Practical Utilities of Isallobaric Wind Chart for Weather Forecasting.

BY

SAKUHEI FUJIWHARA and SAEMONTARÔ NAKAMURA.

On the way of discussing the isallobaric chart in his celebrated book 'Forecasting Weather,' Sir Napier Shaw alluded a little to the "isallobaric wind"(1). In this country the isallobaric chart has been used in daily weather forecasting since 1882, but the change of wind was not taken into account, because of practical inconvenience. Recently we devised dials which permit us easily to get the isallobaric wind from the observed direction and force of winds, and succeeded to prepare the isallobaric wind chart for daily use. In order to get the isallobaric wind i. e. the vector change of the wind velocity during the last 6, 12 or 24 hours, we used two wind dials, one of which is drawn with red ink on a sheet of paper and the other is drawn with black ink on a transparent celluloid plate. Get the end point of the vector on the paper dial, which represents the wind direction and velocity of the preceeding observation. Put the origin of the celluloid dial on the end point just obtained, and turn the upper dial until its directions coincide with those of the lower dial. Then the vector on the upper dial, which has its end point just upon the point just obtained on the lower dial is the vector change of the wind. This method is very easily practicable, so that we have used these two dials twice daily since February this year for forecasting weather at Osaka. We have entered the isallobaric wind thus obtained into the isallobaric chart, and found a few suggestive facts.

Firstly this isallobaric wind serves for the aid to draw isallobaric lines. As well known, it is very difficult to draw isobaric lines over an area where the stations are scanty, for example over the ocean area, unless we bring the wind velocity and direction to the help. Now for isallobars similar difficulties arise, and natural direction of thought leads

(1) Shaw: Forecasting Weather p. 341.
us to use the isallobaric wind for help. Let $P$ denote the pressure distribution in a map at a given time, and $W$ the wind distribution.\(^{(2)}\) Between $P$ and $W$ a certain relation, say $P = f(W)$ exists, which enables us to use wind for drawing isobars. Let us suppose there exists a certain relation between isallobaric wind and pressure. Then we shall have

$$\frac{dP}{dt} = \phi\left(\frac{dW}{dt}\right), \text{ or } f'(W)\frac{dW}{dt} = \phi\left(\frac{dW}{dt}\right).$$

The most simple and practicable case is that $\frac{dW}{dt}$ and $\phi\left(\frac{dW}{dt}\right)$ are independent of $W$. In such a case

$$f'(W) = \text{a const., say } a \text{ and } \phi\left(\frac{dW}{dt}\right) = a\frac{dW}{dt}.$$  

Hence

$$P = f(W) = aW + b,$$

where $b$ is a constant.

This result shows that the most practicable case is that there exists a linear relation between the pressure and wind distribution, and vice versa. We have Guldberg and Mohn's equation between pressure gradient and wind as

$$0 = G_0 \cos \alpha_0 - \mu V$$

$$0 = G_0 \sin \alpha_0 - 2\rho \omega V \sin \varphi$$

where $G_0$ is the normal pressure gradient, $V$ the wind velocity, $\alpha_0$ the normal deviation between the direction of the pressure gradient and wind, $\mu$ the so called friction coefficient, $\omega$ the angular velocity of the earth rotation, $\rho$ the air density and $\varphi$ is the latitude. These equations represent the linear relation between $G_0$ and $V$. Thus we see that so far as Guldberg and Mohn's equations hold good i.e. for the case of the very slow change in which equilibrium exists ap-

\(^{(2)}\) There are several way to express pressure distribution. Pressure at a point is available for this purpose when it implies the surrounding pressure condition, but it is very difficult to express such a complicated connotation with a symbol. Most simple one is perhaps the pressure gradient of a point as a function of time and space coordinates. In order to represent $W$, the distribution of wind, it will be enough to use wind velocity vector at a point as a function of time and space.
proximately at every moment, we can make use the isallobaric wind for constructing isallobaric chart as we use actual wind for an isobaric chart. Of course this principle hold also good for the gradient wind. Practically this relation always holds for ordinary weather. In Fig. 1, we see, as an example, the isallobaric chart for 6 am. of May 12th, 1919 over Nippon (Japan). Barometer was rising in the eastern coast district by 0.1 mm of mercury for last 12 hours. Isallobaric lines close themselves enclosing the rising area, and isallobaric winds blow out anticyclonically from this. Barometer was falling in Manchuria, so that isallobaric winds blow cyclonically into this region. The second fact is that in summer months, the above relation is not clearly observed, unless we take the effect of the land and sea breeze into the account. For this purpose we must make the seasonal mean daily change of wind at the time concerned, say 6 am and 6 pm, and reduce this amount from the actual isallobaric wind. In winter months the land and sea breezes are weak and cause no much trouble to us.

The third fact is that if, though rarely, we encounter a case in which the above relation is broken by some or other agencies other than the land and sea breezes, we must take care for an unusual weather change.

The fourth fact is that the barometric high and low have a tendency to appear some 12 or 24 hours later at a diverging and converging area of isallobaric winds. This law is not absolutely true, but holds in a greater part of cases. Fig. 2 shows an example of this.

In order to denote weather changes, the following symbols are used in the chart:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Weather Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>rainy ............. clear</td>
</tr>
<tr>
<td>☐</td>
<td>rainy ............. fair</td>
</tr>
<tr>
<td>☐</td>
<td>cloudy ............ clear</td>
</tr>
<tr>
<td>☐</td>
<td>cloudy ............ cloudy</td>
</tr>
<tr>
<td>☐</td>
<td>cloudy ............ fair</td>
</tr>
<tr>
<td>☐</td>
<td>fair .............. clear</td>
</tr>
<tr>
<td></td>
<td>No change</td>
</tr>
</tbody>
</table>
Terms rainy, cloudy, fair and clear have the ordinary meaning, except for the skys of cirrus and cirro-stratus. In the last case the weather in which the amount of cloud is 0 to 5 is taken as clear and 5 to 10 as fair.

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Nov. 1919, the Central Meteorological Observatory, Tokyo.
Fig. 1.
Isobaric Weather Chart
6am May 12th 1919

Isobaric Chart
May 1919
12th 6am

Isobaric Chart
May 1919
13th 6am

Falling
Rising

Isobaric Chart
Fig. 2.

Isobaric Weather Chart
6am February 12th 1919

Isobaric Chart
February 1919
12th 6pm

Isobaric Chart
February 1919
13th 6pm