

**Annual Air Quality
Monitoring Report
1997**

**T Aberkane
June 1998**

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Executive Summary

Ambient air quality monitoring is conducted at a number of sites in the Canterbury Region. In 1997 these sites included St Albans, Hornby and Opawa in Christchurch, and a new site in Timaru. The contaminants monitored at the sites included suspended particulate (i.e., particles in the air less than 10 microns in diameter and referred to as PM₁₀), carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and nitric oxide (NO). Meteorological conditions are also monitored by measuring wind speed, wind direction and temperature.

In Christchurch PM₁₀ and CO regularly exceed health guidelines in the winter because of poor dispersion of contaminants due to meteorological conditions, combined with increased emissions from domestic heating. Measured concentrations in 1997 are compared to Council guidelines and previous monitoring data.

The CRC guideline for suspended particulate (PM₁₀) was exceeded on 33 days at the St Albans monitoring site and from 10 to 22 days at the other Christchurch monitoring sites. PM₁₀ concentrations measured at Timaru were considerably lower than those measured at the St Albans monitoring site, with the CRC guideline for suspended particulate exceeded on 22 days.

The Ministry for the Environment guideline for 8 hour average carbon monoxide concentrations was exceeded on 11 days at the St Albans monitoring site. No exceedences for carbon monoxide occurred at other sites.

Concentrations of SO₂ and NO₂ measured at all sites were below guideline concentrations. SO₂ monitoring data provide information about potential sources at a number of sites. At the Timaru monitoring site it is likely that the high daytime concentrations arise as a result of emissions from industrial activities in the city centre, whereas evening and morning concentrations are more likely to come from domestic heating. At Opawa SO₂ concentrations have shown seasonal variations in 1997 not previously seen at this site. At Hornby 24 hour average SO₂ concentrations have increased compared to 1996, with a maximum concentration at 80% of the guideline.

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1 Introduction

This report details results from the ambient air quality monitoring sites in the Canterbury Region for 1997. It provides a background to sites currently in operation and presents results for each contaminant at each site. Concentrations of these contaminants are compared to health guidelines and previous monitoring data. The contaminants include suspended particulate (i.e., particles in the air less than 10 microns in diameter and referred to as PM₁₀), carbon monoxide (CO), sulphur dioxide (SO₂), nitrogen dioxide (NO₂) and nitric oxide (NO).

2 Air quality monitoring sites

2.1 Christchurch

Christchurch's primary air quality monitoring site is located in St Albans. This site was established by the former Department of Health in 1988. The Ministry of Health has continued to operate this monitoring site as part of its contribution to an international air quality monitoring programme. Data from the Tapered Element Oscillating Microbalance (TEOM) particulate monitor at this site is used in reporting high pollution episodes in Christchurch. High pollution is defined as a 24 hour average PM₁₀ concentration greater than 50 µgm⁻³.

PM₁₀ data from a Beta Gauge Automated Particle Sampler is also collected at this site by the Ministry of Health. However the Canterbury Regional Council report PM₁₀ concentrations measured by the TEOM for a number of reasons. The TEOM is:

- the only type of PM₁₀ monitor used at other monitoring sites in the Canterbury region
- more sensitive to changes in mass concentration

- able to measure concentrations for periods less than one hour
- a direct measure of mass concentration.

Monitoring sites were established in 1995 in the residential areas of Hornby (at the South Hornby School), and Beckenham (at the Christchurch City Council Service Centre). Use of the Beckenham site was discontinued in March 1997. In July 1996 a monitoring site was established at Opawa in a residential area (Mary McLean Place), adjacent to a large industrial area. The location of these sites is shown in Figure 2.1.

2.2 Timaru

In January 1997 the Canterbury Regional Council established a new air quality monitoring site in Timaru at the Timaru Main School. Like other air quality monitoring sites in the region, this site was selected as a representative, rather than a worst case, ambient air quality monitoring site. The area to the east of the site is the main commercial area and also includes some industries. To the west of the monitoring site are residential areas. Previously smoke monitoring had been carried out between 1987 and 1989, and in 1993 at various sites in Timaru, as shown in Figure 2.2. This is the first permanent site established outside Christchurch to continuously monitor air contaminants and meteorological parameters in the Canterbury Region.

2.3 Operation¹ of sites

The St Albans monitoring site is currently operated by the Institute of Environmental Science and Research Limited (ESR) on behalf of the Ministry of Health. Data are quality assured to Canterbury Regional Council standards and supplied on a monthly basis. The Canterbury Regional

¹ Operation includes maintenance of the site, calibration and provision of quality assured data.

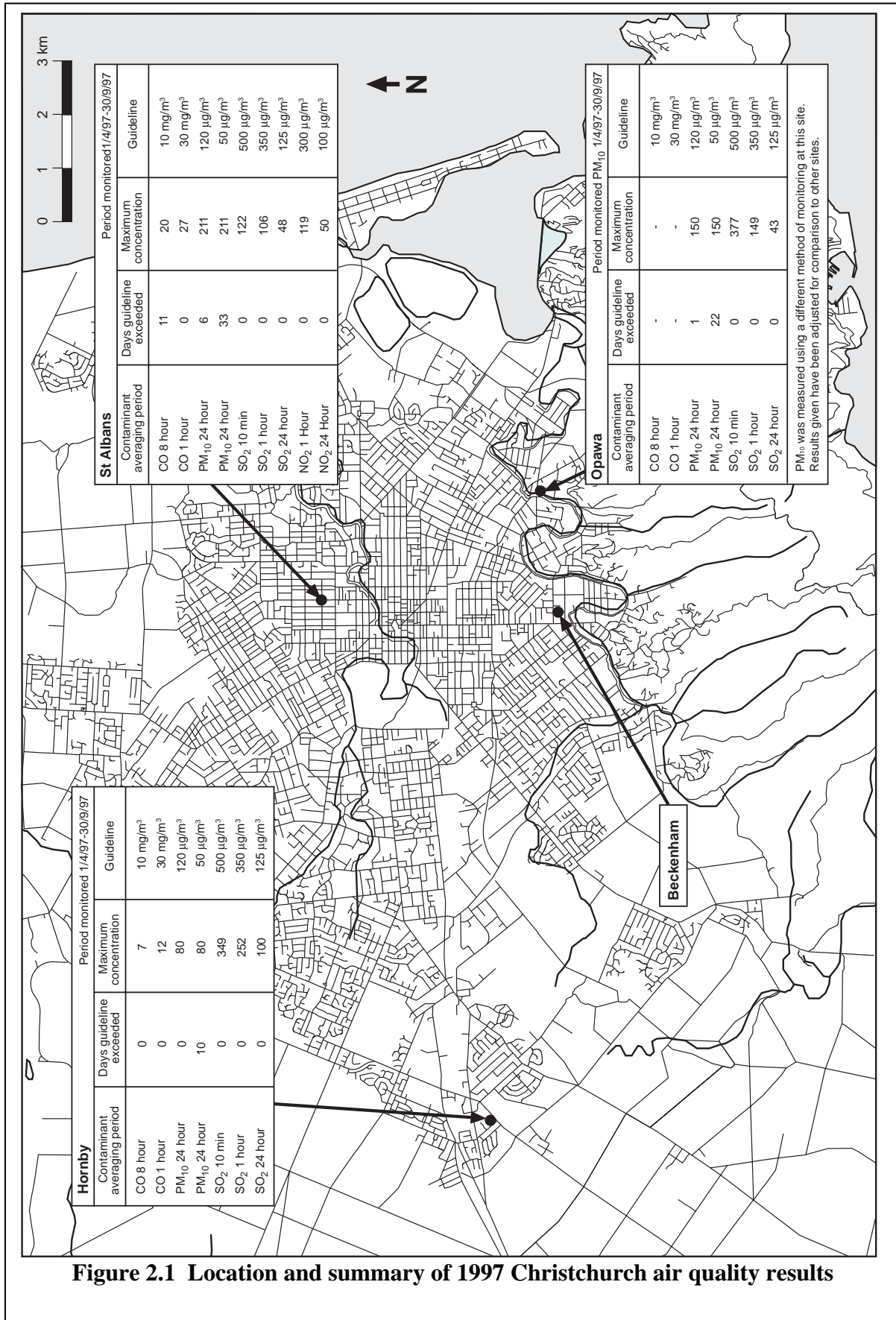
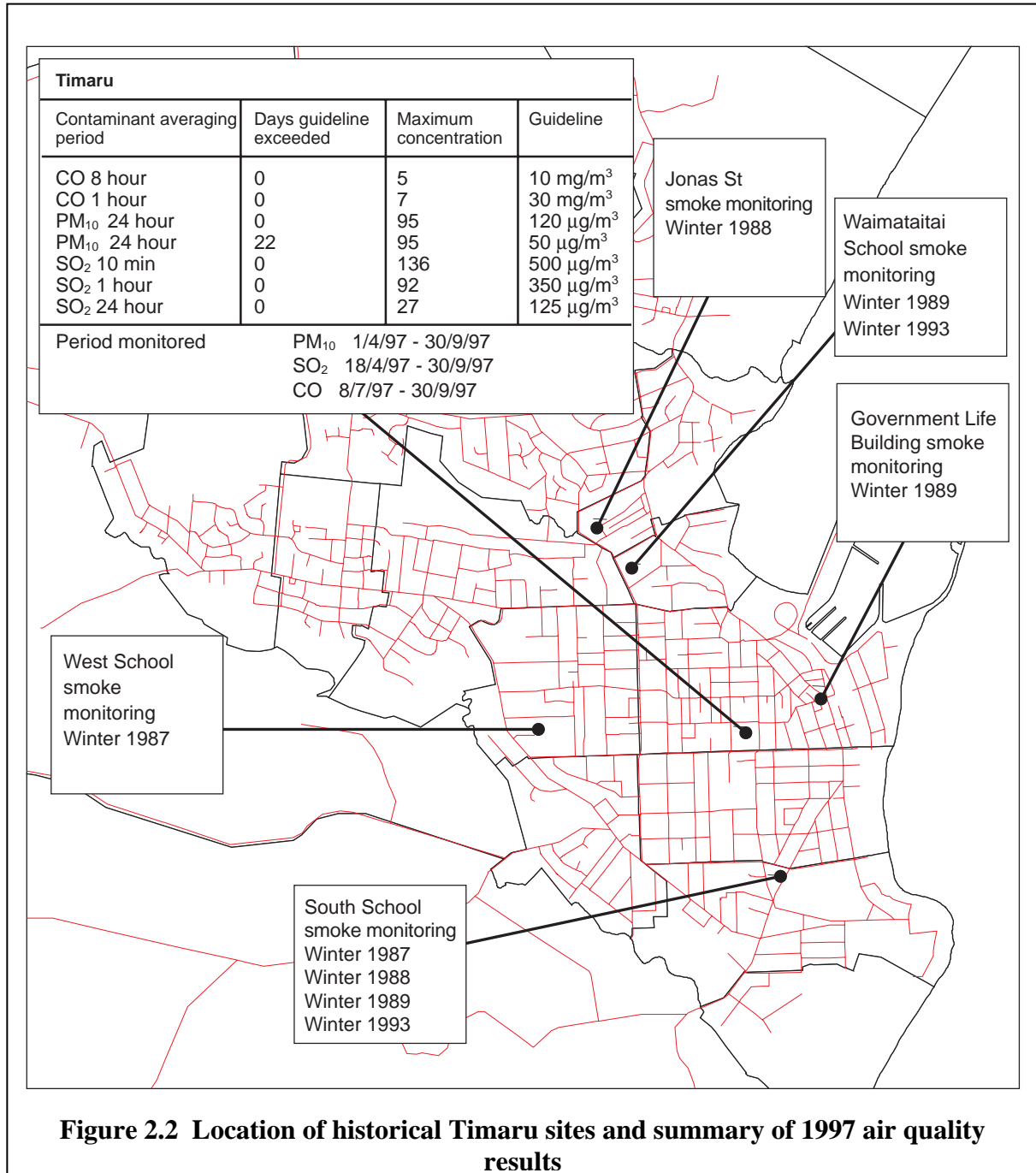


Figure 2.1 Location and summary of 1997 Christchurch air quality results

Council also has direct access to raw data on a daily basis via modem.

The Beckenham, Hornby, Opawa and Timaru sites were operated on a contract basis until November 1997. The National Institute of Water and Atmospheric

Research (NIWA) operated these sites until 30 June 1997. ESR operated these sites from July to October 1997. The Canterbury Regional Council took over the operation in November 1997.



Sites are operated in accordance with quality assurance procedures specified in the Canterbury Regional Council Draft Quality Assurance Manual. Major changes to these operational procedures during 1997 included downloading and validating raw data using FLOSYS (telemetry software integrated with TIDEDA database). Previously data were supplied to the Canterbury Regional Council, quality assured, in EXCEL format, and were archived in a TIDEDA database. Raw data accessed manually required some manipulation for graphical checking. With FLOSYS, data are retrieved automatically and are readily available in a graphical form in TIDEDA format.

are listed in Table 2.1.

2.5 Data loss

Data loss in 1997 has occurred through instrument malfunction and changes in the methods of logging data. Each of the different contractors responsible for data collection at different stages used different methods to store and retrieve data. Changes in these methods occurred in early July, November and December and resulted in some loss of data. Overall, the percentage of data available, compared to the total possible number of observations for each parameter at each site, is indicated in Table 2.2, for all of 1997 and for the critical winter months, April to September.

2.4 Parameters measured

The contaminants and meteorological

Table 2.1: Parameters measured at ambient air quality sites in Canterbury

St Albans	Hornby	Opawa	Timaru
PM ₁₀	PM ₁₀	PM ₁₀	PM ₁₀
SO ₂	SO ₂	SO ₂	SO ₂
CO	CO		CO*
NO ₂			
NO			
Wind speed	Wind speed	Wind speed	Wind speed
Wind direction	Wind direction	Wind direction	Wind direction
Temperature @ 1m		Temperature @ 6m	Temperature @ 6m
Temperature @ 10m			
Relative humidity			
Light scattering (nephelometer)			

* From July 1997

parameters measured at each of the sites

Table 2.2: Percentage of data available in 1997 for annual and winter periods

	PM ₁₀		SO ₂		CO		NO ₂	
	Annual	Winter	Annual	Winter	Annual	Winter	Annual	Winter
St Albans	96%	92%	96%	95%	94%	89%	95%	95%
Timaru	86%	95%	81%#	76%#	85%*	96%*	NA	NA
Hornby	98%	98%	92%	92%	98%	99%	NA	NA
Opawa	86%	98%	94%	91%	NA	NA	NA	NA

From April 1997 * From July 1997

3 Results

3.1 Annual variation of contaminants

Over a year most contaminants at Canterbury sites show a seasonal variation with maximum concentrations measured in the winter and minimum concentrations in the summer. The annual variation for 1997 is illustrated in Figures 3.1 to 3.4 for PM₁₀, SO₂, CO and NO₂. During winter

meteorological conditions are such that dispersion of contaminants is frequently low compared to other seasons. Emissions from the domestic home heating sector also increase during this period. The resulting effect of the additional emissions and poor dispersion is an increase in contaminant concentrations during the winter.

The exception to this pattern is SO₂ concentrations in Hornby (Figure 3.2). At

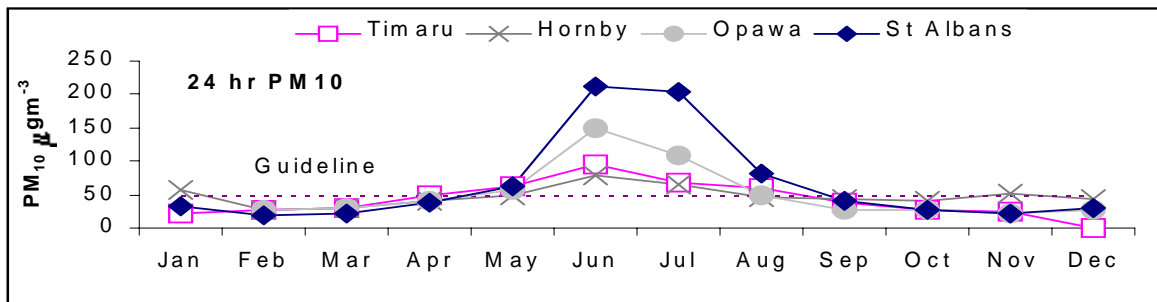


Figure 3.1: Maximum 24 hour average PM₁₀ concentration each month in 1997 at Canterbury sites

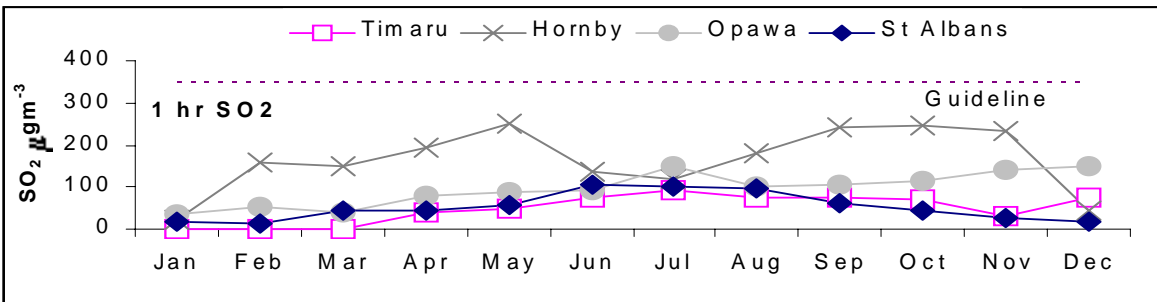


Figure 3.2: Maximum 1 hour average SO₂ concentration each month in 1997 at Canterbury sites

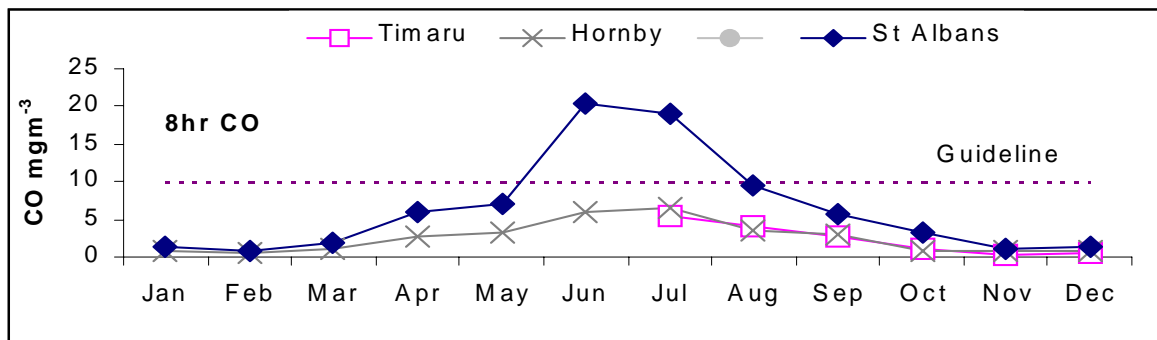


Figure 3.3: Maximum 8 hour average CO concentration each month in 1997 at Canterbury sites

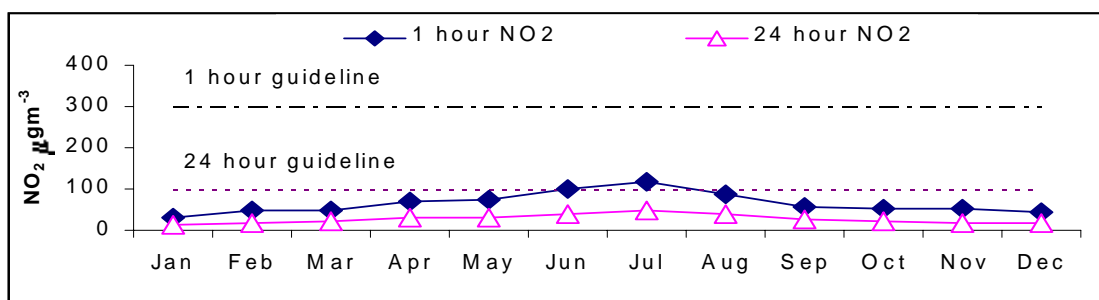


Figure 3.4: Maximum 1 hour average and 24 hour average NO₂ concentration each month in 1997 at St Albans site

this monitoring site the effects of industrial emissions of SO₂ are stronger than the domestic home heating effects recorded at the St Albans monitoring site. Opawa and Timaru show some industrial influences also. Concentrations of SO₂ in these areas are explained in later sections.

Results for contaminants other than SO₂ are reported for the months May to August, being the period of increased concentrations in 1997.

3.2 Winter weather in Christchurch

The frequency and extent of high pollution episodes during the winter are largely dependent on weather patterns during these months. Elevated pollution concentrations are generally associated with still and frosty nights as the temperature inversion, which occurs in these conditions, restricts the dispersion of contaminants.

PM₁₀ concentrations in winter 1996 and 1997 are shown in Figure 3.5 and

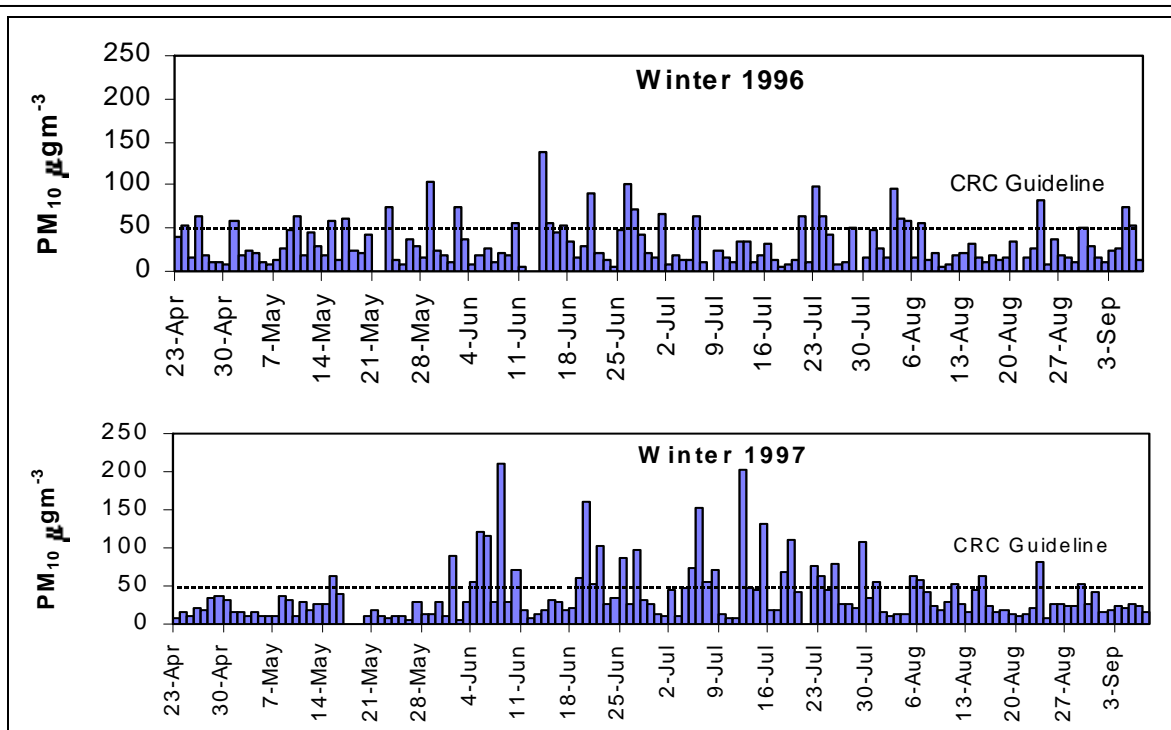


Figure 3.5: 24 hour average PM₁₀ concentrations measured at the St Albans monitoring site, winter 1996 and 1997 (includes one estimated exceedence in July 1997)

variations may be explained by comparing weather patterns during this time.

Winter started late in Christchurch in 1997 with a mild May and only one exceedence of the guideline of $50\mu\text{g}\text{m}^{-3}$ before June. In 1996 the first frost was in late April and the nights were colder than average in May. Exceedences occurred 8 times before June.

June's weather was average in 1997 compared to a wetter than normal June in 1996. There were 12 exceedences in June 1997 compared to 8 in 1996.

July was drier and sunnier than normal in 1997, with more frosts, compared to a very wet and cloudy July in 1996. In 1997 there were 14 exceedences compared to only 5 in 1996.

August is typically changeable. In 1997 there was more sunshine and rain than normal and in 1996 temperatures were below normal. The number of exceedences in August was similar with 6 in 1997 and 5 in 1996. Exceedences also

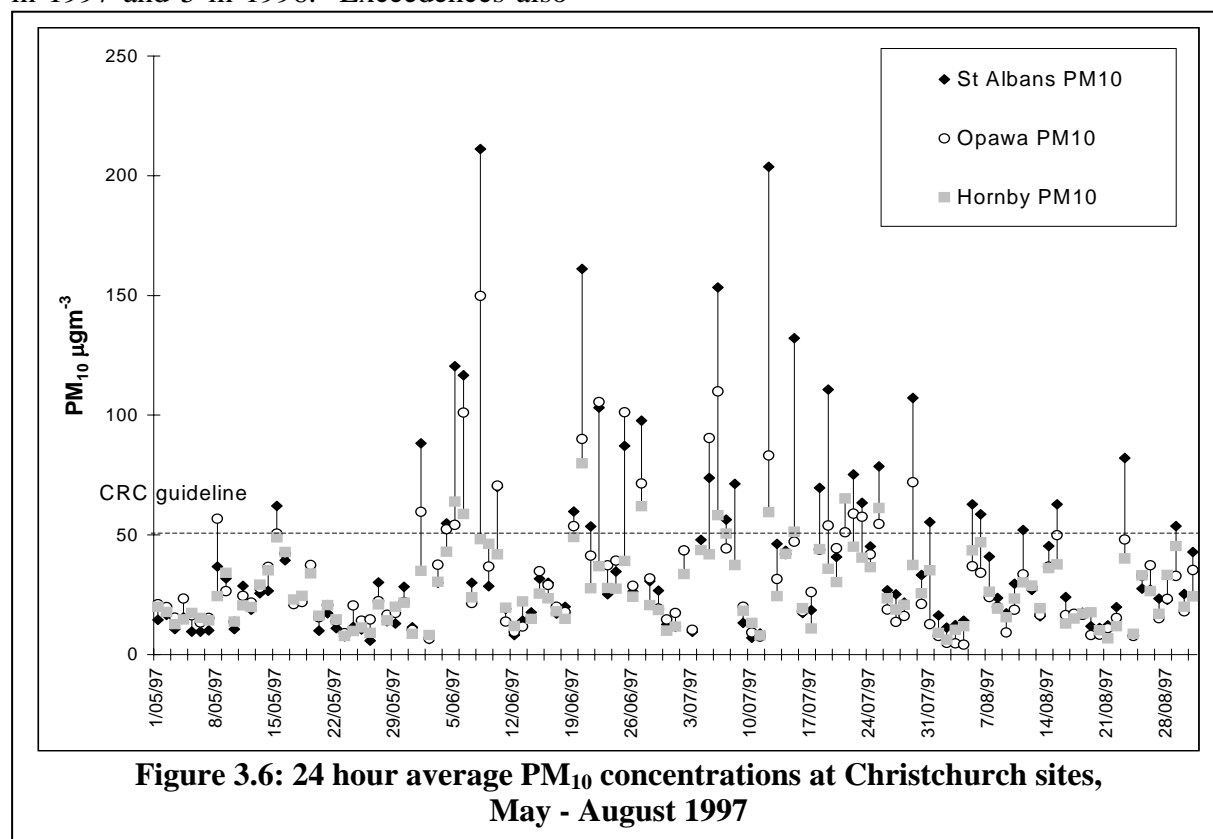
occurred in September in 1996, but not in 1997.

(Weather information from *Meteorological Society of New Zealand Newsletter Nos. 65-71*)

3.3 Suspended particulate in Christchurch

The results of monitoring at the St Albans, Hornby and Opawa sites are shown in Figure 3.6 compared with the Canterbury Regional Council guideline of $50\mu\text{g}\text{m}^{-3}$ for 24 hour average PM_{10} concentrations. The number of exceedences of the CRC guideline at each site is summarised in Table 3.1.

The high pollution nights (i.e., PM_{10} concentrations in excess of $50\mu\text{g}\text{m}^{-3}$ averaged over 24 hours) were spread over the winter months from May to August, with the maximums at each site occurring in June and July. On most high pollution nights the levels recorded at the St Albans monitoring site were higher than those recorded at other sites. Variations in



emissions and proximity to sources could account for some variation between these sites. The non-residential open space areas in the Hornby, and to a lesser extent, Opawa areas, compared to St Albans, are also likely to contribute to the variation in results between sites.

The yearly maximum 24 hour average PM₁₀ concentration measured at St Albans and the number of days the guidelines were exceeded each year is shown in Figure 3.7. The number of exceedences and annual maximum in 1997 are ranked 3rd highest since monitoring began at this site in 1988. Overall, no particular trend is evident in pollution concentrations over the period of monitoring.

3.4 Carbon monoxide in Christchurch

Carbon monoxide concentrations at the St Albans and Hornby monitoring sites are shown in Figures 3.8 and 3.9 compared with the 8 hour average guideline of 10 mgm⁻³ and the 1 hour average guideline of 30 mgm⁻³. In the 1997 winter carbon monoxide concentrations exceeded the 8 hour guideline on 11 days at St Albans. There were no exceedences of the 1 hour guideline. The number of exceedences of CO guidelines at the St Albans monitoring site during 1997, compared to exceedences for the years 1988 - 1996 are shown in Figure 3.10.

Table 3.1: Summary of guideline exceedences for PM₁₀ in Christchurch

	Days exceeded PM ₁₀ guideline Period monitored 1/4/97 - 30/9/97	Maximum 24 hour average PM ₁₀ concentration (µgm ⁻³)
CRC Guideline concentration	50 µgm ⁻³	
St Albans	33	211
Hornby	10	80
Opawa	22	150

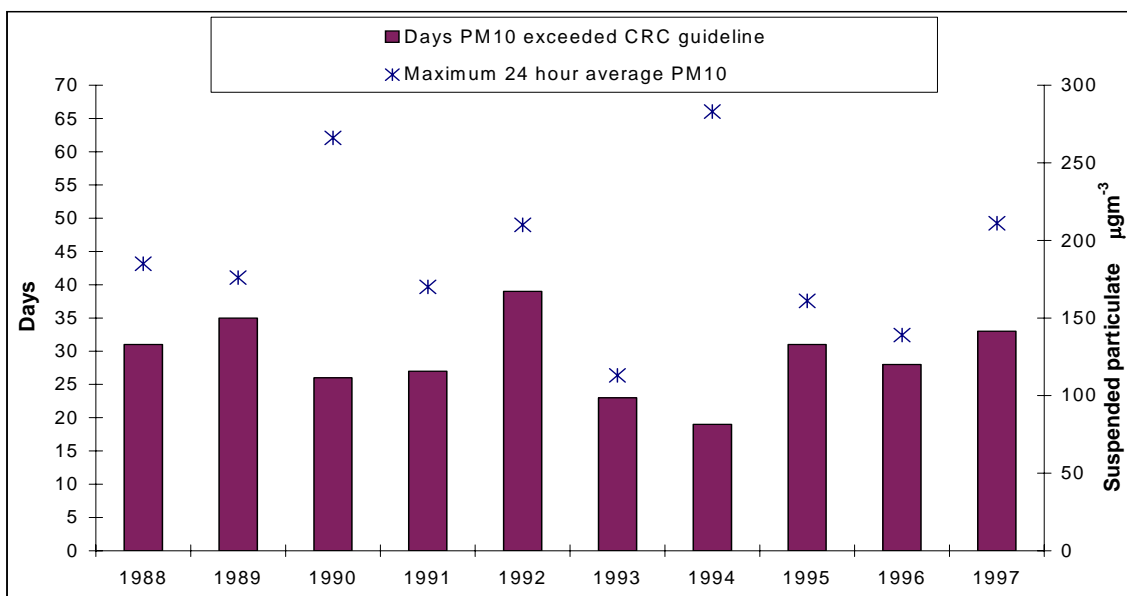


Figure 3.7: PM₁₀ monitoring results for St Albans, 1988-1997

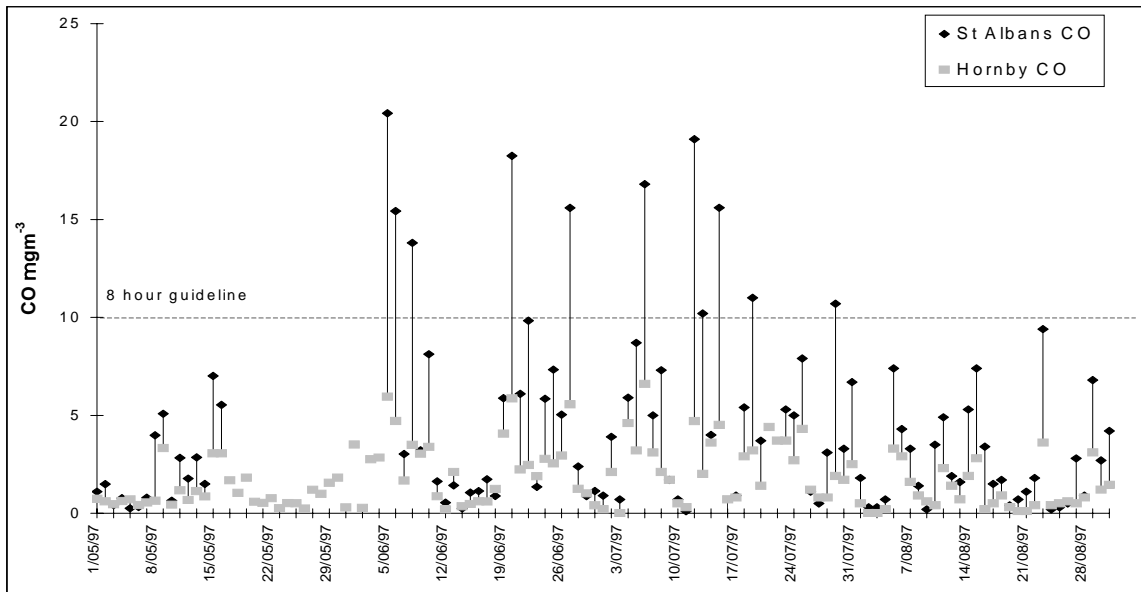


Figure 3.8: Daily maximum 8 hour average CO concentrations at Christchurch sites, May - August 1997

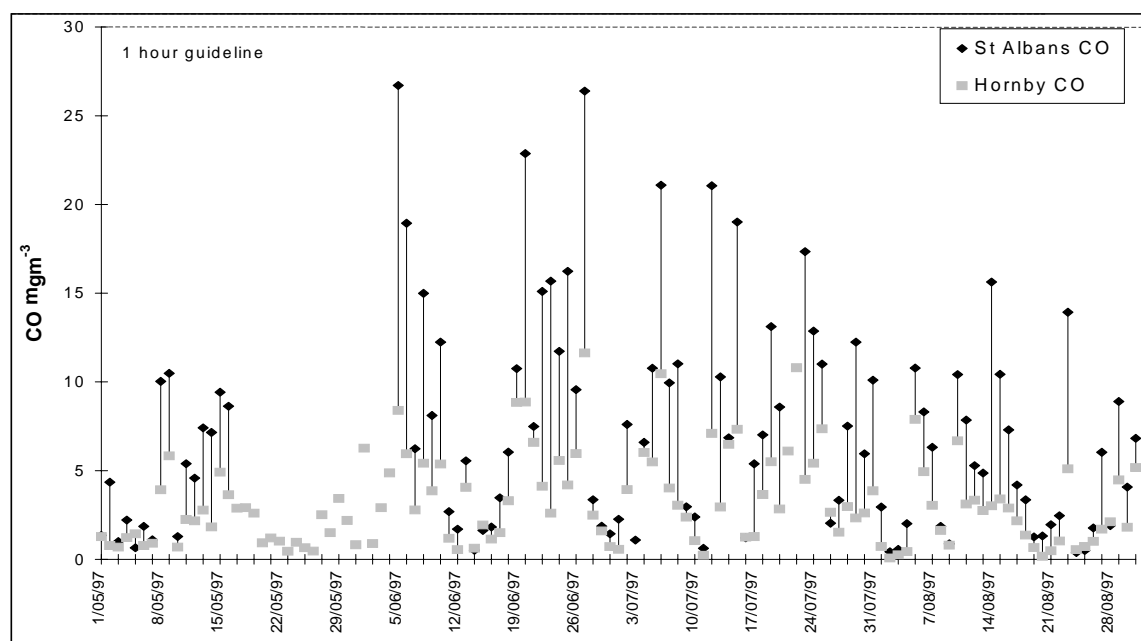


Figure 3.9: Daily maximum 1 hour average CO concentrations at Christchurch sites, May - August 1997

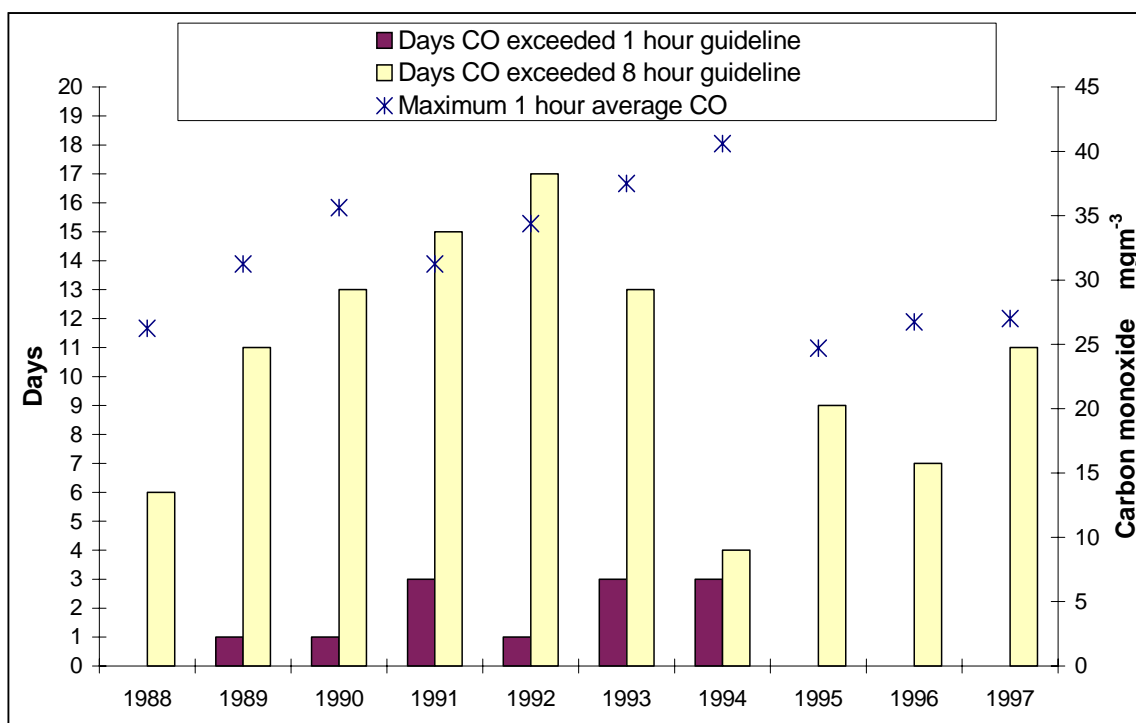


Figure 3.10: CO monitoring results for St Albans, 1988-1997

3.5 Sulphur dioxide in Christchurch

SO₂ concentrations in Christchurch compared to the 10 minute average, 1 hour average and 24 hour average guidelines are listed in Table 3.2. This shows that the maximum 10 minute concentration at the Opawa monitoring site is more than 3 times the maximum at St Albans, though the maximum 24 hour average is similar at both sites. This indicates that high concentrations measured at the Opawa site only occur for short periods of time.

At the Hornby monitoring site the maximum 10 minute average concentration is similar to that at Opawa, but the maximum 24 hour average is more than double that measured at the Opawa and St Albans sites. 24 hour averaged SO₂ concentrations, as illustrated in Figure 3.11, indicate an increase during 1997 at Hornby. The maximum 24 hour average recorded to the end of 1996 was 56 µgm⁻³, measured in November 1995. As noted in Table 3.2 the maximum to date is 100 µgm⁻³.

Table 3.2: Summary of maximum concentrations for SO₂

	Maximum concentration for:			Period monitored
	10 min average	1 hour average	24 hour average	
St Albans	122	106	48	1/9/96 - 30/9/97
Hornby	349	252	100	1/9/96 - 30/9/97
Opawa	377	149	42	1/9/96 - 30/9/97
MFE guideline concentration	500 µgm ⁻³	350 µgm ⁻³	125 µgm ⁻³	24 hour average

The 24 hour average concentrations measured at the Christchurch sites since 1995 are shown in Figure 3.11. Concentrations of SO₂ measured at the St Albans monitoring site show seasonal variations with higher concentrations occurring during the winter period. As shown in Figure 3.11 maximum concentrations at the Hornby monitoring site can occur throughout the year, with minimum concentrations during the period from early December to mid February. This is likely to be due to the industrial nature of the area and the impact of SO₂ emissions from nearby industries. This suggestion is supported by the period of decreased concentrations, which coincides with the closure of some local industries over the Christmas period.

Although not as marked as the seasonal variations observed in SO₂ concentrations measured at St Albans, concentrations of SO₂ measured at Opawa show some variation, with higher concentrations

measured during the winter months. These seasonal variations have been observed at this site since September 1996. Monitoring conducted at the Opawa site prior to September 1996 has not shown any seasonal variation. The reason for this is unclear.

The maximum concentrations of SO₂ measured at the St Albans monitoring site since 1988 are shown in Figure 3.12. No exceedences of the guidelines have occurred during this time.

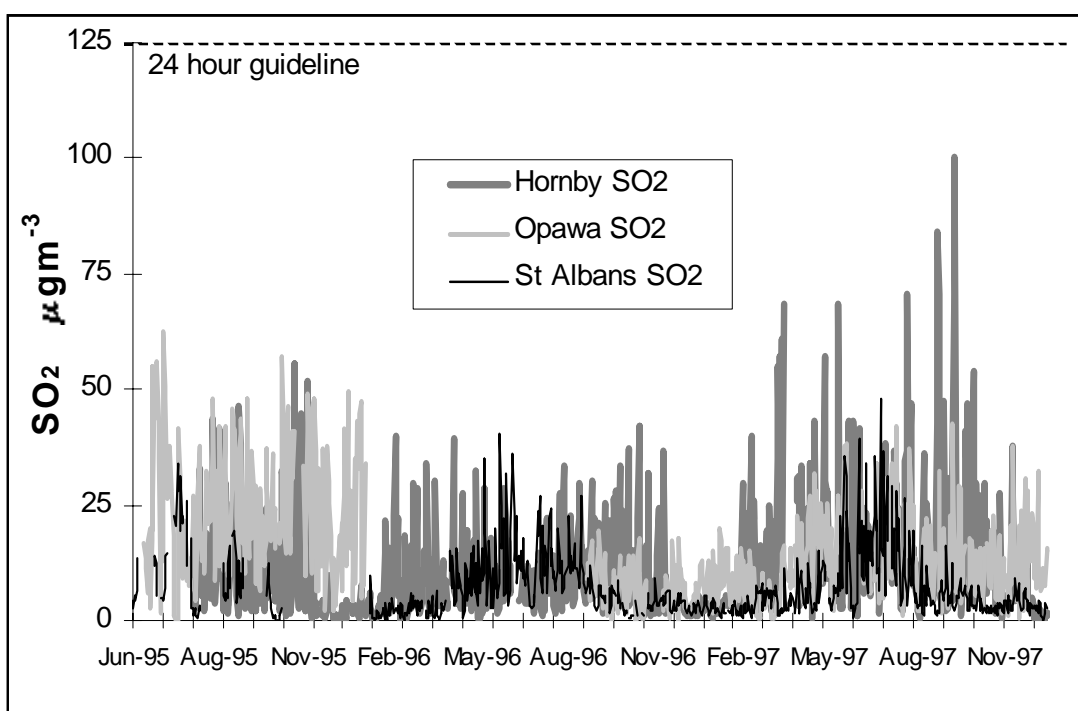
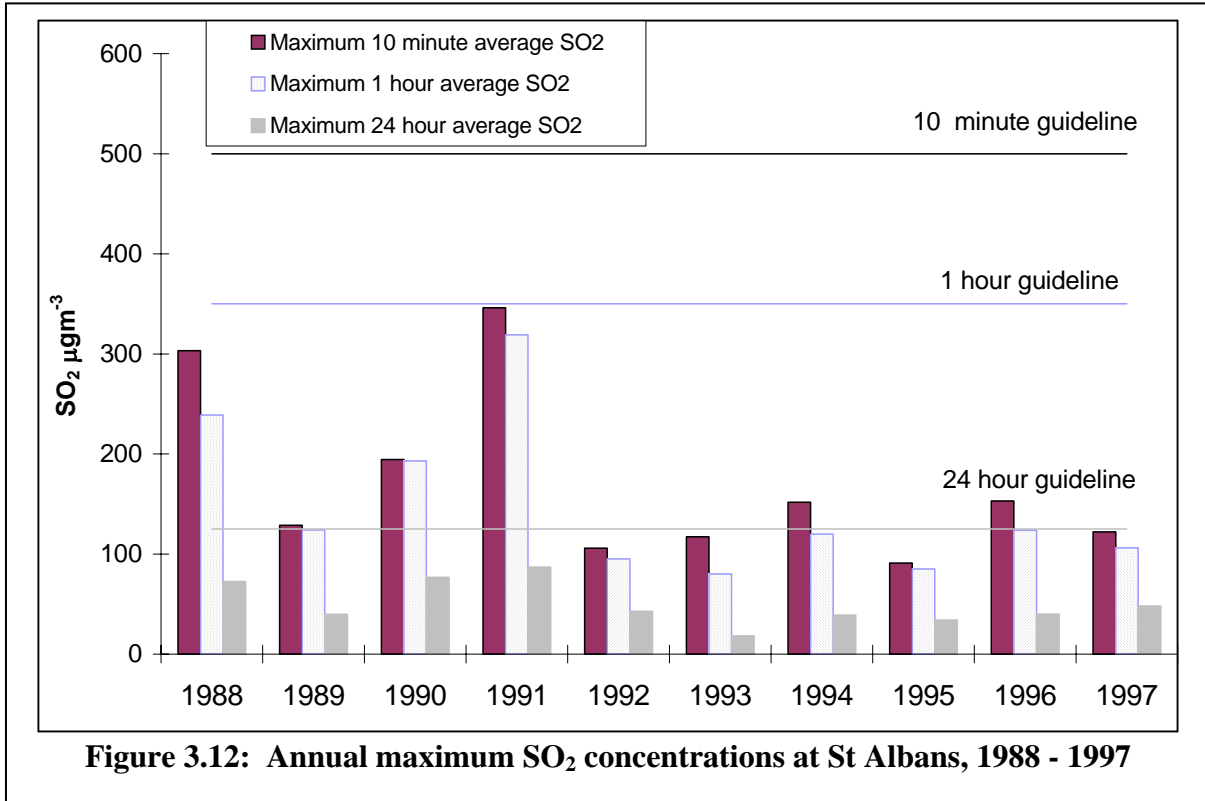


Figure 3.11: 24 hour average SO₂ concentrations at Christchurch sites, June 1995 – December 1997

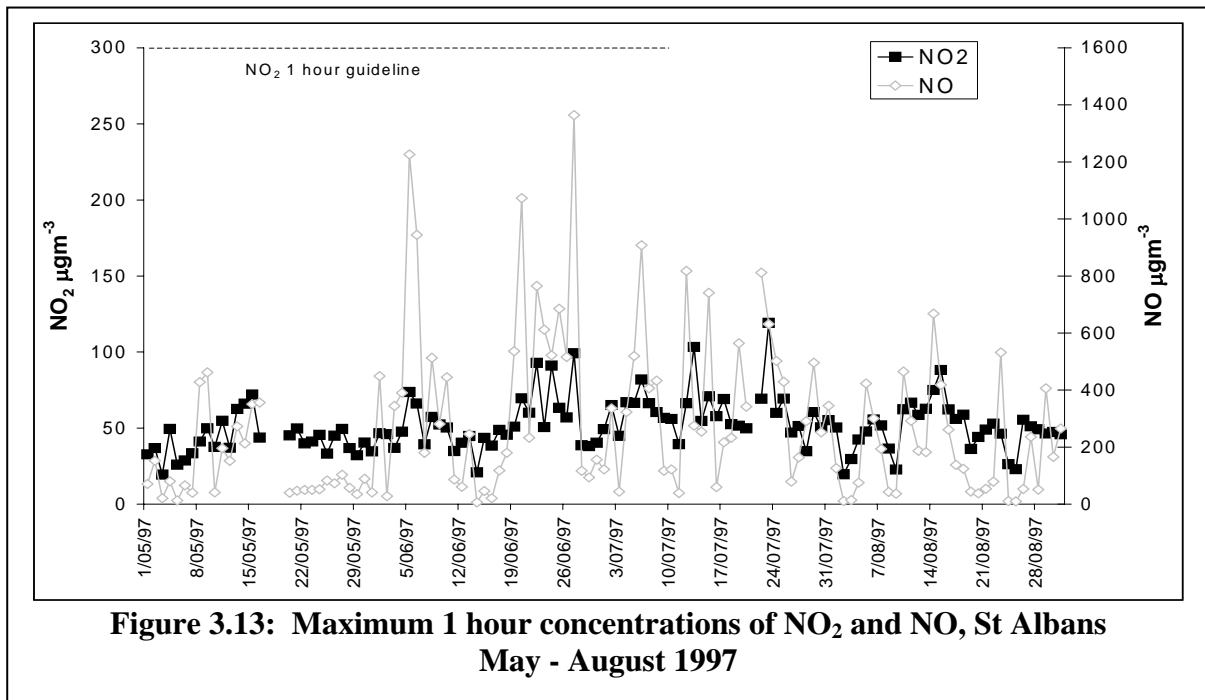


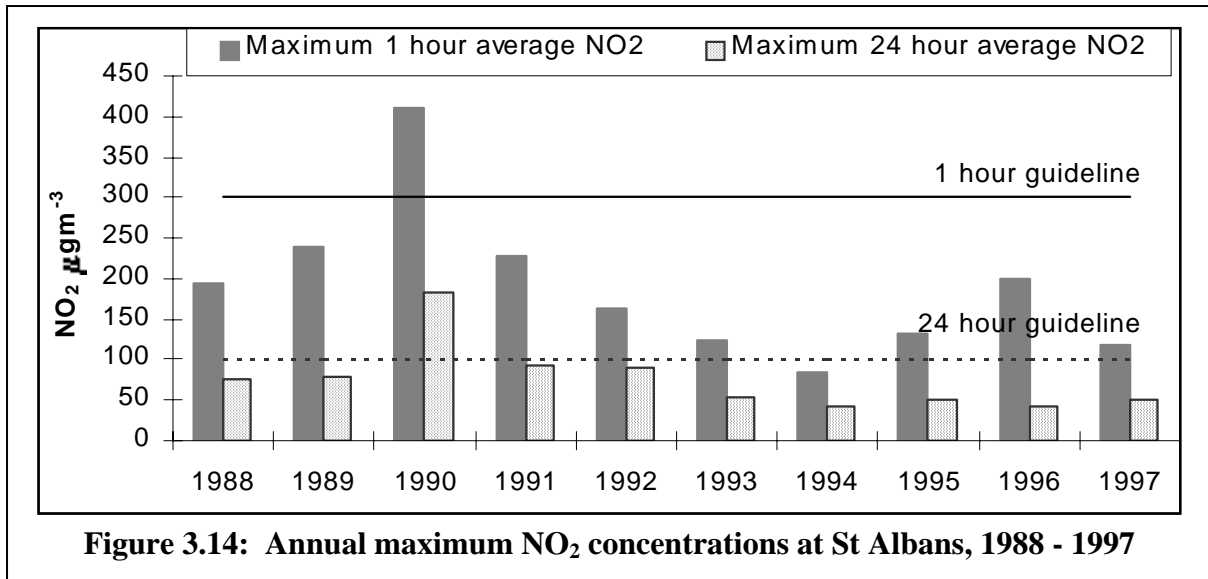
3.6 Nitrogen dioxide in Christchurch

While there is no guideline concentration for NO, it is monitored because of its potential for conversion to NO₂ in the lower atmosphere. The 1 hour average concentrations for the 1997 winter are

shown in Figure 3.13.

The maximum concentrations of NO₂ measured at the St Albans monitoring site since 1988 are shown in Figure 3.14. On only one occasion have the guidelines been exceeded.



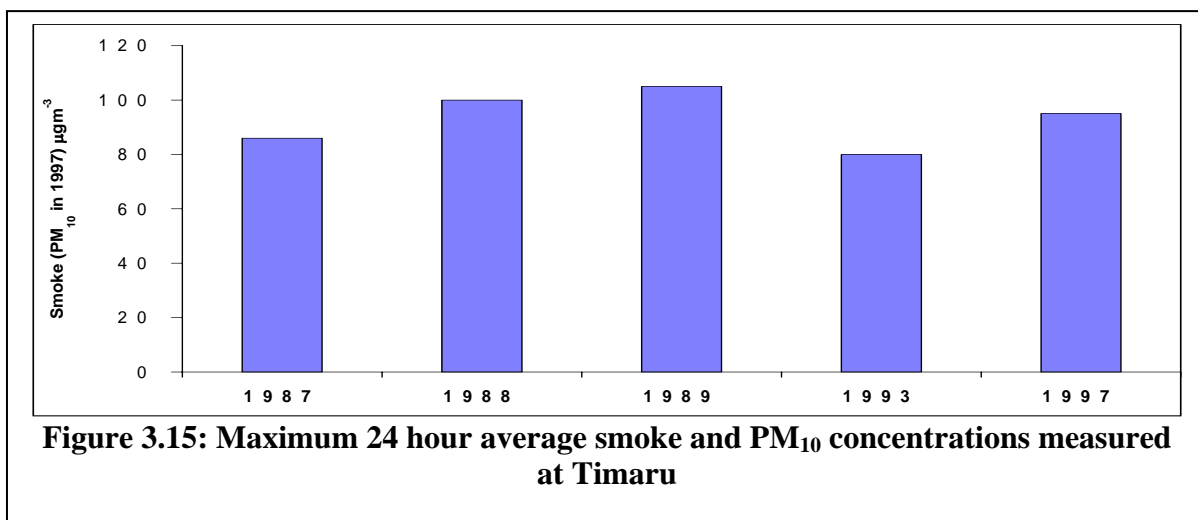


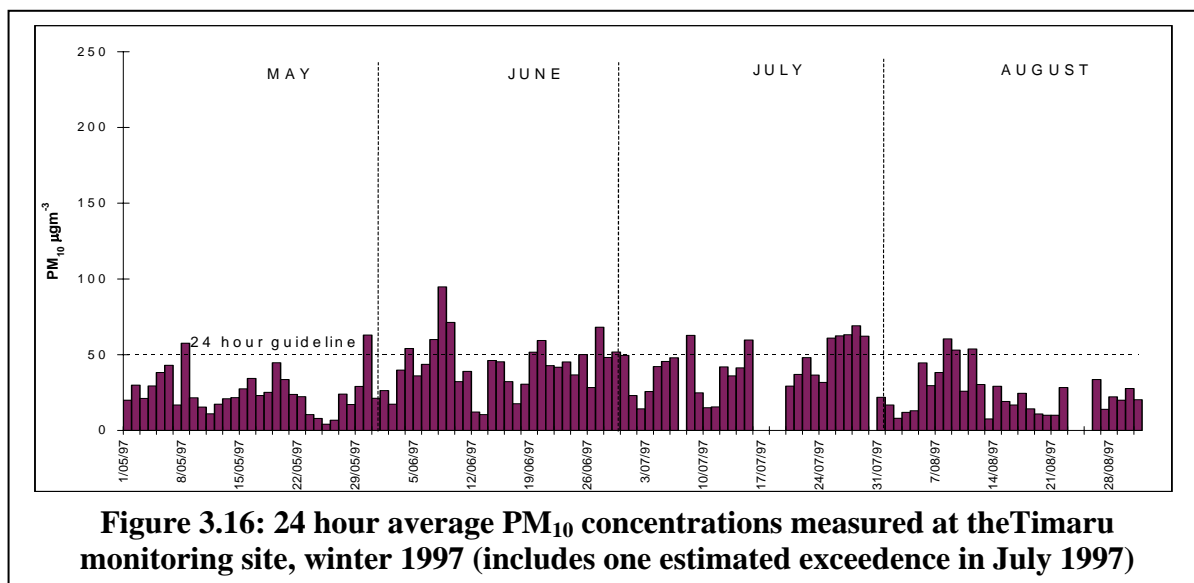
(Paterson, 1981)

3.7 Timaru

In the past smoke monitoring has been carried out in various sites in Timaru. Suspended particulate is the inhalable portion of smoke, those particles less than 10 microns in diameter, and is therefore the portion of smoke that is associated with health effects. Suspended particulate (PM₁₀) is currently being measured in Timaru. The maximum 24 hour average smoke concentrations measured in the years 1987 to 1989 and 1993 are shown in Figure 3.15 along with the maximum 24 hour PM₁₀ concentration recorded in 1997. Previous analysis in Christchurch has shown that smoke measurements compare reasonably well to PM₁₀ concentrations.

In general, Timaru experiences similar weather to Christchurch with southerly wind changes occurring a few hours earlier. On occasions Timaru may have calm conditions while a fresh sea breeze is blowing in Christchurch, resulting in high air pollution in Timaru and low in Christchurch. Although Timaru had 22 high pollution days in winter 1997 the maximum 24 hour PM₁₀ concentration measured was 95 µgm⁻³ compared to the maximum recorded at St Albans of 211 µgm⁻³. The variation of PM₁₀ concentrations in Timaru is illustrated in Figure 3.16. For comparison to Christchurch PM₁₀ concentrations at St Albans see Figure 3.5.





Carbon monoxide monitoring commenced in July 1997 and results are shown in Figure 3.17. There were no exceedences of the guidelines (10 mgm⁻³ for the 8 hour average and 30 mgm⁻³ for the 1 hour average) during this monitoring period.

Sulphur dioxide concentrations measured in Timaru during 1997 are well below guidelines (Table 3.3).

Figure 3.18, which illustrates the wind direction associated with SO₂

concentrations, indicates that the highest concentrations occur when the wind is from the east. Figure 3.19, which illustrates the time of day SO₂ concentrations occur, indicates that the highest concentrations occur during daylight hours. Data from Figures 3.18 and 3.19 are combined in Figure 3.20, showing the highest SO₂ concentrations for both wind direction and time of day. This indicates the SO₂ concentrations from the east occur during the day and the evening concentrations are from a westerly

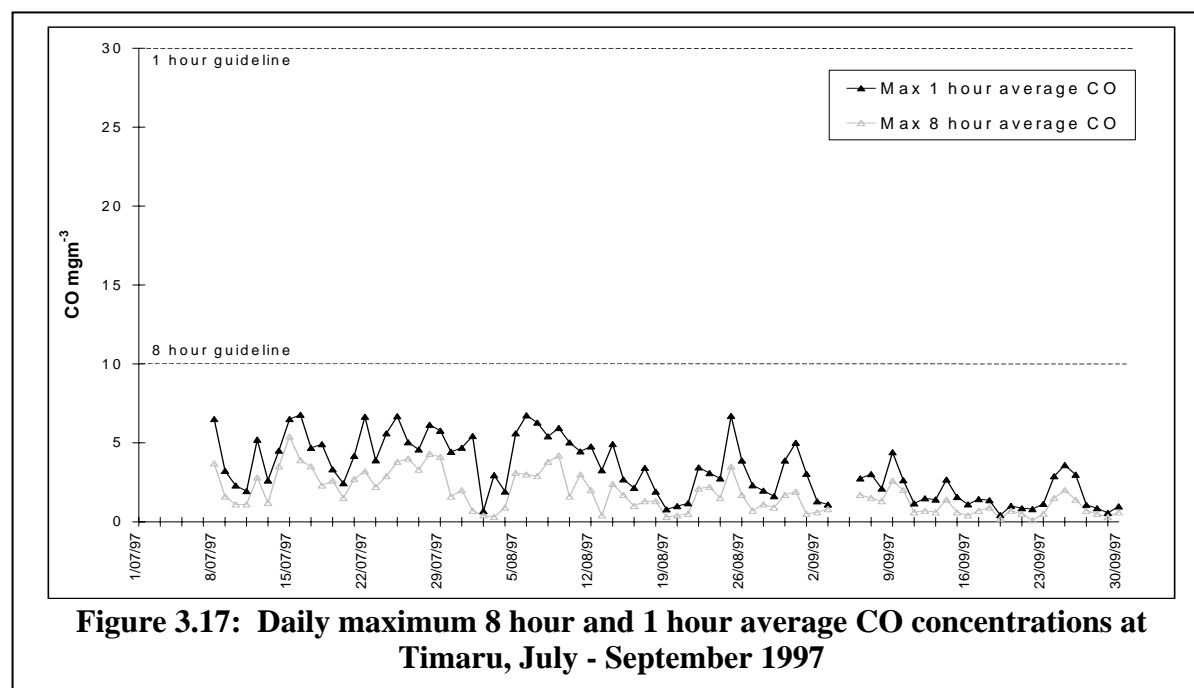


Table 3.3: Summary of maximum concentrations for SO₂

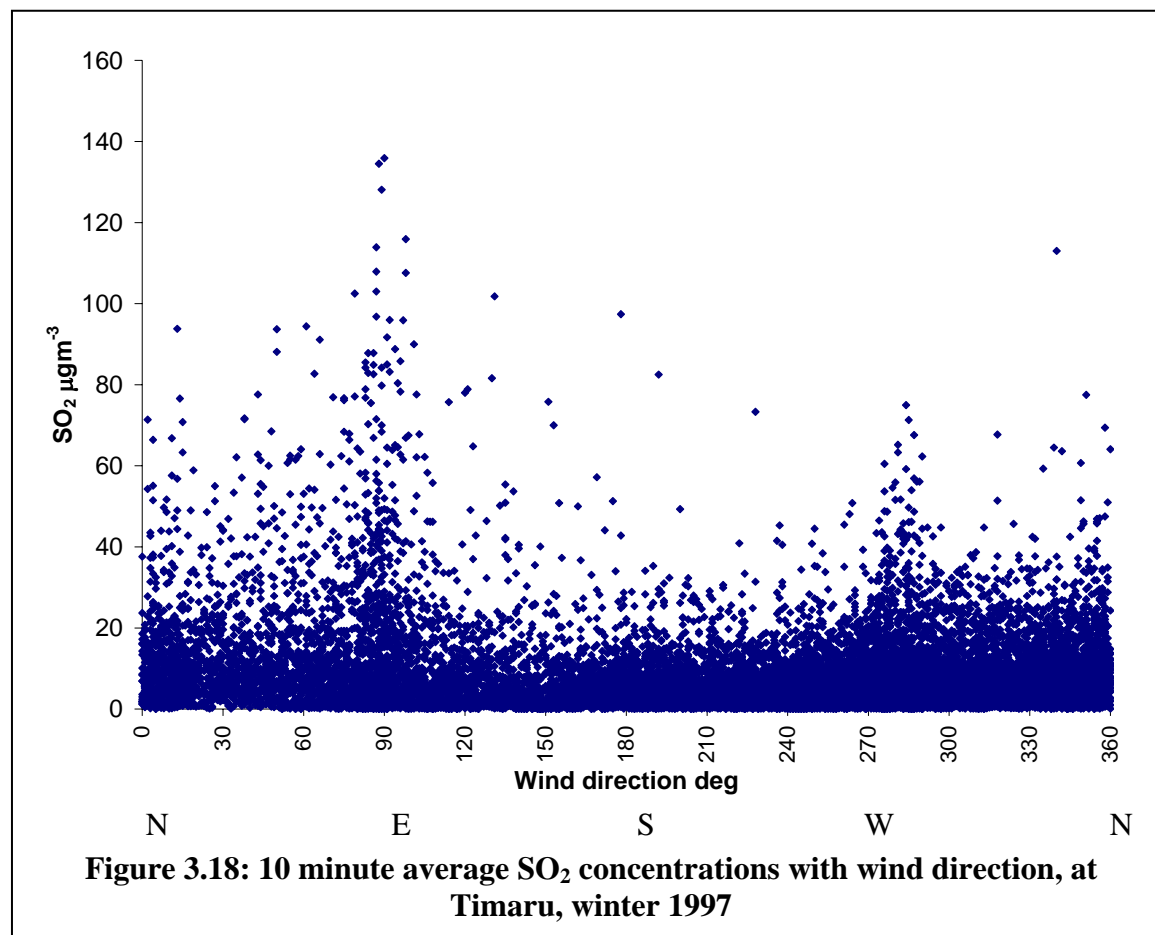
	Maximum concentration for:			Period monitored
	10 min average	1 hour average	24 hour average	
Timaru	136	92	27	14/5/97 - 30/9/97
MFE guideline concentration	500 µgm ⁻³	350 µgm ⁻³	125 µgm ⁻³	24 hour average

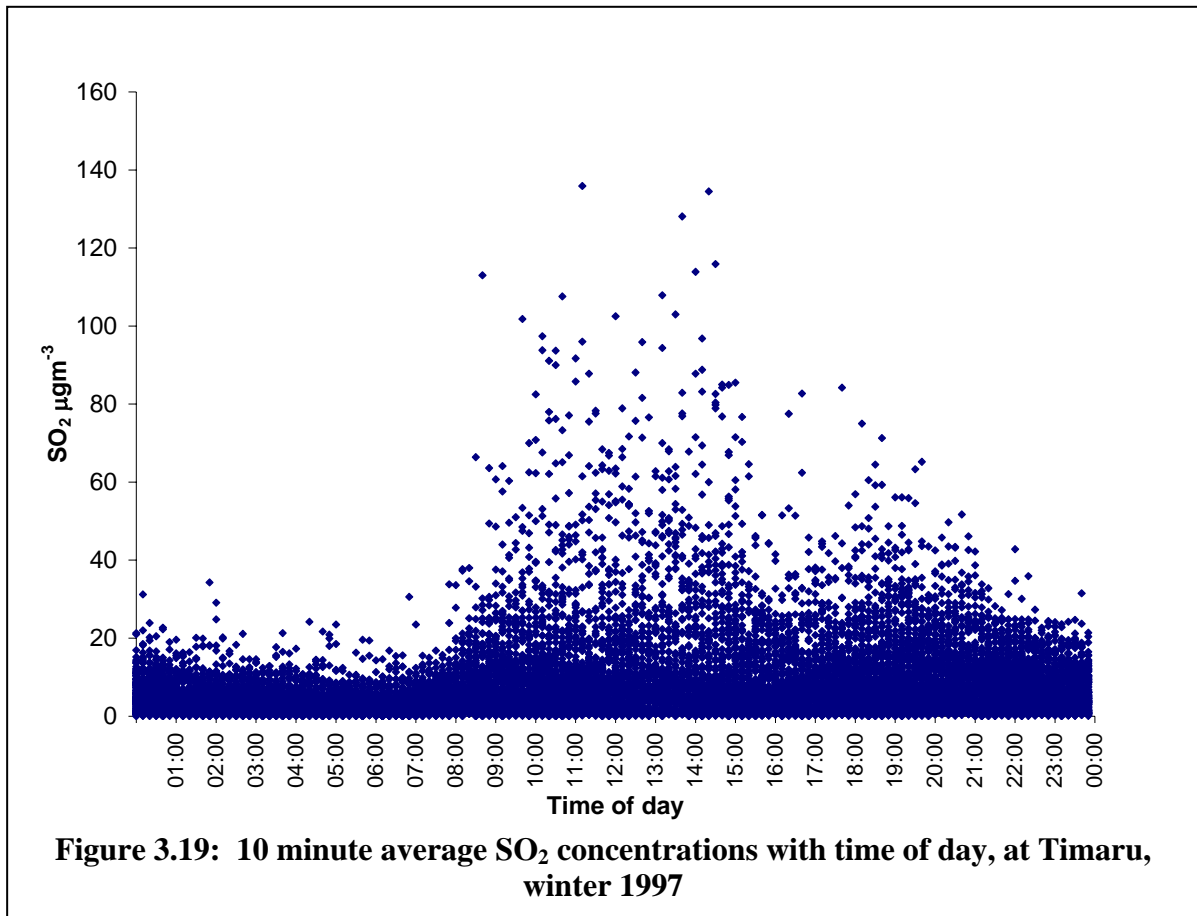
direction.

Figures 3.21 and 3.22 show similar graphs for PM₁₀ and CO. These indicate that high concentrations are associated with wind from the westerly direction and occur in the morning and evening periods. These are likely to be a result of emissions from home heating, however further investigations into emission sources for Timaru are required.

By comparison, elevated SO₂ concentrations occur during the day and are more likely to be associated with

sources other than domestic sources. These elevated concentrations during the day have continued through the summer. This eliminates the nearby boiler at the Aoraki Polytechnic as a potential source as it operates between April and October. No other potential sources have been identified. It is likely that these concentrations arise as a result of emissions from industrial activities (including industrial and trade processes).





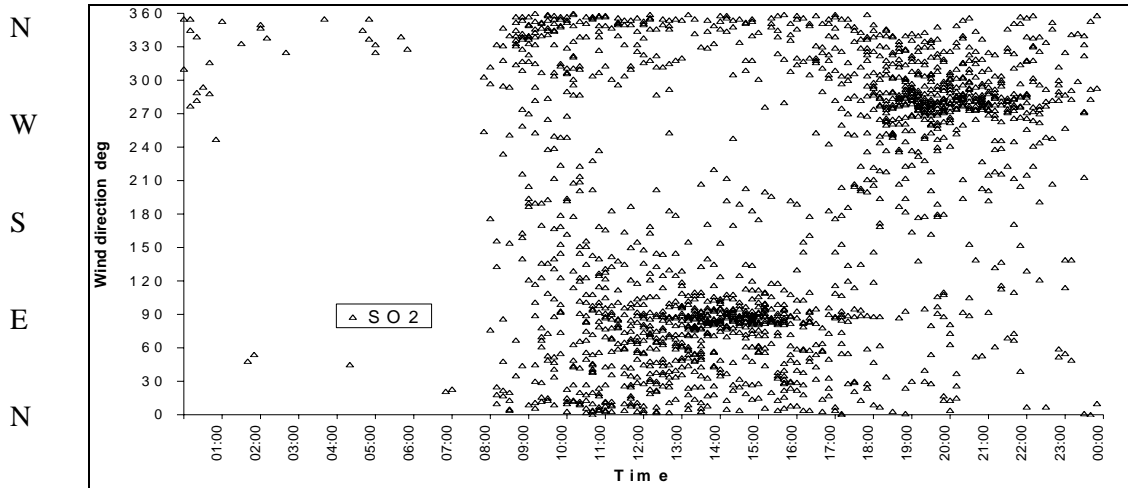


Figure 3.20: Top 10% ($>18.5 \mu\text{g m}^{-3}$) 10 minute SO₂ concentrations recorded at Timaru for time of day and wind direction

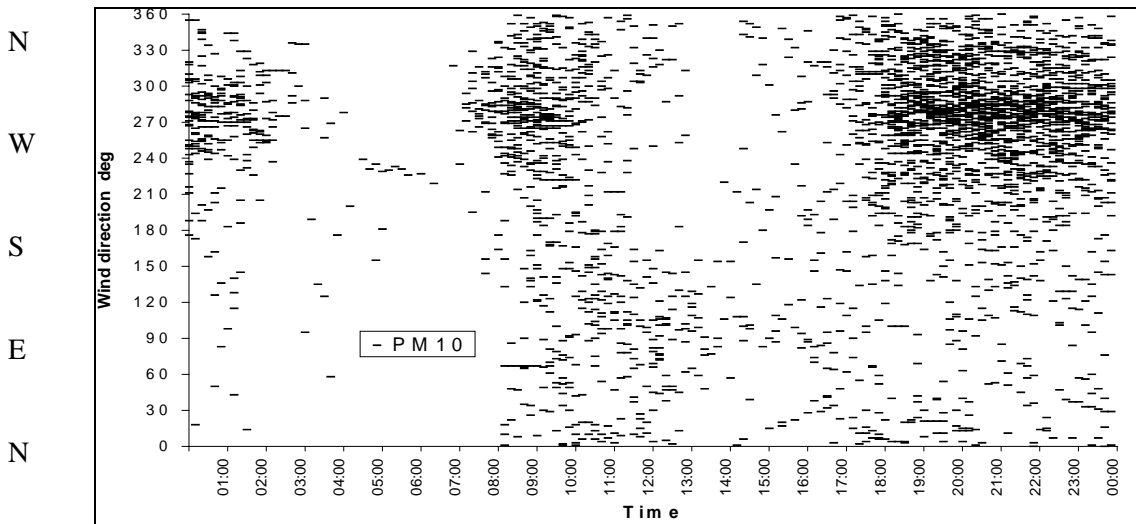


Figure 3.21: Top 10% ($>54.8 \mu\text{g m}^{-3}$) 10 minute PM₁₀ concentrations recorded at Timaru for time of day and wind direction

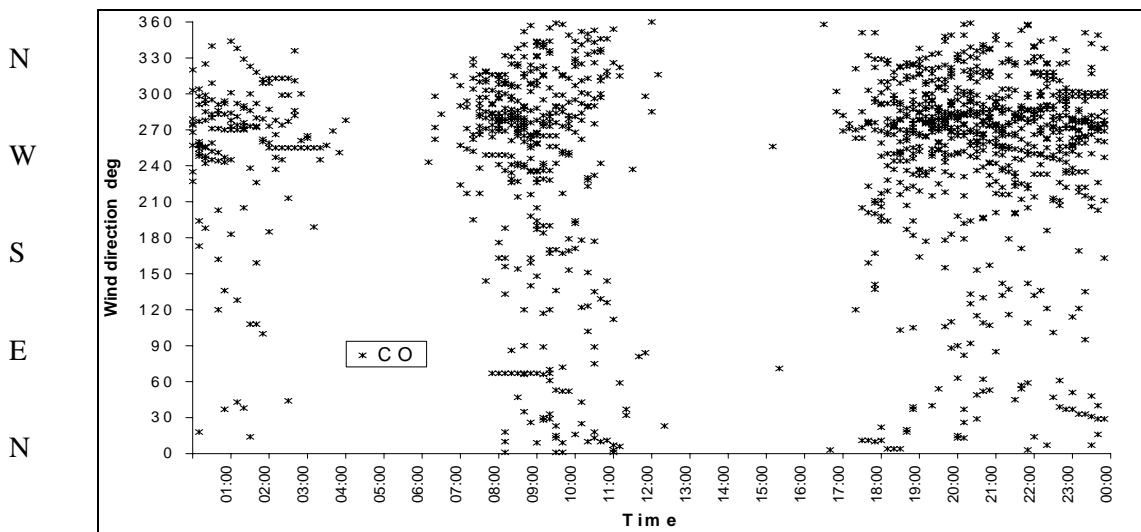


Figure 3.22: Top 10% ($>2.6 \text{ mg m}^{-3}$) 10 minute CO concentrations recorded at Timaru for time of day and wind direction from July 1997

4 Conclusions

- (i) The CRC guideline for suspended particulate was exceeded on 33 days at the St Albans monitoring site and from 10 to 22 days at the other Christchurch monitoring sites. These exceedences occurred during the months from May to August.
- (ii) PM₁₀ concentrations measured at Timaru were considerably less than those measured at the St Albans monitoring site, with the CRC guideline for suspended particulate exceeded on 22 days. The maximum 24 hour average concentration measured at Timaru was 95 µgm⁻³ compared to the maximum recorded at St Albans of 211 µgm⁻³. The exceedences occurred during the months May to August showing similar seasonal patterns to Christchurch sites.
- (iii) The MfE guideline for 8 hour average carbon monoxide concentrations was exceeded on 11 days at the St Albans monitoring site. No exceedences for carbon monoxide occurred at other sites
- (iv) Concentrations of SO₂ and NO₂ measured at all sites were below guideline concentrations.
- (v) Concentrations of SO₂ show the greatest variation at the monitoring sites:
 - a) At Opawa SO₂ concentrations have shown seasonal variations not previously seen at this site.
 - b) At Hornby 24 hour average SO₂ concentrations have increased compared to 1996, with a maximum concentration at 80% of the guideline.
 - c) At Timaru SO₂ concentrations showed variations by time of day and wind direction. Maximum concentrations occur during the day from the direction of the city centre. High concentrations during the evening and morning were typically from a westerly direction. It is likely that the high daytime concentrations arise as a result of emissions from industrial² activities in the city centre, whereas evening and morning concentrations are more likely to come from domestic heating.

5 References

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² includes industrial and trade processes

