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Environmental and Pollution Measurements in the MULTI-ASSESS Project

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Abstract

The environmental and pollution data in the MULTI-ASSESS project is obtained from two field exposure programmes: The broad field and the target field exposure. The broad field exposure benefit from the measurements and test sites in the existing UN ECE International Co-operative Programme on Effects on Materials, including Historic and Cultural Monuments (ICP Materials). The paper describes the database structure and how the projects interact. For the use of the database for dose-response analyses data from low to high values are needed. The spread in the most important parameters are presented as well as the trends observed in the ICP materials programme for the period from 1987 to 2003. The spread is sufficient for statistical analyses for all parameters presented. Trend analyses show a large reduction in the SO2 pollution level a illustrated with the data from The Prague test site while the change for the other parameters are less dominating.

1 Introduction

The decreasing SO_2 levels in most parts of Europe and the increasing car traffic causing elevated levels of N compounds, ozone and particulates has created a new multi-pollutant situation. This has been acknowledged i.a. in the activities within the UN ECE Convention on Long-range Transboundary Air Pollution, where a multi-pollutant, multi-effect protocol has been adopted. In contrast to SO_2, the effects of O_3 and N compounds are not well documented and in particular the total effects of car traffic. This is especially true for nitric acid (HNO_3), as well as particulates, which can damage materials both by enhancing the rate of degradation and by soiling.

The development of dose-response relations, which quantify the effects of pollutants in combination with climatic parameters on the deterioration and soiling of different materials, constitutes a necessary condition for prediction of damage and for establishment of threshold levels. To perform this in the limited time and restricted budget, the MULTI-ASSESS project is combined with the UN ECE International Co-operative Programme on Effects on Materials, including Historic and Cultural Monuments (ICP Materials). The ICP Materials programme was established in 1987 as an international exposure programme on the effects of pollution on materials.

In Figure 1 the interaction between the measurements carried out in the ICP materials programme and the contribution from the MULTI-ASSESS project is illustrated.

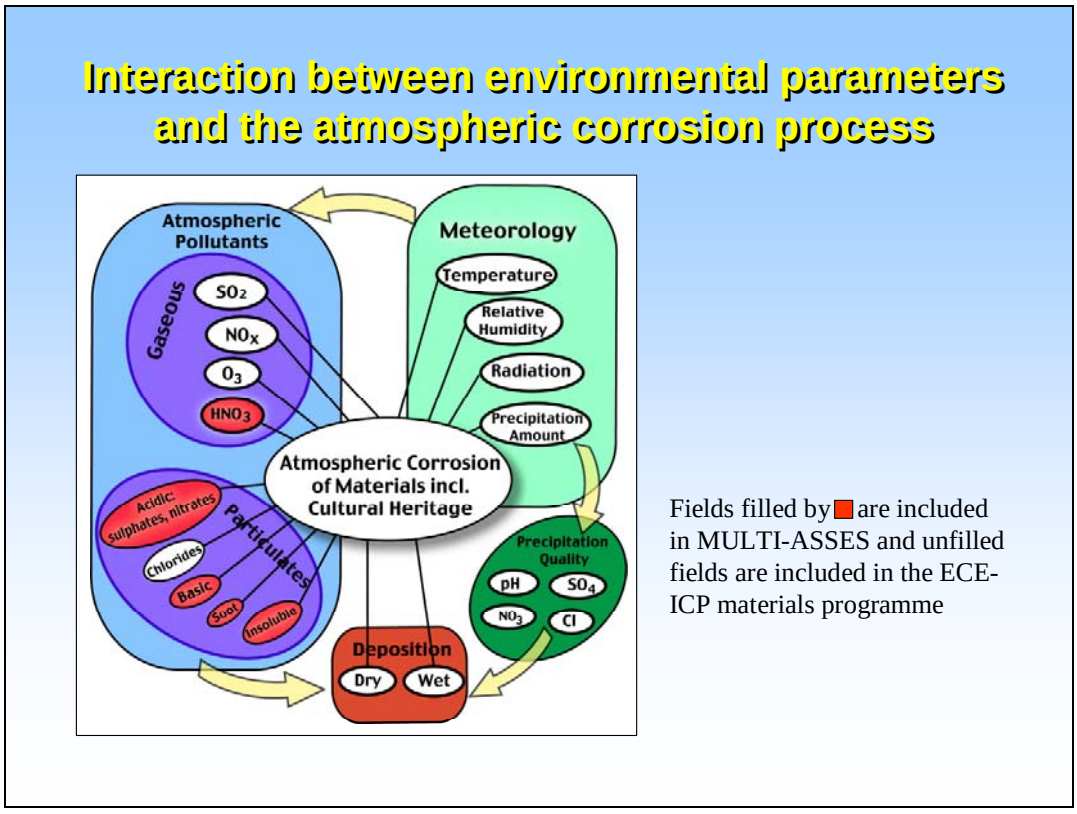

Figure 1: An illustration of the parameters introduced in the MULTI-ASSESS project together with the parameters already reported in the ICP-materials programme.

2 The complete environmental database

The MULTI-ASSESS environmental database is designed to contain the environmental parameter needed to develop the correlation between material damage and the environmental impact.

The database is unique for the following reasons:

- The amount of parameters measured close to material exposure racks is larger than in any other exposure programme
- The test sites represent both rural, urban and industry areas in Europe.
- Most of the test sites are also sites in the UN/ECE ICP material programme with data records back to 1987. The database is therefore very useful for trend analysis of environmental enterprises around Europe.

The MULTI-ASSESS database shall cover the results from two different exposure programmes. The broad field exposure covers all the ICP-material test sites and it also includes the same data for the main exposure racks in the target field exposure programme. The target field exposure programme is design to cover soiling on buildings in different distance from pollution sources.

2.1 Parameters recorded in the broad field exposure programme

The data files are separated so it possible to keep the record of the environmental data reported in the ICP-materials programme as well as for the data obtained in the

MULTI-ASSESS project. The ICP material programme shall report the following data:
Main parameters:

- Climate: Monthly average Temperature (ºC) and Relative Humidity (%) Monthly amount of sun radiation (MJ/m^2)
- Gas parameters: Monthly average of SO_2, NO_2 and O_3 ($\mu g/m^3$)
- Precipitation parameters: Monthly amount of precipitation (mm). Monthly average of rain chemistry for pH, SO_4-S, NO_3-N, Cl (mg/l) and Conductivity (µS/cm).

Secondary parameters:

- Monthly average of rain chemistry NH_4-N, Na, Ca, Mg and K (mg/l). Mainly for quality control of the rain chemistry data.

- Gas: Monthly average of HNO_3 ($\mu g/m^3$) (Other measurements than the MULTI-ASSESS passive HNO_3 measurements)

- Particles: Monthly average PM_{10} measurements ($\mu g/m^3$)

The contribution from MULTI-ASSESS to the broad field exposure is:

Particles:
Measurements for passive deposition, monthly average for two months exposure period:
Total deposition, Cl, SO_4-S, NO_3-N, NH_4-N, Na, Ca, K, Mg and insolvable amount (mg/m2·month).

Gas: Two month average value of HNO_3 ($\mu g/m^3$).
Two month average values with denuders HNO_3 and NO_3 ($\mu g/m^3$)

2.2 Parameters recorded in the target field exposure programme

In the target field exposure, seven main sites have the same parameters as in the broad field exposure.

Five of the target sites also have sub-sites with exposure of materials and measurements under sheltered conditions. Soiling is the main studies under these conditions and the measurements are focusing on particle:

Particles:
Measurements of one-year passive deposition, as monthly average for the exposure period:
Total deposition, Cl, SO_4-S, NO_3-N, NH_4-N, Na, Ca, K, Mg and insolvable amount (mg/m2·month).

3 Spread of data

For the use of environmental data for creating dose-response functions we need sufficient data with sufficient spread for the environmental values.
To obtain this spread, the sites are geographically distributed through out Europe with 9 rural sites, 3 typical industry sites and 22 urban sites more or less influenced by

industry. In Figure 2-6 the spread in the concentrations for the some of the most important parameters are given.

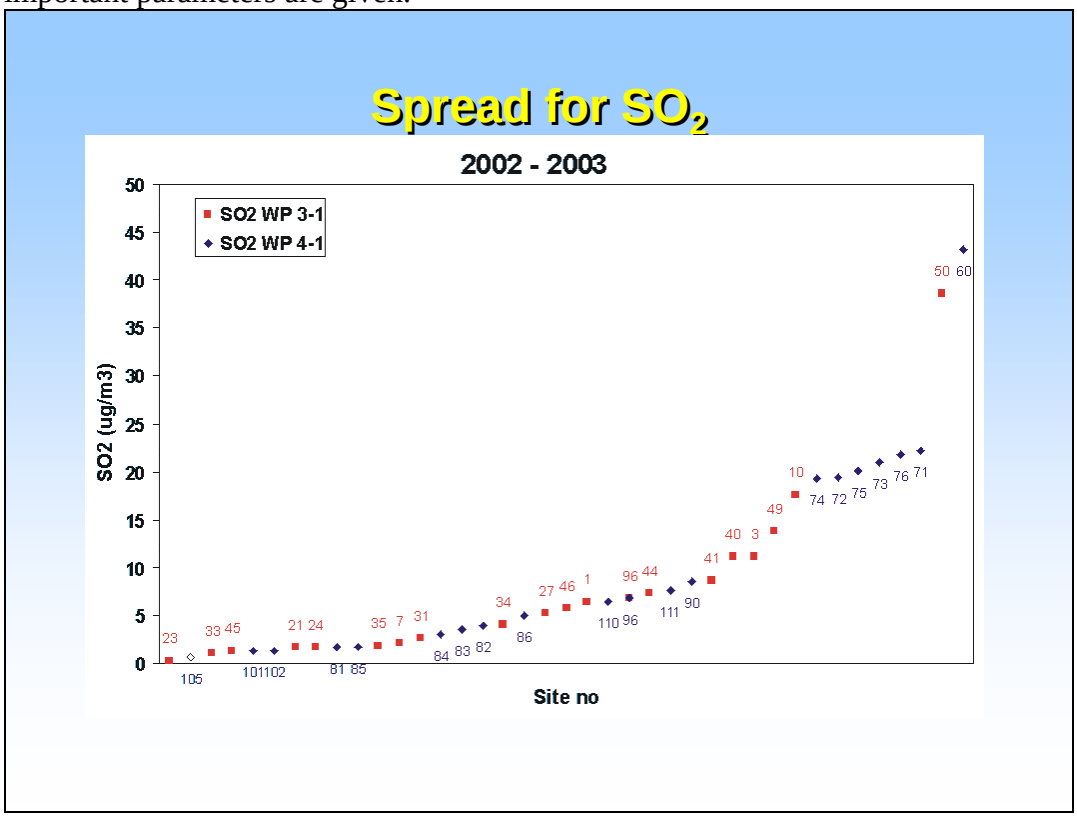

Figure 2: The spread inside the data file for the SO_2 concentrations.

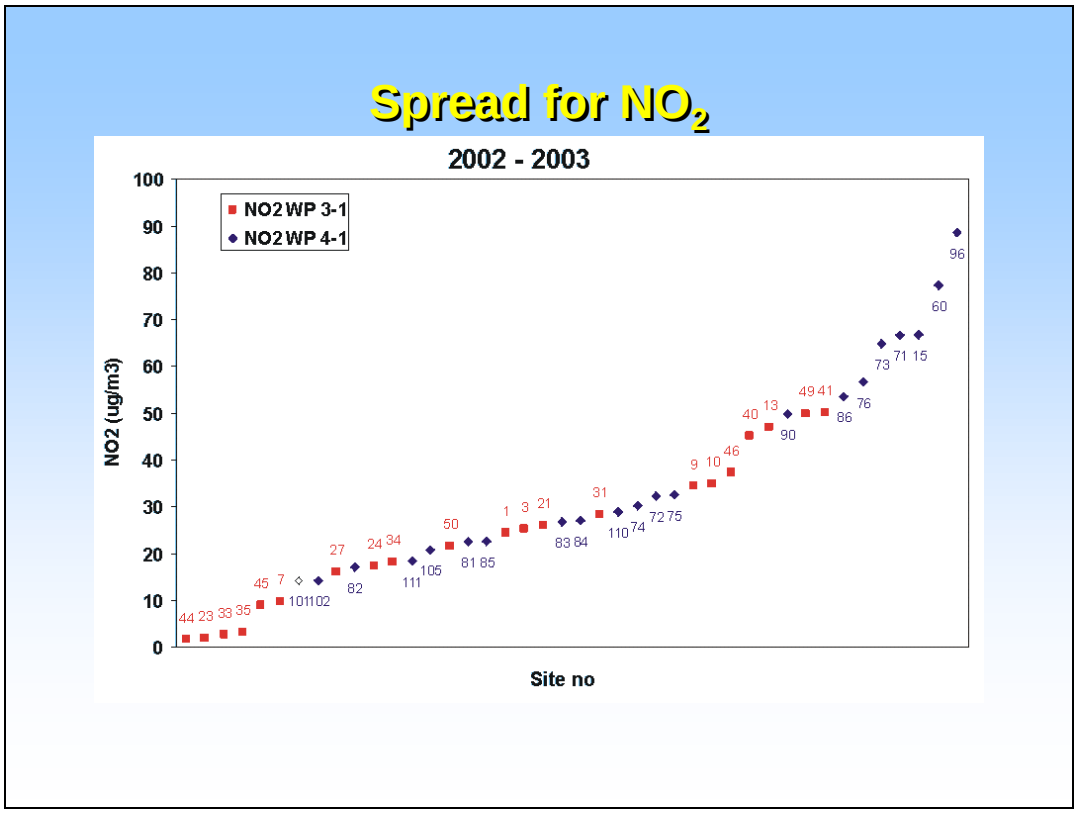

Figure 3: **The spread inside the data file for the NO_2 concentrations.**

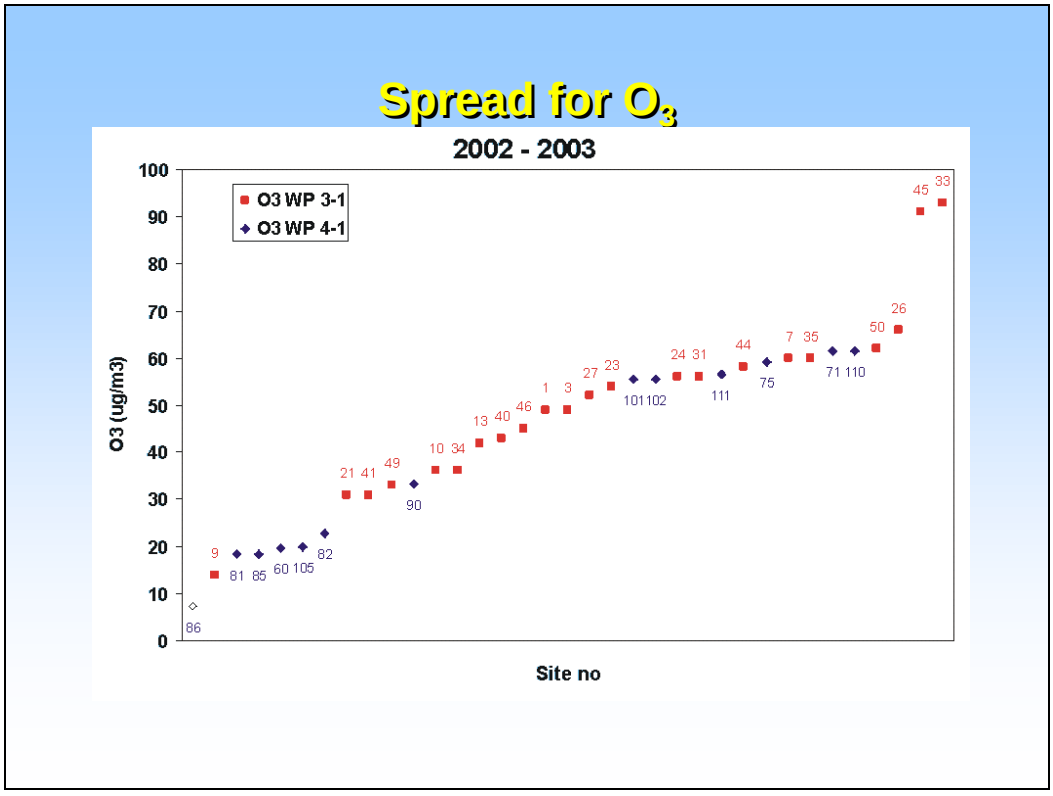

Figure 4: **The spread inside the data file for the O_3 concentrations.**

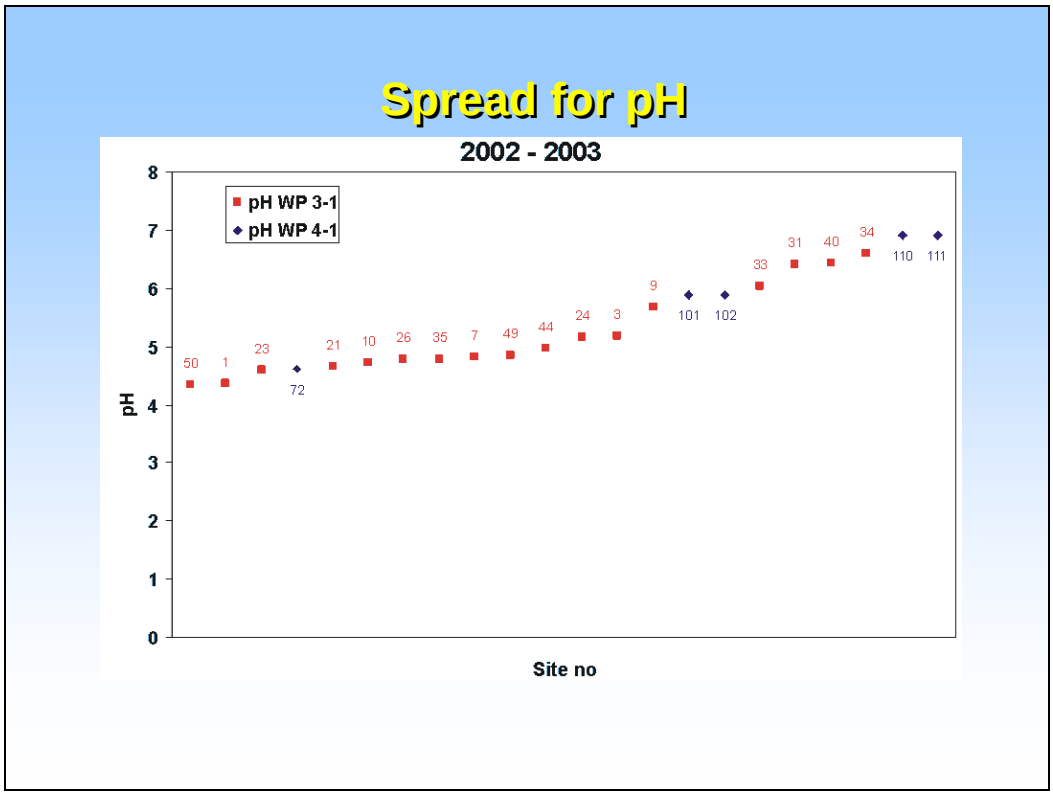

Figure 5: **The spread inside the data file for the pH values.**

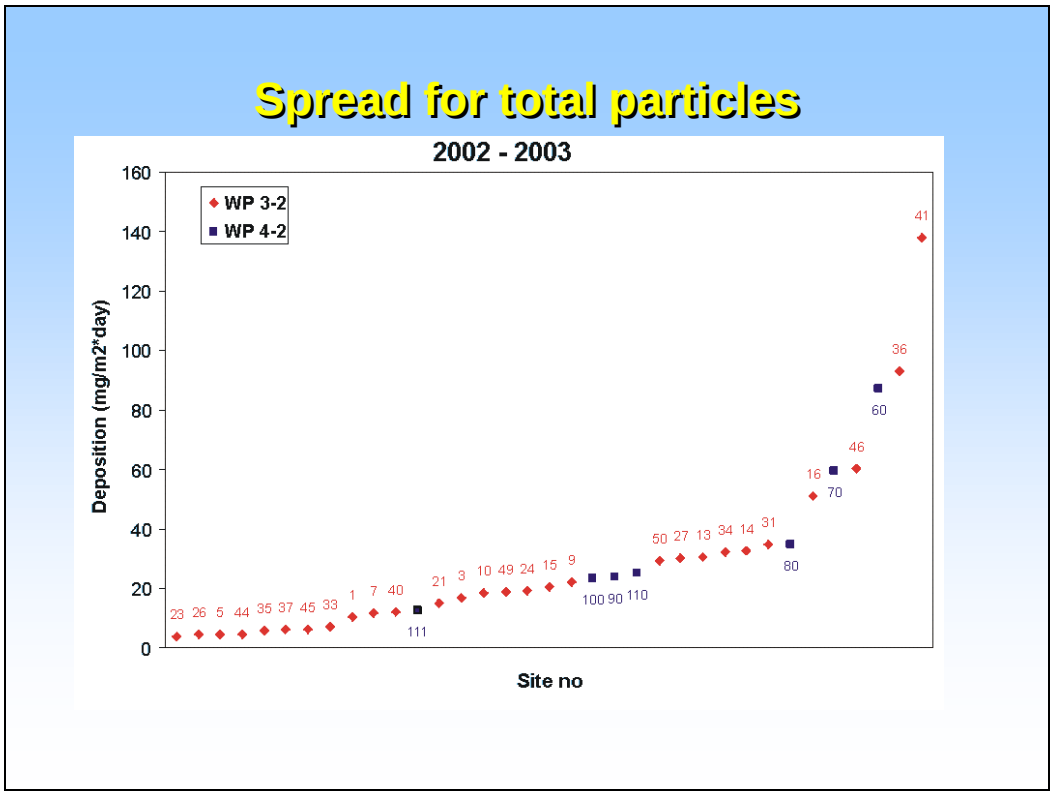

Figure 6: **The spread inside the data file for the deposition of particles.**

4 Summary - Spread

- The spread in the data measured is sufficiently large for correlation analysis of the environmental effect to material deterioration.

- The importance of measuring climate parameters during the field test is illustrated by the variation in yearly amount of rain during the measuring period in Prague.

5 Trend analyses

During the ICP materials programme the pollution situation in most parts of Europe has changed dramatically. To day we have more mixed gas pollution situation. The SO_2 concentration has been reduced in most cases while there is a fairly small change in the NO_2 and O_3 concentrations. In Figure 7-9 this is illustrated for the measuring site in Prague for SO_2 and NO_2 and for the background site Aspreten for O_3. The reduction in the SO_2 concentration is obvious, but even NO_2 has a trend to lower concentrations while the O_3 concentration has no clear trend.

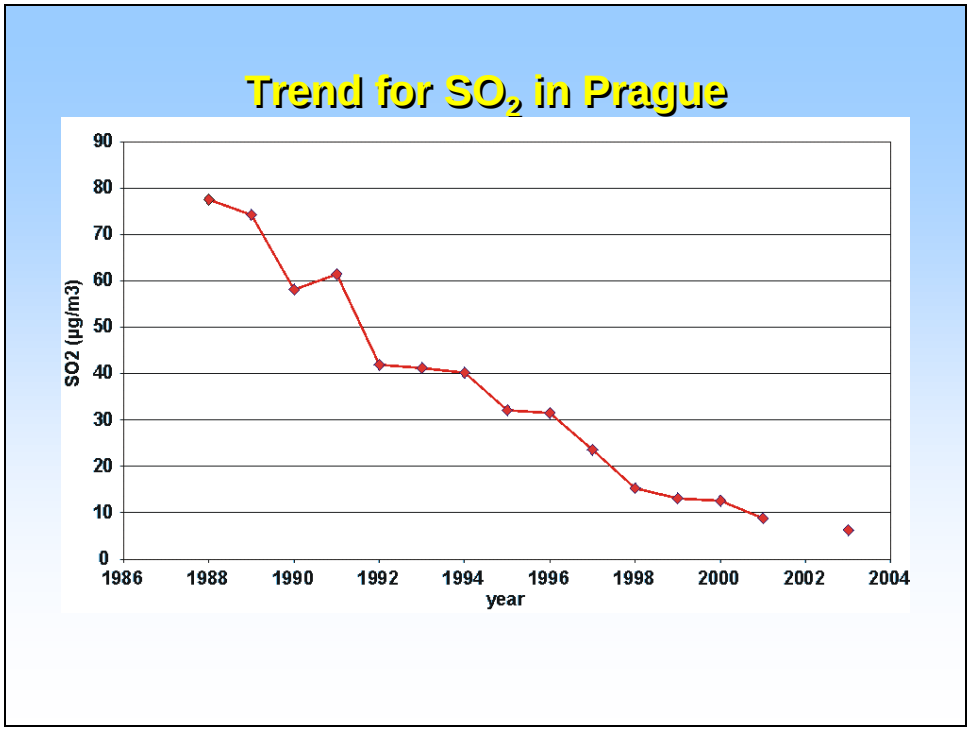

Figure 7: The SO_2 concentration at the Prague test site from 1987 to 2003.

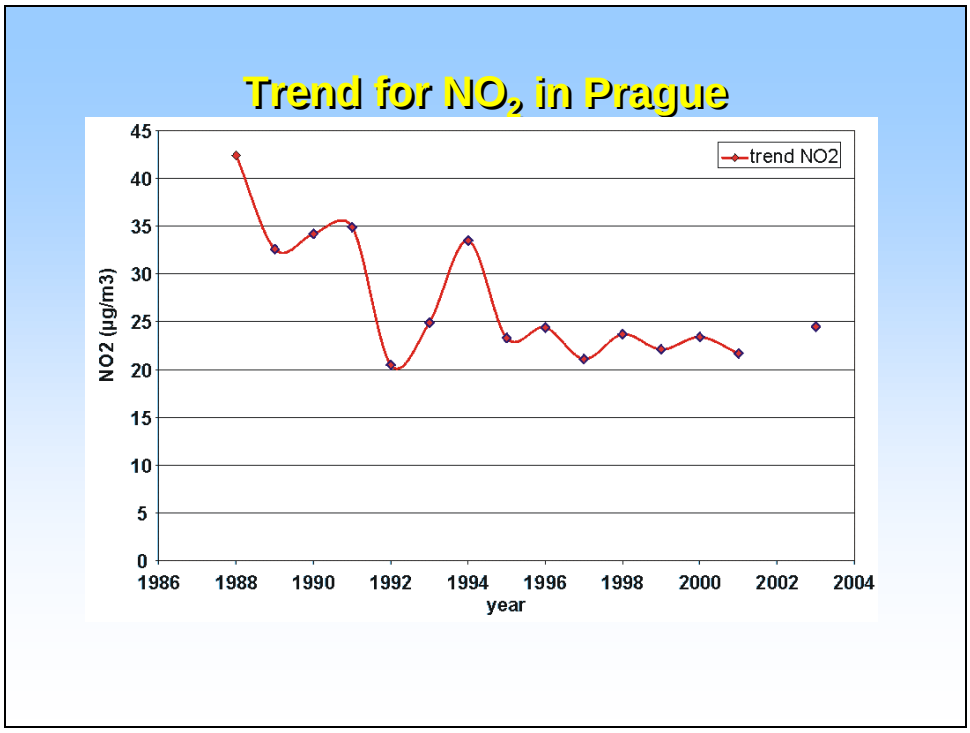

Figure 8: The NO_2 concentration at the Prague test site from 1987 to 2003.

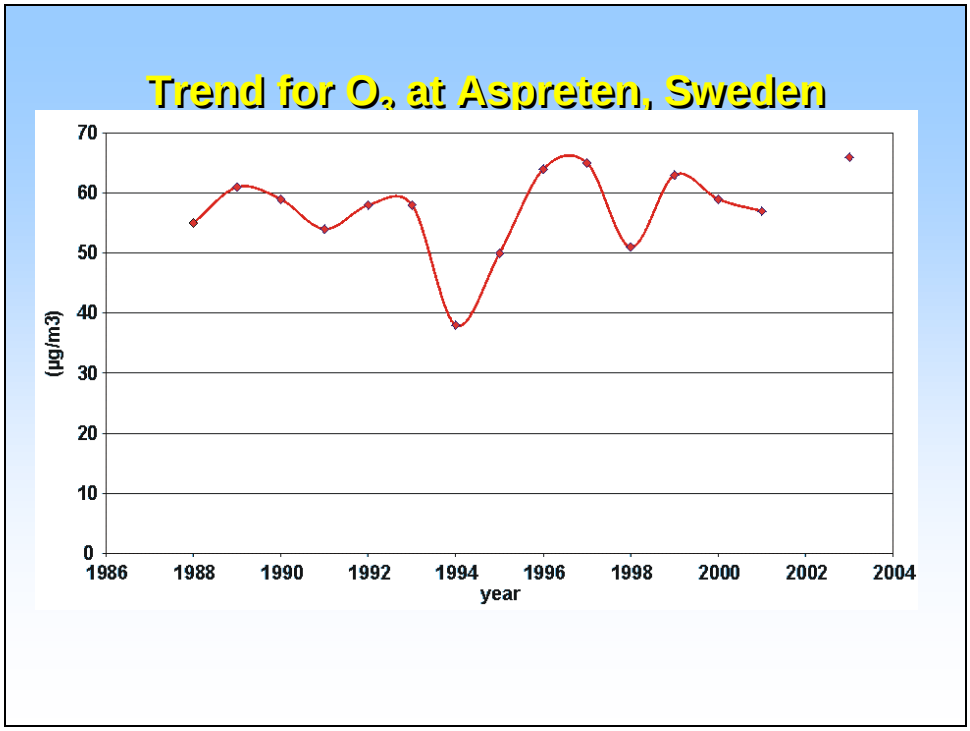

Figure 9: **The O_3 concentration at Aspreten test site from 1987 to 2003.**

To illustrate that not all parameters recorded in the programme is expected to have a trend, the yearly amount of precipitation for the period 1987 to 2003 is plotted.

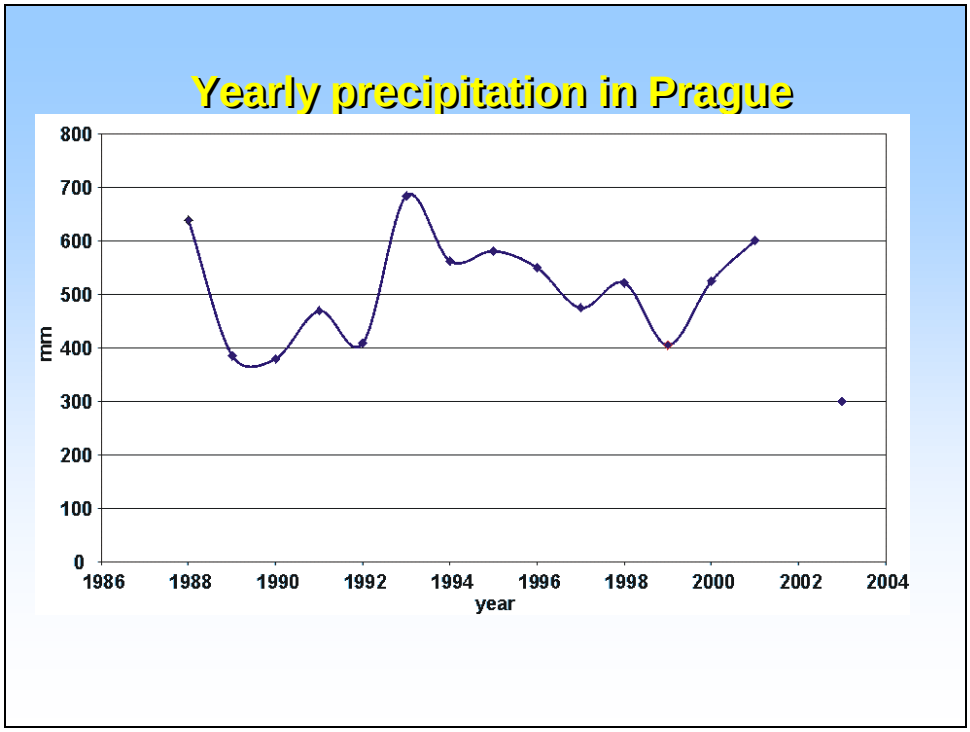

Figure 10: **The yearly presentation at Prague test site from 1987 to 2003.**

5.1 Summary – Trend

- The SO2 concentration has been reduced on all test sites in the programme during the complete measuring period.
- The NO2 concentration has been reduced at most urban and industry site in the programme during the measuring period.
- The O3 concentration has no significant trend for most test sites during the measuring period.
- Climatic parameters like precipitation is not expected to show any trend during the ICP-material exposure programme.