

# nitrogen oxides

## INTRODUCTION

There are a number of oxides of nitrogen, normally referred to as  $\text{NO}_x$ . The two oxides of primary concern in air pollution are nitric oxide (NO) and nitrogen dioxide ( $\text{NO}_2$ ). Nitric oxide is a colourless toxic gas which is readily oxidised in the air to form nitrogen dioxide, a stable gas which is more toxic than nitric oxide. The reddish-brown gas nitrogen dioxide is heavier than air and is water soluble, forming nitric acid.

Nitric oxide is formed in high temperature combustion of fossil fuels in the presence of atmospheric oxygen. In ambient air NO oxidises to form  $\text{NO}_2$  which plays a significant rôle in the photochemical production of secondary air pollutants such as ozone. Oxidation occurs more rapidly in bright sunlight.

## HEALTH EFFECTS

Nitrogen oxides can cause irritation to lung tissue and may increase susceptibility to viral infections, bronchitis and pneumonia.

Nitrogen dioxide can cause throat and eye irritation and nitric oxide may have a synergistic effect on blood oxygen with carbon monoxide inhibiting the efficiency of haemoglobin.

NO is not normally present in sufficient concentrations in ambient air to present any significant hazards but  $\text{NO}_2$  may trigger biological changes at relatively low concentrations and short exposures. Asthmatics may be particularly sensitive to  $\text{NO}_x$ .

## OTHER EFFECTS

There is no evidence suggesting that NO is directly damaging to plants although  $\text{NO}_2$  can cause injury to vegetation and depress growth.

Exposure to high levels of  $\text{NO}_2$  can cause fading of textiles and oxidation of metals.

Nitrogen oxides contribute about a third of the acidity in acid deposition and are one of two groups of compounds necessary for the production of photochemical smog which itself causes eye and nose irritation.



**Figure 3.1** Power generation is the major stationary source of nitrogen oxide emissions.



## SOURCES

The natural production of nitrogen oxides, by for example bacterial and volcanic activity, is far greater than man-made emissions which derive mainly from the combustion of fossil fuels in stationary sources (heating and power generation) and in motor vehicle engines.

Anthropogenic emissions are however concentrated in urban areas with motor vehicle exhaust emissions being the single largest source accounting for over 50% of the total in urban areas such as Southwark. The levels of  $\text{NO}_x$  increase with greater vehicle use.

## STANDARDS

The air quality standard for nitrogen dioxide is set by EU Directive 85/203/EEC which has been implemented in the UK by the Air Quality Standards Regulations 1989. Limit and Guide Values are specified and summarised in table 3.1.

$\text{NO}_2$  is also included in the Department of the Environment air quality bands with the levels shown in table 3.2.

The World Health Organisation guidelines are shown in table 3.3.

Vehicle emissions are indirectly controlled by numerous regulations covering design, construction, use, composition of fuels, road-worthiness and vehicle testing. Current provisions regarding fuel are made under the Clean Air Act 1993 but are not enforceable by local authorities.

**Table 3.1** Air Quality Standards for nitrogen dioxide

*EU Limit Value - reference period 1 year*

$200\mu\text{g}/\text{m}^3$  (98th percentile/hourly mean)  
[105 ppb]

*EU Guide Values - reference period 1 year*

$135\mu\text{g}/\text{m}^3$  (98th percentile/hourly mean)  
[71 ppb]

$50\mu\text{g}/\text{m}^3$  (50th percentile/hourly mean)  
[26 ppb]

**Table 3.2** DoE Air Quality categories for  $\text{NO}_2$

Very good	$\leq 49$ ppb
Good	50 - 99 ppb
Poor	100 - 299 ppb
Very poor	$\geq 300$ ppb

**Table 3.3** WHO nitrogen dioxide guidelines

Maximum 1 hour average	$400\mu\text{g}/\text{m}^3$ [210 ppb]
Maximum 24 hour average	$150\mu\text{g}/\text{m}^3$ [80 ppb]



# nitrogen oxides



## MONITORING SITES

Nitrogen dioxide has been monitored at the locations shown in figure 3.2.



Figure 3.2 Nitrogen dioxide monitoring sites

## COMMENTARY

Although the recorded levels of  $\text{NO}_2$  show a slight net increase over the monitoring period at some sites the annual levels are generally stable with no significant or dramatic episodes.

It should be noted that direct comparison of the levels against the standard is not possible since, for simplicity, the graphs show monthly averages (based on weekly means) and this would therefore conceal exceedences of the hourly means.

This is shown dramatically in figure 3.13 presenting both the monthly means and 98th percentile for the same data. At this site none of the monthly average levels exceed either the Limit or Guide Values (applicable since 1989) although the 98th percentile of monthly averages not only exceeded the Limit Value for 9 of the 26 months but also regularly exceeded the WHO guidelines. When considering the hourly means, for comparison against the standard, it is evident that these are likely to have exceeded the Air Quality standard on a number of occasions and, most probably, at a number of sites.

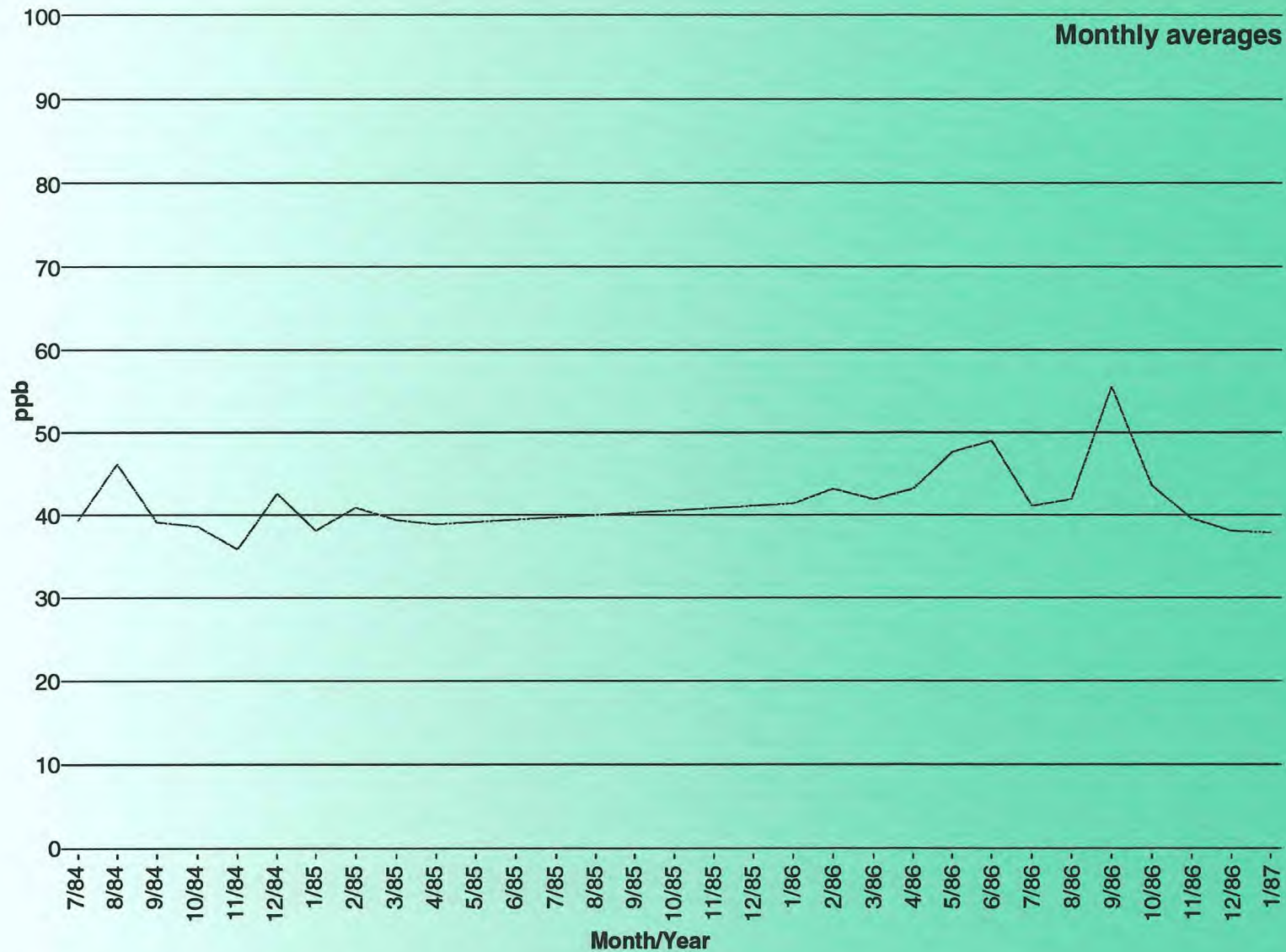
In addition regard should be had to the rôle of  $\text{NO}_2$  in the photochemical production of ozone. This process reduces the apparent levels of nitrogen dioxide particularly during sunny days. Nitrogen dioxide levels mirror ozone levels in a diurnal cycle.

Without direct kerbside monitoring, which was not practicable during most of the monitoring period, it is not possible to determine actual roadside levels and hence the contribution made by vehicles and the associated trends due to increases in road usage.

## LEVELS AND TRENDS

The following graphs show the mean concentrations of nitrogen dioxide at the sites indicated in figure 3.2.

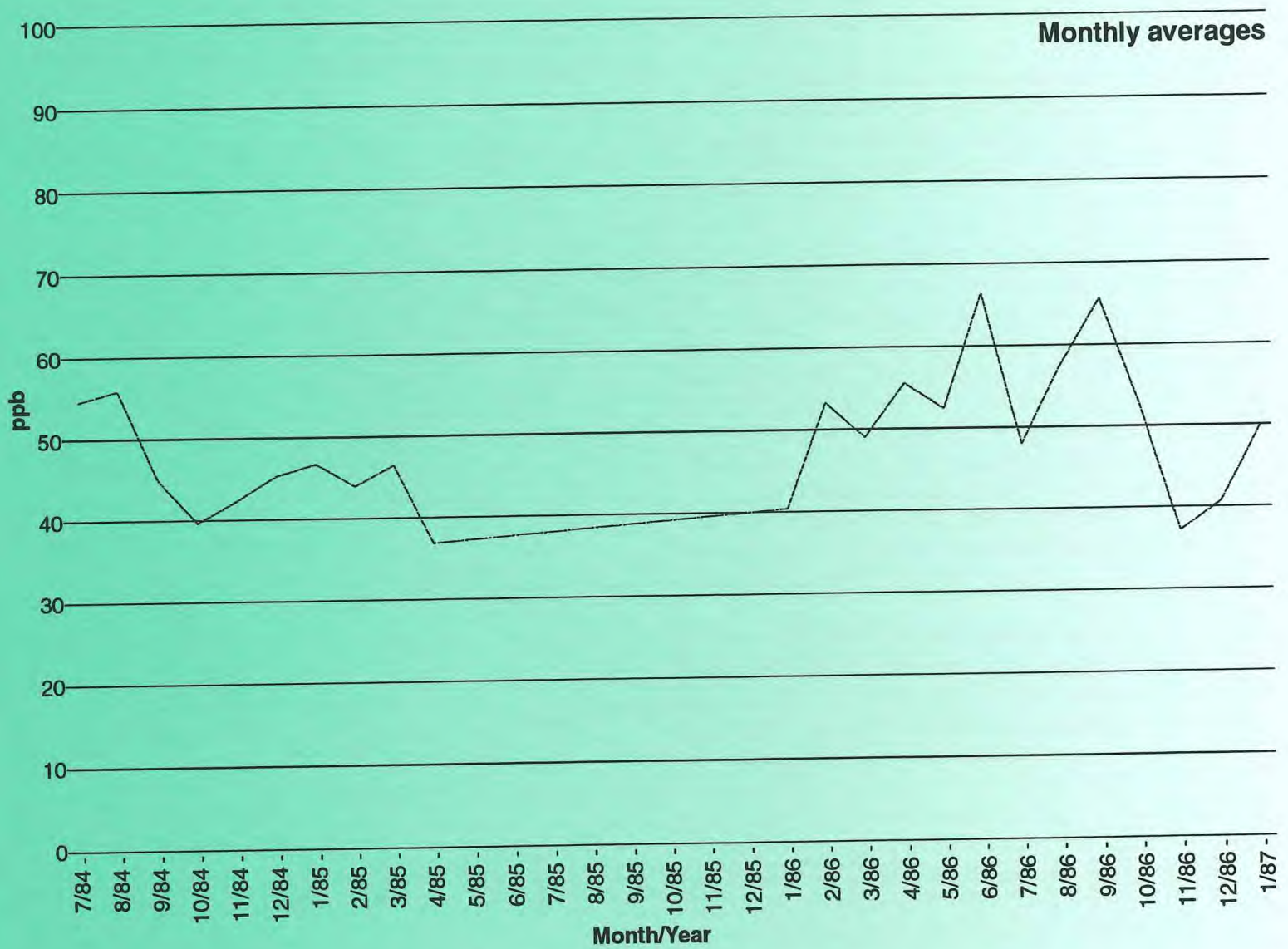
*Note: all graphs in this chapter except figure 3.13 have the same scale vertical axis and are therefore directly comparable.*



**Figure 3.3** Nitrogen dioxide levels at Evelina Road  
July 1984 to January 1987



# nitrogen oxides



**Figure 3.4** Nitrogen dioxide levels at Old Kent Road  
July 1984 to January 1987

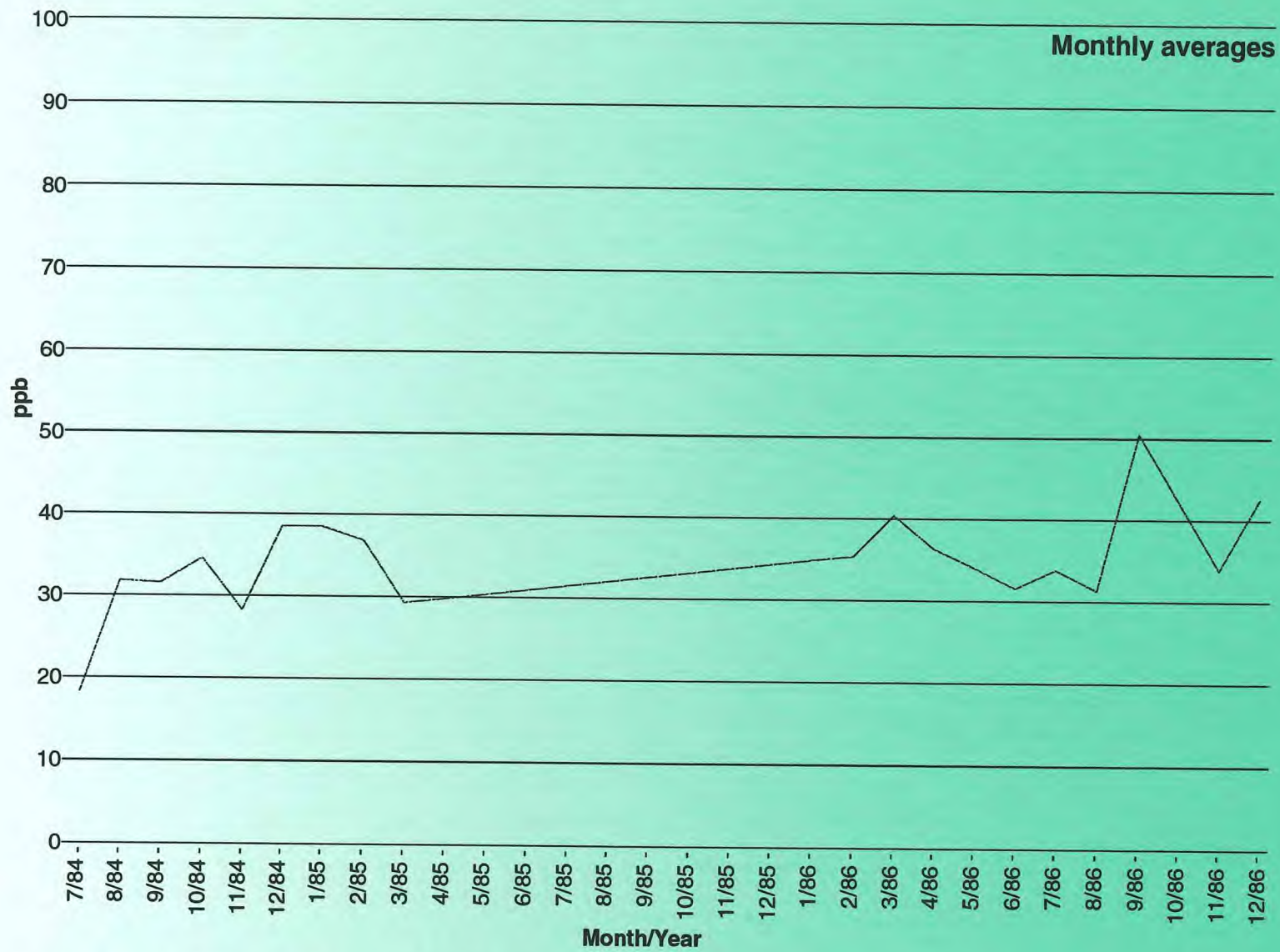
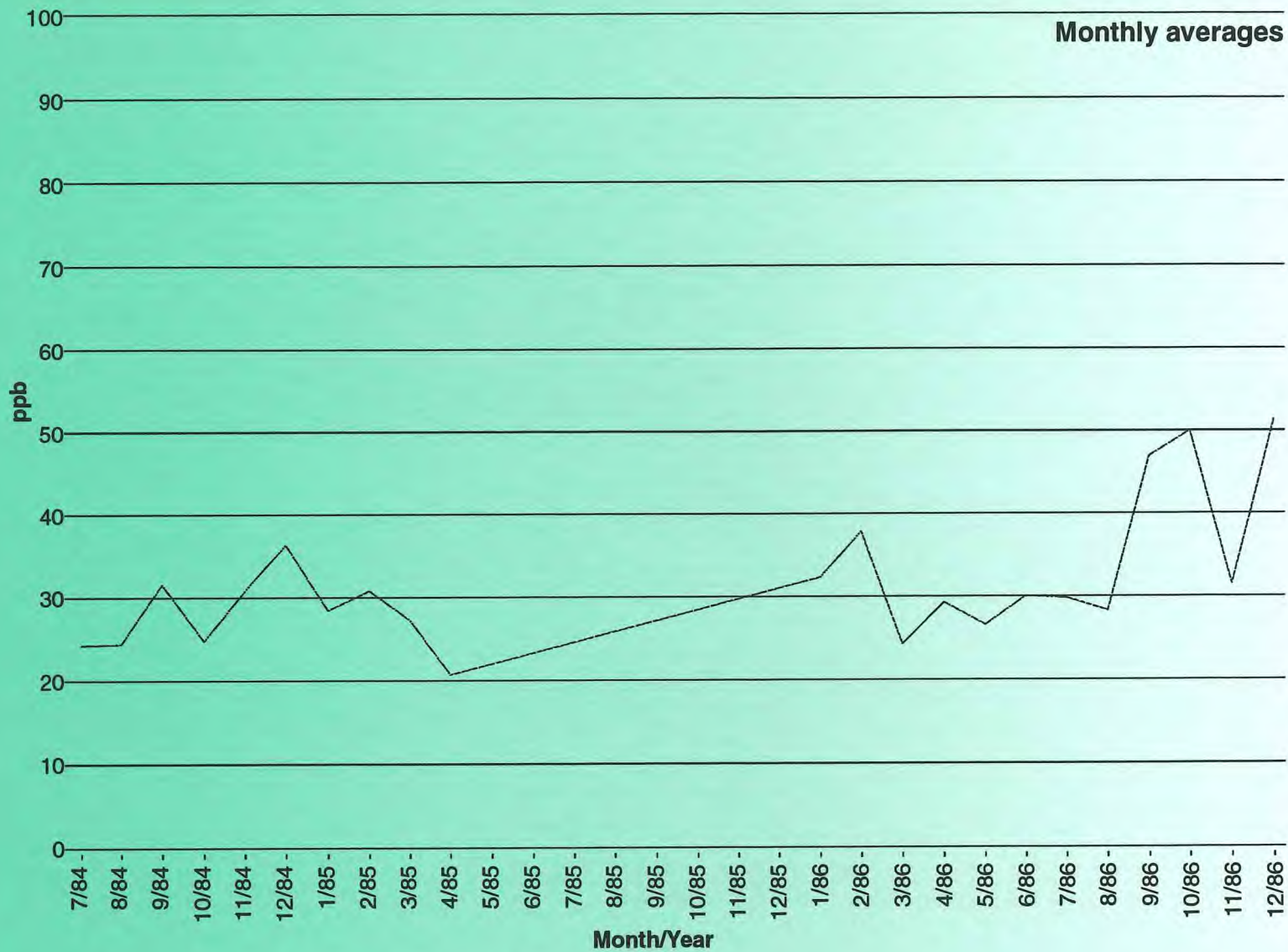


Figure 3.5 Nitrogen dioxide levels at Keyse Road  
July 1984 to December 1986

# nitrogen oxides

# nitrogen oxides



**Figure 3.6** Nitrogen dioxide levels at Canada Wharf  
July 1984 to December 1986

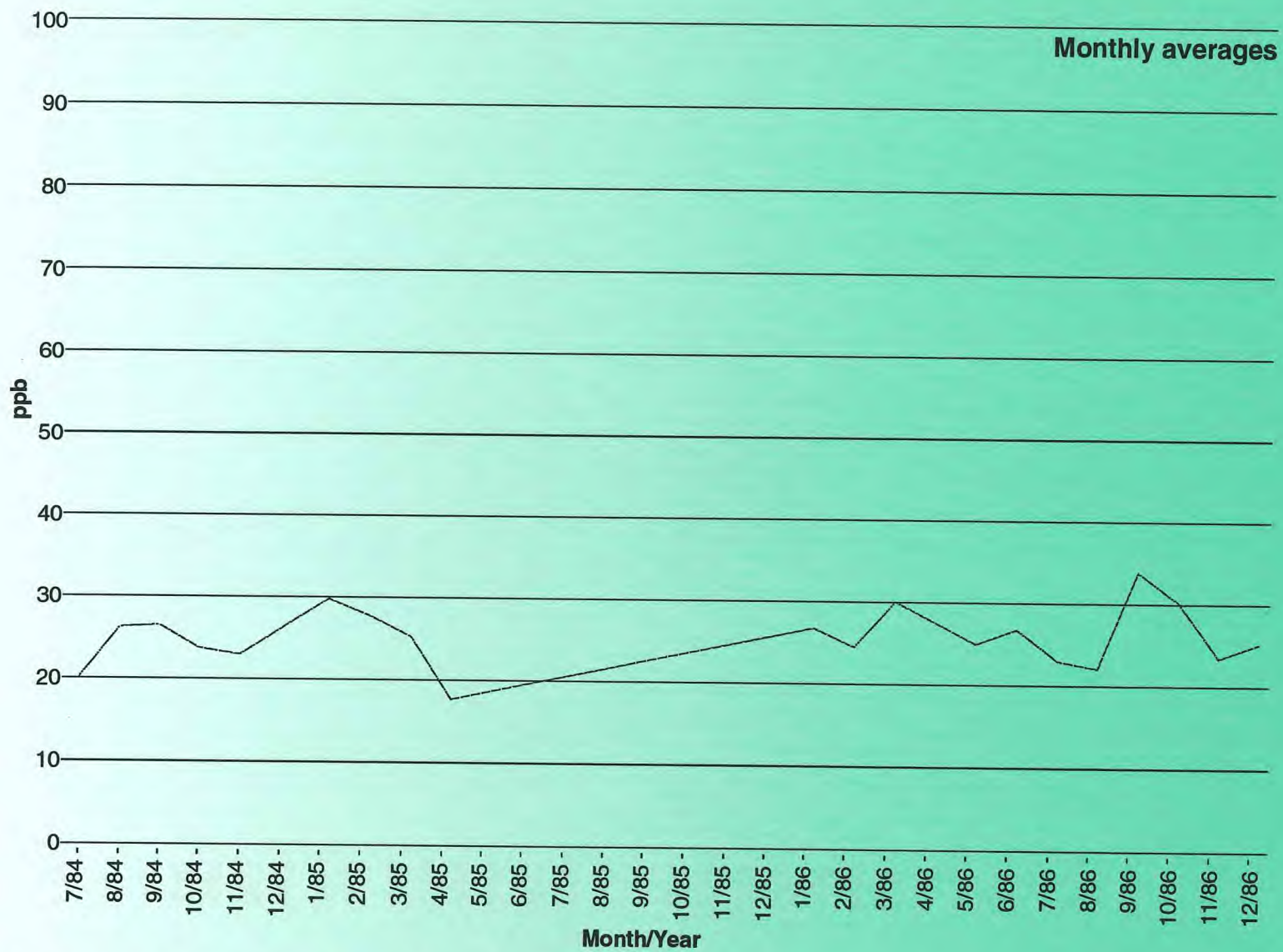
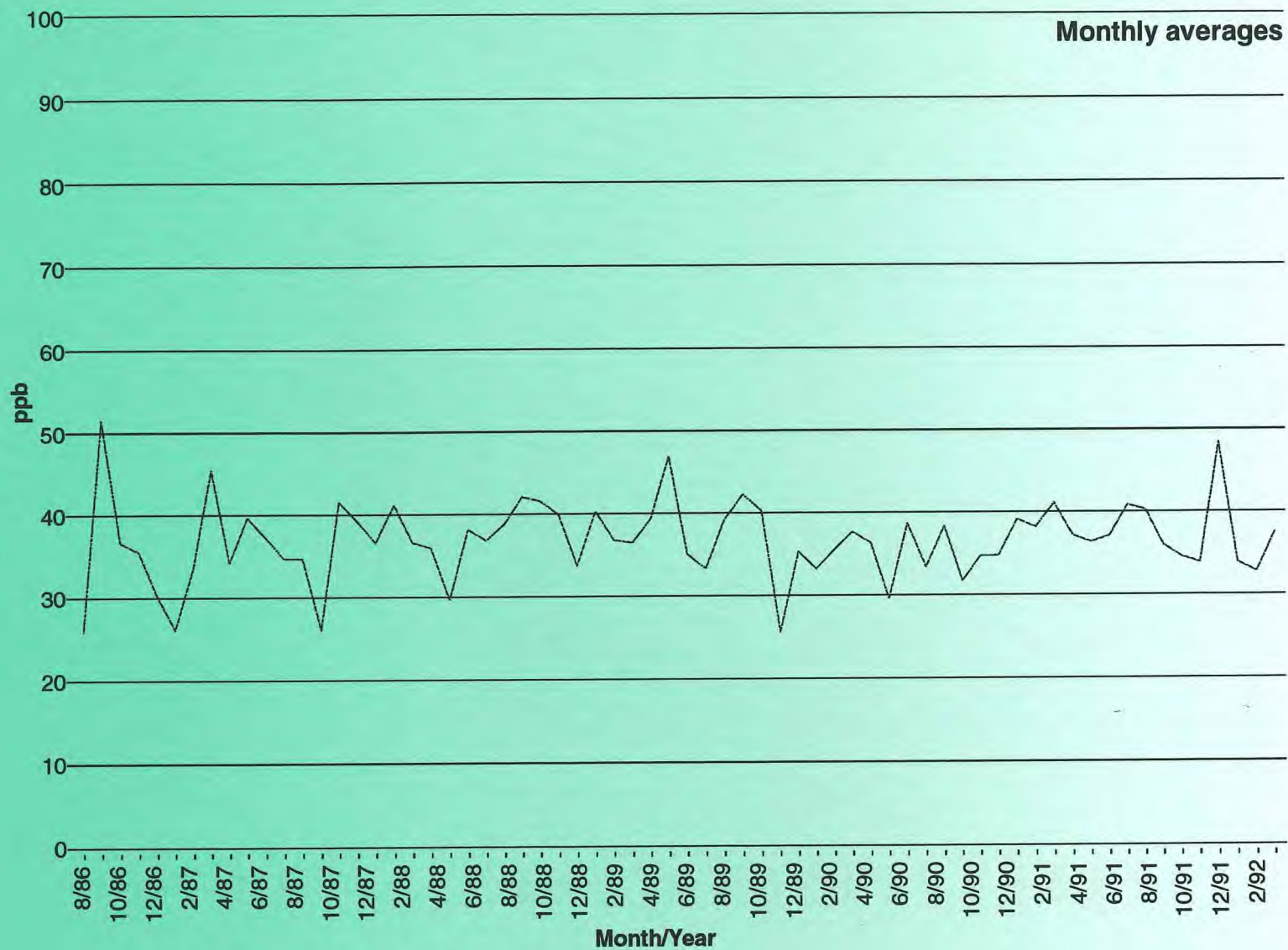


Figure 3.7 Nitrogen dioxide levels at Dulwich Park  
July 1984 to December 1986

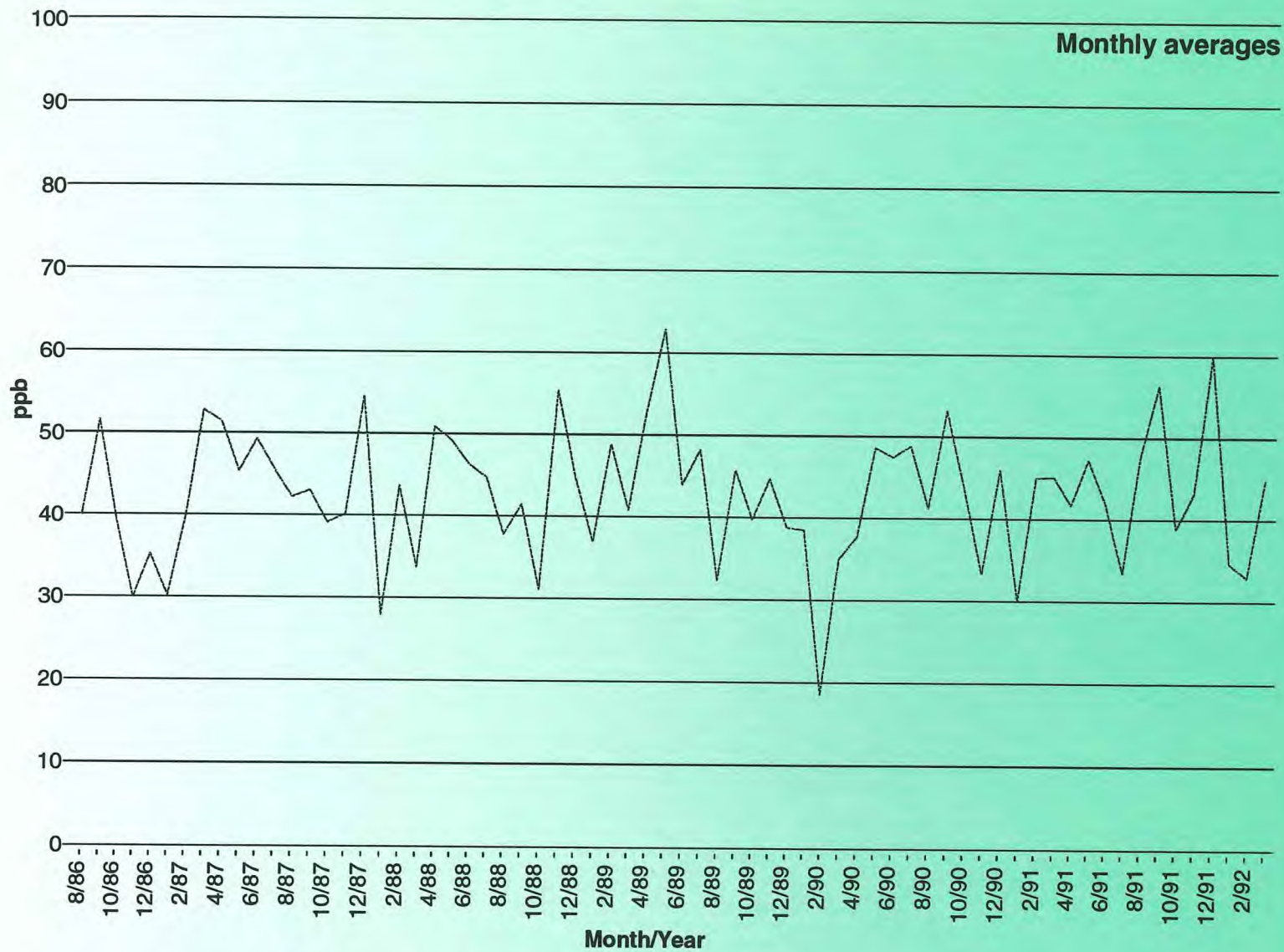
# nitrogen dioxide



# nitrogen oxides



**Figure 3.8** Nitrogen dioxide levels at Evelina Road August 1986 to March 1992

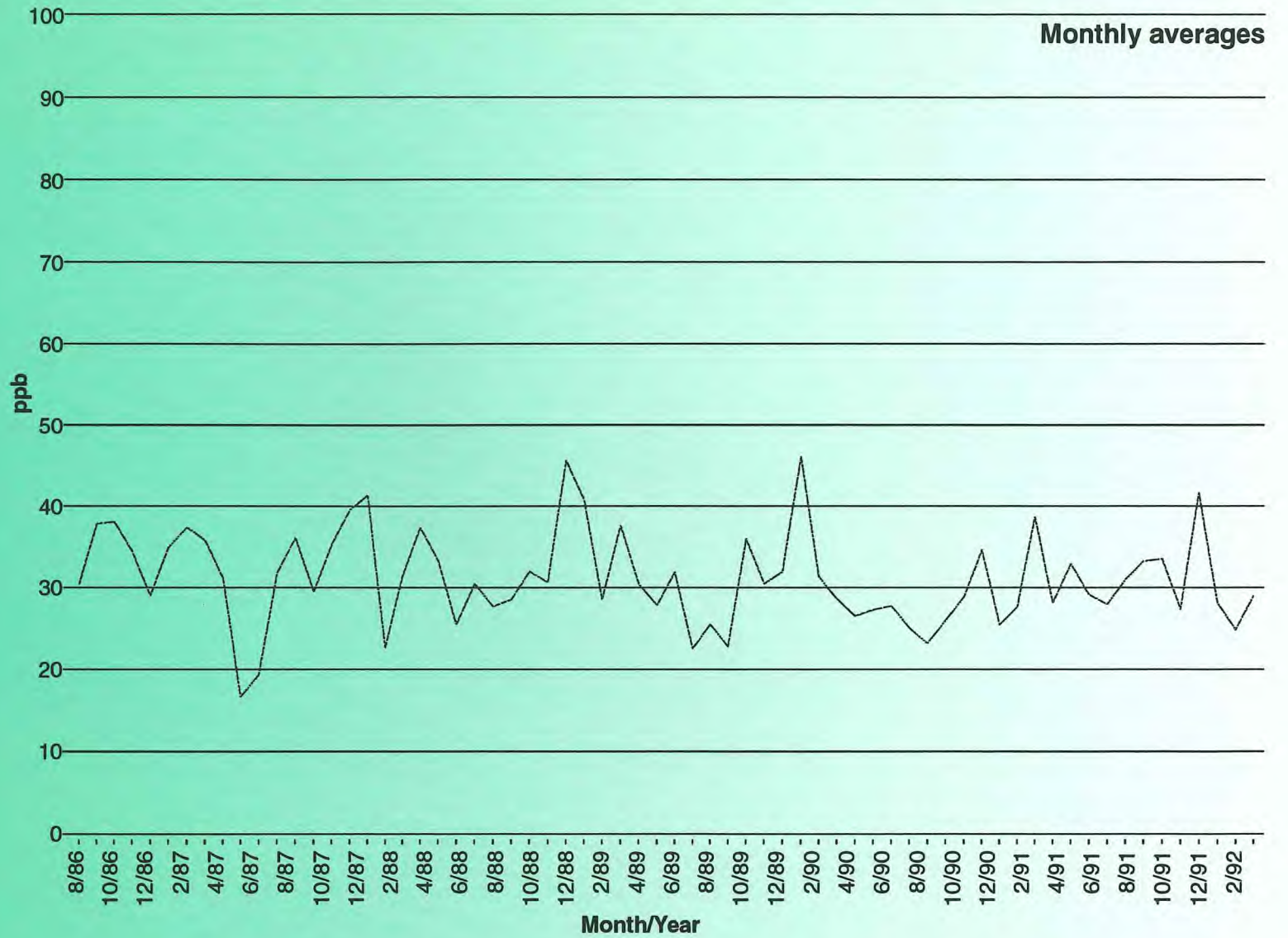


**Figure 3.9** Nitrogen dioxide levels at Old Kent Road August 1986 to March 1992



# nitrogen dioxide

# nitrogen oxides



**Figure 3.10** Nitrogen dioxide levels at Keyse Road August 1986 to March 1992

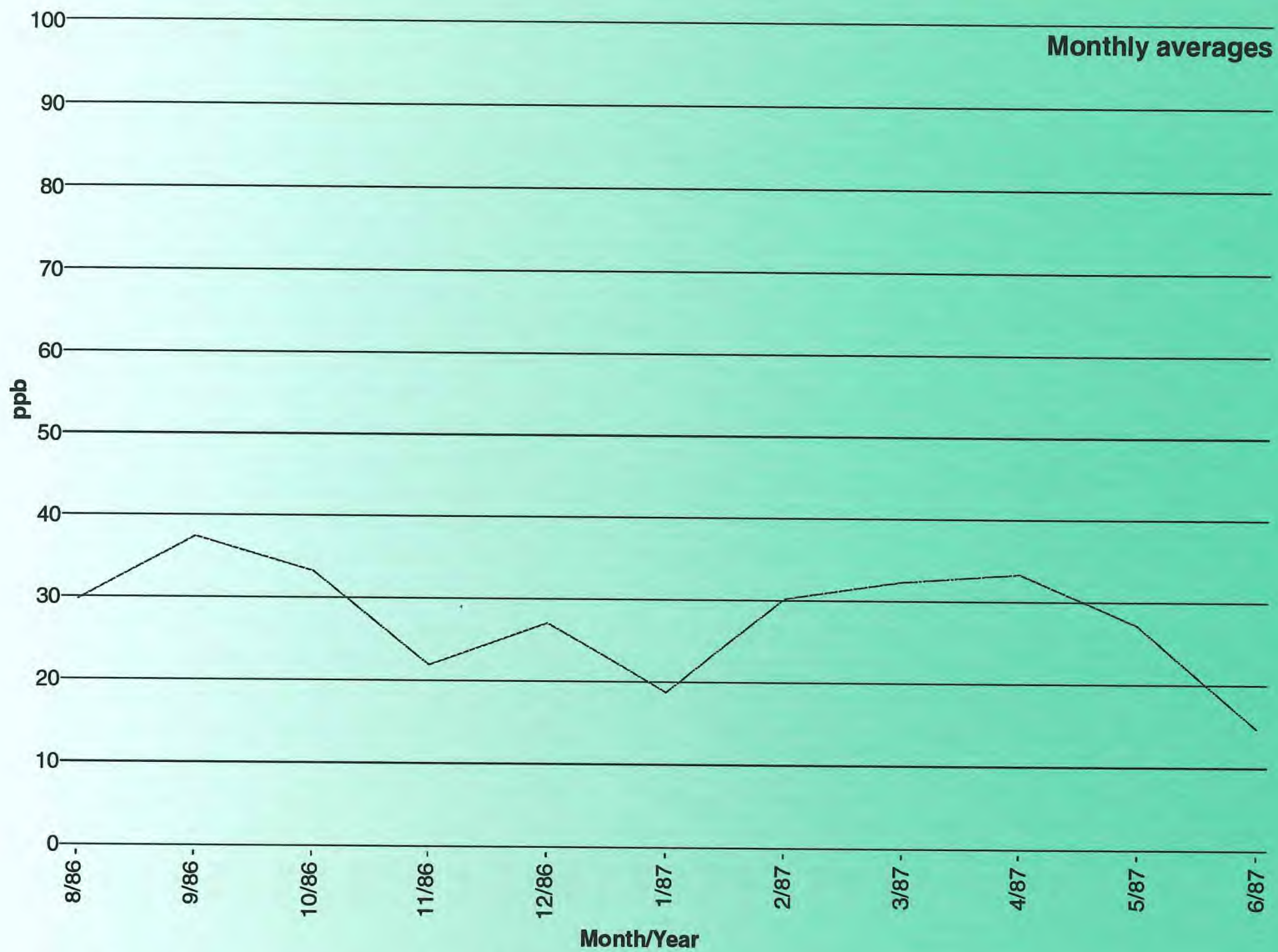
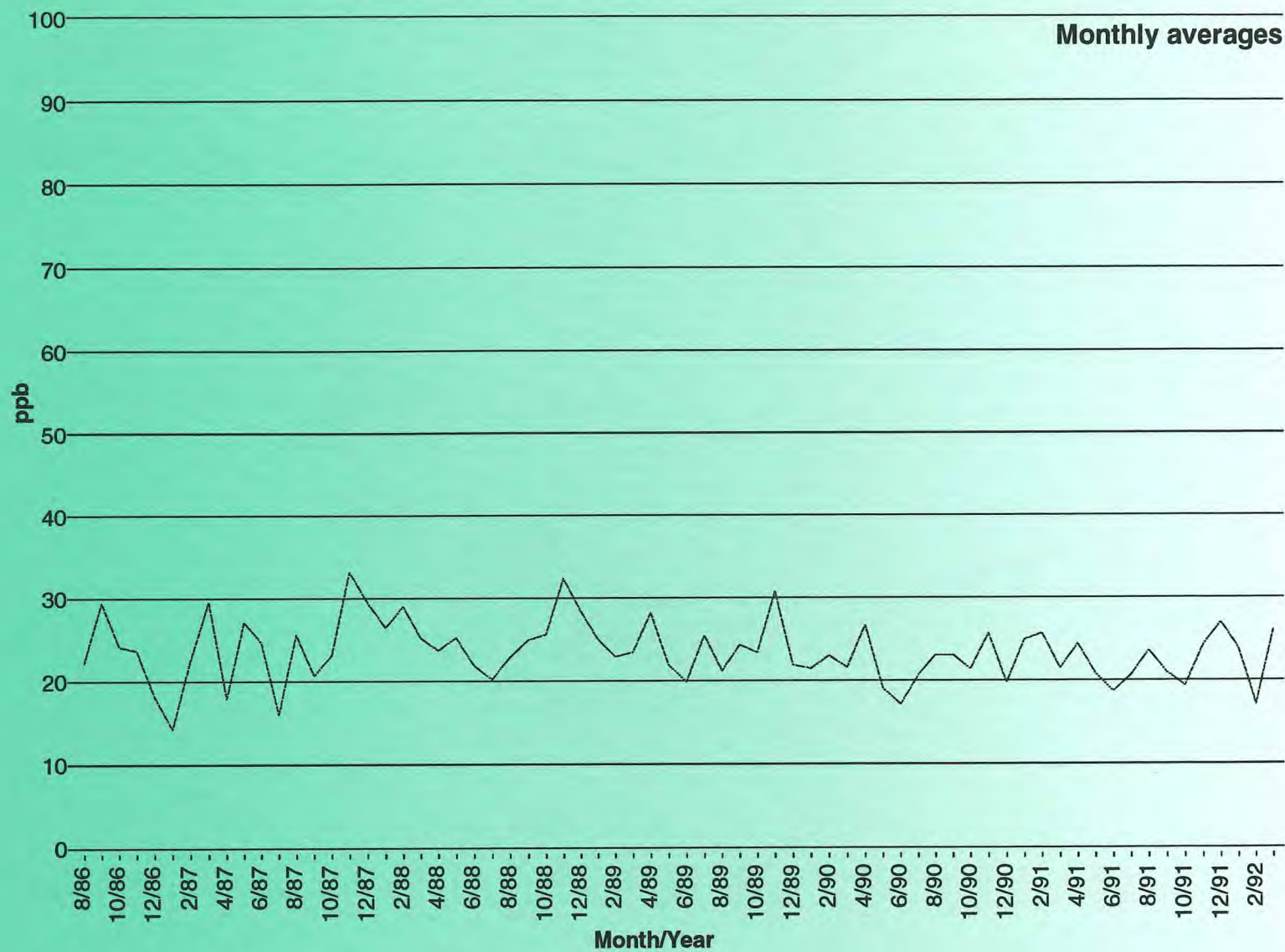


Figure 3.11 Nitrogen dioxide levels at Canada Wharf August 1986 to June 1987

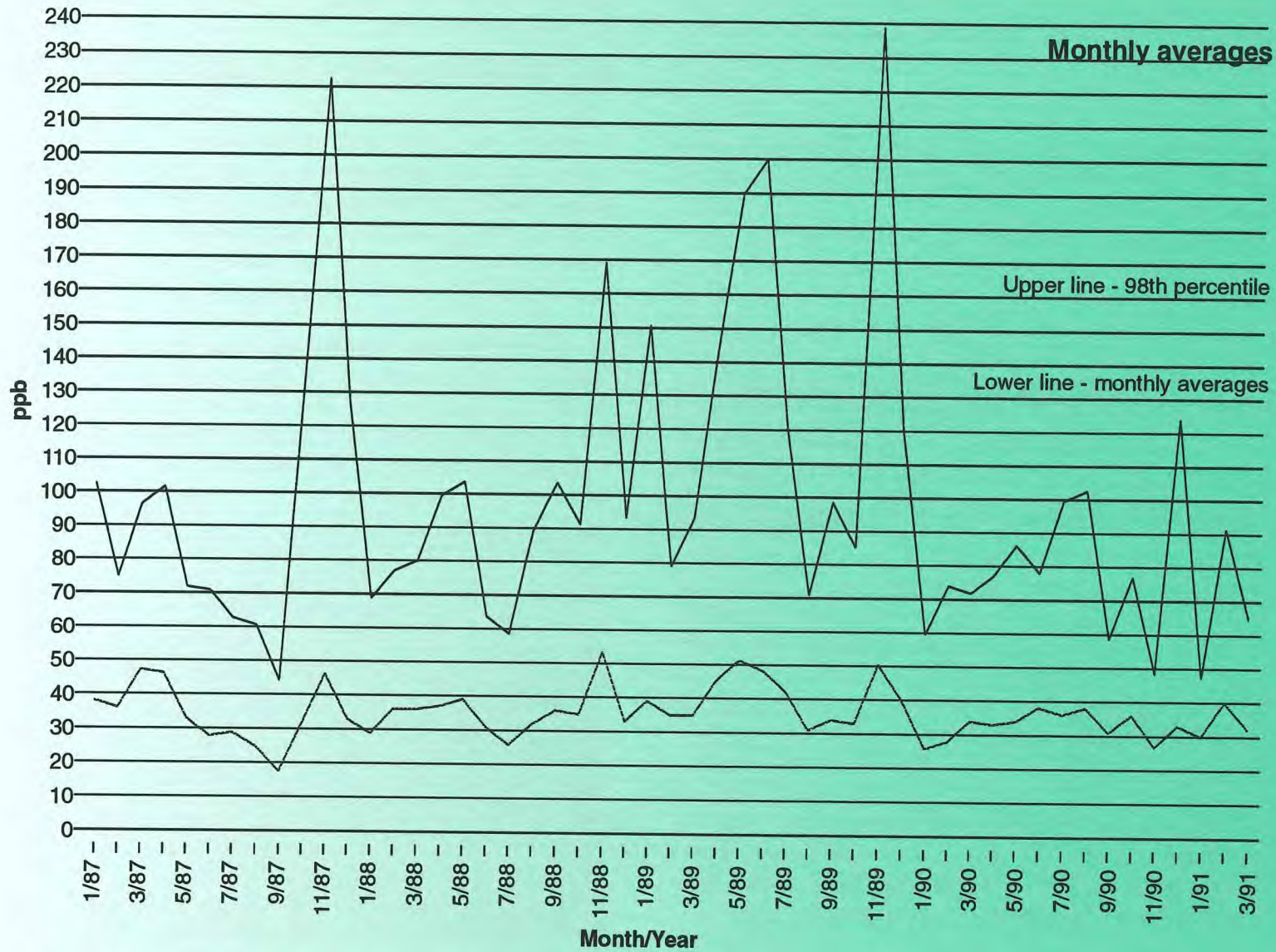


nitrogen  
dioxide

# nitrogen oxides



**Figure 3.12** Nitrogen dioxide levels at Dulwich Park August 1986 to March 1992



**Figure 3.13** Comparison between monthly averages and the 98th percentile for the same data

# nitrogen oxides