10.5 The Statistical Forecasting Model

A physical and chemical diffusion models are generally used for estimating air pollution. However, in the case of the pollution of which physical and scientific models have not established or when any input data for the physical pollution model cannot be obtained or when it is only necessary to forecast the air pollution level for a few hours after then statistical methods to estimate the pollution using time series concentration data or the pollution and weather data are used.

The category classification method by weather charts is used for the forecasting of the air pollution level. This method estimates the pollution level by examining the concentration of the pollution for each pattern, classifying a pattern in the weather by season and the existence or non-existence of high atmospheric pressure, low atmospheric pressure, fronts and so on. This method is used to estimate the density level of photochemical oxidants and nitrogen oxides for the whole area. An example of a classification of a typical weather chart is shown in Table 10.5.1.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN</td>
<td>North high and south low type (Baiu type, Okhotsk high type, etc.)</td>
</tr>
<tr>
<td>PE</td>
<td>East high and west low type</td>
</tr>
<tr>
<td>PS</td>
<td>South high and north low type (Typical summer pressure type, the bright in May, etc.)</td>
</tr>
<tr>
<td>PW</td>
<td>West high, east low type (Strong northerly wind type in winter)</td>
</tr>
<tr>
<td>OW</td>
<td>Weak west high and east low type (Weak northerly wind type in winter)</td>
</tr>
<tr>
<td>H</td>
<td>Covered with a traveling high pressure. Covered with a long belt high.</td>
</tr>
<tr>
<td>F</td>
<td>Front (Influence from an active front).</td>
</tr>
<tr>
<td>T</td>
<td>Typhoon (Influence from a typhoon)</td>
</tr>
<tr>
<td>LF</td>
<td>Strong cyclone front</td>
</tr>
<tr>
<td>LC</td>
<td>Strong cyclone central area</td>
</tr>
<tr>
<td>LB</td>
<td>Strong cyclone rear area</td>
</tr>
<tr>
<td>LS</td>
<td>Strong cyclone warm area</td>
</tr>
<tr>
<td>OLF</td>
<td>Weak cyclone front</td>
</tr>
<tr>
<td>OLW</td>
<td>Weak cyclone central area</td>
</tr>
<tr>
<td>OLB</td>
<td>Weak cyclone rear area</td>
</tr>
<tr>
<td>OLS</td>
<td>Weak cyclone warm area</td>
</tr>
<tr>
<td>L_2</td>
<td>Middle area of twin cyclone</td>
</tr>
<tr>
<td>OL_2</td>
<td>Weak twin cyclone</td>
</tr>
<tr>
<td>MX</td>
<td>There are a low-atmospheric-pressure and a traveling high-atmospheric pressure which is strong within 500 km.</td>
</tr>
<tr>
<td>OX</td>
<td>Others</td>
</tr>
</tbody>
</table>

The auto-regression estimate method, which is called multiple regression analysis, a Karman filter or Wiener filter, is a way to make a quantitative estimate several hours after the concentration without using a physical diffusion model. The change of concentration is divided into the random component and the periodic component like the
transition of a day and a numerical value filter method is used for the random component.

In other words, the estimate object, which is the concentration $C(t)$ at the time of $t$ is divided into the diurnal change $C_p(t)$ and an irregular component $C'(t)$, and past concentration data can be used for the day change. As for an irregular component, for example in the Wiener model, $Ce(t)$, which is the estimate model of $C'(t)$ is estimated by the weight function $w(\tau)$ as shown in Eq. (21).

$$Ce(t) = \int_{0}^{\infty} w(\tau) C'(t-\tau) \, d\tau$$  \hspace{1cm} (21)

Here, $\tau$ is delay time and $w(\tau)$ is sought in order to minimize the error of $C'(t)$ and $Ce(t)$. Fig. 10.5.1 shows an example of the estimate results of one hour ahead for SO$_2$ using the Karman filter model.

**Fig. 10.5.1** An example of one-hour ahead estimate of SO$_2$ by the Karman filter model