely, sea salt but regional anthropogenic pollutants.

2. 3. Monitoring of Regional and Global Climate Change using a 3D Global Atmospheric Chemistry and Transport Model (CTM)

The license agreement on the use and the contract to make joint efforts for further development of MOCAGE (MOdèle de Chimie Atmosphérique à Grande Echelle), the 3D Atmospheric Chemistry and Transport Model of Météo-France, was made between Météo-France/CNRM and KMA/METRI on December 11, 2003 for close collaboration between the two parties and we set to work to develop and apply MOCAGE to our study, the regional and global climate change monitoring.

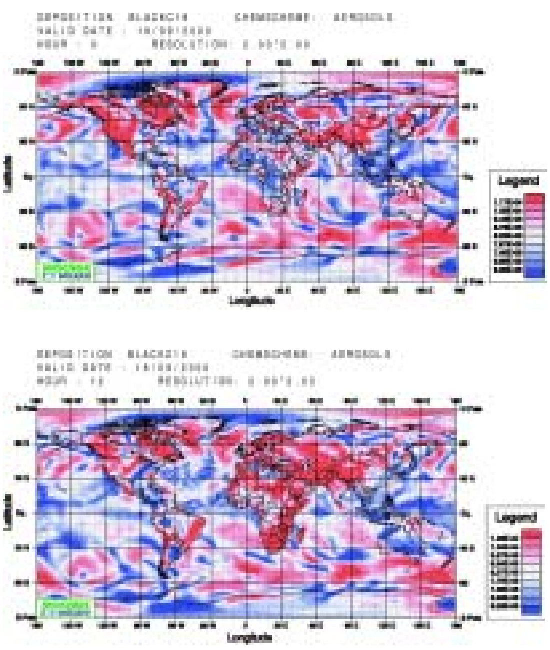

Fig. 8. Global distribution of dry deposition velocity of 1.2μm diameter particle having 1.0 $g.cm^{-3}$ density. Cases at 0UT (upper image) and 12UT (lower image) on Sep. 18, 2000.

Presently, the principal part of the atmospheric cycle (emission, transport, and removal processes) of black carbon aerosols is under parameterization: the emission and dry deposition processes are parameterized whereas gravitational settling and wet scavenging processes are in the final step of parameterization being under sensitivity test. Fig. 8 shows one the simulation results of dry deposition velocity calculated in the model for particles of diameter 1.2m and of specific density 1 g/cm. The upper figure represents the case for 00UTC on September 18, 2000 and the lower one shows 12UTC for the same day. It can be seen that the dry deposition velocity position velocity zeBEles is of the order of 0.01 to 0.1 mm/s and it undergoes a diurnal variation over land with high values during the daytime while this trend is not clear over ocean. The results are in good agreement with those in the literature.

2. 4. Stratospheric Ozone layer over Korea region

In order to see the effect of natural oscillation to the total ozone change, the correlation between monthly total ozone anomaly and natural oscillation indices were analyzed. Trend analyses in total ozone commonly include the dependence of ozone on three natural oscillations of the seasonal cycle, Quasi-Biennial Oscillaton(QBO) and solar cycle. But

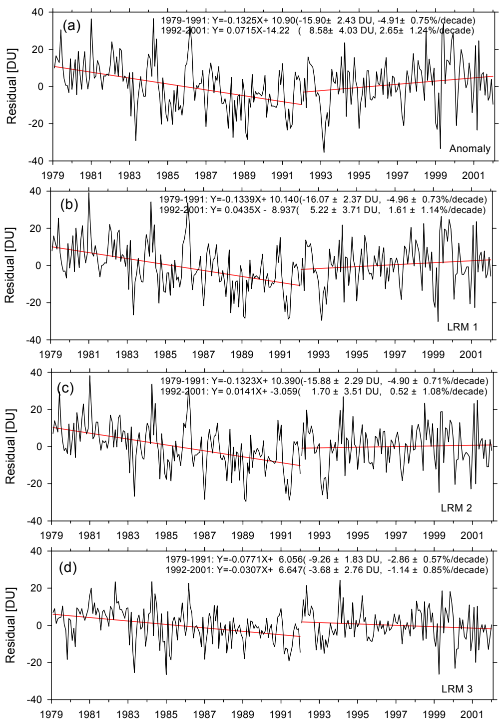

Fig. 9. The comparison of trends which are calculated using different models for two different periods of 1979-1991 and 1992-2001 at Seoul; (a) trend from Model 1, (b) trend from Model 2, (c) trend from Model 3, and (d) trend from Model 4.

recently, other ancillary natural oscillations affecting ozone levels have been reported. In this study, after developing a new multiple linear regression model, the effects of the explanatory natural oscillations were assessed by the model on the long-term trend of the total ozone data measured by the Dobson instruments at Yonsei University (WMO/GO_3OS Station No. 252), Seoul, Korea and reconstructed with Total Ozone Mapping Spectrometer(TOMS) data and other Dobson observations for the period of 1958-2001. The trends have been calculated for three different periods of 1979-2001, 1979-1991 and 1992-2001, using the multiple linear regression models as shown in Fig. 9. These natural oscillations include Arctic Oscillation(AO), Southern Oscillation(SO), Northern Pacific Oscillation(NPO), Pacific Decadal Oscillation(PDO), tropopause pressure(TROP), and North Atlantic Oscillation(NAO) in addition to the seasonal, QBO and solar cycles. Additionally, in order to show a regional coherent features in ozone trend over East Asia, the trend analyses are also performed with Dobson data measured at Sapporo(#012), Tateno(#014) and Kagoshima(#007) in Japan. By using additional six explanatory natural oscillations to the seasonal, QBO and solar cycles in the ozone trend analysis, the negative trends are consistently reduced in magnitude by 0.66 to 2.32% per decade for the former period 1979-1991 and the positive trends are also reduced by 1.52 to 2.75% per decade with the exception of Kagoshima for the latter period 1992-2001. The net effects of the QBO and the solar cycle terms on total ozone trends are from -0.06 to 0.18 for the former period and from 1.04 to 1.82% per decade with the exception of Tateno for the latter period. And the net effects of the SO term are from +0.04 to +0.75 and from -0.31 to -2.62% per decade for the respective period. As a result, the net forcing mechanism of the natural oscillations on the ozone variability might be noticeably different in two time intervals with positive forcing for the former period and negative forcing for the latter period over East Asia. The fact that the overall net effects of six ancillary natural oscillation terms are larger than those of the QBO and the solar cycle terms, suggests that the ancillary explanatory natural oscillations should be included in the multiple regression model for better analyses of the ozone trend. Consequently, the large negative trends of total ozone in the 1980s and the positive trends in the 1990s during the period 1979-2001 may not reflect the control of ozone-depleting substances in the atmosphere, but could be mainly due to other natural oscillations than the QBO and the solar cycle.

2. 5. Impacts of global warming and urbanization on the air temperature

The most important anthropogenic influences on climate are the emission of greenhouse gases and changes in land use, such as urbanization and agriculture. But it has been difficult to separate these two influences. We estimated the impact of urbanization on climate change by comparing trends observed by surface stations with surface temperatures derived from the NCEP/NCAR 50-year Reanlaysis. The NCEP/NCAR Reanalysis should not be sensitive to urbanization effect, although it will show climate changes to the extent that they affect the observations above the surface(Kalnay and Ming, 2003).

Fig. 10 and 11 compare time series of 30 years (I: 1973 to 1982, II : 1983 to 1992 and III : 1993 to 2002) of monthly mean temperature anomalies for Seoul and Chupungnyeong including the average decadal difference between observations and the NCEP/NCAR Reanalysis. A growing trend in the difference between the surface observations and NCEP/NCAR Reanalysis is showed with the increase of 0.88, 1.04 and 1.45℃ in Seoul during the 3 decades (1973 to 2002) period. But there is not shown a growing trend at Chupungnyeong. A remarkable contrast between Seoul and Chupungnyeong is could be due to increasing "urban heat island" effect in Seoul.

This suggests that similar comparisons with other stations may provide a useful tool in assessing the impact of urbanization effects on surface temperature and help separate them from climate trends.

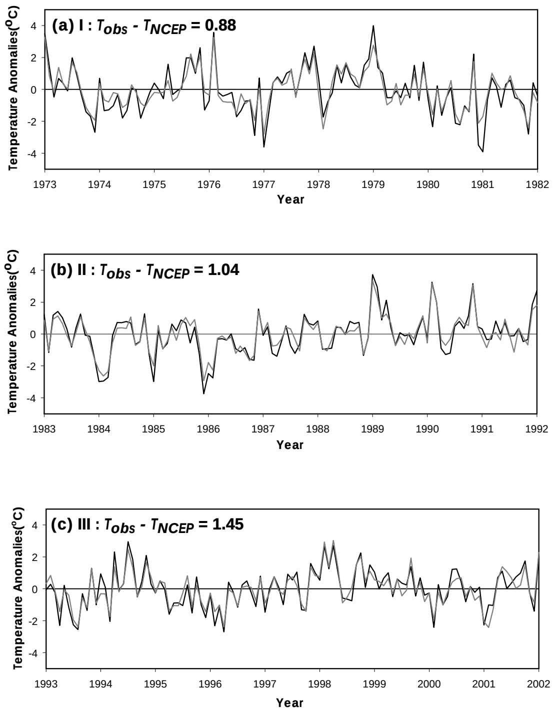

Fig. 10. Comparisons of monthly mean observed and NCEP reanalyzed surface air temperature anomalies with respect to their annual cycles of Seoul. T_{obs}, observed monthly mean air temperature in °C, shown in black. T_{NCEP}, analyzed monthly mean temperature in °C, shown in dark gray.

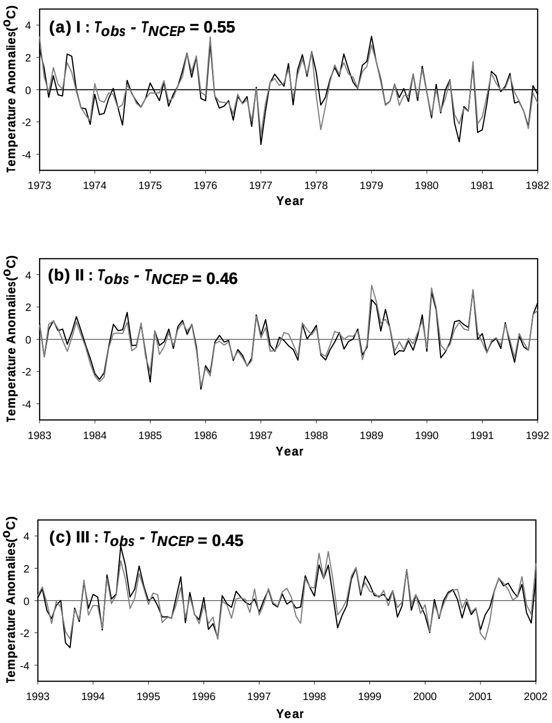

Fig. 11. Same as Fig. 10 except Chupungnyeong.

3. CONCLUSION

The goal of the research study is to understand characteristics of greenhouse gases, aerosol and radiation in Korea background atmosphere, and to develop the techniques on its future trends. An observing site was established in 2001 at Gosan, Jeju, and as the most following works, ACE-Asia international measurements had been accomplished with participating 13 countries during the spring time 2001. The site is closely connected with other Asian climate monitoring sites and open for international GAW projects.

The results of this research project will contribute for the future studies on climate change and the site will provide all available climate change data that are used in the development of climate models and the prediction works of global climate change trend as follow ABC project.

4. ACKNOWLEDGEMENTS

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