CONSIDERATION ON CRITERIA OF SYNOPTIC CLIMATOLOGICAL ANALYSES

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INTRODUCTION

Synoptic climatology, which was proposed by W. C. Jacobs (1946, 1947), has provided more substantial and precise descriptions of climate than so-called classical climatology. An approach is in general to note both the frequency of the type identified by a specified criterion, and the frequency of occurrence of climatic elements under the type. It is also a synoptic climatological approach to note both the frequency of the type and the average condition of climatic elements under the type. In the latter approach it is assumed that the average conditions of climatic elements discriminated one another. It is indispensable for the latter approach to examine this assumption.

If a complete criterion is set up, the averages of the element by each type or item in the criterion are thoroughly discriminated one another at all the stations in a region. However there would be rarely such a complete criterion. In case of a better criterion, average conditions by each item may be discriminated one another at stations which are more in number and at the same time more broadly distribute in a region. In other words, the superiority of criteria depends upon the number and the spatial distribution of stations, at which averages of element by each item are different one another.

From the above mentioned viewpoint the author examined in the previous investigation the superiority regarding four criteria for synoptic climatological analyses of winter temperature (i.e., daily maximum and minimum temperature and diurnal range of temperature) in Kanto Plain, Central Japan. He took a stochastic statistical methods with the significant level of 0.05 (Hohgetsu, 1979). In this investigation the author tries to give the same consideration as in the previous one but with the significant levels of 0.10 and 0.01.

DATA AND METHODS

The data of temperature were, as well as in the previous investigation, taken for three winter months (December, January and February) from 1961 to 1964, nine months in all, at seventyeight stations which almost evenly distribute in the Kanto Plain.

The superiority was examined regarding the same criteria as in the previous investigation: (A) surface pressure patterns in Far East at 00 GMT (Japan standard time, at 9 a.m.)

(Yoshino & Kai, 1974), (B) contour line patterns at 700 mb level in East Asia at 00 GMT (Hohgetsu, 1975), (C) eight and (D) sixteen compass point directions of 700 mb level wind observed at 00 GMT at Tateno Aerological Observatory (36°03N, 140°08E), at which direction may approximately represent those in the Kanto Plain. Criteria (A) and (B) are equivalent to J level and (C) and (D) to F level of Jacobs' scheme (1946, 1947).

Table 1 shows relative frequencies of items in each criterion. Referring to these frequencies, an analysis was made with the following items in each criterion: winter monsoon type, trough type and migratory high type in (A) criterion, I (the southernmost location of 3000 gpm is west of 130°E), II (between 130°E and 150°E), and III (east of 150°E) in (B) criterion, NW, W and SW in (C) criterion and NW, WNW, W and WSW in (D) criterion. These items are the same as in the previous investigation.

In this investigation these four criteria are compared one another. So multivariate statistical methods such as principal component analysis, canonical correlation analysis or factor analysis are not valid for this investigation. As mentioned before, the superiority of a criterion depends upon the number and the spatial distribution of stations at which averages are discriminated one another. So the following methods were applied to each kind of temperature (i.e., maximum and minimum temperature, range of temperature): First of all, data of temperature at each station were divided into groups based on the above mentioned items of each criterion. These groups were taken for probability samples. Then, with regard to respective stations each combination of the groups taken based on items of the same criterion was tested by F and 'student-*t*' tests to examine whether population means, from which the groups were respectively taken, were significantly different each other at the 0.10 or 0.01 levels. The numbers and the spatial distributions of stations where 'student-*t*' test is significant, were compared one another to find a better criterion. It was assumed in this investigation that distributions of air temperature conform well to the normal distribution.

RESULTS

Spatial distributions of stations where 'student-*t*' test is significant are outlined regarding the four criteria, respectively.

(A) Surface Pressure Patterns

Summary of stations in respective quadrants of the Kanto Plain in case of each combination of the items is tabulated (Table 2). It is found from this table that in case of the 0.10 level the test is significant at much more than half the stations in every quadrant of the Plain. On the other hand, in case of the 0.01 level distributions of stations where the test is significant are different for different quadrants or kinds of temperature. It is axiomatic that the number of stations where the test is significant is larger in case of the 0.10 level than that in case of the 0.01 level in every quadrant. It is noticeable that the test is significant at almost all the stations in every quadrant at both the levels in the following cases; the combination of winter monsoon and migratory high types for maximum temperature (1.00, 1.00), that of winter monsoon and trough types for minimum temperature (1.00, 1.00) and that of trough and migratory high types for range of temperature (1.00, 0.92). Here the

Table 1 Daily occurrence frequencies of the items of the criteria (%)
(a) Surface pressure patterns (Yoshino & Kai, 1974)
(b) 700 mb contour line patterns (Hohgetsu, 1975)
(c) Eight compass point directions of 700 mb level wind at Tateno
(d) Same as (c), but for sixteen compass point directions

(a)

ITEM	1961/62	1962/63	1963/64	AVERAGE
winter monsoon pattern	49	42	32	41
trough pattern	22	26	32	26
migratory high pattern	19	26	21	22
frontal pattern	3	2	8	4
the others	7	4	7	7

(b)

ITEM	1961/62	1962/63	1963/64	AVERAGE
I	13	19	22	18
II	39	58	35	44
III	48	23	43	38

(c)

ITEM	1961/62	1962/63	1963/64	AVERAGE
NE	0	1	0	0
N	3	2	1	2
NW	35	28	26	30
W	53	52	50	52
SW	9	14	20	14
S	0	2	3	2
NO WIND	0	1	0	0

(d)

ITEM	1961/62	1962/63	1963/64	AVERAGE
NE	0	1	0	0
N	2	2	0	2
NNW	2	5	3	3
NW	17	11	13	14
WNW	30	23	22	26
W	25	35	28	28
WSW	21	13	25	20
SW	2	6	5	4
SSW	1	1	3	2
S	0	2	1	1
NO WIND	0	1	0	0

Table 2 Summary of stations in respective quadrants of the Plain in case of each combination of the items of the criterion (a), surface pressure patterns

○: Test is significant at (almost) all the stations in a quadrant.

△: Test is significant at about half of the stations in a quadrant.

*: Test is significant at few or no stations in a quadrant.

combination of items	element	significant level	NW	NE	SE	SW
			quadrant of the Plain			
winter monsoon — trough	max	0.10	○	○	○	○
		0.01	△	△	○	*
	min	0.10	○	○	○	○
		0.01	○	○	○	○
	range	0.10	△	○	△	○
		0.01	*	○	*	△
winter monsoon — migratory high	max	0.10	○	○	○	○
		0.01	○	○	○	○
	min	0.10	△	△	△	○
		0.01	△	△	△	△
	range	0.10	○	○	○	△
		0.01	○	○	○	△
trough — migratory high	max	0.10	○	○	△	○
		0.01	*	△	*	△
	min	0.10	△	○	○	○
		0.01	*	○	△	△
	range	0.10	○	○	○	○
		0.01	○	○	○	○

former number in every bracket is a ratio of the number of stations where the test is significant to that of all the stations at the 0.10 level, and the latter one is that at the 0.01 level. Fig. 1 shows the distribution of stations where the test is significant at the 0.10 level in case of the combination of winter monsoon and trough types for range of temperature.

(B) 700 mb Contour Line Patterns

Table 3 shows, in the same manner as Table 2, summary of stations where the test is significant at respective significant levels. It is noticed from this table that the test is not significant even at the 0.10 level at most stations in every quadrant, but in case of the combination of I and II for minimum temperature the test is significant at the 0.10 level at more than half the stations in respective quadrants.

(C) Eight Compass Point Directions of 700 mb Wind at Tateno

Summary of stations where the test is significant is shown in Table 4. It is found from this table that the test is not significant at much more stations in case of maximum temperature as compared with minimum temperature and range of temperature. The test is significant at each level at almost all the stations in every quadrant in cases of the

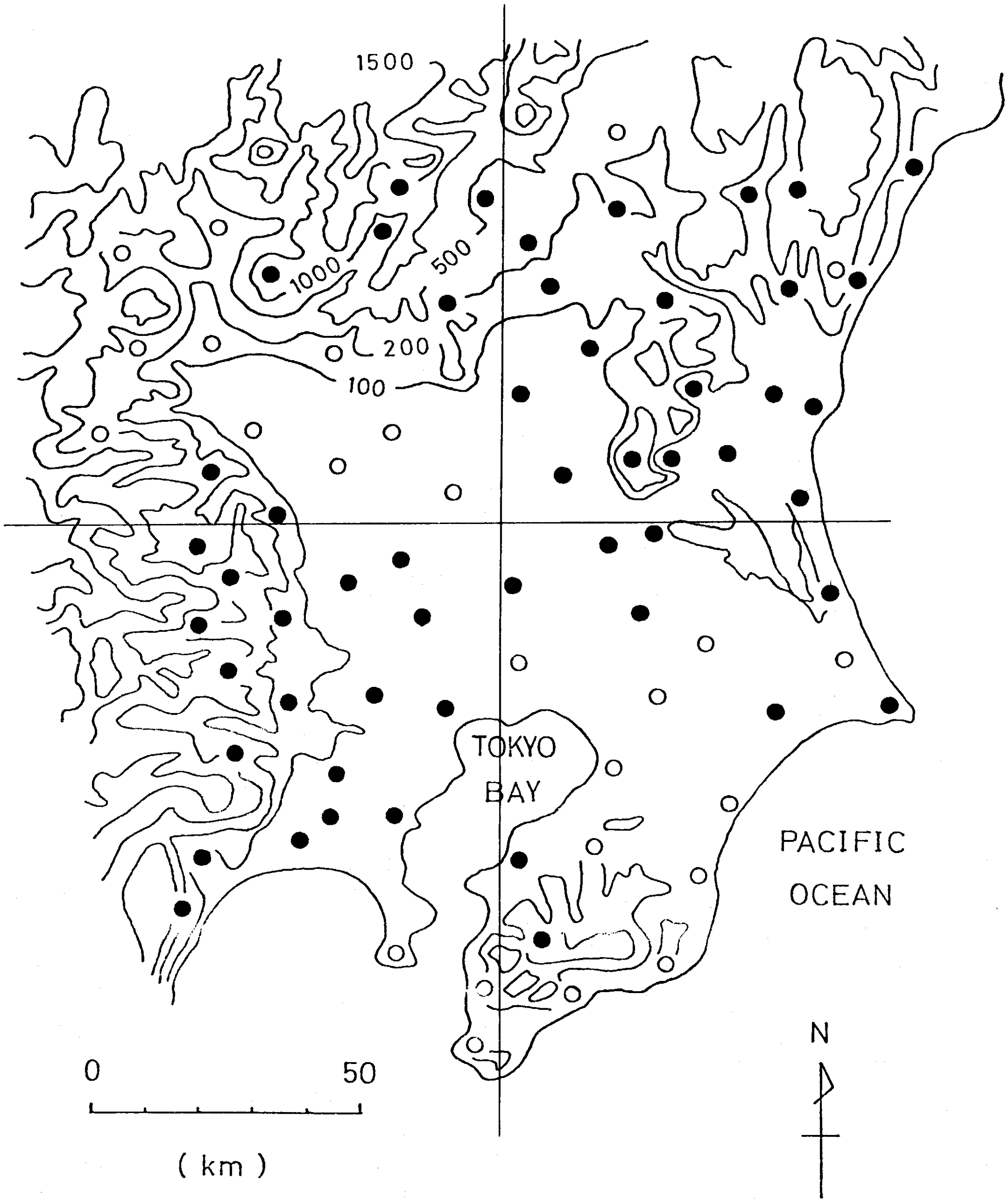

Fig. 1 Results of 'student-*t*' test at the 0.10 level in case of the combination of winter monsoon and trough types for range of temperature in the criterion (A)
Black disks denote stations where the test is significant

Table 3 Same as Table 2, but for the criterion (b), 700 mb contour line patterns

combination of items	element	significant level	NW	NE	SE	SW
			quadrant of the Plain			
I – II	max	0.10	△	*	*	*
		0.01	*	*	*	*
	min	0.10	△	○	○	○
		0.01	*	△	*	*
	range	0.10	*	*	*	△
		0.01	*	*	*	*
I – III	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	*	○	○	△
		0.01	*	△	*	*
	range	0.10	*	○	*	△
		0.01	*	*	*	*
II – III	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	*	*	*	*
		0.01	*	*	*	*
	range	0.10	*	*	*	*
		0.01	*	*	*	*

combinations of NW and SW, and W and SW for minimum temperature, W and SW, and NW and SW for range of temperature.

(D) Sixteen Compass Point Directions of 700 mb Wind at Tateno

Table 5 shows, in the same manner as Tables 2, 3 and 4, summary of stations where the test is significant at respective levels. It is found from this table that the test is significant at more stations in case of minimum temperature as compared with maximum temperature and range of temperature. The test is significant at both the levels at most stations in respective quadrants in cases of the combinations of WNW and WSW, W and WSW and NW and WSW for minimum temperature. But in case of the combination of WNW and NW for minimum temperature the test is at respective levels not significant at almost all the stations in every quadrant. There are some cases that the test is significant at the 0.10 level at more than half the stations in almost all the quadrants, but at the 0.01 level the test is not significant at most stations. The combination of W and WSW for range of temperature is one of such cases. Such a case can be also seen in other combinations and criteria.

Table 4 Same as Table 2, but for the criterion (c), eight compass point directions of 700 mb level wind at Tateno

combination of items	element	significant level	NW	NE	SE	SW
			quadrant of the Plain			
W – NW	max	0.10	○	△	○	*
		0.01	△	*	*	*
	min	0.10	*	○	○	○
		0.01	*	△	△	△
	range	0.10	△	*	*	△
		0.01	*	*	*	*
W – SW	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	○	○	○	○
		0.01	○	○	△	○
	range	0.10	○	○	○	○
		0.01	△	○	○	○
NW – SW	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	○	○	○	○
		0.01	○	○	○	○
	range	0.10	△	○	○	○
		0.01	△	○	○	○

DISCUSSION

As mentioned before, the superiority of a criterion depends upon both the number and the spatial distribution of stations where the test is significant.

First of all the ratios of the number of stations, where the test is significant, to that of all the stations are examined to compare the criteria from the viewpoint of the number. As mentioned before, the criteria (A) and (B) are equivalent to J level, and (C) and (D) to F level of Jacobs' scheme (1946, 1947). So the criteria in the same level are first compared each other. Table 6 shows ratios of the number of stations, where the test is significant, to that of all the stations regarding the criteria (A) and (B). Here the ratios in case of the significant level of 0.05 are shown together. It is found from Table 6 that at each significant level the ratios for the criterion (A) are much higher than those for the criterion (B) regarding respective kinds of temperature (i.e., maximum and minimum temperature and range of temperature). It is also found that in case of the criterion (A) there are no remarkable differences in ratio among three kinds of temperature. In case of the criterion (B) the ratios for minimum temperature are higher than those for maximum temperature. From the facts on the ratios described above, it may be said that the criterion (A) is superior to (B) regarding respective kinds of temperature.

Table 7 shows, in the same manner as Table 6, the ratios regarding the criteria (C) and

Table 5 Same as Table 2, but for the criterion (d), sixteen compass point directions of 700 mb level wind at Tateno

combination items	element	significant level	NW	NE	SE	SW
			quadrant of the Plain			
W – WNW	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	*	○	○	△
		0.01	*	*	*	*
	range	0.10	*	△	△	△
		0.01	*	*	*	*
W – NW	max	0.10	○	*	*	*
		0.01	*	*	*	*
	min	0.10	*	△	△	△
		0.01	*	*	*	*
	range	0.10	△	*	*	*
		0.01	*	*	*	*
W – WSW	max	0.10	*	*	*	*
		0.01	*	*	*	*
	min	0.10	○	○	○	○
		0.01	○	○	○	○
	range	0.10	○	○	△	△
		0.01	*	△	*	*
WNW – NW	max	0.10	△	*	*	*
		0.01	*	*	*	*
	min	0.10	*	*	*	*
		0.01	*	*	*	*
	range	0.10	○	*	*	*
		0.01	*	*	*	*
WNW – WSW	max	0.10	△	*	△	*
		0.01	*	*	*	*
	min	0.10	○	○	○	○
		0.01	○	○	○	○
	range	0.10	○	○	○	○
		0.01	*	○	*	*
NW – WSW	max	0.10	○	△	○	*
		0.01	△	*	*	*
	min	0.10	○	○	○	○
		0.01	△	○	○	○
	range	0.10	*	△	*	△
		0.01	*	*	*	*

(D). It is found from this table that at respective significant levels the ratios for the criterion (C) are higher than those for the criterion (D) regarding minimum temperature and range of temperature.

From these facts on the ratios, it may be said that the criterion (C) is superior to (D) regarding minimum temperature and range of temperature. It cannot be, however, said from the ratios which criterion is superior to the other one regarding maximum temperature.

From the ratios in Tables 6 and 7, it may be said that the criterion (A) is superior to the other three criteria regarding maximum temperature and range of temperature, and regarding minimum temperature the criteria (A) and (C) are almost equally superior to the others. All the kinds of temperature considered, the criterion (A) is superior to the other three criteria (see average ratios in Tables 6 & 7).

Next to the numbers of stations where the test is significant, from the viewpoint of their spatial distributions the criteria are examined. Regarding respective criteria, times at which the test is significant were counted at each station. As mentioned before, stations where the test is significant may more broadly distribute in case of a better criterion. From this point of view, distribution maps showing the above-mentioned times were compared to examine the superiority of the criteria. Fig. 2 is an example of such distribution maps.

It may be said by comparison of these maps that regarding each kind of temperature the criterion (A) is evidently superior to the criterion (B), and the criterion (C) is superior to

Table 6 Ratios of the number of stations, where the test is significant, to that of all the stations (%)
Criterion (A): Surface pressure patterns (Yoshino & Kai, 1974)
Criterion (B): 700 mb contour line patterns (Hohgetsu, 1975)

	CRITERION (A)			CRITERION (B)		
	0.10	0.05	0.01	0.10	0.05	0.01
MAX	0.885	0.799	0.573	0.119	0.047	0.034
MIN	0.855	0.778	0.667	0.462	0.333	0.124
RANGE	0.846	0.769	0.658	0.239	0.158	0.051
AVERAGE	0.862	0.782	0.633	0.273	0.179	0.070

Table 7 Same as Table 6
Criterion (C): Eight compass point directions of 700 mb level wind at Tateno
Criterion (D): Same as criterion (C), but for sixteen compass point directions

	CRITERION (C)			CRITERION (D)		
	0.10	0.05	0.01	0.10	0.05	0.01
MAX	0.256	0.201	0.060	0.259	0.162	0.064
MIN	0.885	0.855	0.701	0.656	0.596	0.487
RANGE	0.701	0.662	0.521	0.440	0.299	0.113
AVERAGE	0.614	0.573	0.427	0.452	0.352	0.222

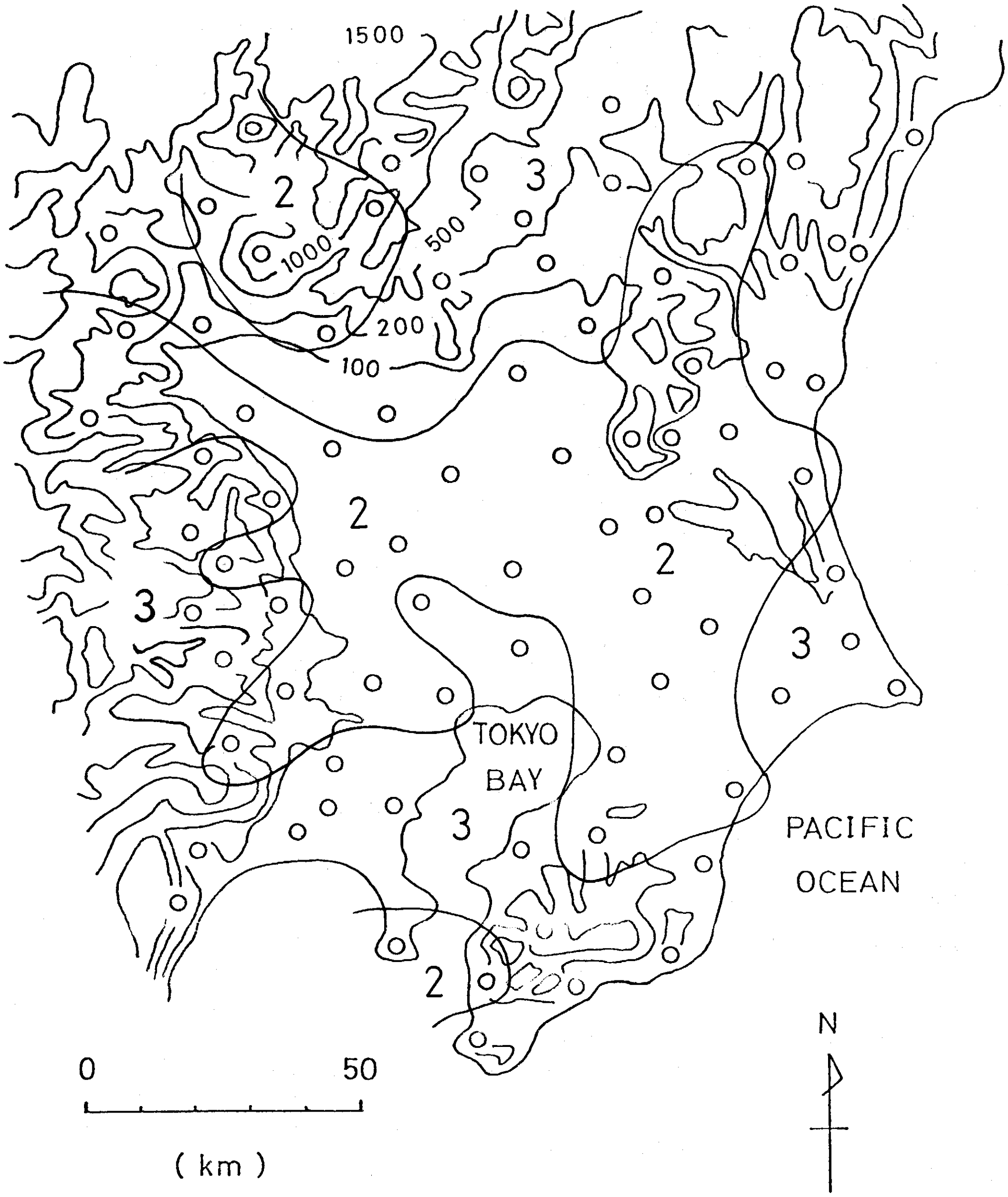

Fig. 2 Distribution of times at which the test is significant at the 0.10 level in case of the criterion (A) for minimum temperature

For example, the number '2' denotes that the test is significant two times for times at which the test is done, in this case, for 3.

(D). It may be also said that regarding maximum temperature and range of temperature the criterion (A) is evidently superior to the other three criteria, and regarding minimum temperature the criteria (A) and (C) and almost equally superior to the others. All the kinds of temperature considered, the criterion (A) is superior to the other three criteria (see Tables 2, 3, 4 & 5).

As mentioned before, a better criterion among the four criteria on the basis of the numbers coincides on the whole with that on the basis of the spatial distributions. So it is concluded that all the kinds of temperature considered, the criterion (A) is superior to the other three criteria. This conclusion is the same as in the previous investigation (Hohgetsu, 1979). And it is also concluded that regarding maximum temperature and range of temperature the criterion (A) is superior to the others, and regarding minimum temperature the criteria (A) and (C) are superior to the others. These conclusions are drawn at each significant level.

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