USE OF SHOWALTER'S STABILITY INDEX IN THUNDERSTORM FORECASTING

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Because of the great amount of damage done by electrical activity, heavy rain, and accompanying wind squalls and hail, the successful prediction of thunderstorms is a major task of the forecaster.

As an aid in anticipating the occurrence of thunderstorms A.K.Showalter of the U.S. Weather Bureau evolved a stability index in 1946, making use of radiosonde observations. He stated (1953) that the U.S. Air Force was using the Gardner-Scherhag stability index in Europe, and that both methods are similar. The purpose of the stability index was to provide a quick check on the possibility of thunderstorms. In Australia, too, there seems to be a need for a simple tool which could be applied quickly as a daily routine, either all the year round or on a seasonal basis.

In evolving his stability computation, Showalter assumed that there would be little or no time for plotting thermodynamic diagrams. The data required can be used directly from the RAOB message. He states that the stability index for each station is transmitted at the end of RAOB messages in U.S.A., and that "all those who have tested the index (in U.S.A.) have indicated that it is a highly significant but not perfect forecast tool".

The present writer found the Showalter index useful in the spring and summer of 1953-54 as an aid in the forecasting of thunderstorms in eastern New South Wales, using the only available radiosonde sounding, that of Williamtown (10 miles north-east of Newcastle) as the basis of the computation. Its value as a quickly applied initial check for a limited area was fairly significant.

This note gives the method of computation of the index as presented by Showalter with some examples of its use. The conditions in the atmosphere which are believed to be necessary for the formation of thunderstorms are set down by Showalter in his paper and only one need be repeated, viz. - thunderstorms are likely to form when there is sufficient convergence, frontal activity, or orographic lifting to cause convective exchange of potentially unstable air between the 850 and 500 mb level.

The stability index is therefore computed as follows:-

The 850 mb parcel is lifted dry adiabatically to saturation, and then pseudo-adiabatically to 500 mb. The lifted 500 mb temperature is then subtracted algebraically from the observed 500 mb temperature. A negative number indicates instability (rising air warmer than its surroundings) and a positive number indicates stability.

Experience in U.S.A. indicates than an index of + 3 degrees C or less is very likely to produce thunderstorms. There is increasing probability as the index falls to a smaller value. Negative values of 3 degrees or greater may be indicative of severe thunderstorms.

Having been alerted by this simple initial check from the RAOB message, the forecaster can then apply his more elaborate tests such as:-

(a) computation of the equivalent wet bulb curve,

(b) anticipation of advective changes,

(c) anticipation of low level convergence, and of frontal and orographic lifting,

(d) estimation of dynamic processes on upper level charts, and so on.

It is recommended that these more refined analyses be made when the stability index gives a result of + 5 degrees C or less. The routine check ought to be applied daily to RAOB stations relevant to the forecast.

Figure I shows how the index is computed, the only requirements being the 850 mb. temp. and dew point and the 500 mb. temperature, and a blank aerological diagram. The data is that for Laverton (Victoria) for 0300 G.M.T. on 8th January, 1956, and it is plotted on a skew T - log P diagram.

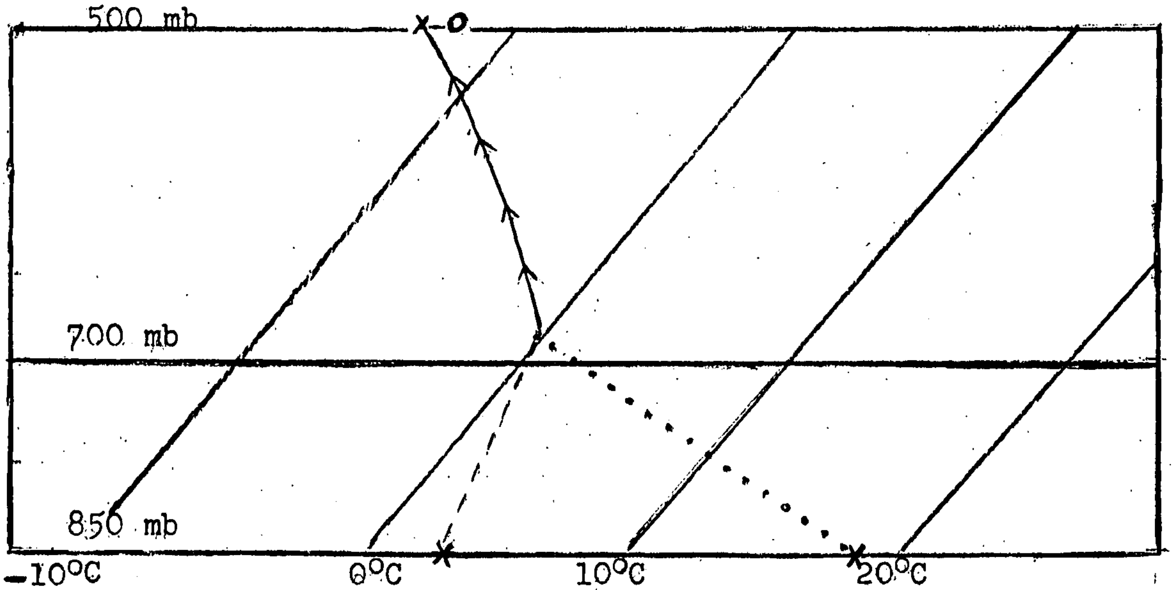

Figure 1. Data for Laverton, Victoria. 0300 G.M.T. 8.1.56 on Skew T - log P diagram. Observed 850 mb temperature (18.8°C), dew point (3.2°C) and lifted 850 mb temperature (-14.0°C) all marked X. Observed 500 mb temperature (-12.8°C) marked O. Stability index 1.2°C. ....., - - - - , and ←—←—← dry adiabat, mixing ratio, isopleth and moist adiabat respectively.

From this diagram it can be seen that the stability index is 1.2°C. Thunderstorms occurred in the general area late on 8th and early on 9th January, and on the evenings of 9th and 10th. The stability indices between 6th and 12th January were:-

6th, + 8°C; 7th, + 2.5°C; 8th, + 1.2°C; 9th, - 1°C;

10th, + 1°C; 11th, + 9.5°C; 12th, 5.5°C

Another example from Laverton is that for 0300 G.M.T. 16th January, 1956, when the results were:-

Lifted 850 mb temp. = -13.5°C
Observed 500 mb temp= -12.8°C
Stability Index = 0.7°C

The stability index is computed as 0.7°C. Prolonged and violent thunderstorms began on the afternoon of the following day. The stability index for 14th January was + 6°C and for 15th only 2.5°C. Initial thunderstorm activity occurred in the early morning of 16th. In these cases the necessary lifting appeared to be provided by orography and the sea breeze and in the early morning case a weak cold front passage provided it.

Table 1 shows the computed index for Woomera in South Australia from February 3 to February 6, 1956. Thunderstorms and convective showers began in the area on 5th, and continued on 6th with heavy thunderstorms. It would appear that frontal activity was absent, but low level convergence showed an increase.

TABLE 1. Stability Index at Woomera
3-6 February 1956

Date and Time	Stability Index
0100Z 3 Feb.	6.0 deg. C
0300Z 4 Feb.	1.0 "
0300Z 5 Feb.	-1.5 "
0300Z 6 Feb.	-3.0 "

Experience with the index has shown that its value is not limited to summer. For example a heavy thunderstorm in Melbourne on 3rd May, 1955, was preceded by a stability index of +3°C computed from the Laverton sounding at 0300 G.M.T. on 2nd May. On this occasion a marked cold front provided the lifting mechanism.

Table 2 shows the stability indices calculated from the radiosonde ascents at Williamtown (New South Wales) in relation to thunderstorm occurrences reported over an area within about 50 miles of the station in December, 1955.

This distance was selected at random. The land is flat around Williamtown, but within 50 miles and between NNE and NW of the station it rises to nearly 3000 ft., and within the same distance to the southwest rises to about 2000 feet. The passages of cold frontal zones through the whole or part of the area are indicated by CFP in the column on the right. There were three periods of fairly widespread and/or heavy thunderstorm activity. The stability indices on the afternoon of the days preceding the onset of each of these periods were, respectively, 4.5, 6.0, and 2.0; on the mornings before the onset of the first two the values were 0.5 and 2.5. These have been underlined in the table. In the period between

TABLE 2

Date	Williamtown Stability Index		Occurrence of thunderstorms within 50 miles radius (X)		Cold front passages in the area are shown CFP
	0500 EST	1400 EST	Heavy and/or fairly wide-spread thunderstorms	Lightning seen or isolated thunder	
30 Nov.		4.5			
1 Dec.	0.5	-3.0	X		CFP p.m.
2 "	2.5	3.0		X	
3 "		6.0		X	CFP p.m.
4 "		3.0		X	
5 "		11.0		X	
6 "		14.5			
7 "	13.5	14.0			
8 "	12.5	11.0			
9 "	16.5	11.5			
10 "		8.5			
11 "		5.0			
12 "		4.0			
13 "		7.5			
14 "		4.0		X	
15 "		6.0			
16 "	2.5	0	X		CFP p.m.
18 "		6.5			
19 "	9.5	6.0		X	
20 "	3.0	3.0		X	
21 "	2.5	5.0			CFP early
22 "	3.0	3.0		X	
23 "	4.5	7.5		X	CFP p.m.
24 "		2.0		X	
25 "		-2.0	X		
26 "		4.5	X		
27 "	3.5	2.0	X		
28 "	2.0	1.5	X		
29 "	9.5	6.0	X		
30 "		2.0		X	CFP p.m.
31		3.0		X	

24th and 29th during which time there were no frontal changes the index on the afternoon <u>before</u> the day of thunderstorm was 2.0 or less with the exception of 26th when it was 4.5. In any case all these values are less than 5.0°C. However, on three occasions during the month values of 5.0 or less did not result in any reported activity on the following day. On only one occasion did fairly widespread occurrences follow indices greater than 5.0.

In conclusion, it may be stated that the Showalter stability index is by no means a conclusive test - its value lies in its use as an "alerting" aid. It is believed that its daily computation should form part of a forecaster's check list.

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<u>Reference</u>

Showalter, A.K. Bull. Am. Met. Soc. 34, pp. 250-252

TORNADO AT RICHMOND 20TH FEBRUARY 1956 (SEE PAGE 47)

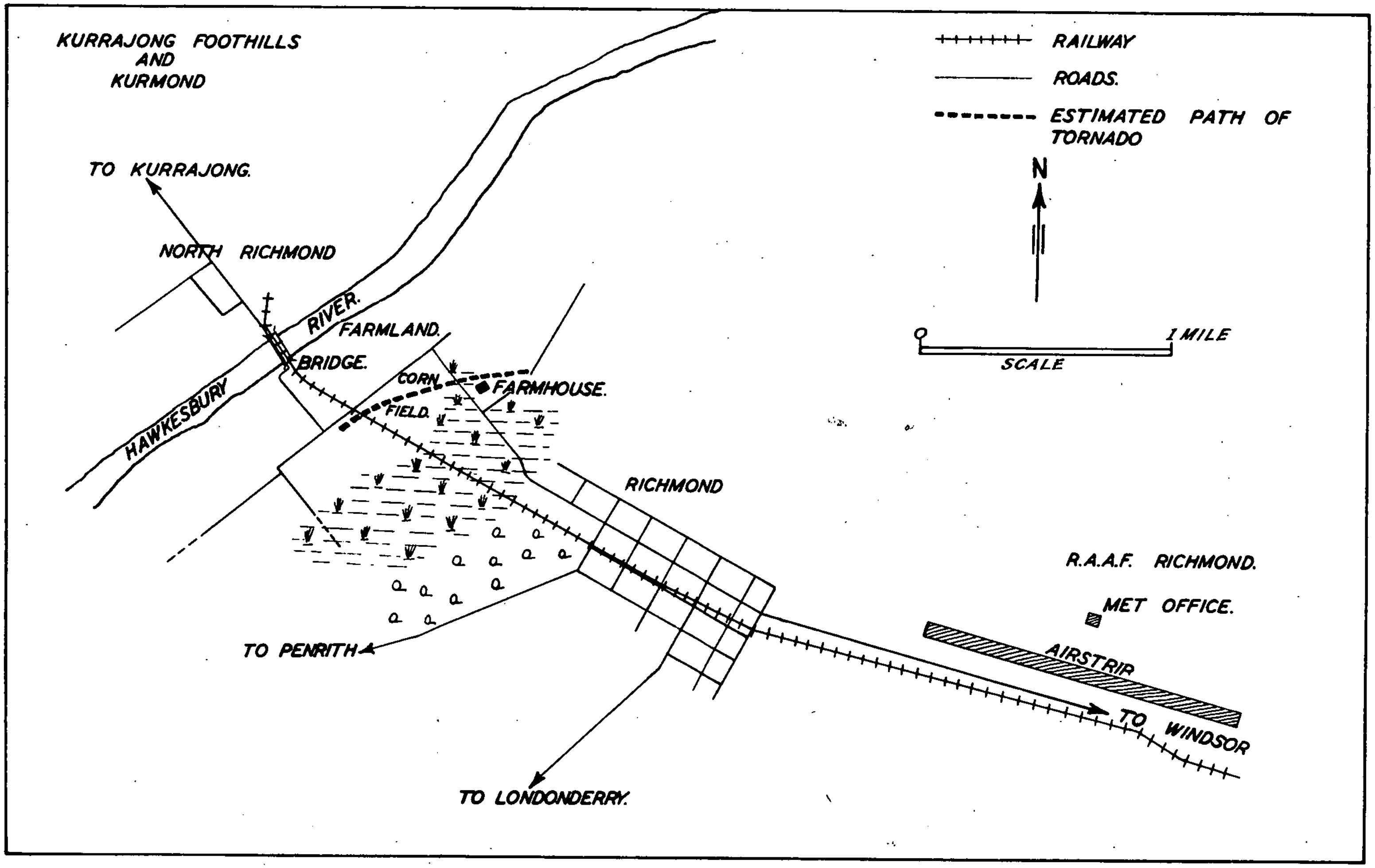

FIGURE. 1. RICHMOND AREA SHOWING PATH OF TORNADO