Further Studies on the Current Climate Change in Taiwan and its Impact on Air Pollution Potential

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ABSTRACT

The diffusion of pollutant and the air pollution potential are highly influenced by the local climate situations. We have investigated the impact of the distribution of the air pollution potential in Taiwan area due to climate change.

As a first step, we use a set of standard air pollution emission inventory and Texas Climate logical Model (TCM) to test the air pollution potential distribution due to different climate situations. Current trend of the climate change during the last decade (1991~2003) and its influence on air pollution potential are studied.

During the last decade, central, east and south regions show trend of improving air pollution potential, with yearly rate of decreasing concentration of 3.56%, 2.15% and 0.52% respectively. Meanwhile, a reverse trend is find in north region, with increasing rates of 5.24%. The trend of the variations of principle meteorological factors and their the relationship with the influence of the air pollution potential are discussed. Finally, the seasonal variation of the air pollution potential and its decadal trend is discussed.

Keywords: Climate Change Impact , diffusion, air pollution potential.

1. Introduction

Air Pollution in a region depends on the emission of pollutants and local meteorological conditions. Recently, air pollutant emission in Taiwan is well under controlled. Yet, episodes of high air pollution concentrations in a particular region may still be observed during favorable weather situations. The probability of air pollution episodes occurring may be estimated based on simple atmospheric dispersion models with proper meteorological data and predefined typical air pollution sources. For the present study, the Taxes Climatological Model (TCM)[(1)] is used to calculate the maximum long period mean pollution concentrations for each of the four climatological regions in Taiwan. Representative hourly meteorological data from Central Weather Bureau (CWB) stations (Fig.1) in each of the regions in period 1990 to 2003 is employed for model calculations. The calculated maximum air pollutant concentrations are then used as an index comparing air pollution potentials among the four different regions. Current trend of the climate change for each region during the last decade and its influence on air pollution potential are examined. Interseasonal and interannual variations among different regions are discussed.

2. Atmospheric Diffusion Model

The Texas Climatological Model (TCM) is designed to predict the ground level and long-term concentrations of atmospheric pollutants. Calculations are based on the steady state Gaussian plume equation, Briggs [(2)] plume rise formulations for buoyant and momentum dominated plumes, the empirically derived Pasquill-Gifford[(3)] vertical dispersion coefficients, and a meteorological joint frequency function. This model has been approved by USEPA and is used widely in Taiwan.

A rectilinear array with 1km×1km grid size and 40 km×40km in area is used for the calculation of air pollution concentration. A predefined pollution source is located at the center of the array.

3. Sources and meteorological condition

The sources adopted in this work were five stacks of different heights from 20 to 200 meters, and with different emission boiler sizes and emission rates (see Table 3.1)[(4)] The meteorological data adopted in this study included hourly wind direction, wind speed and cloud amount for the period 1990-2003. All data were provided by the CWB.

4. Results of the modeling and Discussion

This study, hourly meteorological data from four CWB weather stations (Fig. 1), namely Taipei(North), Taichung(Central), Kaoshiung(South)and Hualien(East) for the last decade (1990-2003) and a set of standard air pollution emission inventory (SO_2 for this study) are applied to TCM model. The model simulated seasonal and annual maximum average SO_2 concentration are used as air index for intercomparision of the air pollution potential among four climate regions of Taiwan.

Since the air pollution emission rates are fixed throughout the simulation period and are the same for every region, the temporal and spatial variation of air pollution potential are solely due to the variation in meteorological condition of each region. Table3 4.1-3.4.4 and Fig 3.4.1-3.4.4 summarize annual and seasonal average temperature, wind speed and maximum average ground SO_2 concentrations (and its grid point location) from 1990 to 2003 for each station.

4.1 Comparison of the annual and seasonal air pollution potentials among different regions

In spite of the interannual variation, Taichung(Central) show highest annual and seasonal maximum average SO_2 concentrations. This can be attributed to lower wind speed throughout the year in this region. Hualien(East) on the other hand show lowest SO_2 concentration during winter, spring and autumn when north-easterly monsoon prevail and the wind is strong. The SO_2 concentration in

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Hualien become higher during the summer when south-westerly monsoon prevail and Hualien is then on the lee side of the Central mountain range, and the wind is weak.

Taipei(North) influenced by both north-easterly monsoon during winter, spring and autumn and south-westerly monsoon during summer show low SO_2 concentration throughout the year.

4.2 Interannual variation of the air pollution potential

4.2.1 Taipei(North)

From Table 3.4.1 and Fig 3.4.1 we observe a decreasing trend of wind speed and increasing trend of temperature for Taipei station during the last decade. The annual maximums average SO_2 concentrations show a slight increasing trend of about 5.24% per year. Significant increasing trend of SO_2 concentration were also observed during this period with an increasing rate of 6.61% per year for autumn, 3.86% per year for winter, 2.40% per year for spring and 1.66% per year for summer.

4.2.2 Taichung(Central)

From Table 3.4.2 and Fig 3.4.2 Taichung area show significant trend of decreasing SO_2 concentrations with a rate of 3.56% per year for annual average and 3.85%, 3.32% and 3.20% per year for those of autumn, winter and spring, respectively. The summer value of SO_2 concentration show only minor variation through out the decade. It is interesting to note that, there were no significant trend of variation of average temperature and wind speed in Taichung area during the last decade, The trend of SO_2 concentration variation must be due to the variation of cloud amount which affect the stability of the atmosphere.

4.2.3 Kaoshiung(South)

Interannual variations of average temperature and wind speed were observed for Kaoshiung station (Table 3.4.3 and Fig 3.4.3), but no significant trend of increasing or decreasing can be identified. In The mean time, minor trend of decreasing annual average SO_2 concentrations at a rate of 0.52% per year was observed.

There were trend of decreasing seasonal average SO_2 concentration for autumn, winter, summer, and with increasing trend for spring.

4.2.4 Hualien(East)

Hualien area experienced rather significant interannual fluctuation in average

wind speed and temperature, during the last decade (Table 3.4.4 and Fig 3.4.4), The air pollution potential variation responds quite well with that of the wind speed. There was an decreasing trend for interannual variation of the spring average maximum SO_2 concentrations at a rate of 2.91% per year. The trend is not sighificant for the other seasons.

5. Conclusion

This study, we adopted the TCM Diffusion Model to calculate the long term mean SO_2 concentration, which is then used as an index for comparing interannual variation of air pollution potential in four climatological region in Taiwan. Clearly, the air pollution potential is strongly influenced by local circulation and atmospheric stability. The locations and values of the maximum concentrations for each area vary significantly between seasons. The mountain valley in central Taiwan and inland areas located downwind of the mountain range are regions of high air pollution potential. [(5)]

Taiwan is situated in the East Asian monsoon region, with north-easterly winds prevailing in winter, spring and autumn and south-westly winds prevailing in summer. The north-south oriented central mountain range which has an average elevation of about 2000m complicates the local circulation patterns on the island. Consequently, regional variation of climate condition and air pollution potential is quite significant. Among four climate zones in Taiwan, the north and east regions are more favorable for air pollution diffusion with maximum average ground concentration about half that of the central and south region .

During the last decade(1990-2003), central, east and south regions show trends of improving air pollution potential, i.e, more favorable for pollutant diffusion in the region, with yearly rate of decreasing maximum concentration of 3.56%, 2.15% and 0.52% respectively. The trend of decreasing SO_2 concentration is primary due to the change of cloud amount and thus the atmospheric stability. Meanwhile, a reverse trend is find in north region, with significant increasing rates of 5.24% per year . The trend is related to the weaking of the wind speed. (Fig. 4)

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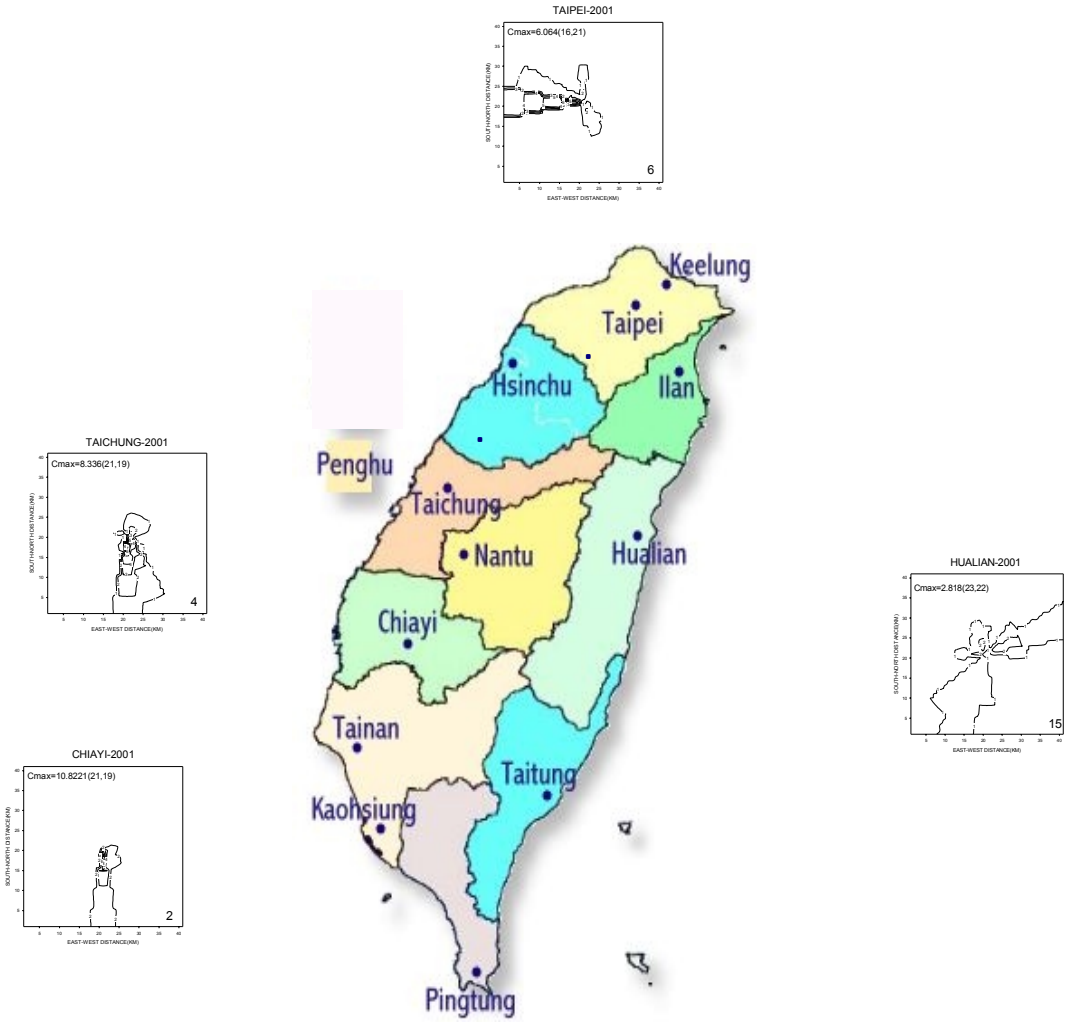


Fig. 1 Map of Taiwan(YEAR)

Table 3.1 Assumed stacks

No. element	1	2	3	4	5
H(m)	20	50	100	100	200
D(m)	0.5	2	3	3	7
Q(g/sec)	2	6	10	400	800
T(℃)	100	100	100	150	200

Remarks:
H:stack height D:diameter
Q:emission rates T:temperature
The air pollutant is assumed to be SO_2

Table 3.4.1 average wind speed, temperature and simulated results of maximum average SO_2 concentrations in 1990-2003 for Taipei(North)

season \ Year		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	average	Increasing rate per year
Annual	Wind speed(ms^{-1})	3.9	3.3	2.9	3.0	3.0	2.7	2.9	2.6	2.5	2.7	2.5	2.8	2.7	2.8	2.9	5.24%
	Temperature(℃)	21.9	21.6	21.3	21.5	21.8	22.4	22.5	22.6	23.6	23.0	23.6	23.4	23.8	23.5	22.6	
	SO_2 conc.(ppb)	4.9943	4.2262	2.7193	3.7580	3.4734	4.9684	5.7001	3.5029	4.1719	4.7363	4.1719	6.4547	6.4037	7.0490	4.8	
	Grid point location of Max. SO_2 concentration	14,17	14,17	14,18	14,17	14,18	20,19	14,19	15,20	15,19	14,18	15,19	15,20	17,20	15,20		
Winter	Wind speed(ms^{-1})	3.8	3.7	2.7	3.4	3.1	2.8	3.0	2.6	2.6	3.0	2.6	2.9	2.7	2.9	3.0	3.86%
	Temperature(℃)	16.5	14.9	14.8	14.6	16.3	15.5	16.1	16.6	17.4	16.9	17.4	17.9	17.5	17.0	16.4	
	SO_2 conc.(ppb)	6.5301	5.2942	3.2589	5.0016	3.9728	6.3558	6.7953	4.6060	4.9368	6.7212	4.9368	7.3043	6.6521	8.0071	5.7	
	Grid point location of Max. SO_2 concentration	12,18	12,18	12,18	12,18	13,20	13,20	14,19	13,20	14,17	14,18	14,17	14,21	15,20	15,20		
Spring	Wind speed(ms^{-1})	3.7	3.8	2.7	2.7	2.7	2.4	2.9	2.7	2.2	2.7	2.2	2.6	2.6	2.9	2.8	2.40%
	Temperature(℃)	20.7	21.2	20.3	20.4	20.2	21.2	20.4	22.0	23.0	21.9	23.0	22.2	23.9	22.3	21.5	
	SO_2 conc.(ppb)	4.7632	5.2968	4.2590	3.5614	3.8702	5.7338	5.5332	4.5631	4.1177	4.4244	4.1177	5.5148	5.6525	7.4243	4.9	
	Grid point location of Max. SO_2 concentration	12,18	14,17	12,21	12,18	12,18	20,19	13,20	14,19	18,19	14,18	18,19	14,19	15,20	14,21		
Summer	Wind speed(ms^{-1})	3.5	2.5	2.5	2.1	2.9	2.2	2.2	2.3	2.1	2.0	2.1	2.5	2.6	2.3	2.4	1.66%
	Temperature(℃)	28.6	28.5	28.4	29.0	28.4	28.7	28.8	27.4	29.3	28.4	29.3	29.4	29.5	29.5	28.8	
	SO_2 conc.(ppb)	2.8714	5.2270	4.0544	4.3672	3.0576	8.8600	7.3369	3.9096	4.6516	4.6527	4.6516	5.3866	6.0308	4.8931	5.0	
	Grid point location of Max. SO_2 concentration	20,22	20,22	20,22	19,22	21,19	20,19	20,19	21,19	21,20	22,20	21,20	18,20	18,20	20,22		
Autumn	Wind speed(ms^{-1})	4.4	3.3	3.6	3.6	3.5	3.2	3.4	2.6	3.0	3.1	3.0	3.1	2.8	3.2	3.3	6.61%
	Temperature(℃)	21.7	21.8	21.7	21.9	22.2	24.0	24.6	24.1	24.6	24.7	24.6	23.7	24.3	25.0	23.5	
	SO_2 conc.(ppb)	7.0593	4.6739	4.4202	5.4351	4.4854	5.1938	8.2354	5.7934	6.5849	6.6989	6.5849	8.7033	8.2735	9.1787	6.7	
	Grid point location of Max. SO_2 concentration	14,18	14,18	14,18	14,18	15,19	15,20	15,20	15,19	15,19	15,19	15,19	15,20	17,20	15,20		

Table 3.4.2 average wind speed, temperature and simulated results of maximum average SO_2 concentrations in 1990-2003 for Taichung(Central)

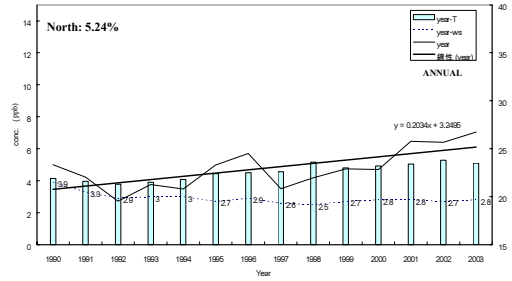
season \ Year		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	average	Increasing rate per year
Annual	Wind speed(ms^{-1})	1.6	1.6	1.6	1.7	1.6	1.7	1.7	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	-3.56%
	Temperature(℃)	23.6	23.8	23.2	23.6	23.6	23.1	23.4	23.5	24.5	23.7	23.9	23.9	24.3	24.1	23.7	
	SO_2 conc.(ppb)	10.8547	11.6462	10.8284	9.1318	9.0394	9.8524	10.0473	9.2943	7.9875	7.7551	8.0911	7.1568	4.6390	5.3363	8.7	
	Grid point location of Max. SO_2 concentration	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	21,18	21,18		
Winter	Wind speed(ms^{-1})	1.8	1.6	1.7	1.8	1.6	1.8	1.8	1.7	1.7	1.9	1.8	1.7	1.7	1.8	1.7	-3.32%
	Temperature(℃)	18.4	17.9	17.1	17.5	18.8	16.5	17.3	17.6	18.6	17.8	18.2	18.5	18.5	17.8	17.9	
	SO_2 conc.(ppb)	13.9116	13.6933	14.4263	12.2701	11.0895	12.5433	14.7159	11.2831	9.9367	11.3129	10.8101	8.6764	6.4452	7.0155	11.3	
	Grid point location of Max. SO_2 concentration	20,18	20,18	20,18	20,18	20,18	20,17	20,18	20,18	20,18	20,18	20,18	20,17	21,18	21,18		
Spring	Wind speed(ms^{-1})	1.5	1.5	1.5	1.6	1.6	1.6	1.6	1.5	1.5	1.6	1.6	1.6	1.6	1.6	1.6	-3.20%
	Temperature(℃)	22.3	24.0	22.8	22.7	23.3	22.6	21.7	23.7	24.4	23.7	23.1	23.7	24.9	23.6	23.3	
	SO_2 conc.(ppb)	10.7550	10.4243	8.4818	7.9986	8.1265	8.6271	9.3443	9.4889	7.8189	8.7020	8.1869	5.9249	4.0807	5.0805	8.1	
	Grid point location of Max. SO_2 concentration	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	21,18	20,18	20,18	21,18	21,18		
Summer	Wind speed(ms^{-1})	1.6	1.5	1.6	1.8	1.6	1.7	1.8	1.5	1.6	1.6	1.6	1.5	1.6	1.7	1.6	-0.50%
	Temperature(℃)	28.0	28.8	28.2	28.6	28.1	28.2	28.8	27.8	28.9	28.1	28.2	28.7	28.7	28.9	28.4	
	SO_2 conc.(ppb)	6.4525	7.3550	7.0057	8.0400	7.2784	6.0757	8.5238	7.1687	7.9701	8.1358	6.3922	5.3618	6.2531	7.5194	7.1	
	Grid point location of Max. SO_2 concentration	20,22	22,21	22,21	22,21	21,21	21,21	21,21	21,21	21,21	20,21	21,22	21,20	20,22	20,22		
Autumn	Wind speed(ms^{-1})	1.5	1.6	1.8	1.6	1.6	1.7	1.7	1.5	1.6	1.6	1.8	1.8	1.7	1.7	1.7	-3.85%
	Temperature(℃)	25.0	24.2	24.2	25.4	24.4	24.9	25.8	25.0	25.8	25.5	25.7	24.3	25.0	25.9	25.1	
	SO_2 conc.(ppb)	13.6642	17.3239	14.5332	13.3600	11.7021	12.6440	12.8985	10.2742	11.0280	8.9588	10.2458	9.7029	6.5260	6.6300	11.4	
	Grid point location of Max. SO_2 concentration	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	20,18	21,18		

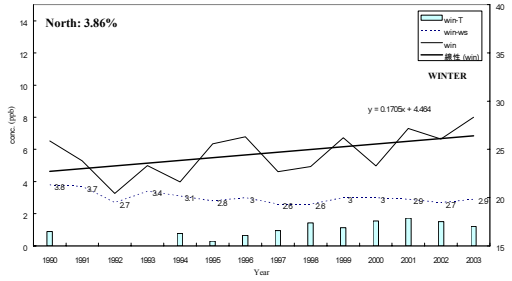
Table 3.4.3 average wind speed, temperature and simulated results of maximum average SO_2 concentrations in 1990-2003 for Kaoshiung(South)

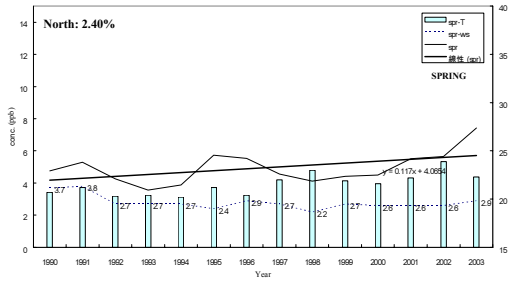
season \ Year		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	average	Increasing rate per year
Annual	Wind speed(ms^{-1})	2.5	2.3	2.1	2.3	2.3	2.3	2.2	2.3	2.2	2.3	2.3	2.2	2.3	2.3	2.3	
	Temperature(℃)	25.2	25.3	24.9	25.1	25.2	24.6	24.8	25.0	25.8	25.2	25.1	25.2	25.7	25.5	25.2	
	SO_2 conc.(ppb)	6.3234	5.8291	6.4293	6.2686	5.7572	6.9800	8.0621	6.2686	6.2510	6.0532	6.1229	5.0144	6.3171	5.6625	6.2	-0.52%
	Grid point location of Max. SO_2 concentration	22,19	22,19	22,19	22,19	22,20	22,19	22,20	22,20	22,19	22,19	22,18	22,19	22,20	22,20		
Winter	Wind speed(ms^{-1})	2.4	2.3	2.1	2.2	2.2	2.3	2.2	2.2	2.2	2.2	2.2	2.1	2.2	2.3	2.2	
	Temperature(℃)	20.8	20.3	19.7	19.9	21.2	19.0	19.6	19.9	21.2	20.2	20.3	20.7	20.8	20.3	20.3	
	SO_2 conc.(ppb)	6.1656	8.6850	10.6761	7.2482	7.9680	8.6608	8.5474	8.2178	6.5551	8.8542	9.9633	7.3850	6.8636	7.8700	8.1	-0.60%
	Grid point location of Max. SO_2 concentration	22,19	20,18	20,18	20,18	20,18	20,18	22,19	20,18	20,18	20,18	20,18	20,18	20,18	20,18		
Spring	Wind speed(ms^{-1})	2.6	2.4	1.9	2.3	2.4	2.3	2.1	2.3	2.2	2.3	2.2	2.2	2.3	2.2	2.3	
	Temperature(℃)	24.7	26.1	25.2	24.8	25.2	24.8	24.0	25.4	25.9	25.8	25.2	25.5	26.2	25.6	25.3	
	SO_2 conc.(ppb)	6.4483	8.0589	5.9060	8.0061	6.2379	6.8115	8.4679	9.1461	7.1291	9.4257	9.0736	5.6898	7.9117	7.3268	7.5	0.87%
	Grid point location of Max. SO_2 concentration	22,18	22,19	20,22	22,19	22,19	22,20	22,19	22,20	20,22	22,19	22,18	22,20	22,20	22,20		
Summer	Wind speed(ms^{-1})	2.8	2.5	2.3	2.5	2.7	2.6	2.6	2.6	2.5	2.4	2.3	2.3	2.4	2.6	2.5	
	Temperature(℃)	28.9	29.3	29.1	29.4	28.4	28.6	29.3	28.4	29.2	28.5	28.4	28.8	29.2	29.2	28.9	
	SO_2 conc.(ppb)	5.9475	8.2078	7.5409	8.0791	8.1555	7.5004	8.8603	9.1449	6.7540	6.1464	6.7664	7.8973	6.4785	7.3028	7.5	-0.33%
	Grid point location of Max. SO_2 concentration	22,19	20,22	22,19	20,22	20,22	22,20	22,20	20,22	20,22	20,22	22,20	22,20	22,20	20,22		
Autumn	Wind speed(ms^{-1})	2.4	2.1	2.2	2.2	2.1	2.1	1.7	2.1	2.1	2.1	2.3	2.4	2.2	2.2	2.2	
	Temperature(℃)	26.2	25.6	25.5	26.3	25.9	26.2	27.1	26.3	27.1	26.3	26.6	25.6	26.5	26.7	26.3	
	SO_2 conc.(ppb)	7.2225	5.6742	8.0141	6.8336	7.9868	7.9549	15.2526	8.6424	7.9897	5.6486	7.2878	5.6053	7.1021	6.3797	7.7	-0.78%
	Grid point location of Max. SO_2 concentration	22,19	22,18	22,19	22,20	22,20	22,19	22,20	22,20	22,20	22,19	22,19	22,19	22,20	22,20		

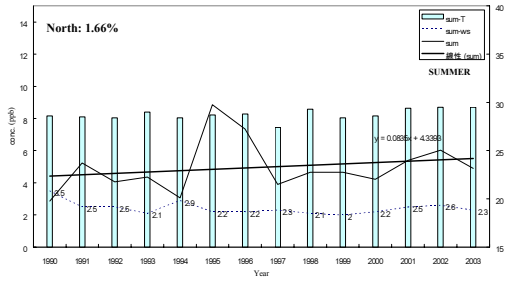
Table 3.4.3 average wind speed, temperature and simulated results of maximum average SO_2 concentrations in 1990-2003 for Hualien(East)

season \ Year		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	average	Increasing rate per year
Annual	Wind speed(ms^{-1})	2.5	1.9	2.5	3.1	2.6	2.5	2.4	2.2	2.4	2.3	2.1	3.0	3.0	3.1	2.5	
	Temperature(℃)	23.3	23.6	23.1	23.4	23.9	23.1	23.4	23.4	24.3	23.6	23.7	23.7	23.9	23.6	23.6	
	SO_2 conc.(ppb)	4.0115	4.8371	3.7112	3.9659	3.9394	4.3213	4.2921	4.1227	3.7305	4.2073	4.4700	3.0317	2.7568	2.9568	3.9	-2.15%
	Grid point location of Max. SO_2 concentration	18,20	19,19	19,19	18,20	22,21	18,18	18,18	18,18	21,21	18,18	19,21	22,21	19,22	22,21		
Winter	Wind speed(ms^{-1})	3.1	1.9	2.2	3.4	2.8	2.7	2.6	2.3	2.5	2.5	2.3	2.7	3.2	3.4	2.7	
	Temperature(℃)	19.2	18.6	18.5	18.8	19.7	17.9	18.4	18.6	19.5	18.8	19.3	19.2	18.8	18.4	18.8	
	SO_2 conc.(ppb)	4.1921	5.2775	4.8806	4.0113	4.1138	5.6180	5.3852	4.4028	4.1927	5.7694	5.1467	3.1045	2.9137	3.2597	4.4	-1.71%
	Grid point location of Max. SO_2 concentration	18,18	18,18	19,19	16,17	22,21	16,17	17,17	18,18	17,16	18,18	18,18	22,21	22,21	16,15		
Spring	Wind speed(ms^{-1})	2.8	2.0	1.5	2.9	2.5	2.6	2.2	2.1	2.3	2.2	1.8	2.9	3.0	2.9	2.4	
	Temperature(℃)	22.0	23.5	22.5	22.3	23.3	22.6	21.7	23.0	23.7	22.7	22.5	22.8	24.1	22.8	22.8	
	SO_2 conc.(ppb)	4.0035	6.1049	6.8526	4.6258	4.3938	3.4833	5.2354	5.2684	5.1063	4.9054	4.4677	2.6228	3.6486	2.3741	4.5	-2.91%
	Grid point location of Max. SO_2 concentration	20,22	19,19	19,20	18,20	19,22	21,21	18,18	18,18	21,21	18,18	22,21	22,21	19,22	19,22		
Summer	Wind speed(ms^{-1})	2.0	1.9	2.7	3.0	2.6	2.2	2.3	2.3	2.3	2.2	2.2	3.0	2.6	3.0	2.5	
	Temperature(℃)	27.8	28.3	27.7	28.2	28.2	27.5	28.5	27.4	28.7	28.1	28.0	28.3	28.2	28.3	28.1	
	SO_2 conc.(ppb)	7.8068	8.9394	6.7710	6.9477	7.3504	7.3690	11.1690	7.4090	7.0059	7.0180	8.3439	5.5806	4.7954	5.8890	7.3	-1.79%
	Grid point location of Max. SO_2 concentration	18,20	19,21	19,21	18,20	19,21	19,21	19,22	19,21	19,21	19,21	19,22	19,22	18,20	19,22		
Autumn	Wind speed(ms^{-1})	2.2	1.8	3.6	3.0	2.5	2.4	2.3	2.2	2.6	2.3	2.2	3.2	3.1	3.3	2.6	
	Temperature(℃)	24.2	23.8	23.9	24.3	24.5	24.5	25.0	24.4	25.2	24.7	25.2	24.2	24.4	24.8	24.5	
	SO_2 conc.(ppb)	4.3193	6.1479	3.6914	3.3969	5.4396	7.4038	5.3257	4.7178	4.1595	4.4024	5.1821	2.7906	3.0323	3.3694	4.5	-2.31%
	Grid point location of Max. SO_2 concentration	18,18	19,19	17,16	22,22	18,18	18,18	18,18	19,21	19,18	18,18	19,21	19,15	25,21	22,21		









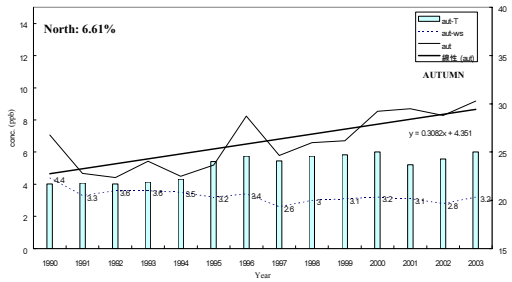
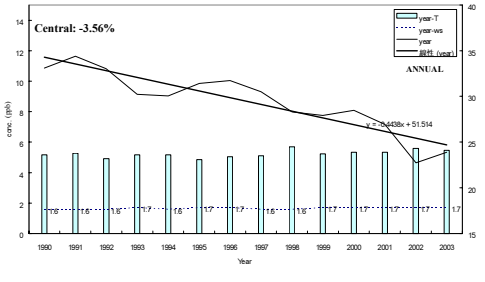
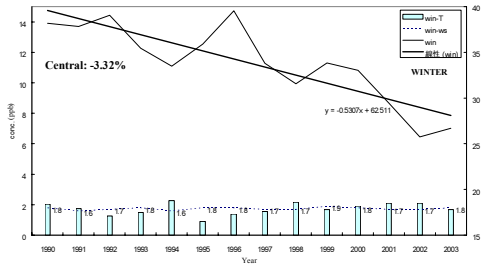
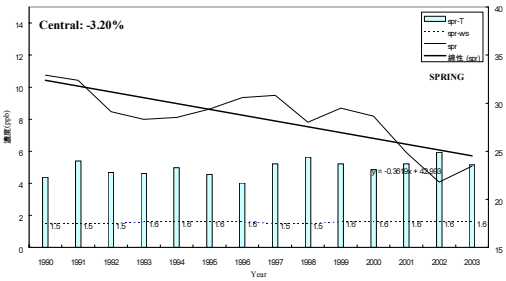
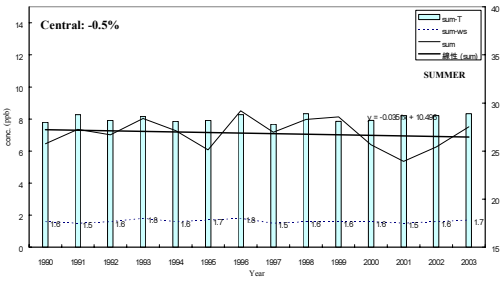


Fig 3.4.1
Interannual variation of the air pollution potential, average temperature and wind speed for Taipei(North) during 1990-2003.









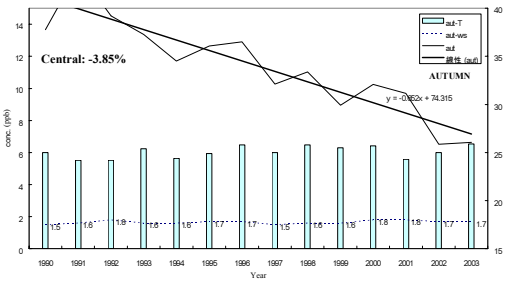
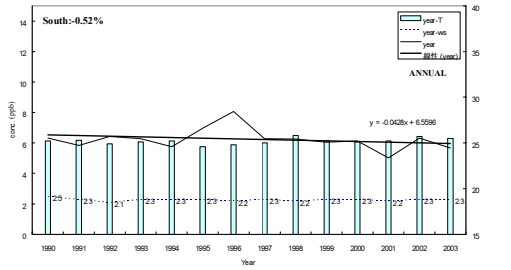
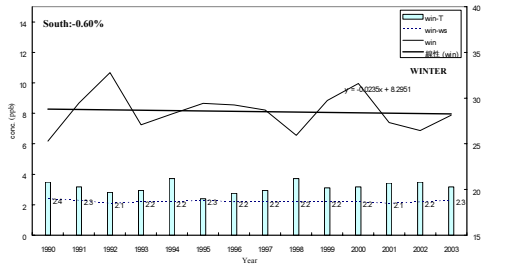
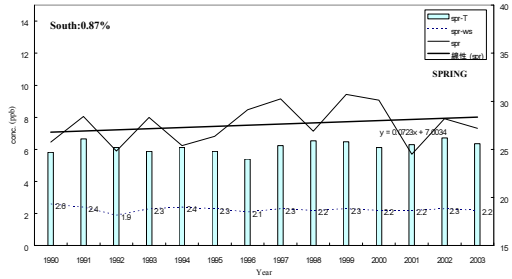
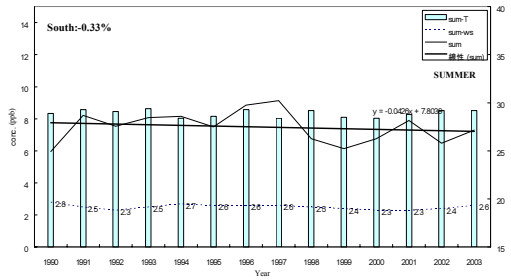


Fig 3.4.2
Interannual variation of the air pollution potential, average temperature and wind speed for Taichung(Central) during 1990-2003









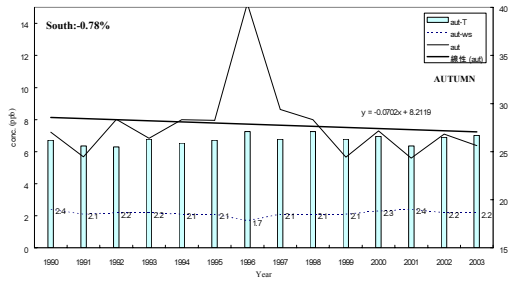
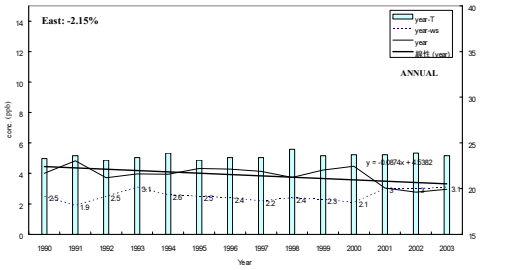
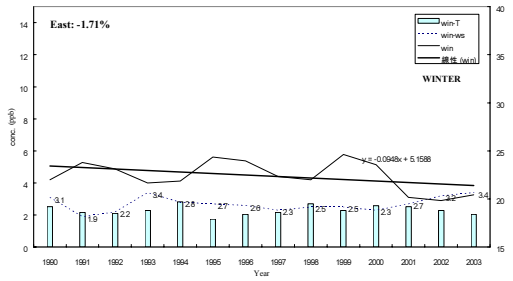
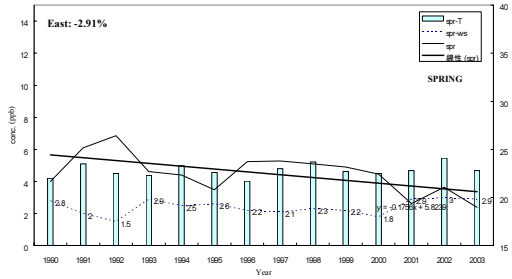
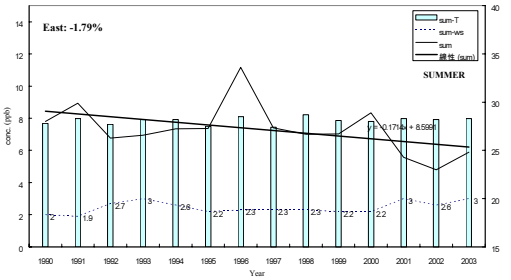


Fig 3.4.3
Interannual variation of the air pollution potential, average temperature and wind speed for Kaoshiung(South) during 1990-2003.









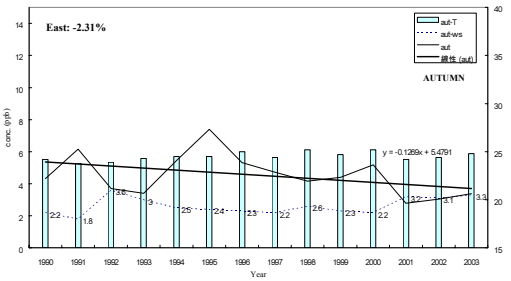
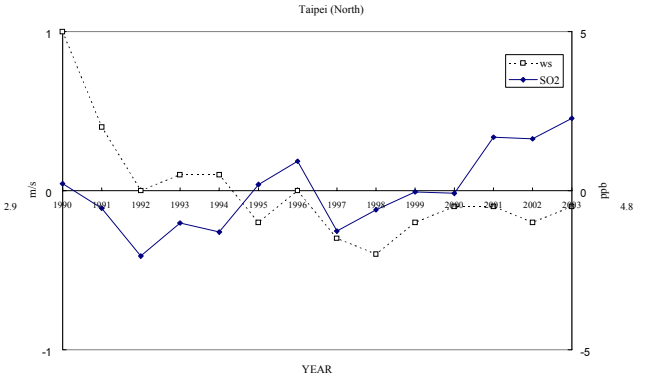
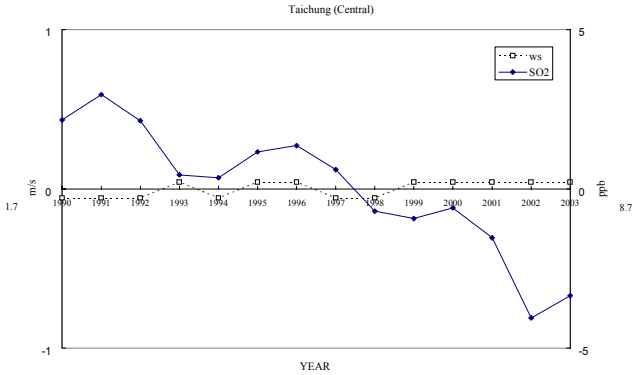


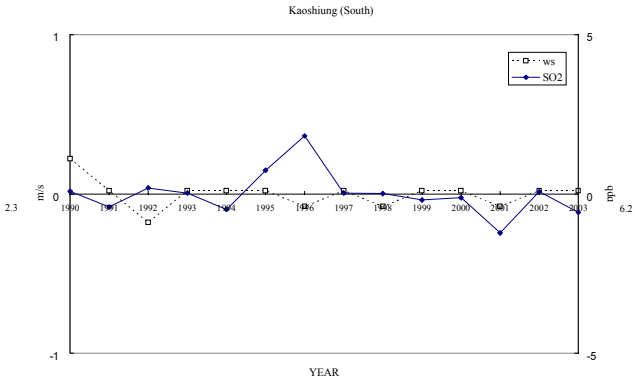
Fig 3.4.4
Interannual variation of the air pollution potential, average temperature and wind speed for Hualien(East) during 1990-2003



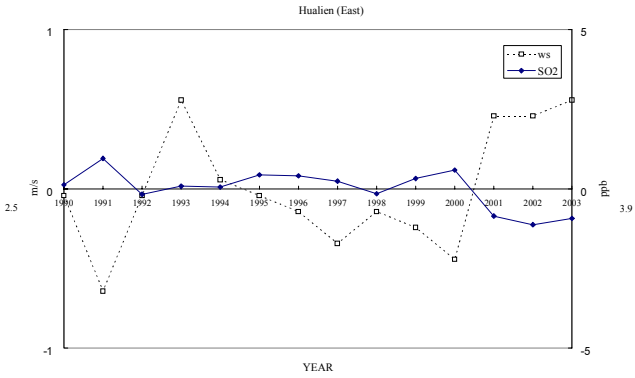
Interannual variation of the deviation from decadal average for wind speed and SO2 during 1990-2003



Interannual variation of the deviation from decadal average for wind speed and SO2 during 1990-2003



Interannual variation of the deviation from decadal average for wind speed and SO2 during 1990-2003



Interannual variation of the deviation from decadal average for wind speed and SO2 during 1990-2003

Fig. 4 Interannual variation of the deviation from decadal average for wind speed and SO_2 during1990-2003.