Statistical Modeling of Maximum NO_x Concentrations in the Tel Aviv Area

A contribution to subproject SATURN

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Summary
Based on ground-level meteorological data and radiosonde probing, regression equations for maximum morning and evening NOx concentrations were developed and tested. Among the model variables the vertical temperature gradient in the surface atmospheric layer is the most significant factor. Predicted NOx concentrations are in a good agreement with the observed values.

Activity and results
To forecast the morning and evening maximum NO_x concentrations, two multiple-linear regression models have been developed and tested. The models based on half-hour measurements of NO_x from five traffic monitoring stations of the Ministry of Environment. The stations are located in the central area of the Tel Aviv conurbation and operate since 1998. The set of input meteorological data for the model development included standard ground-level meteorological parameters and data from diurnal (11:00 GMT) and nocturnal (23:00 GMT) radiosonde launches at the Bet Dagan meteorological station near Tel Aviv. Expediency to develop two separate models for morning and evening hours follows from the double peak diurnal NO_x distribution and essential distinction in the morning and evening meteorological conditions.

For the model development one-year data set of 1999 (half-hour average NO_x concentrations, standard ground-level meteorological parameters and vertical temperature distribution) was used. Using an ordinary least squares method and stepwise regression, the set of predictor variables for each of the model was obtained (Table 1). The predictant is the maximum NO_x concentration during the morning and evening hours.

For operative forecast of NO_x concentration the meteorological parameters, predicted by the Israel Region Forecasting Model (IR/HRM), were used. The results of one-year predictions versus observed values, from May 2000 till May 2001, are presented in Figures 1 and 2. The morning model predicted correctly 96% of occurrences of the admissible NO_x concentrations (less the National Air Quality Standard level of 500 ppb) and 64% of exceeding of the limit level (> 500 ppb). The corresponding results of evening prediction are 89% and 63%, respectively.

Conclusions
Used in combination with the IR/HRM data, the developed regression models can be a useful tool for the urban air quality forecasting.

Aims for the next 2002 year

During 2002 statistical models for the operative NO_x forecast will be validated and updated, using the meteorological parameters, predicted by the Israel Region Forecasting Model (IR/HRM) as input data (Activity 2). It is proposed that such prognostic meteorological data will be used in the future for the short-time air quality forecast.

One more set of two regression models will be developed and tested. These models will be based on the predicted by IR/HRM meteorological parameters (Model Output Statistics Method) and not on the observed data.

Table 1. Input parameters for the NOx forecast models

	Morning model [a]	Evening model [b]
Previous day maximum concentration, [c] ppb	+	+
Wind direction (normalized scale)	+	
Gradient of temperature in the first 100 m, C	+	+
Temperature, C		+
Temperature of dew point, C	+	+
Temperature at 850 mb level, C	+	+
Relative humidity, %	+	
Turner stability category [d]		+
Monin-Obukhov length	+	+
Friction velocity		+
Cloud cover [e]	+	+
Height of low clouds	+	+

[a] For the morning forecast (7-9 LST) the predictive nighttime (23:00GMT, 01:00 LST) meteorological data are used;
[b] For the evening forecast (19-22 LST) the predictive daytime (11:00GMT, 13:00 LST) meteorological data are used, excepting the gradient of temperature. For the gradient of temperature the following nighttime (23:00 GMT) predictive value is used;
[c] Maximum NO_x concentrations observed during morning and evening hours, respectively;
[d] Stability category, S, Monin-Obukhov length, L, and friction velocity, u*, are the calculated input parameters;
[e] Cloud cover and low clouds height used only for the definition of S, L and u*.

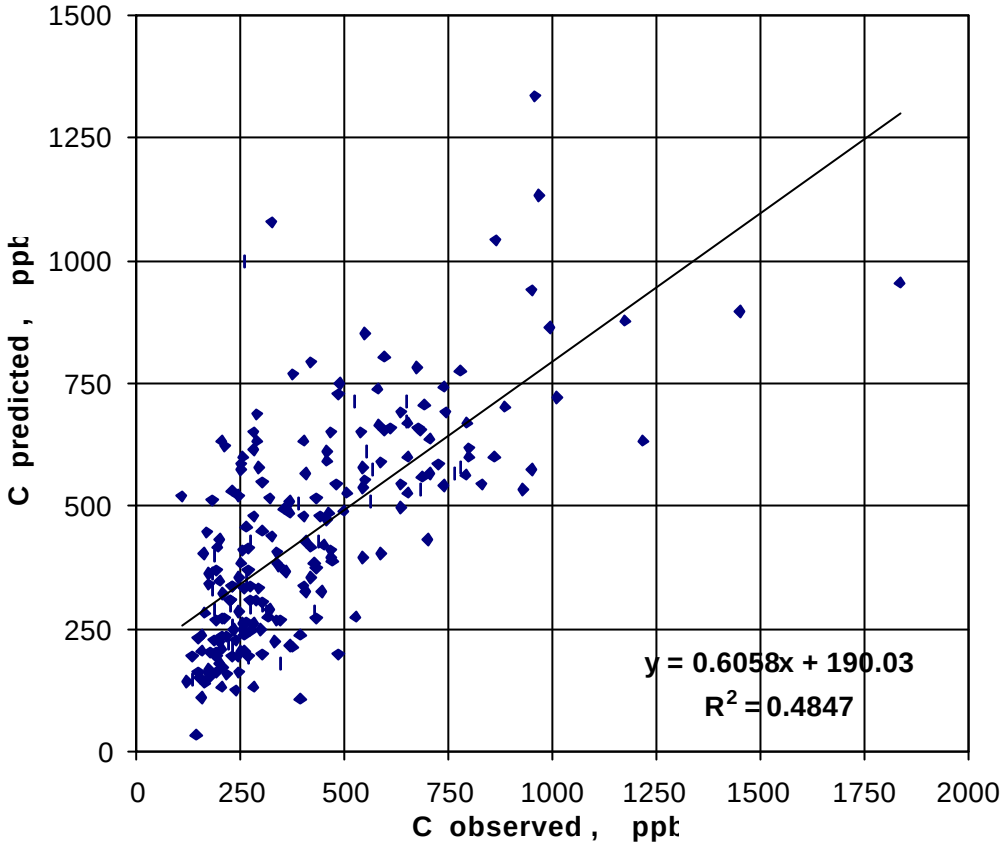

Figure 1. Maximum NO_x morning concentrations during May 2000 – April 2001.

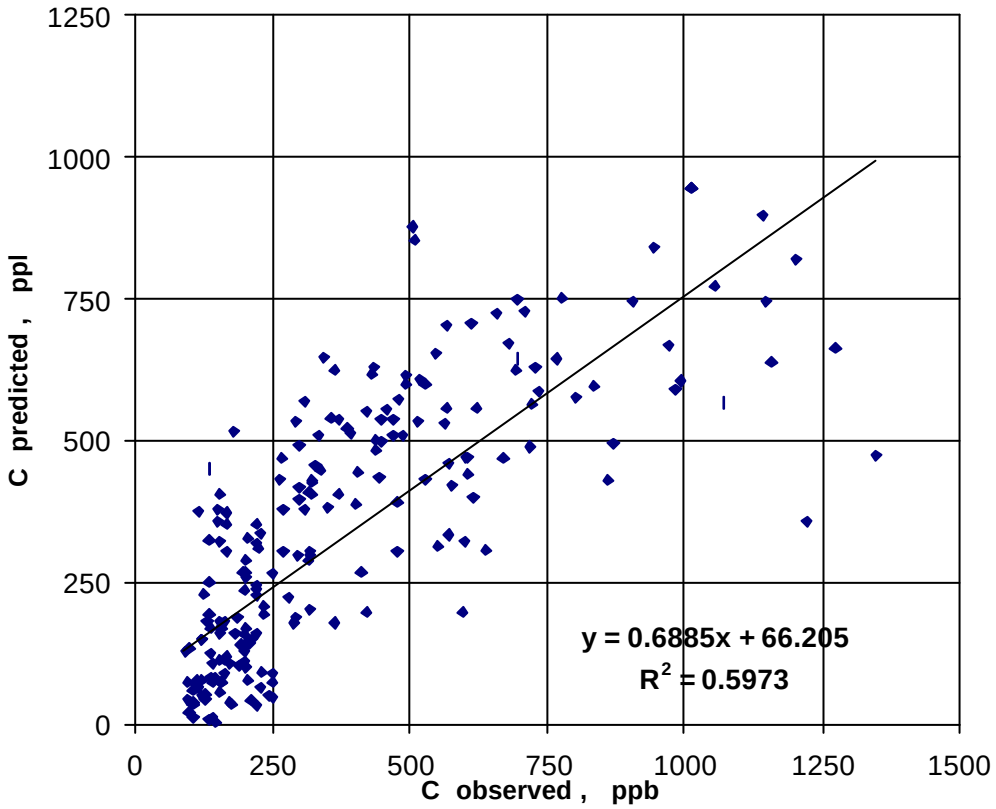

Figure 2. Maximum NO_x evening concentrations during May 2000 – April 2001.