ON FIELD ITENSITY RECORDING OF ATMOSPHERICS AT 27 kc/s IN ACCORDANCE WITH THE RECOMMENDATION OF WMO

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ABSTRACT

In order to see if the recommendation 40 of working group of WMO in 1957 can be applied well on the results obtained in Japan, the authors examined the records of intensity meters of atmospherics at 27 ks/s observed continuously in 1957 at Toyokawa station.

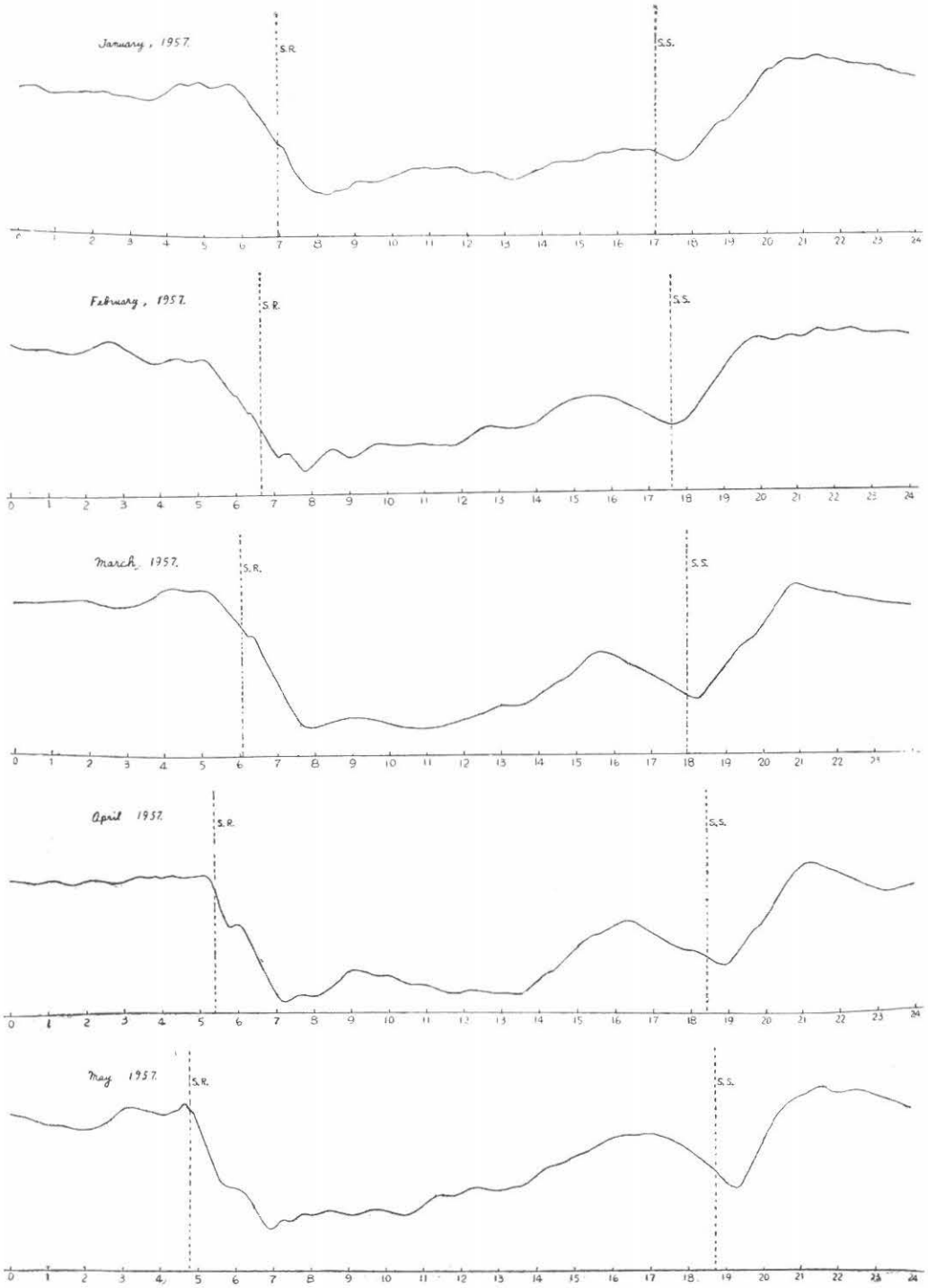
They found fairly regular behaviours of atmospherics which can be reasonably explained by the distribution of sources with seasonal variations as well as by the principle of wave propagation.

"A" (Sunrise effect) is found generally 20 min. before sunrise except in winter where it is found about 2 hours before sunrise. "B" (First minimum) and "C" (Recovery effect) are often found more than once and also found frequently in the evening. "D" (Morning minimum) is found about 2 hours after sunrise, but sometimes not clearly. "E" (Afternoon maximum) is found about 2 hours before sunset and sometimes indicates flat maximum. "F" (Late minimum) is found within half-hour about sunset. "G" (Night maximum) is not found in Toyokawa. After sunset the field intensity of atmospherics increases gradually and reaches night levels about 2½ hours after sunset, and keeps its level nearly constant till dawn when "A" is found. "G" should be called "sunset effect" in Japan. It is due to the difference of distribution of sources between Europe and Asia.

On the occasion of the Third IGY it is requested that the field intensity recording of atmospherics should be made after the recommendation 40 "Atmospheric Noise Recording" of Working Group of WMO held in 1957[1]. The authors made an investigation on the records of intensity meter of atmospherics at 27 kc/s obtained in 1957 to see whether the recommendation can be applied well to the ones in the Far East. In our institute, the integrated intensity measurement is made continuously on 10, 21 and 27 kc/s of which the records on 27 kc/s were specifically investigated according to the resolution of XIth General Assembly of URSI[2]. Our intensity recording equipments[3] have often been reported and so its duplicated description is avoided here. Time mark is put down on the record at every 6 minutes, derived from crystal controlled clock which is kept at an accuracy of 10^{-7} calibrated by Japanese Standard Waves.

In order to avoid local disturbances, about 10 days' records were selected as representatives of every month. They took the average and drew curves which indicate a diurnal variation of every month as shown in Fig. 1. Sunrise and sunset in Fig. 1 and Table 1 are those of 15th of every month at Toyokawa.

In accordance with Recommendation 40, "A" (Sunrise effect), "B" (First minimum), "C" (Recovery effect), "D" (Morning minimum), "E" (Afternoon maximum), "F" (Late minimum) and "G" (Night maximum) were determined for every month and are shown in Fig. 2 and Table 2.


January, 1957.
S.R.
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February, 1957.
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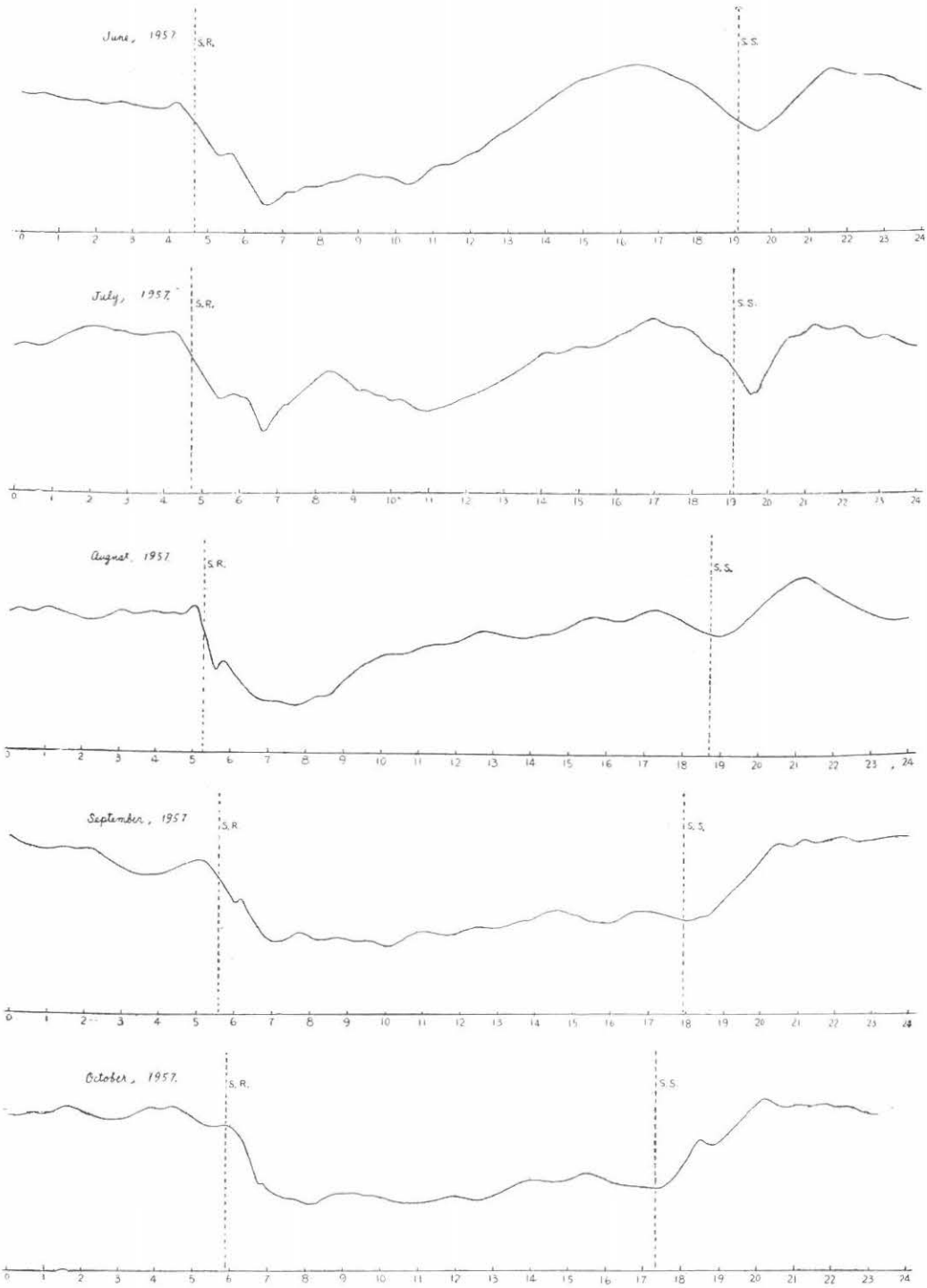
Fig. 1-1


June, 1957
S.R.
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July, 1957
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August, 1957
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September, 1957
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October, 1957.
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Fig. 1 - 2

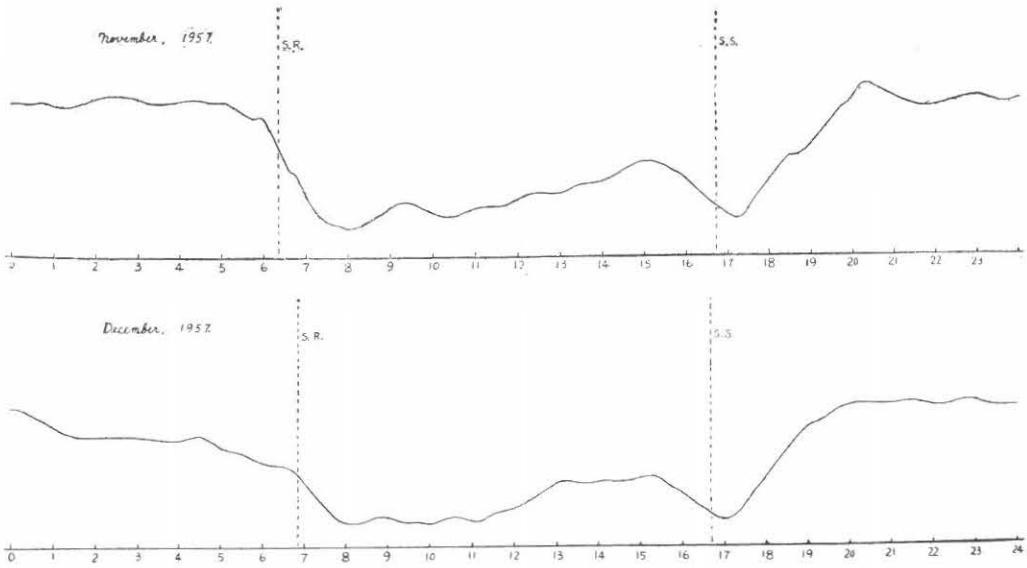


Fig. 1 - 3

Table 1. The sunrise and the sunset at Toyokawa (N 34°50′, E 137°22′) in J. S. T.

Month	Sunrise	Sunset
	hr m	hr m
1	6 58	17 1
2	6 38	17 33
3	6 2	17 58
4	5 20	18 22
5	4 48	18 46
6	4 36	19 5
7	4 48	19 5
8	5 10	18 40
9	5 33	17 59
10	5 56	17 17
11	6 24	16 46
12	6 51	16 41

As these nomenclatures were determined among European workers, some are fit but others are not to the records in the Far East where the distribution of sources or foyers are different from those in Europe. For example, at our station the intensity of atmospherics increases after sunset and reaches night levels in 2 to 3 hours after sunset and it is kept till dawn, and in general it does not indicate remarkable night maximum as it is found in Germany. Our proposal to modify some of the nomenclatures will be submitted to Prof. Lugeon.

Investigating the curves in Fig. 2, the following characteristics are noticed.

"A" (Sunrise effect) is a border between day and night. In "A" higher night levels begin to decrease gradually to lower daylight levels. In genral "A" is

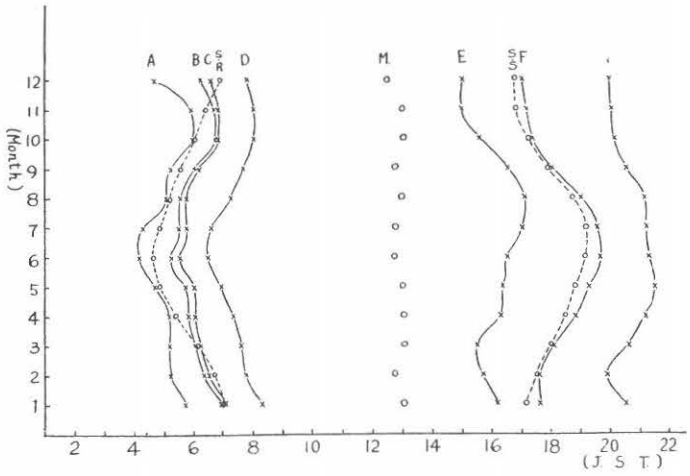


Fig. 2

Table 2. Characteristics of the intensity of atmospherics at Toyokawa in 1957 recorded after Recommendation 40.

Month	A	B	C	D	E	F	G
	hr m	hr m	hr m	hr m	hr m	hr m	hr m
1	5 40	6 55	7 00	8 15	16 10	17 35	20 30
2	5 15	6 20	6 30	7 45	15 40	17 35	19 55
3	5 10	6 05	6 10	7 35	15 30	18 05	20 45
4	5 10	5 50	6 05	7 15	16 20	18 50	21 10
5	4 40	5 45	6 05	6 55	16 20	19 15	21 30
6	4 10	5 15	5 35	6 30	16 30	19 40	21 20
7	4 15	5 30	5 50	6 35	17 00	19 30	21 15
8	5 05	5 35	5 50	7 20	17 05	19 00	21 10
9	5 10	6 05	6 10	7 40	17 20	18 00	20 30
10	6 00	6 45	6 50	8 00	15 30	17 20	20 15
11	5 55	6 40	6 45	8 00	15 00	17 15	20 05
12	4 40	6 15	6 35	7 55	15 00	17 00	20 00

about 20 minutes earlier than the sunrise at Toyokawa except in winter where the difference is about 1½ to 2½ hours.

"D" (Morning minimum) is the conversion point where the night time propagation changes into the daylight one. It is found at about 2 hours after sunrise all the year round, but sometimes it appears not so clear.

"F" (Late minimum) is a phenomenon similar to "D" in the morning, and is found within 20 to 30 minutes about the sunset all the year round.

"G" (Night maximum) is not the night maximum at our station. After sunset the field intensity of atmosphrics increases gradually and reaches night time values about 2½ hours after sunset except in winter where it appears 30 minutes later than other seasons.

When night time levels appear, they keep the values nearly constant till morning where "A" is found. "G" is a corresponding point to "A" and so it is

more reasonable to call it "Sunset effect" in the Far East.

"B" (First minimum) and "C" (Recovery effect) are found rather clearly in daily records, but they are not always found only once, sometimes several, and often almost the same phenomena in the evening. In the averaged curve it is frequently difficult to point out "B" and "C". In a word, it is a complicated phenomenon, originating from a distribution of sources and the propagation paths, and it is not so simple as Bracewell[4] explained with twice-reflected waves.

"E" (Afternoon maximum) is found in general about 2 hours before sunset and in summer the intensity is larger than the one at night. Time of appearance does not depend directly upon the diurnal temperature variation at Toyokawa, but depends more on that of the continent.

The median point between "A" and "G" is nearly constant and is 1200 to 1300 JST in all seasons, and it suggests that "A" and "G" are symmetrical about the median point. It may be one of the characteristics in the Far East.

These behaviours and seasonal variations of atmospherics mentioned above are found annually without serious changes in Japan.

These regular variations of the intensity of atmospherics can be explained by the distribution of sources and the propagation paths as follows.

The distribution of sources and the seasonal variations were studied extensively and published already by one of the authors[5] and the directional variation of the arrival of atmospherics were studied by colleagues[3] in our institute. The results of these observations are shown in Fig. 3 and Table 3.

Taking into consideration the radius of the earth 6371 km and the equivalent height ef the ionosphere, reflecting long waves, 90 km, the sunrise on the ionosphere above the the district 1,000 km west to Toyokawa occurs at the same instant with the ground sunrise at Toyokawa.

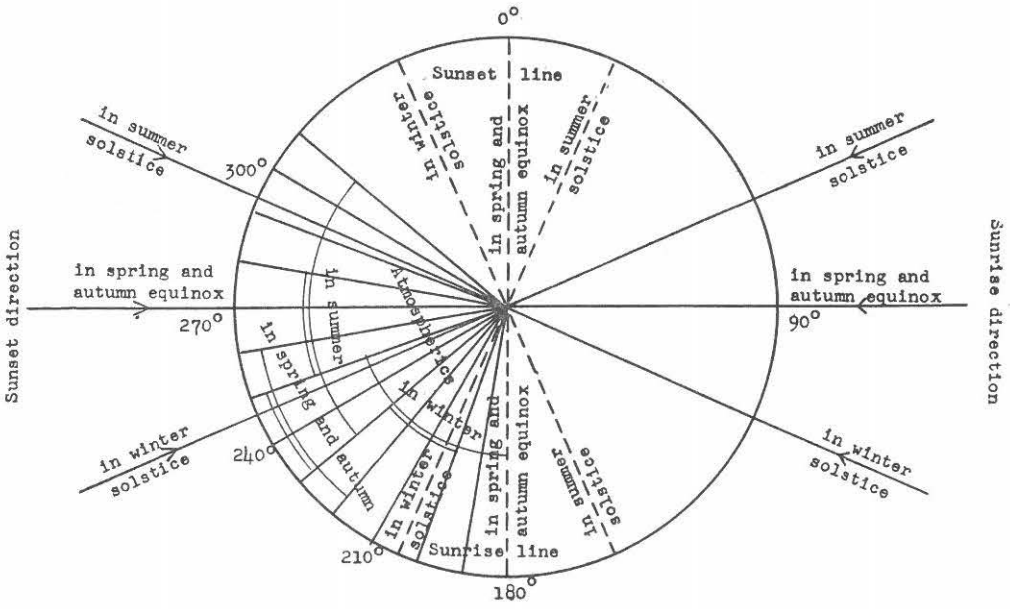
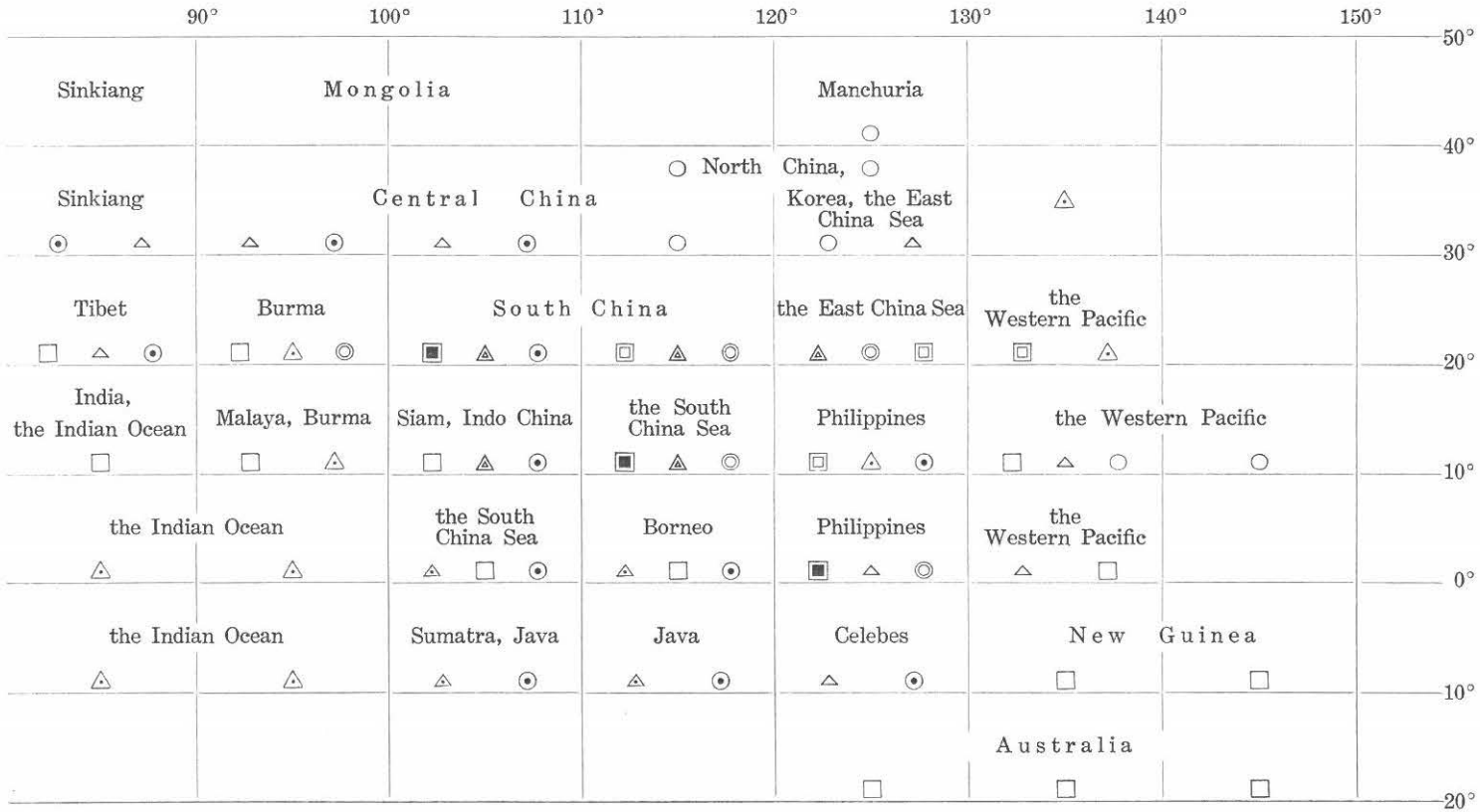


Fig. 3

Table 3. Distribution of sources of otmospherics at night throughout the year



Note: Frequency of occurrence is indicated by symbols: ◬ (heavy), △ (medium), △ (light) in spring and autumn; ◎ (heavy), ⊙ (medium), ○ (light) in summer; ▣ (heavy), ■ (medium), □ (light) in winter.

In spring, summer and autumn the main sources to be lighted by the rising sun are distributed nearly in the same direction from Toyokawa, i. e. in China, Tibet, Burma, etc. The atmospherics coming from these districts find gradually weakening daytime propagation conditions and the field intensity will reach minimum "D". "D" is found generally about 2 hours after sunrise. It corresponds to the ground sunrise at E 105° and tne sunrise on the ionosphere at E 95°, and therefore the propagation of atmospherics originating in Sinkiang, Tibet and India changes from night to daytime conditions, i. e. the propagation conditions become most unfavourable. It is because "D" is found about 2 hours after sunrise. The distribution of sources on the East China Sea is very remarkable in these seasons. Considering 20 minutes earlier sunrise on the ionosphere above districts between Toyokawa and the East China Sea, we can easily understand why "A" (Sunrise effect) is found about 20 minutes earlier than the sunrise at Toyokawa and the intensity begins to decrease gradually at "A".

On the other hand in winter the sources of atmospherics are distributed from south-west to south directions and the bearing of sunrise deviates to south-east; for example, the sunrise on 15 December in local time is 0628 at N 20°, 0609 at N 10°, 0552 at 0°, 0534 at S 10° and 0515 at S 20°.

Comparing these times with that at Toyokawa, N 35°, 0701 in local time, the sunrise in southern districts is to be 1 to 2 hours earlier than that at Toyokawa. Considering the sources in the Philippines, Celebes, New Guinea, and Australia, and taking into account the 40 minutes earlier sunrise on the ionosphere, we can easily understand the reason why in winter "A" appears 2 hours earlier than the ground sunrise at Toyokawa.

"E" (Afternoon maximum) results from the atmosphrics mainly coming along the earth surface, and the magnitude in summer is nearly equal to that of "G". The time of appearance of "E" is somewhat later than the time of maximum temperature at Toyokawa, and it suggests that "E" depends on the atmospherics in China and on the China Sea rather than the ones in Japan.

"F" (Late minimum) appears almost the same time as the sunset and very clearly all over the year. It is due to the fact that the main atmospherics in Japan come from the sources in south-west direction and passes through almost the same route in all seasons, and consequently the propagation conditions change from that of the day to the night, almost in the same way as the VLF waves show near sunset. As the night proceeds to middle and south China, Tibet, Burma, Sinkiang, etc., the intensity of atmospherics increases gradually, superposing those coming from these regions, and reaches the maximum value about 3 hours after sunset, and keeps its value almost constant till dawn when "A" appears. It seems that atmospherics which arrive Japan consist of sources in Sinkiang, Tibet, India as a western border in south-west direction.

In conclusion the diurnal and seasonal variations of the intensity of atmospherics received in Japan are somewhat different from those in Europe. These behaviours are almost the same every year, and can be explained from the propagation conditions and the distribution of sources in the Far East. Therefore we suggest the Recommendation 40 should be modified to be applied in the Far East. Moreover as the main sources of atmospherics in the Far East is concentrated in the middle and to the southern part of the continent and it changes the distribution regularly after the variations of the season, we can understand the

behaviours quite well by applying the principle of wave propagation.

We are grateful to Mr. Sao and other colleagues in our Institute who made incessant observations and arrangements of records. We also desire to thank Dr. Lauter in East Germany who sent us many valuable records taken in his stations.

References.

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