Monitoring of Climate Change of Northeast Asia and Background Atmosphere in Korea

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In general, the parameters of climate change include aerosol chemical compounds, aerosol optical depth, greenhouse gases(carbon dioxide, CFCs, methane, nitrous oxide, tropospheric ozone), ozone distribution, precipitation acidity and chemical compounds, persistent organic pollutants and heavy metals, radioactivity, solar radiation including ultra-violet and standard meteorological parameters.

Over the last ten years, the monitoring activities of Korea regarding to the climate change have been progressed within the WMO GAW and ACE-Asia IOP programs centered at the observation sites of Anmyeon and Jeju Gosan islands respectively.

The Greenhouse gases were pointed out that standard air quality monitoring techniques are required to enhance data comparability and that data presentation formats need to be harmonized and easily understood. Especially, the impact of atmospheric aerosols on climate depends on their optical properties, which, in turn, are a function of aerosol size distribution and the spectral reflective indices. Aerosol optical depth and single scattering albedo in the visible are used as the two basic parameters in the atmospheric temperature variation studies. The former parameter is an indicator of the attenuation power of aerosols, while the latter represents the relative strength of scattering and absorption by aerosols. For aerosols with weak absorption, surface temperature decreases as the optical depth increases because of the domination of backscattering. For aerosols with strong absorption, however, warming could occur as the optical depth increases.

The objective of the study is to characterize the means, variability, and trends of Greenhouse gases and aerosol properties on a regional basis using data from its baseline observatories in Korea peninsula. A further goal is to understand the factors that control radiative forcing of the greenhouse and aerosol.

Key words : Climate change monitoring, greenhouse gases, aerosol, baseline observations, radiative forcing

1. Background

Applied Meteorological Research Laboratory of Meteorological Research Institute (METRI) operates two atmospheric baseline monitoring stations, Anmyeon KGAWO and Gosan super site, that conduct measurements on atmospheric constituents capable of forcing climate change and those that cause cloud formation in North East Asia. In addition, a climate research project on monitoring the climate change elements and developing the techniques based on analysis of climate variability is closely related to the observations under the financial supports of National Research Laboratory program of Ministry of Science and Technology (MOST), Korea. The climate change parameters for the measurements at both sites include the greenhouse gases, aerosol, solar and terrestrial radiations and meteorology. With respect to the observations, since 1996 the Korean Global Watch Observatory (KGAWO; 36°32'N, 126°19'E) have observed the climate change elements at Anmyeon island, located in the mid-west coastal area of South Korea. Otherwise, the Gosan super site has measured the atmospheric constituents at Jeju island since 2000 when the program of Aerosol characterized Experiment in Asia (ACE-Asia) had been operated for the spring

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in the year.

2. Programs

Since 1990, the Applied Meteorologcial Research Laboratory (AMRL) of METRI has measured carbon dioxide (CO_2), which is produced by the burning of coal, oil, and natural gas of North East countries. Over the years a number of other gases have been added to the measurements. Those include methan (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), CFC_{11}, CFC_{12} and ozone (O_3). The analysis of these trace gas species are conducted through a international cooperative works through NOAA and University of Sandiego.

Table 1 lists program at Gosan for 2000-2003, Jeju island as well as Anmyeon Korea GAW observatories in 1996-2003. Highlights of the program are as follows.

Atmospheric aerosols measurements began at both sites since 1996. The original objectives of aerosol baseline measurements are to detect a response of atmospheric aerosols to changing climate condition on the North East Asia scale.

3. Results

The mixing ratio and growth rates of atmospheric carbon dioxide and methane are shown in Figs 1 and 2. The results reflect the global trend and source and sinks with winds.

Aerosol monitoring at both baseline stations in Korea provides long term records of aerosol physical and chemical properties due to change in sources and transports patterns. In addition, the aerosol variated are loosely related to radiation measurements in its optical properties. The column integrated aerosol optical property at both sites were provided by the automatic sun and sky scanning radiometer, provided by CIMEL, and was established as an Aerosol Robotic Network AERONET site (Holben et al. 2001)[3]. The CIMEL radiometer made measurements of the direct sun and diffuse sky radiances, within the spectral range 340-1020nm and 440-1020nm, respectively. For the analysis, as in the study of Smirnov et al.(2002)[5], the cloud screened atmospheric aerosol optical conditions were characterized by two parameters: τ_a (500nm), which is the aerosol optical depth at a wavelength of 500nm, and the Ångström parameter, α,

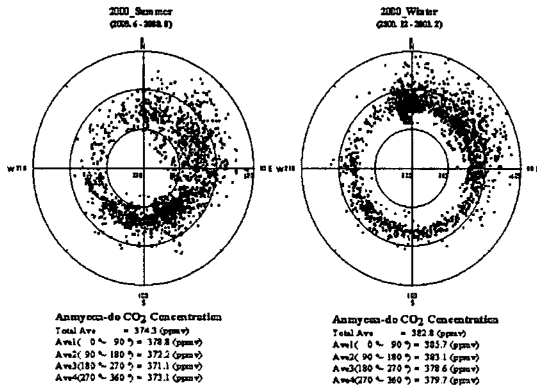

Fig. 1. Concentration as a function of Wind direction of CO_2 at Anmyeon GAW in 2000.

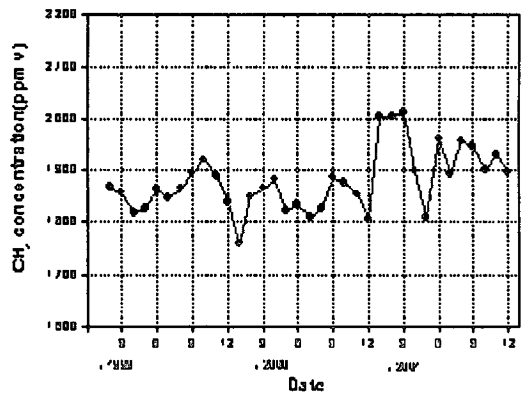

Fig. 2. The variation of methan concentration at Anmyeon GAW in 2000.

derived from a multi-spectral log linear fit to the classical $\tau_a \sim \lambda\text{-}\alpha$. Results showed a significant contrast in the atmospheric optical depth (AOD) between the Anmyeon and Gosan atmosphere. The average value of AOD τa (500nm), at the KGAWO, Anmyeon, was 0.59, ranging from 0.10 to 3.20, while at Gosan the value was 0.35, ranging from 0.10 to 1.40. However, on the Asian

Table 1. Summary of measurement parameters and instruments at Gosan and Anmyeon GAW stations.

	factor		Instrument	Sampling Frequency
Gosan	*Gases*	CO_2	NDIR	1 times/week
		Radon	Radon Analyzer	continuous
		CO_2	CO_2 Flask	continuous
		PFC	PFC sampler	1 times/week
	Aerosols	TSP, PM10,PM2.5	Air sampler	continuous
		Particle number concentration	OPC	continuous
	Radiations	Direct irradiance	Pyrheliometer	continuous
		UV solar radiation	UV-B radiometer	continuous
		AOD	Sunphotometer	continuous
		Scattered radiation measurement by aerosol	Sky-radiometer	continuous
		Net radiation	Net-radiometer	continuous
		Total radiation	Pyranometer	continuous
Anmyeon	*Gases*	Greenhouse gases (CO_2, CH_4 N_2O, CFC_{11}, CFC_{12})	GC, NDIR	continuous
		Gasphase pollutants (SOx,NOx,CO, O_3)	Air quality monitoring system	continuous
	Aerosols	TSP, PM!0, PM2.5	Hi-volume air sampler	1 times/week
		Particle number concentration	OPC	continuous
		Soot	Aethalometer	continuous
		Tropospheric aerosol distribution	Aerosol LIDAR	continuous
	Radiations	AOD	Sunphotometer	continuous
		Scattered radiation measurement by aerosol	Sky-radiometer	continuous
		Particle scattering	Nepelometer	continuous
		radiation	Radiation measurement system	continuous
	Chemistry	Major ion components	Ion Chromatography(IC)	anytime
		Metal component	Inductively Coupled Plasma Spectrometer(ICP)	anytime

dust days, both sites showed increased values in the τ_a (500nm) as shown in Fig. 3 and 4.

The study of climate forcing focused on change in quantities which cause climate to deviate from its unperturbed state. The analyzed elements are greenhouse gases, aerosol and radiation. In this study, the climate effects of radiative forcing are analyzed by the based on the surface temperature perturbation as the results of IPCC (2001)[2] as shown in Fig. 5.

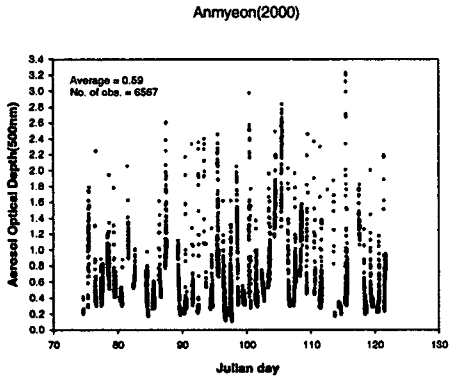

Fig. 3. The aerosol optical depth at 500 nm observed at Anmyeon during the period from March 14 to April 30, 2000.

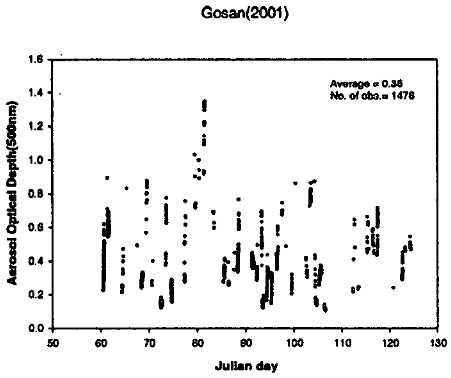

Fig. 4. The aerosol optical depth at 500 nm observed at Gosan Jeju during the period from March 1 to May 4, 2001.

Acknowledgements

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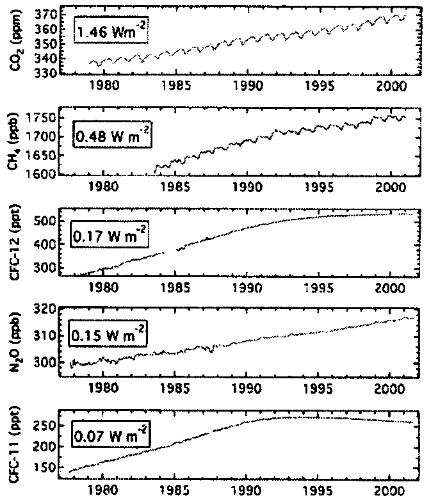

Fig. 5. Recent trends in global climate forcing greenhouse gases measured by CMDL. The number in the boxes give the direct climate forcing resulting from increases during the period of 1750-1998 in Wm-2 for each greenhouse gas (IPCC, 2001).

Reference

1) Charlson, R. J. and J. Heintzenberg, 1995, *Aerosol forcing of climate*, John Wiely & Sons, 2- 10.
2) *IPCC Climate change 2001*, The Scientific Basis, Cambridge Univ. Press, Cambridge, UK, 881pp.
3) Holben, B, N., et al., 2001, An emerging ground-based aerosol climatology: Aerosol optical depth from AERONET, *J. Geophys. Res.*, **106(12)**, 067-12,098.
4) Smirnov, A., B. N. Holben, T. F. Eck, O. Dubovik, and I. Slutsker, 2000, Cloud screening and quality control algorithms for the AERONET database, *Remote Sensing Environment*, **73(3)**, 337-349.
5) Smirnov, A., B. N. Holben, O. Dubovik, N. T. O'Neill, T.F. Eck, D. L. Westphal, A. K. Goroch, C. Pietras and L. Slutsker, 2002, Atmospheric Aerosol Optical Properties in the Persian Gulf. *J. Atmos. Sci.*, **59**, 620-634.